CORRELATION BETWEEN BODY COMPOSITION AND HAND GRIP STRENGTH AMONGST YOUNG PHYSICAL THERAPISTS.

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Abstract : Questions: Is there any correlation between body mass index and hand grip strength? How body composition measures like body fat percentage and lean body mass are correlated to hand grip strength in young female therapist? Design: An observational study. Participants: 150 young female physical therapists of age group 21-26. Intervention: Weight, height and seven-site skinfold measurement of the participants was assessed. Hand grip strength was assessed by Jamar hand held dynamometer for the dominant hand. Outcome measures:Hand grip strength, body mass index, body fat percentage and lean body mass of the participants. Results: According to spearman's rank correlation test, there is a significant strongly negative correlation between body mass index and hand grip strength, and a moderately negative correlation exists between hand grip strength and body fat percentage, also with Lean body mass. (95% CI 0.7-0.5). Conclusion: There was a significant strong negative correlation found between hand grip strength and body mass index, and moderate negative correlation exists between body composition (body fat percentage and lean body mass) and hand grip strength amongst young female physical therapists. Keywords: Hand grip strength, body mass index, body composition, body fat percentage, lean body mass.

I. INTRODUCTION

Most Physical therapists are at risk of developing work-related musculoskeletal disorders (WMSDs).[1, 2] Reported higher prevalence of WMSDs have been found in younger therapists. Increased prevalence of thumb symptoms and hand strength are found to be related to use of mobilization and manipulation techniques. A higher prevalence of neck and upper-limb symptoms are related to risk factors associated with workload.[1] Younger physiotherapists and newly qualified are the most in need of intervention services for controlling injury rates and strengthening upper limb and hand.[3]

Anthropometric measurements and body composition are considered to be the important tools to evaluate the health status and nutritional pattern. Also, different components of body composition reflect energy balances with the functional and metabolic parameters of the body, but are highly associated with the cardio respiratory health. Skeletal muscle function is also influenced by nutrition and hand grip strength (HGS) measurement predicts motor function or skill-related functions of the entire musculature components of the arm.[4]

Grip strength is vividly used as an indicator for overall physical health, hand and forearm muscles functions, as a measure of functional index of nutritional status and physical fitness. Hand grip strength is a variable affected by factors like hand size or hand span, age, gender, posture, grip and span, muscle length insertion, angle of tendon at time of contraction, nutritional status, BMI, fatigue tendencies, hand dominance, pain threshold, cooperation of the patient, sensory loss, hip/waist circumference, body size, arm and calf circumferences, various subcutaneous skin folds.[5,30]

Grip strength proves to be an objective index for the measurement of functional integrity of upper extremity. Activities of daily living of professionals during the work require high activity levels and strength of the muscles of forearms and hands. The muscles are involved in gripping and strength varies from task to tasks, like Physical therapists and Dentists etc. Physical therapist does patients manipulation and ambulation, where good amount of grip strength and endurance is necessary to be successful in their professional tasks and activities of daily living.[6,7,8]

Research studies have correlated grip strength to other physical components as nutritional status, rotator cuff weakness, fatigue, and overall physical function. 35 Muscles are functioning in gripping activities, movement of forearm and other hand functions. During gripping the musculature responsible for flexor mechanism of hand and forearm generates force to grip while the extensor muscles stabilize the wrist.

Many Nutritional studies have confirmed correlation of hand grip strength. Guo et al (1996) and Kenjil et al (2005) found that grip strength to be a firm predictor of nutritional status. These findings resemble to the results of the anthropometric measurement researches.

The changes of variables like height, mass, finger length and perimeter also has an effect on the outcome of grip strength testing. One such study reported there were highly significant relationships between maximal handgrip strength of the dominant hand and general anthropometric measures.

Hand grip strength test measures the maximum isometric contraction strength of the hand and forearm muscles. Physical therapists require an accurate reliable method for evaluating muscle strength. The use of hand held dynamometer for muscle testing is a standard method used widely.[6, 7, 8]

The present study is conducted to find out correlation between body composition and hand grip strength amongst physiotherapists, since physiotherapy is the most important upcoming medical field and emerging young physical therapists are prone to WMSDs and their hand grip strength and anthropometric data is essential for ergonomic considerations. The body composition will be measured by skin fold measurements using Jackson and Pollock seven site formula. And the hand grip strength will be measured by hand held dynamometer.

