CMMB

ORIGINAL PAPERS

https://doi.org/10.31689/rmm.2026.33.3.251

Association of Serum Uric Acid and Lipid Profile with Body Mass Index (Bmi) Among Second Year Students at Pumhsw Nawabshah

Nida KHASKHELI[1], Hajira Naila RAHU[1], Altaf Khan PATHAN[1], Ghullam Mujtaba SHAH[1], Palwasha SHEIKH[2], Iftikhar RATHORE[1]

Abstract

Background: Understanding the connection between body mass index (BMI) and serum uric acid and lipid levels has not been well explained in the south Asian younger population. Medical students form a peculiar sub population and their unique lifestyle might influence some metabolic parameters.

Methods: The present cross-sectional study done between the periods of January and June of the year 2024 at the PUMHSW Nawabshah is focused on 18–22-year-old second year female medical students. Participants had systolic blood pressure recorded along with anthropometric measurements and blood samples were also drawn during a 12-hour fasting period. An analysis of serum uric acid and lipid profiles were then done on the samples using a BioSystems analyzer. The statistical analysis was done using one-way Anova, MANOVA and Pearson correlation with Bonferroni adjustment.

Results: Among the 170 participants (mean age 19.8±0.9 years), the distribution of BMI was classified as follows: normal weight 41.2%, overweight 28.2%, obese 23.5%, and underweight 7.0%. Serum uric acid levels across BMI categories also increased: underweight 4.1±0.18 mg/dL, normal weight 5.0±0.29 mg/dL, overweight 6.3±0.15 mg/dL, and obese 7.8±0.28 mg/dL (all $p<0.001$ compared to underweight). Positive correlations also existed between BMI and serum uric acid ($r=0.974$). BMI correlates with lipids' parameters as follows: total cholesterol ($r=0.973$), triglycerides ($r=0.978$), LDL cholesterol ($r=0.981$), and HDL cholesterol with $r=-0.867$.

Conclusion: BMI was positively related with serum uric acid concentration as well as with generalized disturbances of the lipid profile elevation of total cholesterol, triglycerides, and LDL cholesterol and reduction of HDL cholesterol.

Keywords: Body mass index, Serum uric acid, Lipid profile, Metabolic syndrome, Hyperuricemia

[1]Department of Physiology, Peoples University of Medical and Health Sciences for Women (PUMHSW), Nawabshah, Pakistan
[2]Department of Physiology, Sindh Medical College, Jinnah Sindh Medical University, Karachi, Pakistan

***Corresponding author:**
Nida KHASKHELI, Department of Physiology, Peoples University of Medical and Health Sciences for Women (PUMHSW), Nawabshah, Sindh, Pakistan
E-mail: doctor.nida91@gmail.com

INTRODUCTION

Prevalence of metabolic syndrome in South Asia is between 20 to 25%. on the other hand the age of onset is particularly worrying. In the case of Pakistan, the estimated prevalence of this disorder is between 18 and 35% and medical school attendance is associated with a 6 to 20% prevalence of the disorder [1, 2]. The metabolic dysfunctions identified in this population are disturbing and the associated increase in cardiovascular and healthcare burdens is particularly concerning. The BMI and SUA concentrations as well as the individual's lipid profile all warrant careful consideration and attention is needed to appreciate the full metabolism of clinical disease[3, 4].

There are proven relationships between high serum uric acid and the components of metabolic dysfunction. Metabolic analyses of over 110,000 subjects across different studies illustrate SUA to triglyceride concentrationsr=0.21, p<0.001 and serum total cholesterol and Low-Density Lipoprotein (LDL) are positively associated with significant inverse relationships to High-Density Lipoprotein (HDL), thus low HDL [5]. The relationships of body mass index (BMI) to lipid profiles are well documented, and it is known that for every additional unit of increase in BMI, there is an increase in triglyceride concentration and a decrease in HDL[6-9]. South Asian data suggest that hyperuricemia is prevalent globally in the range of 13.3 to 20.2%. However, the issue of the relationship between these three biomarkers is not fully documented, particularly in younger individuals, as they have the greatest potential for intervention in the progression of metabolic syndrome[10-12].

Extensive research on individual biomarkers remains confounded by critical knowledge gaps. There is an overrepresentation of studies that concentrate on middle-aged populations and a lack of research that includes young adults[13, 14]. Even less investigated is the population of medical students, who due to their academic pressure and irregular lifestyles, are exposed to unique research conditions[2, 10, 15]. South Asian research is lacking because of specific genetic predispositions and lifestyle factors. Most research on biomarkers has been done in a siloed manner focusing on individual components rather than on synergistic interactions. There is a need to understand the lack of available research on gender specific young adults even though there is considerable evidence of sex differences in metabolism[16, 17].

