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Original Research Article

PHYSICAL ACTIVITY, BODY MASS INDEX (BMI) AND ITS ASSOCIATION WITH STRESS AMONG SCHOOL ADOLESCENTS IN WESTERN UTTAR PRADESH

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ABSTRACT

Background: Adolescence is a critical developmental stage where lifestyle factors such as physical activity and nutritional status influence both physical and mental health. Research has highlighted the inadequate physical activity as well as high levels of stress among adolescents due to numerous factors. Body Mass Index (BMI) is a widely used measure to assess nutritional status, while physical activity has been associated with multiple benefits along with reducing the stress. However, evidence on their combined impact on stress related outcomes remains mixed. This study aimed to examine the relationship between physical activity, BMI, and stress among Indian school-going adolescents.

Materials and Methods: A cross-sectional study was conducted among 260 adolescents aged 15–17 years, sampled from secondary schools. Anthropometric measurements were taken to calculate BMI, and physical activity was assessed using the Global Physical Activity Questionnaire (GPAQ). Stress levels were assessed using the Perceived Stress Scale (PSS). Data were analyzed using descriptive statistics, Chi-square tests, and logistic regression models, with significance set at $p < 0.05$.

Results: More than half of the students (58.3%) had normal BMI, while 23.5% were underweight, 15.0% overweight and 3.2% obese. Physical activity levels were predominantly moderate (49.6%), followed by low (37.3%) and high (13.1%). High stress was reported by 27.6% of participants and moderate stress by 56.8%, with 15.6% in the low-stress category. Logistic regression showed that physical activity was a significant predictor of stress ($p = 0.046$), while BMI was not significant ($p = 0.926$).

Conclusion: Physical activity plays a stronger role than BMI in reducing stress among adolescents. While BMI status alone was not a significant predictor, the moderate prevalence of underweight highlights ongoing nutritional concerns. School-based interventions focusing on physical activity and nutrition may help reduce stress and promote adolescent well-being.

Keywords: Adolescents; Physical activity; Stress; BMI

INTRODUCTION

Stress refers to any changes that cause physiological or psychological strain.[1] It can be described as the way one deals with expectations and pressure from the environment that can be experienced as threatening or overwhelming by an individual.[2] While Perceived stress is the extent to which certain situations are judged to be stressful.[3]

Adolescence is a critical period of physical, cognitive, and psychosocial development, where lifestyle factors such as physical activity, diet, and body composition significantly influence long-term health outcomes.[4,5]

Stress during adolescence is a major concern in India, where academics and peer competition, contribute significantly to psychological strain.[6] Adolescent Stress has multiple determinants like family life, School performance, Peer pressure Conflicts in the

school & Financial pressure, but growing evidence highlights the role of physical activity and BMI.[7,8] Poor interpersonal relationships, high parental expectations, and severe academic burdens, all of which may bring about psychological distress, mental exertion, and psychological burdens, expose adolescents to increasing psychosocial stress.[9]

Physical activity is defined as any bodily movement produced by the contraction of skeletal muscles that result in a substantial increase in caloric requirements over resting energy expenditure.[10] It is in fact a 'physiological stressor' placed on the body, when done properly; it has the benefit of buffer¬ing psychological stress, enhancing immunity and improve psychological state.[11] Physical activity has been shown to enhance cerebral blood flow, stimulate neurogenesis, and improve executive functions.[12]

The World Health Organization (WHO) recommends that adolescents engage in at least 60 minutes of moderate-to-vigorous physical activity daily.[13] Globally, 23% adults and 81% school going children are inactive, failing to meet WHO recommendation on physical activity.[14] According to World Health Organization (WHO), 1.6 million deaths are caused by physical inactivity.[15]

BMI remains the most widely used tool to classify underweight, normal weight, overweight, and obesity. Excess weight in adolescence increases the risk of chronic diseases,[16] while both underweight and obesity are linked to poorer academic outcomes through nutritional deficiencies or psychosocial stress.[17-19]

Studies suggest that active adolescents perform better in school, while obesity is associated with reduced scores and engagement.[20] The relationship is, however, complex and multidirectional, influenced by gender, socioeconomic status, family size, parental education, food preferences and physical activity.[21,22] Understanding this interplay is crucial for designing effective interventions. This study aimed to examine the relationship between physical activity, BMI, and perceived stress among Indian school-going adolescents.