Therefore, the specific research questions for this study were:

Is there any correlation between body mass index and hand grip strength?

How body composition measures like body fat percentage and lean body mass are correlated to hand grip strength in young females?

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Method

Design: The study employed an observational and analytical study design. Adult Females were selected through convenience sampling within the university and nearby area. All participants were assessed for three outcome measures: 1) hand grip strength, 2) body mass index, and 3) and total body fat percentage after the consent taken from participants. The assessment was one time, three trials for grip strength readings on a hand held dynamometer, seven site skin fold measurements with calliper, and weight and height was noted of each participant.

Participants

To be included had to be women, of age group 21-26. If they had any recent upper limb fractures (less than 6 months ago) had to be excluded along with women with any upper extremity musculoskeletal or neurological conditions.

Intervention

Participants were selected as per the selection criteria and was explained about the survey. A consent form was filled up from each subject after that further assessment was done.

BMI was calculated by assessing participant's height and weight. On Asian criteria the BMI was evaluated.

Hand grip strength was evaluated by Jamar hand held dynamometer.

The assessment consisted of the measurement body composition by skinfold measurement method using Jackson and Pollock's seven site formula.

Seven-Site Formula (sites: chest, midaxillary, triceps, subscapular, abdomen, suprailiac and thigh):

- Body density = 1.097 - 0.00046971 (sum of seven skinfolds) + 0.00000056(sum of seven skinfolds)^2 - 0.00012828 (age)
- TOTAL BODY FAT PERCENTAGE = 495/BODY DENSITY-450

Outcome measures

There are three outcome measures for this study, to find out the correlation status between hand grip strength and body composition in young female physical therapists. They are: 1) Hand grip strength by JAMAR hand held dynamometer, 2) Body mass index via weight and height assessment of the subjects and 3) Total body fat percentage by using skin fold measurement method and using JP's seven site formula to calculate the same.

Hand grip strength assessment is a basic and important procedure used by therapists and physicians to assess patient status following injuries, surgical techniques, and treatment procedures to the hand and upper extremity.[16] Jamar hand dynamometer is considered as themost reliable and acceptable tool for measuring grip strength. It detects and quantitatively determines the degree of grip strength. The hand grip strength is measured before and after treatment which also helps to study the intervention outcome. Many researches are available and are done to predict the test-retest reliability of jamar hand held dynamometer.[17-20]

Jamar Hand Held dynamometer is a device that functions on controlling the velocity of motion and provides a resistance equally proportional to the force generated by the person using the machine. In 1954, Bechtol introduced the Jamar Dynamometer. It became the most accepted instrument for quantitative measurement of hand grip. It consisted of a sealed hydraulic system with adjustable hand spacing that registered hand grip force.[18-25]

Most of the recent studies of grip strength measurement have reported the Jamar dynamometer to be the most reliable and accurate device for measurement of hand grip strength.[20-24]

Body mass index is the overall anthropometric measure of health status of an individual. BMI is calculated using anthropometric body measures height and weight. Such subjective measures give the individuals correct body mass information in regards to his height and weight. BMI is used to grade the person's health status to healthy, underweight, or obese and is further categorised by WHO criteria and Asian criteria for classification of obesity.[26, 27]

Body composition includes not only the mass of body but also amount of fat, lean muscle, bone density, water content and other minor details in body to give an exact idea of individuals health and nutrition. To determine total body fat percentage skin fold measurement method is used in this study. Skinfold (SKF) measurement method is the most universal method of estimating percent body fat (%BF) because of cost efficiency, ease of performance, and feasibility.

The seven-site skinfold (SKF) measurement technique is arguably the most common method of Body Fat estimation. This method is attractive because of its low relative cost when compared to reference methods such as hydrodensitometry, air displacement plethysmography, and dual-energy X-ray absorptiometry. SKF measurement is quick and less invasive compared to aforementioned reference methods which require minimal clothing, complete exhalation, and/or exposure to X-ray photon. Moreover, as a field measure, SKF technique is feasible, reliable, and valid. [27-32]

The evaluation consisted of the measurement body composition by skinfold measurement method using Jackson and Pollock's seven site formula.