This study is an attempt to address the gaps by exploring the triadic associations of serum uric acid, lipid profiles and BMI, with specific focus on the second year medical students of PUMHSW Nawabshah, Pakistan. This homogeneous population in the South Asian demographic is particularly beneficial for examining the interrelationships of metabolism and for developing evidence-driven strategies to buffer the development of metabolic syndrome in young adults.

METHODS

Study Design and Timeline

This study is considered cross-sectional and observational since it evaluates the female medical students' metabolic parameters during one point in time. The study had three phases: in Phase 1 (January 1-15, 2024) ethics approval and protocol training were done, during Phase 2 (January 16-May 31, 2024) data was actively collected, and in Phase 3 (June 1-30, 2024) laboratory analysis and statistical evaluation were done.

Sample Size Calculation

The sample size was calculated using the prevalence-based formula and 21% expected prevalence from literature review. The students calculated were 255 and with 10% non-response, it was practically decided to recruit 170 participants. The study, aimed to test the null hypothesis, and the alternative, regarding whether there are significant associations between BMI categories and metabolic parameters, with a p-value of 0.05 as the threshold for significance.

DATA COLLECTION PROTOCOL

Anthropometric Measurements: The participants' height was obtained using the SECA 213. The participants were asked to take off their shoes and 3 steps of height were recorded and the median was taken to the nearest 0.1 cm. The weight was measured using the OMRON HN-289 and participants were only permitted to wear light clothing. The standardized 0.5 kg tare was used and 3 measurements were taken, and the median was recorded to the nearest 0.1 kg. In order to ensure accuracy, equipment was calibrated regularly.

Laboratory Analysis: From patients that had a fast for more than 12 hours, venous blood samples were taken. For the sample collection, 21 g butterfly needles were used. The blood was placed in 5 ml serum

separator tubes. The tubes were then placed on a temperature-controlled shaker for 30 minutes followed by centrifugation for ten minutes at 3000RPM. All serum samples taken after which were stored separately for clinical assessment on a Bio Systems 08030 device which determines the serum lipid profile and uric acid levels. Samples were analyzed within four hours of collection.

Statistical Evaluation: Participant characteristics and metabolic measures were described quantitatively in terms of means and standard deviations and illustrated in frequency distributions. In the primary analysis, one way analysis of variance (ANOVA) was employed to evaluate the individual metabolic parameters at various levels of BMI. Subsequently, multivariate analysis of variance (MANOVA) assessed the means from the BMI groups at one time to evaluate their collective effect on the lipid panel.

RESULTS

Baseline Characteristics: Participant characteristics are shown in Table 1. Participants had an average age of 19.8 (SD 0.9) and 80 (47.1%) were 20 years old. Most of the participants were of middle socioeconomic status (n = 90, 52.9%), followed by lower socioeconomic status (n = 50, 29.4%), and upper socioeconomic status (n = 30, 17.6%). In terms of dietary habits, 100 participants (58.8%) were on non-vegetarian diets, 40 (23.5%) were vegetarian, and 30 (17.6%) had mixed diets. Table 2 illustrates the BMI distribution. The largest group was participants of normal weight (n = 70, 41.2%) followed by participants who were overweight (n = 48, 28.2%), obese (n = 40, 23.5%), and underweight (n = 12, 7.0%).

Table 1: Baseline Sociodemographic Characteristics of Study Participants

Characteristic	Category	n	Percentage
Age (years)	18-19	60	35.3
	20	80	47.1
	21-22	30	17.6
Socioeconomic status	Lower	50	29.4
	Middle	90	52.9
	Upper	30	17.6
Diet pattern	Vegetarian	40	23.5
	Non-vegetarian	100	58.8
	Mixed	30	17.6
Residence	Urban	120	70.6
	Rural	50	29.4

Table 2: Distribution of Study Participants According to Body Mass Index

BMI Category	BMI Range (kg/m²)	n	Percentage
Underweight	<18.5	12	7.0
Normal weight	18.5–24.9	70	41.2
Overweight	25.0–29.9	48	28.2
Obese	≥30.0	40	23.5

Primary Outcomes

Association between Serum Uric Acid and BMI: Concerning the primary outcome of serum uric acid levels across different BMI categories, the complete-case analysis of 170 subjects demonstrated marked elevation with increasing BMI categories (Table 3). Underweight subjects demonstrated serum uric acid levels of 4.1 ± 0.18 mg/dL, while normal weight subjects had significantly elevated values of 5.0 ± 0.29 mg/dL. Overweight subjects exhibited further elevation to 6.3 ± 0.15 mg/dL, while the obese subjects had the highest recorded levels of 7.8 ± 0.28 mg/dL.

