

Effect of Stress in Muscle Function between Sedentary and Physically Active Adults using Mosso's Ergograph: A Cross-sectional Study

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ABSTRACT

Introduction: Skeletal muscle is essentially involved in body movement. Structured physical activity refines the physical and mental well-being and it is viewed as one of the important factor which influences the skeletal muscle activity. Stress hormones causes metabolism of muscle proteins thereby reduces the muscle strength.

Aim: To demonstrate the effect of stress in muscle function between sedentary and physically active adults.

Materials and Methods: This cross-sectional study was done amid of 100 (inactive) sedentary and 100 exercising (physically active) adults in Sree Balaji Medical College and Hospital, Tamil Nadu for a duration from January 2022 to April 2022. Total 200 male subjects (100 sedentary and 100 physically active adults) between age group 25-30 years were included in this study. Muscle function (work done) was studied using Mosso's Ergograph. Perceived stress score was analysed by Cohen's

perceived stress scale questionnaire. Work done by muscle and stress score was correlated. Pearson's and Chi-square test were used to assess the correlation between work done by muscle and stress score.

Result: On analysis of 200 study subjects (100 sedentary and 100 physically active), work done by physically active adults was more. The effect of stress in reducing the muscle strength was comparatively lesser in physically active adults. There was a negative correlation found between work done by muscle and stress score among sedentary adults ($r=0.011$, $r=-0.432$, $r=-0.835$) and also among physically active adults ($r=1.524$, $r=-0.012$, $r=-0.035$) with statistically significant (p -value <0.05).

Conclusion: Amount of work done in physically active adults was more as compared to sedentary adults. Perceived stress had a negative effect on the muscle strength (work done) of the young adults. Exercise reduces the stress and improves the work done level of muscle.

Keywords: Mental health, Muscle strength, Physical well-being

INTRODUCTION

Human body is structured by skeletal muscle. It contracts on receiving a voluntary stimulus. Skeletal muscle allows sensible control of muscles after receiving the neural input. Actin and Myosin makes-up the muscle fibre of skeletal muscle. Skeletal muscle contracts by Excitation Contraction Coupling (ECC) mechanism. Through this process, an adequate aid is given to the body by muscular system and it intensifies the body movements. Physical build, training, age, height, sex, and motivation are the factor that affects person's performance [1]. Reduced ability to do work is called fatigue. The dominant factors that influence the beginning of fatigue are the degree, duration and type of work. This can be delayed by exercise, which increases the circulation to the muscles that are contracting [1]. In humans, fatigue first occurs in the cerebral cortex. Inducement and cheering increase the performance level of the individual.

Stress is an inexorable part of life. It is defined as a condition of altering the homeostasis which is prevented by alterable processes. Homeostasis is recovered by emotional, biological, enzymatic and logical behavioural responses [2,3]. The adaptable magnitude to give out with stress is one's fitness which when outstripped may spot the individual at greater possibility for disease [3]. Stress and physical activity are related in a secular manner. More precisely the occurrence of stress influences physical activity. Majority of the research work specifies an contrary connection between these designs. Stress hinders individual attempt to be further physically active, just as it adversely influence health conduct efforts to be additionally physically active. Exercise is a contriving management in case of stress [4].

Previous research work betrayed that those who are involved in significant physical activity outlined low stress and lesser level

of depression [4-7]. Everyday mental stress happen by different constituents like work stress, financial worries, relationship and a lot more [5]. During stress, cortisol level increase in the body which has impact on all the body functions. Increased stress corresponds with catabolic properties in skeletal muscle, that is reduction in muscle protein synthesis, which is in contrary to muscle growth. Exercise strengthen mood, refine the energy level and aids in sleep [5]. Exercise reduces the perceived stress and improves the muscle strength [6]. The previous research papers were focused either on stress or muscle fatigability only for the physically active individuals.(like exercise/ different physical activity). As of now ,no studies have been attempted to find both the perceived stress and their effect on muscle strength among sedentary adults. This study was aimed to analyse both the factors (perceived stress and work done by muscle) among two different groups, sedentary males and physically active adult males and found out whether exercise plays real role against stress, promotes muscle strength, work done level and finally documented the correlation between perceived stress and work done by the muscle.

MATERIALS AND METHODS

This cross-sectional study was conducted at Sree Balaji Medical College and Hospital, Tamil Nadu, India from January to April 2022 at Sree Balaji Medical College and Hospital, Tamil Nadu. Study protocol was approved by Institutional Ethical Committee (IEC) (approval no: Ref no.002/SBMC/IHEC/2022/1692). Study method was described to the participants and the consent was acquired before the study.

Inclusion criteria: A total of 100 sedentary male (work that involves less physical activity) and 100 physically active male adults (who regulary exercise for 30 minutes – 1 hour per day like regular push-

ups, pull-ups, sit-ups) between age group 25-30 years were taken for the study.

Exclusion criteria: Adults with history of alcohol and tobacco consumption, smoking, diabetes, hypertension, cardio-respiratory illness and neuromuscular disorders were excluded from the study.