MATERIALS AND METHODS

Study Design and Setting

A cross-sectional study was conducted to examine the relationship between physical activity, BMI, and stress levels among school-going adolescents. Data were collected from selected secondary schools in urban and semi-urban areas of Moradabad, Uttar Pradesh (W) during the period of March 2025 to August 2025 in the field practice area of Teerthanker Mahaveer Medical College and Research centre.

Study Population and Sampling

The study population included adolescents aged 15 to 17 years, enrolled in grades 9 to 11. A sample of 260 participants was obtained using convenience sampling of schools, followed by stratified random sampling within each school to ensure gender and age representation. Adolescents with chronic illnesses, physical disabilities limiting physical activity and who did not provide the assent, were excluded.

Sample Size

The sample size was determined using the standard formula: $n = Z^2pq/d^2$, where Z = 1.96 for a 95% confidence interval, p = 17 %(23), q = 1 – p, and d = 5% (absolute allowable error). Sample size calculated was 216. But conveniently we have included 260 subjects' data in our study.

Data Collection Tools and Procedures

Height was measured to the nearest 0.1 cm using a stadiometer, and weight to the nearest 0.1 kg with a calibrated digital scale. BMI was calculated as weight (kg)/height (m^2) and categorized according to WHO growth reference standards for adolescents.

Physical activity was assessed using the Global Physical Activity Questionnaire (GPAQ) Version 2 was developed by WHO for physical activity surveillance. It collects information on physical activity participation in three settings (or domains) as well as sedentary behaviour, comprising 16 questions. The 3 domains of the questionnaire are: activity at work, travel to and from places and recreational activities.[24]

The intensity of any activity is expressed as metabolic equivalent (MET). The definition of MET is the value of energy spent while a person is at rest and amounts to caloric consumption of 1 kcal/kg/h. Moderate activity at work, travel, and recreation amounts to four METs while vigorous activity amounts to eight METs. This measurement is categorized into three levels of physical activity in MET-minutes/week which are high (≥ 3.000 MET), moderate (≥ 600 or < 3.000 MET), and low (< 600 MET).[24]

Stress levels were measured using the Perceived Stress Scale (PSS). The Perceived Stress Scale (PSS), validated for individuals aged 12 years and above, has been widely applied in adolescent populations to measure subjective stress. The question in PSS asked about the feelings and thoughts during the last month. The PSS-10 scale measures the level of stress in the life of individuals. In the four items (items 4, 5, 7, and 8), scores are reversed (0 = 4, 1 = 3, 2 = 2, 3 = 1, 4 = 0) and then summed across all scale items. PSS classifies participants into low (0-13), moderate (14–27), and high (28–41) stress categories.[25]

Data Analysis

Data were analyzed using SPSS version 24. Descriptive statistics summarized participant characteristics. Associations between BMI, physical activity, and stress levels were examined using Chi-square tests for categorical variables and Pearson's correlation for continuous variables. Logistic regression was performed to identify predictors of stress, adjusting for age, gender. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 260 adolescents participated in the study (54.6 % male, 45.4% female). (Table 1)

Table 1: Participant Characteristics

Variable	Category	N	%
Gender	Male	142	54.6%
Gender	Female	118	45.4%

The mean BMI was 20.7 ± 4.7 kg/m². Nearly half (58.3%) were normal, 23.5% underweight, 15.0% overweight, and 3.2% obese (Table 2). The mean Physical activity score was 18.5 ± 3.9, with 49.6% reporting moderate activity, 37.3% fell into low category group while 13.1% confirmed high physical activity. (Table 2)

Table 2: Body Mass Index and Physical Activity (N=260)

BMI	N	%
Underweight/Thin	61	23.5
Normal	152	58.3
Overweight	39	15.0
Obese	8	3.2
Physical Activity (GPAQ)	**N**	**%**
Low	97	37.3
Moderate	129	49.6
High	34	13.1

High stress was reported by 27.6% of participants and moderate stress by 56.8%, with 15.6% in the low-stress category. (Table 3)

Table 3: Perceived Stress

Category	N	%
Low stress	41	15.6
Moderate stress	147	56.8
High stress	72	27.6

The logistic regression model improved fit compared to the intercept-only model ($\chi^2 = 11.695$, $p = 0.306$). Physical activity was a significant predictor of stress ($p = 0.046$), while BMI was not significant ($p = 0.926$). (Table 4)