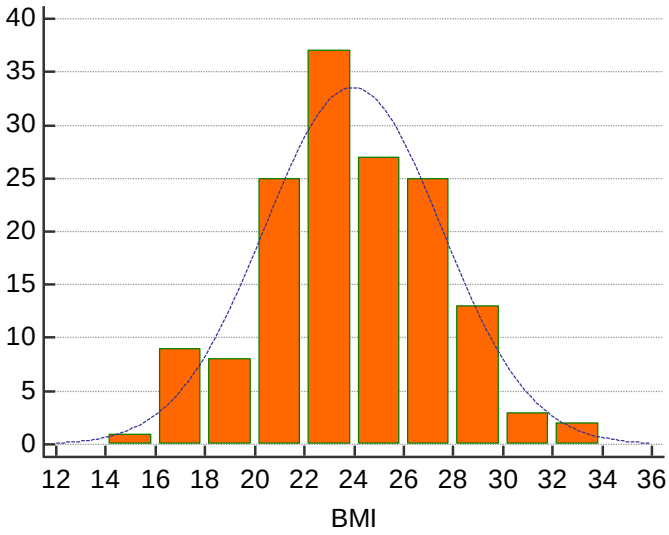
Seven-Site Formula (sites: chest, midaxillary, triceps, subscapular, abdomen, suprailiac and thigh):

- Body density = 1.097 - 0.00046971 (sum of seven skinfolds) + 0.00000056(sum of seven skinfolds)^2 - 0.00012828 (age)
- TOTAL BODY FAT PERCENTAGE = 495/BODY DENSITY-450

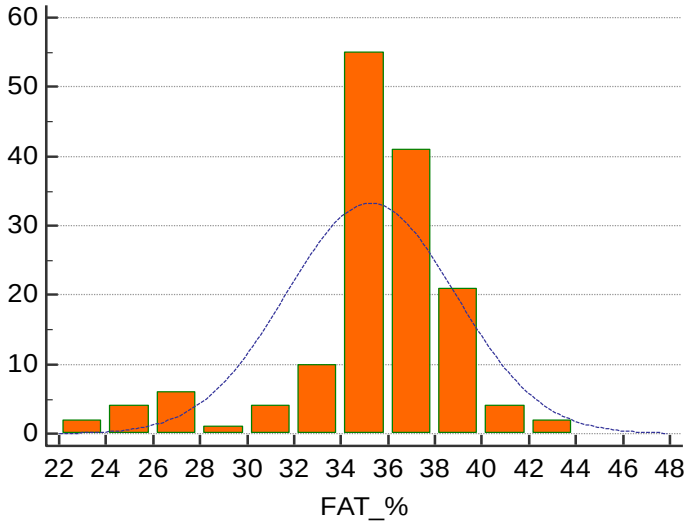
Data Analysis

Normality of the variables (HGS, BMI, total body fat %) were found out and Spearman's Correlation rank test was applied to find out the correlation between BMI and HGS, fat percentage and HGS.

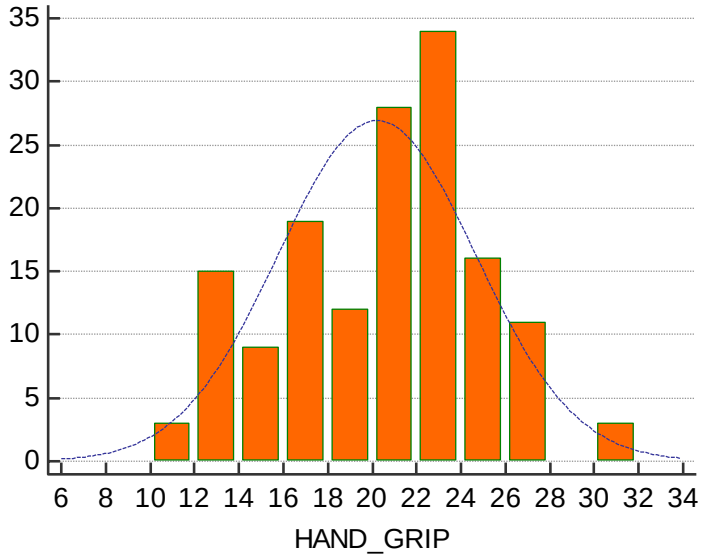
Normality of variables:



BMI is normally distributed.



Total body Fat percentage is not normally distributed.