Sample size calculation: Based on the previous study work [7] sample size was calculated, by using the formula:

$$n = \frac{Z\alpha^2\sigma^2}{d^2}$$

Where, $\alpha=3.6$, standard deviation of work done

Z=standard normal variate

Type I error =5%

d =effect size, 5% of work done

Sample size n=200

Procedure

After enrolment for the study, a proper history was collected to confirm whether the participants were normal and healthy. As the subjects were involved in Mosso's muscle study, Closed type questions (yes/no) were asked relevant to musculoskeletal system like, any difficulty in doing daily living activity (like walking, writing, bathing), any altered sensation, pain, muscle weakness, injury in the upper extremity. Responses were noted and analysed. Demographic details like height (in meters) and weight (in Kg) were analysed. Pragmatic and Pessimistic statements of Perceived Stress Scale questionnaire was given. Perceived stress was evaluated through the scores obtained., (0-13) low stress, (14-26) moderate stress, (27-40) high stress [8].

In human beings, skeletal muscle contraction is recorded by the Ergograph. Function of flexor muscles of the fingers of hand, was evaluated by Mosso's Ergography and fatigue of skeletal muscle was also assessed using the same [1]. Forearm and finger were secured in the provided holder. Over a pulley, thick rope passes through, carrying a load of 3 kg, hooked to a sliding plate which is in turn attached through a sling to the flexor of middle finger. In the Mosso's ergograph, spring loaded writing ball point pen and a paper was set out on the bottom platform. On flexion of middle finger, load was raised and the distance was graphed in the paper attached to the sliding plate, in a graphical pattern known as Ergogram [1].

Subjects were given clear explanation about the study procedure and at the same time it was made sure that subject was in comfortable position. Clamps were used to fix the forearm. Index and ring finger placed into the metal tubes. Middle phalynx of the middle finger was let in the loop to be pulled. Three kg weight was put up and subject was asked to lift the weight. At 30/minute frequency, the metronome was adjusted [1]. By following the metronome beat, the subject was asked to pull and relax the index finger and make succession of maximal contraction without repositioning the shoulder. This had to be done recurrently, till the subject become powerless to lift the load and the readings were calculated from the recorded Ergogram.

Work done was computed by using the formula [9].

$$W=F \times D$$

where W = work done (in kilograms)

F= weight lifted (kg)

D (cm) = number of contractions \times average height of the contractions (A in cm)

$$\text{Where } A = \frac{\text{Area of the triangle} + \text{Area of rectangle}}{\text{Total length of the base}}$$

STATISTICAL ANALYSIS

Statistical data was analysed using Statistical Package for the Social Sciences (SPSS) software version 20.0. Stress level between two groups were calculated by unpaired t-test. Work done by both

the groups was assessed by Chi-square test. Pearson's correlation coefficient was used to find the association between stress and work done level in both the groups. The p-value <0.05 was taken as statistically significant.

RESULTS

A total of 200 male subjects participated in the study. Out of which 100 were sedentary adults and 100 were physically active adults between the age group 25-30 years. All the participants were healthy and don't had any complaints related to muscle study. All the participants responded to closed type questions asked while collecting the history. About 10% of sedentary adults and 1% physically active adults responded 'yes' to the question (any difficulty in doing daily living activities), sometimes they felt tiredness in doing the activity [Table/Fig-1]. In sedentary adult male, height in meters was 1.65 \pm 0.65 and weight in kilograms was 64.62 \pm 5.92. In physically active adults, height in meters was 1.68 \pm 0.81 and weight in kilograms was 55.63 \pm 5.85.

Descriptive analysis of the perceived stress score was done, 20% sedentary adults and 8% physically active adults were highly stressed [Table/Fig-2]. Work done by sedentary adults was lesser than physically active adults [Table/Fig-3]. The correlation between the work done by the muscle and stress level were calculated among the two groups in compliant with their stress category [Table/Fig-4]. The correlation done between work done by the muscle and stress level among stressed sedentary adults showed a significant negative correlation (p-value <0.05). For physically active adults, exercise enhanced their work done level, though a significant mild negative correlation between the work done by muscle and stress level (p-value <0.05).

Questions related to musculoskeletal history	Sedentary adults (n=100)		Physically active adults (n=100)	
	Yes	No	Yes	No
Response				
Any difficulty in doing daily activity	10	90	1	99
Any altered sensation	0	100	0	100
Pain in upper extremity	0	100	0	100
Muscle weakness	0	100	0	100
Any injury	0	100	0	100

[Table/Fig-1]: Response to the questions asked while history collection.

