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STUDY OF CORRELATION BETWEEN BODY MASS INDEX AND MUSCLE FATIGUE IN YOUNG ADULTS

Physiology

Dr. Devarapally Monica* Post Graduate, Department Of Physiology, Guntur Medical College *Corresponding Author

Dr. K Prabhakara Rao Professor And Hod, Department Of Physiology, Guntur Medical College

ABSTRACT

Background: In isotonic muscle contraction, stimulation produces shortening while exerting a constant force when the muscle is stimulated repeatedly for a prolonged period, it loses its physiological property of contraction and decreases the working capacity. This phenomenon is called fatigue which is reversible with rest. Fatigue results mainly from the inability of contractile and metabolic processes of the muscle fibers to continue supplying the same work output. **Objectives:** To study the correlation between Body mass index and muscle fatigue in male and female young adults. **Methodology:** This study included 105 subjects between 18 – 24 years of age. Subjects were divided into four subgroups based on WHO BMI Classification. BMI was calculated from their respective height and weight. Mosso's ergograph was used. Subjects were made to sit; the forearm was properly fixed in adjustable points in the ergograph with the middle finger extended and a weight of 2kgs was suspended and asked to make series of maximal contractions at regular intervals following the beat of metronome until the weight can no longer be moved. **Results:** Mean value is 3.5194kgm in normal weight, 2.361 kg.m in underweight, 4.0224 kg.m in overweight, 3.92 kg.m in obese population. p=0.000031 for underweight, p= 0.05726 for overweight and p= 0.306 for obese population. p= 0.00001 for BMI and work done. **Conclusion:** There is a significant association between BMI and work done. There is significant association between underweight subject's BMI and work done but no significant association between overweight, obese subject's BMI and work done.

KEYWORDS

Muscle Contraction, Fatigue, Body mass index, work done, Mosso's Ergograph.

INTRODUCTION

Skeletal muscle makes up the great mass of the somatic musculature and is generally under voluntary control[1] The Myofilaments in skeletal muscle fibers contain Myosin, Actin, Tropomyosin, Troponin proteins that together makeup the contractile machinery of the skeletal muscle and contract with nervous stimulation. When a muscle contracts against Load it performs work. To perform work means that energy is transferred from the muscle to the external load to lift an object to a greater height or to overcome resistance to movement[2].

Muscle fatigue is the inability to maintain a required force level after prolonged use of the muscle[3] and is believed to be developed soon after the onset of the sustained physical activity[4] due to depletion of acetyl choline at the neuromuscular junction and effect of hypoxia on the synapse between first and second order motor neurons present in the central nervous system.

Development of fatigue depends on Intensity and duration of activity and Individual's physical fitness and nutritional status. With this background the present study was carried out to correlate Body Mass Index (BMI) and muscle fatigue in young adults.

Aims And Objectives

The main aim of the study is to assess Correlation between Body mass index (BMI) and muscle fatigue in healthy young adults.

Methodology:

This Cross-Sectional Study was done at Guntur medical college, Guntur, in the department of Physiology.

Study Population: This study included 105 (Males 58, Females 47) undergraduate medical students of both genders between 18 to 24 years of age recruited from Guntur medical college. Participation in the study was voluntary. The student's consent was taken prior to the study.

The volunteers included physically untrained and moderately trained students who performed at least two hours of regular physical training in a week. Individuals with history of tobacco, alcohol, Caffeine consumption, on medication with steroids, with musculoskeletal disorders and any psychiatric illness were eliminated from the study. The subjects were instructed not to take caffeinated drinks and not to perform extreme physical activity one day before and on the day the test performed.

Subjects were divided into four subgroups based on WHO BMI Classification. Body mass index (BMI) was calculated from their respective height and weight. To assess the strength of the muscle, Mosso's Ergograph was used for this study. The procedure of the test was explained to the subjects before the test was performed. Three trials of recording were done and the best of it was taken for analysis. Mosso's Ergograph is wooden board with two pairs of clamps to fix the forearm of the subject and a pair of finger holders to fix index and ring fingers in position. A hook suspended with 2kg weight was attached to a cord and made to hang over a pulley. A sliding plate which moves to and fro is fitted with a chart paper, and a pen was fitted vertically over the chart paper to record the contractions made by the subject. Subjects were made to sit comfortably; the forearm was properly fixed in adjustable points in the ergograph. With the middle finger extended, subjects were asked to make series of maximal contractions at regular intervals following the beat of metronome until the weight can no longer be moved. The subjects were verbally encouraged to motivate them during the procedure.