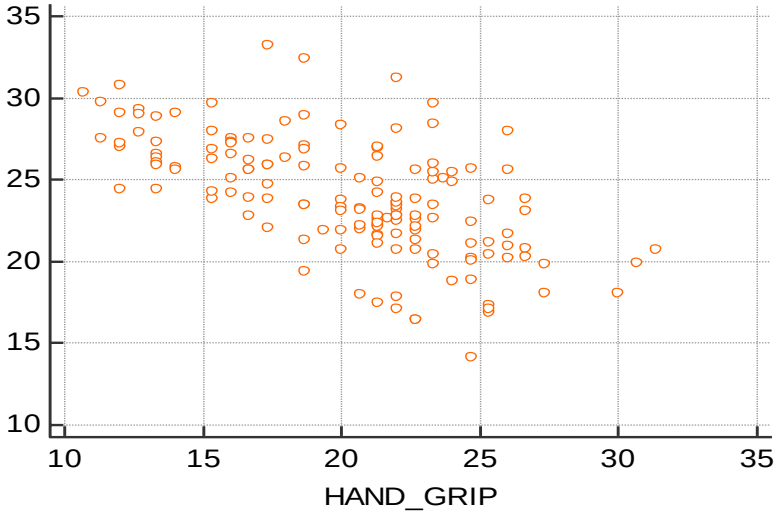


Hand grip Strength average measurement is not normally distributed.
As all the variables were not normally distributed, Spearman's rank correlation test was applied to find out the correlation between BMI, HGS and Total body fat percentage.

Correlation of BMI and HGS :

Variable X	BMI
Variable Y	HAND_GRIP
Sample size	150

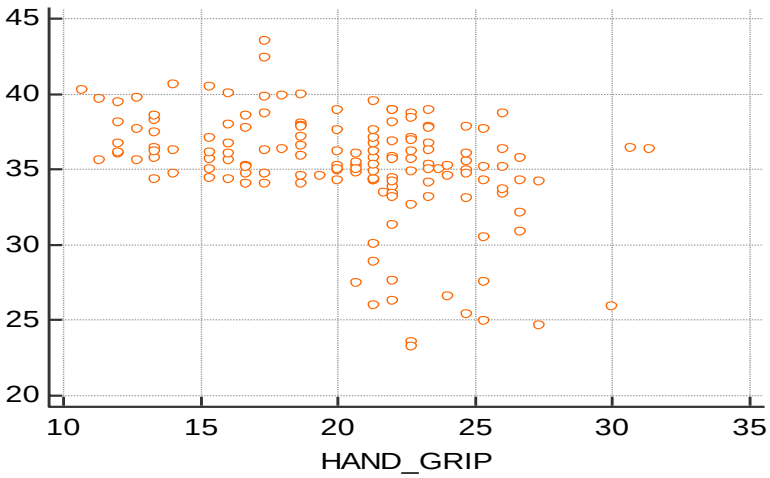
Spearman's coefficient of rank correlation (r)	-0.628
Significance level	P<0.0001
95% Confidence Interval for r	-0.716 to -0.520



As per Spearman's rank correlation test, BMI is moderately negatively correlated to HGS, with a high significance.

Correlation of Total Body Fat % and HGS :

Variable X	FAT_%
Variable Y	HAND_GRIP
Sample size	150
Spearman's coefficient of rank correlation (r)	-0.401
Significance level	P<0.0001
95% Confidence Interval for r	-0.527 to -0.257



As per Spearman's rank correlation test, Total Body Fat Percentage is moderately negatively correlated to HGS, with a high significance.

Results

Our study group consisted of 150 adult female. The average BMI was 23.96 kg/m^2, average fat percentage was 35.26%
The study shows correlation between overall BMI of the subjects with HGS, with *r= -0.628*that shows strongly negatively correlated while and also, correlation between overall Fat percentage of the subjects with HGS, with *r= -0.401* that shows moderately negatively correlated. Our results shows that there was a significant correlation between BMI and HGS and with Fat percentage and HGS with *p<0.0001* being highly significant.

