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Association of Perceived Stress and Mid-Upper Arm Circumference with Muscle Performance Assessed by Mosso's Ergography in Young Adults of South India : A Cross-Sectional Study

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Abstract

Introduction: Young adults often experience high levels of stress due to academic pressure, lifestyle changes, and social factors. With the impact of stress being profound on all human systems, understanding the relationship between stress, diet, physical activity, anthropometric measures and muscle performance is important for promoting both mental and physical well-being. The primary objective of the present study was to correlate the perceived stress levels, anthropometric measures and work done calculated using Mosso's Ergograph in young adults **Methods:** An analytical cross-sectional study was conducted among healthy young adults (n=300), aged 18–25 years. Basic demographic details and anthropometric measures were recorded. Perceived stress was measured using the Cohen's Perceived Stress Scale (PSS-10). Work done was evaluated using Mosso's ergography. Statistical methods were employed to study associations between PSS scores, work done and other variables. **Results:** The study sample comprised of 300 healthy young adults (Male: 41.3%, Female: 58.7%) with a median age of 19 years (IQR: 18–22). Majority of the participants (78.3%) experienced moderate levels of perceived stress. Females had significant higher stress levels than males. Mean work done was 24 ± 10 kg.m2s2. About 60% of the study participants demonstrated excellent endurance based on work done using Mosso's ergography while 23.7% exhibited good endurance, 14% showed average performance, and 2% had poor endurance. Males (84.7%) achieved >20J of work when compared to females (43.2%), indicating excellent endurance performance among males. The association between dietary pattern, BMI, MUAC and work done was not statistically significant. A statistically significant but weak negative correlation was observed between work done and perceived stress scores (p = 0.019). **Conclusion:** Higher levels of perceived stress was associated with decreased muscle strength. The findings highlighted the need for awareness on the importance of physical activity and lifestyle modifications, especially among students experiencing increased stress and a decline in muscle performance.

Keywords: Perceived Stress, Work done, Mosso's Ergography

Asociación del estrés percibido y la circunferencia del brazo medio superior con el rendimiento muscular evaluado mediante ergografía de Mosso en adultos jóvenes del sur de la India: un estudio transversal

Resumen

Introducción: Los adultos jóvenes a menudo experimentan altos niveles de estrés debido a la presión académica, los cambios en el estilo de vida y los factores sociales. Con el impacto del estrés siendo profundo en todos los sistemas humanos, entender la relación entre el estrés, la dieta, la actividad física, las medidas antropométricas y el rendimiento muscular es importante para promover el bienestar mental y físico. El objetivo principal del presente

estudio fue correlacionar los niveles de estrés percibido, las medidas antropométricas y el trabajo realizado calculado utilizando el Ergógrafo de Mosso en adultos jóvenes. Métodos: Se realizó un estudio transversal analítico entre adultos jóvenes sanos (n = 300), de 18 a 25 años de edad. Se registraron detalles demográficos básicos y medidas antropométricas. El estrés percibido se midió utilizando la Escala de Estrés Percibido de Cohen (PSS-10). El trabajo realizado se evaluó utilizando la ergografía de Mosso. Se emplearon métodos estadísticos para estudiar las asociaciones entre las puntuaciones de PSS, el trabajo realizado y otras variables. **Resultados:** La muestra del estudio comprendió 300 adultos jóvenes sanos (hombres: 41,3%, mujeres: 58,7%) con una edad media de 19 años (RIC: 18-22). La mayoría de los participantes (78,3%) experimentaron niveles moderados de estrés percibido. Las mujeres tuvieron niveles de estrés significativamente más altos que los hombres. El trabajo medio realizado fue de 24 ± 10 kg.m2s2. Alrededor del 60% de los participantes del estudio demostraron una excelente resistencia basada en el trabajo realizado utilizando la ergografía de Mosso, mientras que el 23,7% exhibió buena resistencia, el 14% mostró un rendimiento promedio y el 2% tuvo una resistencia pobre. Los hombres (84,7%) lograron >20J de trabajo en comparación con las mujeres (43,2%), lo que indica un excelente rendimiento de resistencia entre los hombres. La asociación entre el patrón dietético, el IMC, el MUAC y el trabajo realizado no fue estadísticamente significativa. Se observó una correlación negativa estadísticamente significativa pero débil entre el trabajo realizado y las puntuaciones de estrés percibido (p = 0,019). **Conclusión:** Un mayor nivel de estrés percibido se asoció con una disminución de la fuerza muscular. Los hallazgos destacaron la necesidad de concienciar sobre la importancia de la actividad física y las modificaciones del estilo de vida, especialmente entre los estudiantes que experimentan un mayor estrés y una disminución del rendimiento muscular.

