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Original Research Article

Correlation between BMI and hand grip strength among healthy young adults of Uttarakhand

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ABSTRACT

Background: Sedentary people who were not actively participating in sports have demonstrated significantly lower HSG compared to physically active people that involved in regular sports activity such as cricket, hockey, tennis, basketball, handball, etc. Therefore, HGS can be used to indicate the sedentary nature of a population, and it would help to predict their potential risk of developing non-communicable diseases such as Myocardial infarction and stroke.
Methods: This study was conducted to establish the possible correlation (if any) between body mass index and handgrip strength and endurance among young healthy adults at the city of Dehradun in the region of Uttarakhand.
Results: While in females there was statistically non-significant positive correlation between HGS and BMI in normal females. Statistically significant positive correlation was observed in overweight and obese females. When HE was correlated with BMI, it was observed that there was non-significant negative correlation in males.
Conclusions: Physical fitness is very much essential for maintaining a healthy lifestyle. Handgrip strength and endurance are important parameters to assess muscular strength of an individual. As the weight increases muscle strength and endurance time also decreases as shown by our study. BMI is considered as a useful tool to measure the degree of overweight, but it will not indicate the factors causing the increase in weight.

Keywords: BMI, HGS, Obese, Overweight, Stroke

INTRODUCTION

Hand grip strength (HGS) is described as the force applied by the hand to hold on to pull on or to suspend object in the hand.[1] It is reliable measurement which can be easily used to evaluate the functional integrity of the hand and hand grip strength. Values have been influenced by many factors such as age, gender, body mass index, hand dominance.[2,3]

Strength of the skeletal muscles depends on multiple factors such as body build and composition, physical activity, hormonal influence etc. HGS reflects total muscle strength and physical fitness.[4] Therefore, it can be used as powerful indicator of the overall strength of the body.[5,6] Sedentary people who were not actively participating in sports have demonstrated significantly lower HSG compared to physically active people that involved in regular sports activity such as cricket, hockey, tennis, basketball, handball, etc.[7] Therefore, HSG can be used to indicate the sedentary nature of a population, and it would help to predict their potential risk of developing non-communicable diseases such as myocardial infarction and stroke. Further, it is important to consider the other factors that are influencing the HGS.[8]

HGS, a form of isometric (static contraction) test is a reliable clinical measure to assess the physical fitness and

nutritional status of an individual. HGS is a good indicator of health status based on the incidence of disability, morbidity, and mortality. In adult population, 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 biometric condition HGS.[9]

A physiological variable is affected by number of factors like age, gender, body size, effort, skeletal muscle bulk and contractility. HGE is the ability of the muscle to sustain a muscular force produced during activity. It is significantly correlated with the strength of a brief maximum effort. Strength is related to age and sex.[10] At all ages, girls have lower average q values than boys and after puberty this difference increases. Until by the age of 18 years, boys have a mean handgrip strength of 60% higher than girls. Males possess considerably greater strength than females for all muscle groups tested. Many handgrip strength studies in young healthy adults have revealed that anthropometric variable like height, weight, BMI, hand length, hand width, grip span, are positively associated with hand grip strength.[11] and also it was found that the dominant hand had approximately 10%, stronger grip strength than the non-dominant hand. There is good evidence that HGS is a strong indicator of health status, based on the incidence of disability, morbidity in adult populations.[12]

And the anthropometric measures constitute the new vital signs of the 21st century, and therefore, warrant urgent assessment if the tide of obesity is to be turned. This is because BMI below 18.5 and over 24.9 is associated with health risk the latter with hypertension, dyslipidemia, type-2 diabetes, coronary heart disease, stroke, gall bladder disease, osteoporosis, sleep apnea, respiratory problems and other systematic conditions. Moreover, the economic and social consequences of these condition could be overwhelming especially in underdeveloped and developing countries (World Health Organization, 2008).[12] An individual's BMI can be categorized into underweight, normal weight, overweight or obese individuals as a result of both sedentary lifestyle and high physical inactivity. Poor muscle strength has been found to be associated with low body weight and poor nutritional status, and many previous studies have attempted to correlate HGS with anthropometrics to predict the outcome of the former. Furthermore, the amount of fat-free muscle has been highly correlated with grip strength in teenagers. Increasing levels of testosterone and greater level of sport performance have been observed to be related to increasing grip strength in boys entering puberty. These findings could help to explain the increasing grip strength difference between boys and girls throughout the teenage years.[13]