Discussion

The results in our study show that there is a significant moderate negative correlation between BMI and HGS in female physiotherapy students and also between Total body Fat% and HGS. *p=0.0001.*
HGS is considered as an index of skeletal muscle function and nutritional status. It is influenced by effort, muscle bulk and contractility of musculature. Skeletal muscle accumulates intramuscular fat with increasing age and obesity. Muscle quality is a measure of muscle strength per unit size, it decreases in such conditions.[21,24] Changes are happening to structural parameters which in return affect the muscle quality. The contractile components within the muscle reduce causing a decrease in the muscle force.[18,19,30] However, the muscle force depends on the contractile components and also on the interaction between the contractile components with base material of the muscle. It is also studied that fat has stiffer material properties than muscle and thus the entry of fat into the muscle creates in a stiffer base material, and thus increasing stiffness acts to resist muscle fibre against shortening and transverse bulging. The fatty subjects show lower force than the lean subjects, even for similar levels of contractile components and this is assumed to be a result of increase in stiffness of the base material due to the inclusion of fat.[28]
These results parallel experimental findings that reports loss of muscle quality by Rahemi H, Nigam N and Wakeling JM [11]. They studied in 2015 that whole-muscle force is largely dependent on its base-material properties, any particular changes to the base material as a result of fatty inclusions in muscle fibres causes decrease in force generated and muscle quality, they also concluded that levels of intramuscular fat have a significant effect on whole muscle force to be generated. Similar to our study that shows, there is a significant moderate negative correlation between total Fat% of body and HGS in female physiotherapy students (*p=0.0001),* similar findings were noted in Dhananjaya et al. [10]Amit Bandhopadhyay et al [4]
BMI is a statistical measurement of body mass based on a weight and height. It does not measure body fat, it is used to estimate healthy bodyweight based on height. Because BMI is easy to measure component and calculate, it is the most widely used diagnostic tool for determining if an individual is underweight, overweight, or obese. BMI is defined as a person's body weight divided by the square of his or her height.
In obesity, lack of muscle strength is mostly by accumulation of fat; also, obese individual have lesser type I than type II b muscle fibers. Fat mass is inversely correlated with type I fibers and is positively correlated with type II fibers. Obese women are found to have reduced muscle strength of extremities as compared to lean women, also can be explained by their lower amount of activity. In overweight females, there was significant negative correlation found between BMI with HGS. The study conducted by Podstawski et al. stated that overweight female students have a significantly reduced levels of endurance and strength abilities than their underweight or normal collaterals. Das and Dutta, in their study, found that males have a higher HGS and endurance than females and a significant correlation is found between BMI and HGS in obese subjects. They also mentioned that significant negative correlation between HGS and body mass of individuals. Evidence show that there can be mark able correlations between grip strength and other parameters, such as weight, height, hand length, and BMI as reported in some previous researches. HGS is a physiological component that can be affected by other factors such as age, gender, and body size are among others. [11]
The reduced muscle strength in underweight is explained on the basis of the energy deficiency. Some studies state that the muscles of obese persons will have a fatty inclusion and infiltration hence changing the distribution, pattern and levels of the type I and type II muscle fibers that in return alters the muscle strength, endurance and force. This association and correlation between the BMI, the body fat percentage and the handgrip strength can be explained on the fact that the BMI is an indicator of the body mass, the fat percentage accounts for muscle properties and the weight changes can be due to an increase or decrease in the muscularity or body fat percentage affecting the muscular properties and strength. [15]
This study shows that, there is a significant moderately negative correlation between BMI and HGS in female physiotherapy students (*p=0.0001),* our study also shows moderately negative correlation between subjects with pre-obese BMI and their HGS, *p=0.0038.*And this study also shows significant moderately negative correlation between normal BMI and HGS, *p=0.0007.*Similarfindings were noted by Kun-His Liao et al [13], Umesh Lad et al [14] and Ravisankar P et al.
What was already known about this topic: There is correlation between BMI, Hand Grip Strength, and Hand Grip Endurance. Hand Grip Strength and endurance depends on various factors such as age, sex, built, strength of muscle, arm span, and diet. A further study in a larger population is required with multiple factors taken into consideration.
What this study adds: There is a moderately negative correlation found between hand grip strength and body mass index and between hand grip strength and body fat percentage amongst young female therapist taken into consideration. This study was based on a large targeted population of 150 young female therapists and the study further adds that hand grip strength needs to be improved in female physical therapists.[30]
Ethical approval: Approved by ethical committee of Dr. D. Y. Patil University, Pune. Written informed consent was obtained from all the participants, prior to their participation in the study.
Competing interest: NIL

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