Palabras Clave: Estrés percibido, Trabajo realizado, Ergografía de Mosso

Introduction

Globally, stress is a serious public health issue, especially for young adults. According to the World Health Organization (WHO), stress-related illnesses account for a sizeable portion of the worldwide disease burden. Stress can influence people across age groups, gender, race, and environments, and can influence both physical and psychological health. Dimitrov (2017) reported that almost 61% of college students experienced high levels of stress. Gao (2023) reported that 70% of Indians suffer from stress and its consequences whereas young adults with academic and vocational stress.

Emerging evidence suggests that chronic stress might impair muscle function through mechanisms such as increased cortisol levels, which can lead to muscle catabolism and reduced neuromuscular efficiency (Chu et al. 2025). Also, long-term exposure to elevated cortisol levels has been linked to reduced protein synthesis, muscular atrophy, and poor muscle recovery after exercise (Hartig et al. 2020). Existing literature has primarily focused on older population or athletes, limiting the generalizability of findings to the young adults in non-athletic settings (Meredith et al.2023). Very few studies have integrated subjective measures of perceived stress with objective assessments of muscle strength and endurance (Stults-Kolehmainen & Sinha, 2014). Hence, the primary objective of the present study was the first attempt to correlate the perceived stress levels, anthropometric measures and work done calculated using Mosso's Ergograph in young adults of South India.

Materials and Methods

The present study was an analytical cross-sectional study conducted at Sri Ramachandra Medical College and Hospital, Chennai, India. Ethics approval was obtained from the Institutional Ethics Committee. Consent was taken from each participant. Young adults (n=300) of 18 and 25 years of age and both sexes were recruited using non-purposive convenience sampling. The participants were healthy individuals who abstained from physical activity and caffeine for 24 hours prior to testing. Exclusion criteria included history of smoking, alcohol or substance use, chronic illness (e.g., diabetes, hypertension), neuromuscular disorders, and drug intake affecting muscle or stress response. Demographic details (age, gender, dietary habits) were collected using a proforma.

Anthropometric measurements were recorded by a single trained examiner using standardized methods of International Society for the Advancement of Kinanthropometry (ISAK). Height was measured using a stadiometer with the participant standing barefoot, heels together, and head in the horizontal plane. The value was recorded to the nearest 0.1 cm. Weight was measured using a digital weighing scale with participants wearing light clothing and no footwear. The measurement was noted to the nearest 0.1 kg. Body Mass Index (BMI) was calculated using the standard formula: weight in kilograms divided by the square of height in meters (kg/m²). Based on the Asia-Pacific

classification, participants were categorized as underweight (<18.5), normal (18.5–24.9), overweight (25–29.9), or obese (≥30).

Mid-Upper Arm Circumference (MUAC) was measured at the midpoint between the acromion process and the olecranon process of the relaxed, non-dominant arm using an anthropometric tape. The circumference was recorded to the nearest 0.1 cm. MUAC values were interpreted as follows: <23 cm - underweight, 23–32 cm - normal, and >32 cm - overweight/obese. Following the measurements, the Perceived Stress Scale (PSS-10) was administered to quantify stress levels. Scores ranged from 0 to 40 and the participants were categorized as Low (0–13), Moderate (14–26) and High (27–40) stress levels based on the calculated scores.