In case of relationships of hand grip strength with stature, weight, arm and calf circumferences and various subcutaneous skin folds, it is found that males attained greater values for also have greater hand grip. In order to have a better understanding HGS has been found to be affected by various known factors including age, body size, posture, hand dominance, forearm girth etc.[14]

As some of the studies show a negative correlation between BMI (body mass index) and HGS, some show a positive correlation between BMI and HGE (hand grip endurance). Furthermore, only a very few studies are done in this direction. Hence, we took a study to compare and correlate BMI with HGS and handgrip endurance time (H). Hand grip endurance (HGE) is the ability to sustain a muscular force.[15] It has often been used as a major of physical performance. Both HGS and HGE play a pivotal role in prevention in injuries. especially during sports activity.[16] The current study was done to ensure us about correlation of parameters.

METHODS

Study design and setting

The current research was carried out in the Department of Physiology, SGRR Institute of Medical and Health Sciences, Dehradun, Uttrakhand-INDIA.

Present study was carried over 140 subjects of 18-25 years of age for the period of six month from (March 2021- September 2021). It was a thesis work under aim of find out the correlation of HGS with BMI and to find out the correlation of HGE with BMI.

Inclusion criteria

Subjects fulfilling the following criteria were included in the study: similar education and socioeconomic status, physically and mentally fit, free of any respiratory or cardiac disease.

Exclusion criteria

Subjects undergoing any physical conditioning program were excluded from the study.

Ethical clearance was obtained from the institutional ethical committee. Informed consent was taken from all participants.

All the subjects (n=140) were divided into three groups i.e., normal weight (n=70), overweight (n=35) and obese (n=35) according to their BMI as per reconditions of WHO.

BMI grading of subjects was done according to WHO criteria. It was developed by Adolphe Quetelet ≤18.5-underweight; 18.5-24.99- normal weight; 25-29.99-overweight; ≥30- obese. The subjects were firstly divided into 3 broad groups Based on BMI: group B (35)- normal with BMI (<25); group A (70)- overweight with BMI (25-29.9); group C (35)- obese with BMI (>30)

Measurement of anthropometric parameters

Age

It was calculated in years to the nearest birthday.

Height

It was measured by using a standard Stadiometer (Avery Pvt. Ltd.) in centimeters with each subject in upright position in front of a wall looking ahead and heels touching one another.

Procedure

Subjects were instructed to stand straight on a flat surface with feet flat, heels almost together, arms at side and looking straight ahead. Heels, hips, shoulder blades and occiput pressing against the vertical bar then the slider was brought down to rest on the rest on the top of the head pressing the hair. The arrow accurately measured the height to an accuracy of ±0.5 cm.

Body weight

It was recorded in kilograms using calibrated weighing machine and asking the subject to stand erect on the weighing machine without shoes, wearing light clothing.

Procedure

The subjects were made to stand upright on the scale wearing minimum clothing after taking off his/her shoes. The weight was recorded to an accuracy of ±0.1 kg.

Body mass index

The BMI of each subject was obtained mathematically using the formula called as Quetlet formula:

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

Hand grip strength (HGS)

It was determined by using a handgrip (dynamometer) for at least 3 seconds. Prior to the test, each subject was given verbal instructions and demonstration of the test. Subject stood upright by holding the dynamometer in the 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.

Hand grip endurance (HGE)

It was determined by asking the subject to sustain 1/3rd of maximal voluntary con-traction for as long as he/she could. Subject was made to sit with the forearm placed on a table, flexed at 900 and was asked to maintain a grip of 1/3rd of MVC (maximum voluntary contraction) and then the time recording was noted in seconds.

Statistical analysis

All the parameters recorded were analyzed using Microsoft EXCEL Soft-ware. Test applied were Student's t-test and Pearson's correlation test.