Table 4: Regression Analysis

Predictor	χ^2	Df	p-value
BMI criteria	2.123	6	0.926
PA criteria	9.710	4	0.046*

Significant at p < 0.05

DISCUSSION

This study investigated the relationship between physical activity, body mass index (BMI), and perceived stress among school adolescents. The findings revealed more than half of the adolescents had moderate level of stress while one in every four adolescent is dealing with the high level of stress though low stress levels were reported by approximately one in seven adolescents. This is concerning, as adolescence is a critical developmental period where academic pressures, examination competition, and social expectations converge, particularly in the Indian context.[26,27]

The high stress prevalence observed in this study is comparable to reports from other Indian school-based studies that have highlighted examination stress, peer comparison, and limited coping resources as key stressors.[28] International surveys such as the Health Behaviour in School-aged Children (HBSC) report similarly identified rising stress among adolescents worldwide.

However, the just 15.6% adolescents in the low-stress category in this sample underscores the acute academic intensity faced by Indian students, a pattern that may be more pronounced compared to Western contexts.[29]

Nutritional status analysis showed that 23.5% of adolescents were underweight, while 18.2% were overweight or obese. This dual burden of malnutrition is consistent with findings from low- and middle-income countries where undernutrition and obesity coexist.[30]

Underweight prevalence in this study was higher than global averages, raising concerns about inadequate dietary intake, socioeconomic barriers, and cultural influences on eating behaviour.[31]

A meta-analysis of data from 57 LMICs found much lower prevalence of undernutrition (5.5%) as compared to overweight/obesity (21.4%),),[32] Contrarily, a study among adolescent girls in

Barabanki district of Uttar Pradesh found much higher prevalence of underweight (47%) than overweight/obese (8.6%).[33]

Underweight adolescents may be at risk for micronutrient deficiencies that impair memory, concentration, and cognitive development.[34]

Conversely, overweight and obese adolescents are more likely to experience psychosocial distress, stigma, and bullying, which can further increase stress levels and reduce academic engagement.[35]

Interestingly, BMI was not a significant predictor of stress in this study, echoing findings from other research that weight status alone does not determine stress levels unless mediated by other external factors.[36] Although a study conducted in Dhaka revealed significant association of BMI with stress among adolescents.[37]

In contrast, physical activity emerged as a robust predictor of stress levels. Adolescents engaging in moderate-to-high activity reported significantly lower stress levels than their less active peers. This aligns with evidence that physical activity has beneficial effects on mood, stress regulation, and academic performance.[38] Beyond physiological mechanisms, psychosocial pathways are also important: participation in physical activity fosters self-confidence, social support, teamwork, and goal setting, all of which strengthen coping skills.[39]

Previous systematic reviews have consistently concluded that physically active adolescents demonstrate improved attention, executive functions, and academic performance compared to inactive peers.[40] These results suggest that promoting regular activity could serve as both a preventive and therapeutic approach to adolescent stress. This is particularly important given that WHO estimates more than 80% of adolescents worldwide fail to meet daily physical activity recommendations.[15]

Future studies should therefore adopt longitudinal and multi-dimensional approaches to fully capture the complex determinants of adolescent stress.

This study has several implications for public health and education policy. Schools should integrate structured physical education and extracurricular sports into curricula without compromising academic learning. Nutrition programs targeting underweight adolescents are equally essential to address deficiencies and prevent cognitive impairments. Moreover, psychosocial interventions such as peer-support networks, stress management workshops, and accessible counseling services must be embedded within school health frameworks. Taken together, these interventions can foster resilience and promote healthier, more motivated student populations.

Limitations

Limitations of this study include its cross-sectional design, which precludes causal inference. Self-reported physical activity may be prone to recall bias, and stress was measured only through the PSS rather than triangulated with clinical measures. Despite these limitations, the study adds to growing literature by providing region-specific evidence on the role of physical activity in mitigating stress among adolescents in India. Future research should use longitudinal designs, objective activity monitoring (e.g., accelerometers), and broader psychosocial assessments to strengthen causal conclusions.

CONCLUSION

In conclusion, this study supports the evidence that physical activity is a more important determinant of adolescent stress than BMI status. Addressing underweight prevalence, promoting physical activity, and integrating psychosocial support are essential steps in creating healthier school environments that foster both academic achievement and mental well-being.

This study demonstrates that physical activity is a stronger predictor of stress levels than BMI among Indian adolescents. While BMI status alone was not significant, the high prevalence of underweight highlights nutritional concerns. School-based interventions promoting physical activity, healthy nutrition, and psychosocial support are essential for reducing stress and supporting academic success in adolescents.