Work done by the forearm muscles was assessed using Mosso's Ergograph, which records voluntary isotonic contractions of the middle finger against a standard load. The participant was seated comfortably with the forearm positioned on a flat wooden board of the ergograph. The forearm was fixed using clamps to prevent movement. The index and ring fingers were secured in metal holders, while the middle finger remained free and was connected to a weight via a thread that passed over a pulley. A standard load of 1.5–2 kg was attached to the pulley system. All measurements were conducted in a controlled environment, maintaining consistent testing. Participants were instructed to perform rhythmic flexion movements of the middle finger in time with a metronome until they could no longer lift the weight, indicating the onset of fatigue. Each upward movement of the finger lifted the weight, and the vertical displacement was recorded on a moving paper via a lever mechanism. Work done was calculated and expressed in $kg \cdot m^2 \cdot s^{-2}$. Statistical Analysis was done performed using Stata version 17.

Results

Table 1. Demographic and Anthropometric characteristics of study population (n=300)

Characteristics	**N (%)**
Age, median (IQR)	19 (18,22)
Gender	
Male	124 (41.3)
Female	176 (58.7)
Education	
Dental	40 (13.3)
Allied Health Sciences	67 (22.3)
Medical	34 (11.3)
Paramedical	159 (53.1)
Type of diet	
Mixed diet	255 (85)
Vegetarian	40 (13.3)
Others	5 (1.7)
Anthropometric characteristics	
Height (cm), mean (SD)	165 (10.9)
Weight (kg), mean (SD)	62.1 (13.5)
Body Mass Index (kg/m^2), mean (SD)	22.8 (4.4)
BMI classification	
Underweight	44 (14.7)
Normal	125 (41.7)
Overweight	54 (18)
Obese	77 (25.6)
Mid-arm circumference, mean (SD)	30.3 (5.3)

Mid-upper Arm Circumference (MUAC)	
Underweight / Undernourished	15 (5)
Normal	178 (59.3)
Overweight/obese	107 (35.7)

Table 1 presents the demographic and anthropometric characteristics of the study sample. Considering the dietary habits, majority of the participants (85.0%, n = 255) followed a mixed diet, while 13.3% (n = 40) were vegetarians, and 1.7%, (n = 5) reported other dietary patterns. Anthropometric analysis showed that the mean height was 165.0 cm (SD ±10.9), and the mean weight was 62.1 kg (SD ±13.5). Based on standard Asian cut offs BMI, 14.7% (n = 44) were underweight, 41.7% (n = 125) had a normal BMI, 18.0% (n = 54) were overweight, and 25.6% (n = 77) were classified as obese. Mid-Upper Arm Circumference (MUAC) as per (15) 5% (n = 15) of participants were found to be underweight or undernourished, while 59.3% (n = 178) fell within the normal range. Additionally, 35.7% (n = 107) were categorized as overweight or obese.

Among the 300 participants assessed for perceived stress levels, 78.3 % (n=235) experienced moderate stress, while 11.7% (n=35) individuals reported high stress levels. Only 30 participants (10%) exhibited mild stress. A statistically significantly higher number of females belonged to “high stress” category (15.3%) when compared to males (6.4%) (p=0.047). (Table 2)

Table 2. Association between Gender and Perceived Stress Levels **(n=300)**

Perceived Stress Levels	Gender		Chi-square p-value
	Male	Female	
Mild	15 (12.1)	15 (8.5)	**0.047***
Moderate	101 (81.5)	134 (76.1)	
High	8 (6.4)	27 (15.3)	

*- p<0.05 was considered to be statistically significant.

Data analysis revealed that moderate stress was common across all educational backgrounds, with MBBS students reporting the highest (85.3%) and the “paramedical” group showing the highest proportion of high stress (16.4%). Despite visible variations, the association between education and perceived stress levels was not statistically significant (p=0.114). Perceived stress levels did not significantly differ across BMI categories (p = 0.892), with moderate stress being predominant in all groups. Chi-square test of association revealed no statistically significant relationship between perceived stress levels and BMI categories (p=0.892).

Using Mosso’s ergography, mean work done was calculated to be 24 ± 10. Based on the work done, the participants were divided into five categories of endurance performance as shown in Table 3.