Significance criteria

P value ≥0.05- not significant#; p value ≤0.05- significant*; p value ≤0.01- highly significant**; p value ≤0.001- very highly significant***.

RESULTS

Table 1 show the mean±standard error of mean (SEM) of all the anthropometric parameters. The mean±SEM for age was 21.0±018 years and height was 1.65±0.1weight was 73.77±1.19 and BMI was 27.09±0.92 kg (per meter square) HGS was 26.51±0.75 kg HGE was 19.0±90 sec. respectively.

Table 1: Parameters of all subjects.

Parameters	Mean±SEM
Age (year)	21.01±0.18
Height (cm)	1.65±0.01
Weight (kg)	73.77±1.19
BMI	27.09±0.42
HGS (kg)	26.51±0.75
HE (sec)	19.40±90

Table 2: Gender based comparison of HGS and HE.

Parameters	HGS	HGE	P value
	Mean±SEM	Mean±SEM	
Male (n=70)	31.28±0.76	20.88±0.87	<0.001***
Female (n=70)	23.65±1.08	13.07±0.63	<0.001***

The mean±SEM of HGS for male was 20.88±0.87 kg and female was 13.07±0.63 kg respectively and it was found highly significant (p<0.001***).

Table 3: Correlation between HGS and BMI for all subjects.

	BMI	HGS	R value	P value
	Mean±SEM	Mean±SEM		
Male (n=70)	26.52±0.55	31.28±0.76	-0.23	>0.05#
Female (n=70)	27.66±0.64	20.88±0.87	-0.15	>0.05#

The mean±SEM of BMI for male group was 26.52±0.55 and the mean±SEM of HGS for male was 31.28±0.76 and

it was found not significant (>0.05#) there was found negative correlation between BMI And HGS.

The mean±SEM of BMI for female group was 27.66±0.64 and the mean±SEM of HGS for female group was 20.88±0.87 and it was found not significant (>0.05#) there was found negative correlation between BMI and HGS.

Table 4: Correlation between BMI and HGS and HGE of all subjects.

	HE (mean±SEM)	P value	R value	HGS	P value	R value
Normal female	12.61±1.45	<0.001***	O.21	24.14±2.28	>0.05#	0.19
Overweight	14.46 ± 0.91	<0.001***	0.46	19.66±1.16	<0.001***	0.42
Obese	11.66±0.84	<0.001***	0.13	<0.001***	<0.001***	0.02
Normal male (n=70)	32.75±1.56	>0.05#	-0.14	32.75±1.56	<0.001**	-0.13
Overweight male	19.66±1.16	<0.001***	-0.18	31.24±1.14	<0.05#	-0.23
Obese	22.90±1.12	<0.001***	0.13	29.66±1.16	>0.05#	-0.23

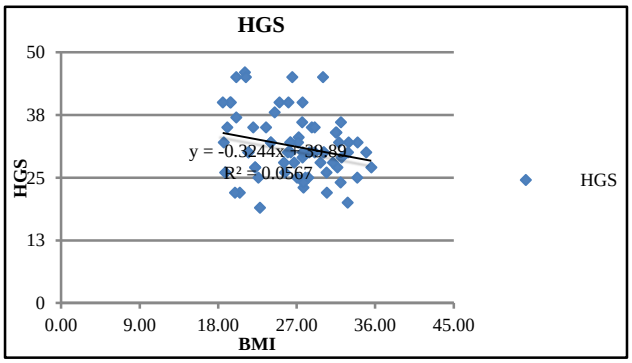

Figure 1: Correlation of BMI and HGS of all males.

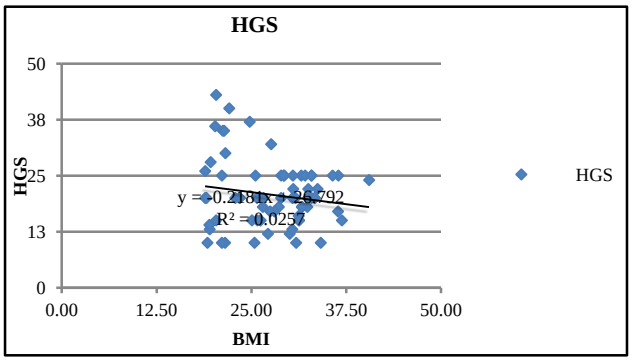

Figure 2: Correlation of BMI and HGS of all female.