REFERENCES

1. VandenBos GR. APA Dictionary of Psychology. 2nd edition. Washington DC: American Psychological Association; 2015.
2. Lazarus RS, Folkman S. Cognitive theories of stress and the issue of circularity. Dynamics of stress: Springer; 1986. p. 63–80.
3. Cohen S, Kamarck T, Mermelstein R. Perceived stress scale. Measuring stress: A guide for health and social scientists. New York: Oxford University Press; 1997.
4. Patton GC, Sawyer SM, Santelli JS, Ross DA, Afifi R, Allen NB, et al. Our Future: the Lancet Commission on Adolescent Health and Wellbeing. Lancet. 2016 Jun11;387(10036):2423–78
5. Ahmed A, Yasui Y, Kokubo Y, Kat Y , Matsumoto C, Teramoto M, et al. Lifestyle Behaviors of Childhood and Adolescence: Contributing Factors, Health Consequences, and Potential Interventions. Am J Lifestyle Med. 2024 Apr 12:15598276241245941. Online ahead of print. doi: 10.1177/15598276241245941
6. Gautam B, Sharma V. Effect of Peer Pressure on Academic Stress among Adolescents. The International Journal of Indian Psychology. 2024 Sept;12(3):2129-34
7. Dighe SV. An Exploratory Study to Assess the Factors Responsible for Stress among the Adolescents Studying at Select School of Rahata Tehsil, Ahmednagar District, M. S. Indian J Nurs Sci. 2023 Mar;8(1):1-4
8. Liu P. Stress buffering effects of physical activity in adolescents: the moderating role of physical activity attitudes. BMC Public Health. 2025 Feb 5;25:463.
9. Xi W, Ma LP. Influence Factors and Group Difference in Adolescents Mental Health: a Multilevel Analysis based on CEPS Data. JSI. 2018;33(04):116–23.
10. Caspersen C, Powell K, Christenson G. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. 1985;100(2):126-31.
11. Lou H, Yan J. Psychoneuroimmunity pathway and suggestion of Physical Exercise to cope with stress in the Epidemic Situation of Serious Infectious diseases. CSST. 2020;56(5):37–42.