Table 3. Distribution of performance category by work done (n=300)

Performance category	N (%)
Excellent endurance (> 20 J)	181 (60.3)
Good endurance (15-20J)	71 (23.7)
Average performance (10-15J)	42 (14)
Poor endurance (5-10J)	6 (2)
Very poor performance (<5J)	0 (0)

Correlation between gender and work done was statistically significant across all categories. (Table 4) A large proportion of males (84.7%) demonstrated excellent endurance, while only 43.2% of females achieved this level. In contrast, a greater percentage of females fell into the good (30.7%) and average (22.7%) endurance categories, while 3.4% classified under poor endurance category.

The distribution of endurance performance (excellent, good, average, poor) did not differ significantly across dietary habits, BMI and MUAC based categories (p=0.641, p = 0.853 and p = 0.696, respectively). While a majority of participants in all BMI categories and MUAC categories exhibited excellent endurance, the statistical tests indicated no significant association between BMI or MUAC and work done (endurance performance levels).

The correlation between perceived stress scores and work done was analysed using Spearman's rank correlation coefficient.

Table 4. Correlation between Gender and Work Done

Work done (m)	Gender (%)		Chi-square p-value
	Male	Female	
Excellent endurance	105 (84.7)	76 (43.2)	**<0.001***
Good endurance	17 (13.7)	54 (30.7)	
Average performance	2 (1.6)	40 (22.7)	
Poor endurance	0 (0)	6 (3.4)	

Though weak, a statistically significant negative correlation was observed between perceived stress and work done (ρ = -0.14, p = 0.019), indicating that higher levels of stress were associated with lower physical work output.

Discussion

Muscle strength and endurance are key indicators of physical fitness and overall health.. Chronic psychological stress activates the hypothalamic-pituitary-adrenal (HPA) axis, resulting in elevated cortisol levels, effects of, heightened catabolism on muscle tissue, reducing muscle protein synthesis and impairing muscle function and repair. A decline in maximal voluntary contraction and muscular endurance is anticipated in individuals with higher levels and duration of stress. Furthermore, stress-induced alterations in autonomic regulation might also affect the blood flow to skeletal muscles, exacerbating fatigue and reducing performance. The focus of the current analytical cross-sectional study was to investigate the relationship between perceived stress levels and muscle strength and endurance among young adults

The present study demonstrated a statistically significant upward trend in childhood obesity indicating a consistent and concerning increase in obesity rates among South Asian youth in recent decades. Nearly 44% of participants were either overweight or obese, highlighting a potential public health concern among young adults similar to the study results of Bansal et al, 2024. The MUAC data of the study population categorised over one-third of the participants as overweight/obese. The results pointed towards a notable proportion of participants with increased upper-body adiposity or muscle mass indicating the need for early lifestyle interventions. The results were also indicative of the shifting nutritional burden from undernutrition to overnutrition in Indian youth reported in recent literature. In a South Indian population-based study, MUAC cut-off values of >30.5 cm for males and >28.3 cm for females were found to correlate strongly with a BMI ≥25 kg/m², indicating overweight or obesity status (Gallagher et al., 2000).

A striking finding in the present study was that 78.3% of participants experienced moderate levels of perceived stress (females > males) indicating a significant subset that might require psychological attention or intervention. The pattern was highly consistent with existing literature conducted among students in healthcare-related disciplines, where academic pressure, performance anxiety, and future uncertainty were frequent contributors to elevated stress levels (Dyrbye et al. (2005). The stress distribution of the current study also aligned with regional studies conducted among college students in Chennai and other parts of Tamil Nadu (Mantur et al. 2025).

In the present study, PSS scores did not significantly differ across BMI categories (p = 0.892), with moderate stress being predominant in all groups. The above findings were consistent with previous literature indicating an inconsistent or weak association between BMI and perceived stress, suggesting that body composition alone might not be a strong predictor of psychological stress levels. (Gariepy et al, 2010) The moderate stress could be attributed to the multifactorial nature of stress perception, which is influenced by a variety of psychosocial, environmental, and behavioural factors beyond anthropometric measures.