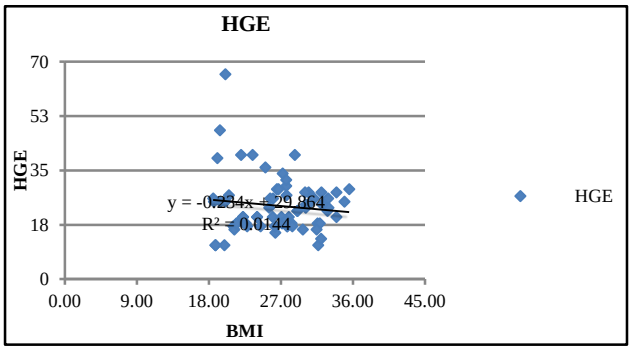

Figure 3: Correlation of BMI and HGE of all males.

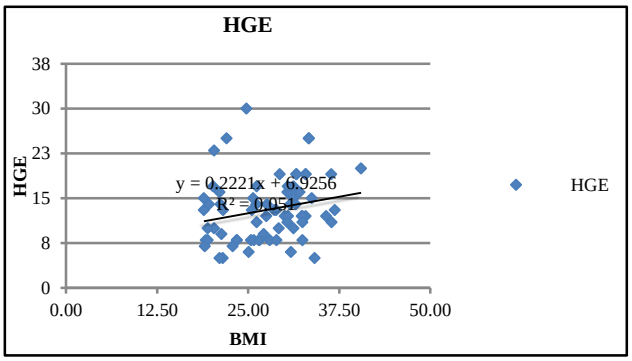

Figure 4: Correlation of BMI and HGE of all females.

Table 5: Comparison of all parameter in males and females.

Parameters	Male	Female	Group 1 error	Group 2 error
BMI	26.52	27.66	0.55	0.64
HGS	31.28	20.88	0.76	0.87
HGE	23.65	13.07	1.08	0.63

The results showed that HGS and HE was more for male subjects. When the subjects were classified according to the BMI it showed that statistically significant negative correlation between HGS and BMI in normal and overweight males but non-significant positive correlation in obese males.

While in females there was statistically non-significant positive correlation between HGS and BMI in normal females. Statistically significant positive correlation was observed in overweight and obese females.

When it was correlated with BMI, it was observed that there was non-significant negative correlation in males. In overweight males, there was statistically significant positive correlation was observed. In females, positive correlation was observed and it was significant in all the categories of females (normal, overweight, obese females). But in overweight females, it was observed that

endurance time (14.46±0.91) is more than normal females (12.6±1.40) and obese females (11.66±0.84) which was significant.

DISCUSSION

The result of our study coincides with the following studies. The HGS and HGE values were higher in males which is similar to our study Gupta et al, who conducted study in Jammu and reported that HGS was 39.12±8.79 and HGE was 43.55±28.84 in males which was higher as compared to females. Similarly, in the study conducted by Dhananjay et al in Karanataka, the HGS was 34.64±7.52 and HGE was 79.77±39.57 in males.

The higher HGS and HGE can be explained as muscle bulk strength is more in male as compared to female because testosterone hormone is responsible for muscle strength and so male are stronger than female. 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 smaller cross-sectional area. It was found that testosterone increases type-2 fibers, which are the fast fibers with high glycolytic enzyme activity. The type-2 are high in males. Thus males have higher HGS and endurance time as compared to female subjects. On BMI based comparison of HGS, we found that as BMI increases strength decreases and HGE also decreases except overweight female who showed increase in endurance time. The decrease in HGS was statistically significant in overweight and Normal weight male. But it showed no significant in obese male.

Statistically significant partial negative correlation between BMI and HGS was observed in normal and overweight males while in female group overweight and obese female subjects showed significant partial positive correlation with BMI and HGS.