Stress Level	Sedentary adults (n=100)	Physically active adults (n=100)	p-value
Low stress (0-13)	54	78	0.001
Moderate stress (14-26)	26	14	0.001
High stress (27-40)	20	8	0.001

[Table/Fig-2]: Comparison of stress level between the two groups (n=100) sedentary adults and (n=100) physically active adults. (Unpaired t-test) p=0.001; bold p-values are significant

At 30/Minute	Sedentary adults	Physically active adults	p-value
Amount of work done (Kg/m)	25 \pm 3.8	35.2 \pm 2.3	<0.001

[Table/Fig-3]: Work done comparison between the two groups. (Chi-square test) data expressed as mean \pm sd, p<0.001; bold p-values are significant

Stress level (PSS)	Low stress	Moderate stress	High stress
Sedentary adults			
Pearson correlation (r-value)	0.011	-0.432	-0.835
p-value	<0.0001	0.037	0.007
Physically active adults			
Pearson correlation (r-value)	1.524	-0.012	-0.035
p-value	<0.0001	<0.0001	0.028

[Table/Fig-4]: Correlation between work done and stress level among sedentary adults and physically active adults. Pearson correlation test; bold p-values are statistically significant

DISCUSSION

This study was done to find the presence of stress among sedentary adults and physically active adults by using Cohen S perceived stress scale [8] and also the muscle strength among the two groups (work done by the muscle) by using Mosso's ergograph. The analysis inscribed the correlation between the stress level and work done by muscle among the two groups. Being physically active is connected with successful ageing. Sustained physical activity enhances survival and the ageing process, especially in view to the perception of stress and other diseases [9,10]. This study supports the statement as the sedentary adults were more stressed when compared to the physically active adults. Prolonged period of stress have a harmful effect on individual's health, which reduces the person's quality of life. Emotional and physical healths are neglected by those who undergo stress [9]. Stress hormones causes catabolism of muscle proteins, thereby decreasing the muscle strength [10]. It bring about oxidative damage in the skeletal muscle and thereby hinders with the quality and function [11]. The detrimental effects of physical inactivity are increased with the perception of high stress that inclines individuals to increased sympathetic nerve activity [11].

The study acknowledged that there was significant decrease in work done level (muscle strength) as the stress increased among the sedentary adults. Stress should be viewed as an independent risk factor for disability and other co-morbid conditions. Chronic physiological stress is also associated with a high oxidative stress, which quicken the cell ageing process that favours the development of diseases [12]. To avert and treat stress, depression and anxiety, it is clearer, that the very good method is regular practice of exercise [10-12]. Regular exercise will bring definite changes in mood which is essential for the psychological well-being and it also increase person's defiance to everyday stress [13,14].

Regular physical activity is responsible for reducing the activation of the sympathetic nervous system and cortisol in response to daily stressors. This physiological adaptation renders physically active adults less sensitive to stress triggers [14] and it also decreases their perceived stress levels. They are also more protected against the development of cardiovascular and metabolic disorders. Sousa CV et al., reported that individuals who practice regular exercise have lower scores of perceived stress and sedentary people have higher scores of perceived stress [10]. The result of this study supports the statement, as analysis confirmed a significant increase in stress level among sedentary adults when compared to physically active individuals and the work done by the physically active adults were more when compared to the sedentary adults. Muscle hypertrophy is the long-lasting outcome of exercise [15].

Consistently performing physical exercise increases the number and function of the mitochondria and there by enhance the skeletal muscle power and endurance [16,17]. Sedentary person goes into fatigue sooner. Fatigue is due to insufficient availability of nutrients like Adenosine Triphosphate (ATP), oxygen, creatine phosphate, neurotransmitter exhaustion and metabolite accumulation. Main site of fatigue is Central Nervous System (CNS) (synapse), then it involves the neuromuscular junction and last one to be fatigued is muscle [17]. Factors that control the onset of fatigue are types of training, muscle fibers and circulation. Regularly exercising individual muscles are supplied with adequate blood, thereby providing nutrients and the metabolic end products are removed [18-20].

Hormones released during stress have a negative metabolic effect in skeletal muscle. There exists a significant negative correlation between maximum voluntary contraction and stress level. Stress can induce earlier decline in muscle strength [21]. Stress factors had a negative correlation with the physical fitness of the individual, which further substantiate the results of this study [22,23]. The result of the study analysis showed negative correlation between work done by the muscle and stress level of the individual of both groups. So

stress not only affects the mental ability of a person but it also affects their physical fitness and quality of life. Stress should be considered as important risk factor that affect the muscle function [3].

Limitation(s)

Although the results were statistically significant, this study had certain limitations like small sample size and the stress hormones were not measured in this study. Despite these limitations, in this study correlation between work done by muscle and stress level was calculated.

CONCLUSION(S)

Persons who practiced regular exercise (physically active adults) had less perceived stress and increased work done by the muscle while sedentary adults had higher perceived stress and their muscle strength was also decreased. Significant negative correlation was found between work done by the muscle and stress level among both the groups. More research studies need to be done to understand the better relationship of the physical activity with perceived stress and the stress should be considered as important risk factor that affect muscle function. Stress reducing measures like yoga and simple exercises can be practiced to overcome stress and lead a better life.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: May 11, 2022
- Manual Googling: Aug 26, 2022
- iThenticate Software: Aug 29, 2022 (7%)

ETYMOLOGY: Author Origin**AUTHOR DECLARATION:**

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **May 07, 2022**Date of Peer Review: **Jun 11, 2022**Date of Acceptance: **Aug 30, 2022**Date of Publishing: **Oct 01, 2022**