Mean work done in young adults was found to be (24±10 $kg \cdot m^2 \cdot s^{-2}$)It can also be represented as 24±10 Joules because gravity is included in the calculation process. The observed values were very similar with the finding of Rani et al. (2022) where an average value of 25±3.8 kg·m (equivalent to 24.5 $kg \cdot m^2 \cdot s^{-2}$ or J) were observed. Further, Mohan et al. (2016) reported similar values of mean work done in males and females - 22.9 ± 3.6 and 23 ± 3.3 kg/m, respectively. (equivalent to 22.4 and 22.5 $kg \cdot m^2 \cdot s^{-2}$ / Joules in males and females). Work done calculated from the ergogram can be categorized and interpreted meaningfully in educational or experimental physiology settings.

While Mosso's ergography is a qualitative and semi-quantitative method, the calculated "work done" could be used to draw inferences in research settings as Within-Subject Comparisons (intra-individual - before and after exercise, with and without mental arithmetic, before and after sleep, non-dominant Vs dominant hand) or Between-Subject Comparisons inter-individual - trained versus untrained, between genders, age groups and other sociodemographic variables). Table 5 represented the cut-offs values for work done.

Table 5. Performance categories based on mechanical work done

Work Done (J)	Performance Category
> 20 J	Excellent endurance
15–20 J	Good endurance
10–15 J	Average performance
5–10 J	Poor endurance
< 5 J	Very poor performance

The study population was stratified into five endurance performance categories based on the calculated work done. Notably, 60.3% of participants demonstrated excellent endurance (>20J), followed by 23.7% with good endurance. Only 2.0% fell into the poor endurance category, and none showed very poor performance. The results of the present study implied that the majority of participants possessed considerable endurance capacity. In the present study. mean work done was significantly higher in individuals of overweight and obesity categories of BMI. The findings were similar to the studies of Mohan et al, 2016 and Rani et al, 2022.

The present study showed significant association between gender and work done. Most males fell into the "excellent endurance" category, while only 43.2% of females achieved the same. Notably, no male participants were found in the poor category, indicating a considerable disparity in endurance capacity between the genders. The study findings could be attributed to the higher muscle mass and strength seen in males due to greater concentrations of testosterone, which promotes muscle hypertrophy and protein synthesis as explained by Lemon PW, (1999).

Lack of a significant association between MUAC and work done in the present study might be due to the multifactorial influence on work done (endurance performance), by muscle mass, cardiovascular fitness, neural drive, motivation, and metabolic factors While individuals in the overweight category had the highest percentage of excellent endurance (66.4%) compared to the normal (56.7%) and underweight (60%) groups, the differences were not statistically significant. The finding highlighted that although larger muscle mass (reflected by higher MUAC) might provide a biomechanical advantage, endurance performance is not solely dependent on muscle girth. Despite the higher prevalence of mixed diet in the study population, no statistically significant differences were observed across dietary groups with work done. The findings were similar to the reports of Nieman (1999).

A statistically significant but weak negative correlation was observed between perceived stress and work done ($\rho = -0.14$, $p = 0.019$). The absence of certain significant associations in the present study could be due to several factors. Firstly, the dietary categories used (mixed, vegetarian, others) were broad and might not accurately reflect the nutrient quality or caloric adequacy of individual diets. Secondly, muscle function was modulated by various confounders including hydration status, habitual physical activity, psychological stress, and sleep and the study had variables that might not have been fully controlled or assessed. Thirdly, the small size of the certain sub groups on stratification reduced the power to detect statistically meaningful differences.

Conclusion

The study revealed that moderate stress was prevalent among young adults, with females exhibiting significantly higher stress and males demonstrating superior endurance and strength. BMI and MUAC were positively but not significantly associated with muscle performance while perceived stress showed a significant but weak negative correlation with work done The present study highlights the need for awareness among the students about stress and its role in muscle function and performance, incorporating regular physical activity and life style modifications to combat stress due to academics and other pressures in adolescence. Future studies with larger and more balanced samples, detailed dietary analysis, and control for physical activity and stress will enhance the understanding of the complex relationship between stress and muscle performance.