Calculation Of Work Done By The Muscle:

The work done by each subject was calculated from the formula, force x distance[5] (W=FxD) where force is the weight lifted (F) and distance is number of lines of contractions on the paper (D).

W: Work done (in kg meters). F: Weight lifted (in kg). D: Total distance (moved in meters).

Calculation of distance (cm) = no of contractions x average height of contraction (A in cm).

$$A = \frac{\text{(Area of triangle + area of rectangle)}}{\text{(Total length of base)}}$$

The result is noted as Work done in Kg.m.

RESULTS:

Table 1 Shows Mean work done in Normal Weight sub group was 3.5194kg.m$\pm$1.078, Overweight subgroup was 4.0224kg.m$\pm$0.9869, Obese Sub group was 3.92kg.m$\pm$1.2096 and Under weight sub group was 2.361kg.m$\pm$0.6038 respectively

Table 1: Correlation of Work Done and BMI

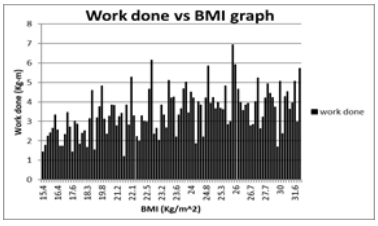
Group	n	Work done (W)	BMI (kg/m^2)	P value
Normal Weight	50	3.5194kg.m 1.078	22.538 (18.5 – 24.9)	0.00001 (<0.05)
Over weight	25	4.0224kg.m 0.9869	26.6 (25.1 – 28.9)	
Obese	10	3.92kg.m 1.2096	31.166 (30 - 35.1)	

Under weight	20	2.361kg.m 0.6038	17.085 (15.4 – 18.3)	

Table2: Comparison of Work Done in Subgroups:

Groups	Mean work done	P value
Normal weight Under weight	3.118 1.1073 kg.m	0.000031 (<0.05)
Normal weight Over weight	3.687 1.0824 kg.m	0.05726 (>0.05)
Normal weight Obese	3.586 1.1207 kg.m	0.306 (>0.05)

Graphical Representation of Work done and BMI



As BMI is Increasing there is increase in Work done.

DISCUSSION:

This study aimed to investigate the relationship between body mass index (BMI) and muscle strength as measured by work done using Mosso's Ergograph among undergraduate medical students. The results demonstrated a significant positive correlation between body mass index (BMI) and the amount of work done by the muscle. Specifically, underweight individuals showed significantly lower work performance compared to their normal weight counterparts, as indicated by the p-value of 0.000031. The findings align with previous research suggesting that underweight individuals generally have lower muscle mass and strength, which can impair physical performance (Janssen et al., 2002)6. In contrast, no significant differences were observed in work done between the normal weight and overweight groups (p = 0.05726) and between the normal weight and obese groups (p = 0.306). These results imply that while moderate increases in BMI might be associated with increased muscle mass and strength, further increases, especially into the obese range, do not confer additional benefits in muscle work performance. This pattern is consistent with findings from studies by Hulens et al. (2001)7, which indicated that moderate overweight can sometimes be associated with better muscle performance, whereas obesity can introduce factors like increased fatigue and decreased endurance that might offset the benefits of higher muscle mass.

Kader NA et al reported a positive correlation of work done with BMI which coincides with the results of the present study, but were not statistically significant in all the subcategories of BMI 8.

Singh D K et al reported in their study that Poor nutritional status is also associated with reduced physical performance leading to fatigue9 coincides with the present study, where underweight individuals with low BMI showed a significant decrease in work done capacity. It has been hypothesized that a low nutrient intake results in corresponding loss of whole-body protein, preferentially from muscle mass the body's greatest protein reserve. This results in cellular adjustments that decrease protein synthesis and increase proteolysis, which causes muscle fiber atrophy which causes a decline in muscular function and strength10.Studies showed that Improved physical activity by exercise training in sedentary individuals resulted in beneficial effects on feelings of energy and reduced the onset of fatigue 11.

The methodology employed, including the use of Mosso's Ergograph for direct measurement of muscle work, provides a reliable means of assessing muscle performance.

This study was limited to a relatively small and specific population of medical students, which may not be representative of the general population.

CONCLUSION:

In conclusion, this study showed an association between BMI and muscle performance, as measured by work done. Underweight individuals showed significantly lower muscle performance compared to those of normal weight, while no significant differences were found between normal weight, overweight, and obese groups. These findings suggest that maintaining a normal weight is beneficial for muscle strength and performance. However, the benefits of increased BMI beyond the overweight range, with obesity did not provide additional muscle performance benefits. Future research should investigate the mechanism that might explain the decreased muscle performance associated with higher BMI levels.

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