In overweight female subjects insignificant negative correlation was observed between BMI and HGS (Dhananjay et al) which was not in consonance with our study where we observed significant positive correlation.

Another study done by Shetty et al, observed significant negative correlation between BMI and HGS in overweight male which is in line with our study.

A negative correlation was noted between BMI and HGS though not significant in Das and Dutta; and Shetty et al.

As regards HGE, there was significant positive correlation between BMI and HGE in obese male, overweight females and obese females which is in consonance with study conducted by Dhananjay et al. But in overweight males significant negative correlation was observed between BMI and HGE in our study which was in agreement with study conducted by Hulens et al.

Another study conducted by Podstawski et al revealed that overweight female subjects had lower endurance time while our study showed that endurance time of overweight females was more than normal and obese female subjects.

In normal males, correlation was statistically insignificant while in normal weight females, correlation was statistically significant between BMI and HGE.

It is mainly due to impairment of muscle strength by accumulation of fat. Obese persons have lesser number of type-I fibres than the lean persons (Dhanjay et al). Fat mass is inversely correlated with type-I fibers and positively correlated with type-2 fibers.

Obese women have lower muscle strength as compared to lean women, which is due to lower degree of activity.

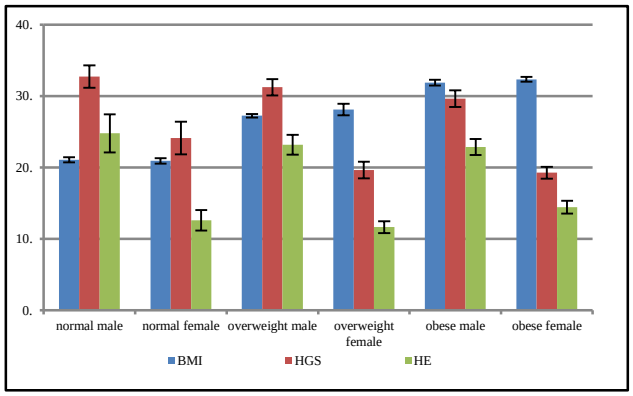

Figure 5: BMI based comparision of all parameters.

This study has few limitations. In our study we observed that the HGE for overweight female subjects was more than the normal and obese subjects. This can be explained by the study done by Malina et al. Handgrip endurance declines with increasing body fat percentages but not with increasing body weight. Excess fat was a limitation for the endurance. BMI being an indicator of body mass, doesn't take the fat percentage into account as an index, and so BMI is not a good indicator to suggest the weight changes which may be due to increase or decrease in the muscle mass and the body fat percentages.

CONCLUSION

This study was conducted in Department of Physiology, SGRRIM and HS, Patel Nagar, Dehradun on 140 subjects were selected and the data parameters were measured in our clinical laboratory.

The data collected was analysed. The result showed that HGS and HE was more for male subjects. When the subjects were classified according to the BMI it showed that statistically significant negative correlation between HGS and BMI in normal and overweight males but non-significant positive correlation in obese males.

While in females there was statistically non-significant positive correlation between HGS and BMI in normal females. Statistically significant positive correlation was observed in overweight and obese females.

When it was correlated with BMI, it was observed that there was non-significant negative correlation in males. In overweight males, there was statistically significant positive correlation was observed. In females, positive correlation was observed and it was significant in all the categories of females (normal, overweight, obese females). But in overweight females, it was observed that endurance time (14.46±0.91) is more than normal females (12.6±1.40) and obese females (11.66±0.84) which was significant.

Physical fitness is very much essential for maintaining a healthy lifestyle. Handgrip strength and endurance are important parameters to assess muscular strength of an individual. As the weight increases muscle strength and endurance time also decreases as shown by our study. BMI is considered as a useful tool to measure the degree of overweight, but it will not indicate the factors causing the increase in weight. The presence of correlation between BMI and HGS and HGE indicate that besides body mass index several other factors like effort, strength, muscular contractility, grip span, hand span and fat mass etc. affect muscular strength and endurance and so further study can be done considering other factors.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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