References

Bansal, D., VS, M.S., Devi, N., Boya, C., Dhora Babu, K., Dutta, P. (2024). Trends estimation of obesity prevalence among South Asian young population: a systematic review and meta-analysis. *Scientific Reports*, 14(1), 596. https://doi.org/10.1038/s41598-023-50973-w

Chu, B., Marwaha, K., Sanvictores, T., Awosika, A.O., Ayers, D. (2024). Physiology, stress reaction. In StatPearls [Internet]. *StatPearls Publishing*. https://www.ncbi.nlm.nih.gov/books/NBK541120/

Dimitrov, G. (2017). A study on the impact of academic stress among college students in India. *Ideal Research: An International Multidisciplinary*, 2(4), 21-34.

Dyrbye, L.N., Thomas, M.R., Shanafelt, T.D. (2005). Medical student distress: causes, consequences, and proposed solutions. *In Mayo Clinic Proceedings*, 80(12), 1613-1622. https://doi.org/10.4065/80.12.1613

Gallagher, D., Heymsfield, S.B., Heo, M., Jebb, S.A., Murgatroyd, P.R., Sakamoto, Y. (2000). Healthy percentage body fat ranges: an approach for developing guidelines based on body mass index. *The American journal of clinical nutrition*, 72(3), 694-701. https://doi.org/10.1093/ajcn/72.3.694

Gao, X. (2023). Academic stress and academic burnout in adolescents: a moderated mediating model. *Frontiers in psychology*, 14, 1133706. https://doi.org/10.3389/fpsyg.2023.1133706

Gariepy, G., Nitka, D., Schmitz, N. (2010). The association between obesity and anxiety disorders in the population: a systematic review and meta-analysis. *International journal of obesity*, 34(3), 407-419. https://doi.org/10.1038/ijo.2009.252

Hartig, E.I., Zhu, S., King, B.L., Coffman, J.A. (2020). Chronic cortisol exposure in early development leads to neuroendocrine dysregulation in adulthood. *BMC Research Notes*, 13(1), 366. https://doi.org/10.1186/s13104-020-05208-w

Lemon, P.W. (1995). Do athletes need more dietary protein and amino acids?. *International Journal of Sport Nutrition and Exercise Metabolism*, 5(s1), S39-S61. https://doi.org/10.1123/ijsn.5.s1.s39

Mantur, V.S., Hiremath, S.S., AN, K. (2022). A Study of Impact of Examination Stress on Musculoskeletal Strength and Fatigue using Mosso's Ergo Graph in first year Medical Students. *Medica Innovatica*, 11(2).

Meredith, S.J., Cox, N.J., Ibrahim, K., Higson, J., McNiff, J., Mitchell, S., Rutherford, M., Wijayendran, A., Shenkin, S.D., Kilgour, A.H.M., Lim, S.E. (2023). Factors that influence older adults' participation in physical activity: a systematic review of qualitative studies. *Age and ageing*, 52(8), afad145. https://doi.org/10.1093/ageing/afad145

Mohan, S., Geetha, M.B., Padmavathi, R. (2016). Study of muscle function in young adults. *Scholar's journal of applied medical sciences*, 4 (7A), 2348-52. http://dx.doi.org/10.21276/sjams.2016.4.7.8

Nieman, D.C. (1999). Nutrition, exercise, and immune system function. *Clinics in sports medicine*, 18(3), 537-548. https://doi.org/10.1016/S0278-5919(05)70167-8

Rani, S. V., Bhavani, R. L., & Sasikumar, S. (2022). Effect of Stress in Muscle Function between Sedentary and Physically Active Adults using Mosso's Ergograph: A Cross-sectional Study. *Journal of Clinical & Diagnostic Research*, 16(10), cc01- cc04. https://doi.org/10.7860/JCDR/2022/57614.17090

Stults-Kolehmainen, M.A., Sinha, R. (2014). The effects of stress on physical activity and exercise. *Sports medicine*, 44(1), 81-121. https://doi.org/10.1007/s40279-013-0090-5

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