12. Donnelly JE, Hillman CH, Castelli D, Etnier JL, Lee S, Tomporowski P, et al. Physical activity, fitness, cognitive function, and academic achievement in children: a systematic review. Med Sci Sports Exerc. 2016;48(6):1197–222.
13. Guthold R, Stevens GA, Riley LM, Bull FC. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1.6 million participants. Lancet. Child Adolesc Health. 2020;4(1):23–35.
14. World Health Organization. Facts in pictures. Physical Activity. Switzerland: World Health Organization. 2018 Feb 26. Available at https://www.who.int/news-room/facts-inpictures/detail/physical-activity
15. GBD 2016 Mortality Collaborators. Global, regional, and national under5 mortality, adult mortality, age specific mortality, and life expectancy, 1970-2016: A systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2017 Sep 16;390(10100), 1084–150.
16. Dwivedi AK, Dubey P, Cistola DP, Reddy SY. Association between obesity and cardiovascular outcomes: updated evidence from meta-analysis studies. Curr Cardiol Rep. 2020 Mar 12;22(4):25.
17. Frayon S, Swami V, Wattelez G, Nedjar- Guerre A, Galy O. Associations between academic achievement and weight status in a multi-ethnic sample of New Caledonian adolescents. PLoS ONE. 2024 Oct 3;19(10): e0309782.
18. Zerga AA, Tadesse SE, Ayele FY, Ayele SZ. Impact of malnutrition on the academic performance of school children in Ethiopia: A systematic review and meta-analysis. SAGE Open Med. 2022 Sep 20;10:20503121221122398.
19. Emran MGI, Mahmud S, Khan AH, Bristy NN, Das AK, Barma R, et al. Factors Influencing Stress Levels among Students: A Virtual Exploration. European Journal of Medical and Health Sciences.2024 Dec;6(6): 1-20.
20. Santana CCA, Hill JO, Azevedo LB, Gunnarsdottir T, Prado WL. The association between obesity and academic performance in youth: a systematic review. Obes Rev. 2017 Oct;18(10):1191–99.
21. Katiso SW, Kerbo AA, Dake SK. Adolescents' nutritional status and its association with academic performance in South Ethiopia; a facility-based cross-sectional study. BMC Nutr. 2021 Apr 29; 7(1):15.
22. Miheret M, Hirbo S, Saba H, Firayad A, Abainash T, Shawel S,et al. Overweight and obesity and associated factors among public and private secondary school adolescent students in Harar city, Eastern Ethiopia: A comparative cross-sectional study. Medicine. 2024 May 24;103(21):p e38271.
23. Shridhar K, Millett C, Laverty AA, et al. Prevalence and correlates of achieving recommended physical activity levels among children living in rural South Asia a multi-centre study. BMC Publ Health. 2016 Dec;16(1):690.
24. World Health Organization. Global Physical Activity Questionnaire (GPAQ) Analysis Guide. Switzerland: World Health Organization. 2021 Nov 13. Available at https://www.who.int/docs/default-source/ncds/ncd-surveillance/gpaq-analysis-guide.pdf
25. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav 1983;24(4):385-96.
26. Currie C, Zanotti C, Morgan A, Currie D, de Looze M, oberts C, et al. Social determinants of health and well-being among young people. Health Behaviour in School-aged Children (HBSC) study: international report from the 2009/2010 survey. Copenhagen: WHO Regional Office for Europe; 2012.
27. Sawyer SM, Azzopardi PS, Wickremarathne D, Patton GC. The age of adolescence. Lancet Child Adolesc Health. 2018;2(3):223–8.
28. Lobstein T, Jackson-Leach R. Planning for the worst: estimates of obesity and comorbidities in school-age children in 2025. Pediatr Obes. 2016;11(5):321–5.
29. World Health Organization. Rising school pressure and declining family support especially among girls, finds new WHO/Europe report. Copenhagen, 2024 Nov 13.
30. Gao L, Bhurtyal A, Wei J, Akhtar P, Wang L, Wang Y. Double Burden of Malnutrition and Nutrition Transition in Asia: A Case Study of 4 Selected Countries with Different Socioeconomic Development. Adv Nutr. 2020 Nov; 11(6):1663-70
31. Popkin BM, Corvalan C, Grummer Strawn LM. Dynamics of the double burden of malnutrition and the changing nutrition reality. Lancet. 2020;395:65 74.
32. Caleyachetty R, Thomas GN, Kengne AP, Echouffo Tcheugui JB, Schilsky S, Khodabocus J, et al. The double burden of malnutrition among adolescents: Analysis of data from the global school based student health and health behavior in school aged children surveys in 57 low and middle income countries. Am J Clin Nutr 2018;108:414 24.
33. Ahmad S, Shukla NK, Singh JV, Shukla R, Shukla M. Double burden of malnutrition among school going adolescent girls in North India: A cross sectional study. J Family Med Prim Care. 2018;7:1417 24.
34. Jumilia J, Cleodora C, Widyastuti M. Analysis of the Impact of Stunting on Psychosocial Development in Pre-School Children in the Working Area Seberang Padang Community Health Center. Compr. Nurs. J. 2023;9:298–310. doi: 10.33755/jkk.v9i3.512
35. Soliman A, De Sanctis V, Alaaraj N, Ahmed S, Alyafei F, Hamed N, et al. Early and Long-term Consequences of Nutritional Stunting: From Childhood to Adulthood. Acta Biomed. 2021;92:e2021168. doi: 10.23750/ABM.V92I1.11346
36. Goodman LP, Walsh DW, Kunin-Batson A, Sherwood NE, Arlinghaus KR. Adolescent sources of stress, stress levels, and associations between stress and changes in weight outcomes at the time of COVID-19 related school closure in March 2020. Prev Med Rep. 2023 Sep 29;36:102447
37. Roy SK, Jahan K, Alam N, Rois R, Ferdaus A, Israt S, et al.. Perceived stress, eating behavior, and overweight and obesity among urban adolescents.. J Health Popul Nutr. 2021 Dec 17; 40(1):54.
38. World Health Organization. Global action plan on physical activity 2018–2030: More active people for a healthier world. Geneva: World Health Organization; 2018.
39. Bailey R. Physical education and sport in schools: a review of benefits and outcomes. J Sch Health. 2006;76(8):397–401.
40. Singh AS, Saliasi E, van den Berg V, Uijtdewilligen L, de Groot RHM, Jolles J, et al. Effects of physical activity interventions on cognitive and academic performance in children and adolescents: a novel combination of a systematic review and recommendations from an expert panel. Br J Sports Med. 2019;53(10):640–7.