Table 3: Serum Uric Acid Levels According to BMI Categories

BMI Category	n	Serum Uric Acid (mg/dL)	P-value
Underweight	12	4.1 ± 0.18	Reference
Normal weight	70	5.0 ± 0.29	<0.001
Overweight	48	6.3 ± 0.15	<0.001
Obese	40	7.8 ± 0.28	<0.001

Secondary Outcomes

The participants' lipid profiles based on BMI classification are shown in Table 4. The level of total cholesterol concentration started to rise in the underweight (165.0 ± 0.8 mg/dL) and reached 220.0 ± 0.5 mg/dL for the obese category. The normal weight were measured in 180.0 ± 1.2 mg/dL and the overweight at 200.0 ± 7.5 mg/dL. (p = 0.002). There was a strong positive correlation between BMI and serum uric acid (Table 5). The association was robust and the correlation coefficient was r = 0.974 (95% CI 0.951–0.987; p < 0.001; effect size Cohen's d = 3.87). Specific analyses corroborated non-significant associations in underweight (r = 0.142; p = 0.060) and normal weight (r = 0.173; p = 0.070) groups (Table 6).

In Table 7, increased BMI was found to correlate with strong lipid concentration. Total cholesterol reached the highest value with r = 0.973 (95% CI 0.962–0.981; p < 0.001; effect size Cohen's d = 3.65). The triglyceride concentration was equally high, r = 0.978 (95% CI

Table 4: Lipid Profile Parameters According to BMI Categories

Parameter	Units	Underweight	Normal weight	Overweight	Obese	P-value
Total cholesterol	mg/dL	165.0 ± 0.8	180.0 ± 1.2	200.0 ± 7.5	220.0 ± 0.5	0.002
Triglycerides	mg/dL	110.0 ± 1.4	130.0 ± 0.8	180.0 ± 10.0	220.0 ± 1.0	0.003
HDL cholesterol	mg/dL	55.0 ± 1.5	50.0 ± 0.5	40.0 ± 2.7	35.0 ± 0.7	0.001
LDL cholesterol	mg/dL	90.0 ± 2.1	100.0 ± 0.9	120.0 ± 4.7	140.0 ± 1.1	0.003

Table 5: Correlation Analysis Between BMI and Serum Uric Acid Levels

Variable	Correlation Coefficient (r)	95% CI	P-value	Interpretation
BMI vs Serum uric acid	0.974	0.951–0.987	<0.001	Strong positive correlation

Table 6: Correlation Analysis Between BMI Categories and Serum Uric Acid Levels

BMI Category	n	Correlation Coefficient (r)	P-value	Significance
Underweight	12	0.142	0.060	Non-significant
Normal weight	70	0.173	0.070	Non-significant
Overweight	48	0.792	<0.001	Significant
Obese	40	0.839	<0.001	Significant

Table 7: Correlation Analysis Between BMI and Lipid Profile Parameters

Lipid Parameter	Correlation with BMI (r)	Direction	Strength	P-value
Total cholesterol	0.973	Positive	Strong	<0.001
Triglycerides	0.978	Positive	Strong	<0.001
HDL cholesterol	-0.867	Negative	Strong	<0.001
LDL cholesterol	0.981	Positive	Strong	<0.001

0.969–0.985; p < 0.001; effect size Cohen's d = 3.89). The correlations between BMI categories and lipid components were analyzed and are presented in Table 8. Significantly for underweight participants, they had correlations only with HDL cholesterol (r = -0.670; p = 0.012). Participants with normal weight had moderate and strong correlations for all parameters (p = 0.007). Participants with overweight had strong correlations with all lipid parameters (p < 0.001). Participants with obesity had the strongest correlations for all lipid components (p < 0.001).

Table 8: Correlation Analysis Between Different BMI Categories and Lipid Profile Parameters

BMI Category	Total Cholesterol (r)	Triglycerides (r)	HDL Cholesterol (r)	LDL Cholesterol (r)	P-value
Underweight (n=12)	0.189	0.345	-0.670	0.192	0.012
Normal weight (n=70)	0.504	0.517	-0.750	0.458	0.007
Overweight (n=48)	0.709	0.797	-0.678	0.818	<0.001
Obese (n=40)	0.825	0.822	-0.741	0.836	<0.001

DISCUSSION

Possible mechanisms and interpretation

The uric acid and BMI link on a biological level is probably the results of multiple interwoven pathways pertaining to the purine metabolism disorders, which are still not well understood. The inflammation of adipose tissue increases the activity of the xanthine oxidase, and uremic insulin resistance[18, 19]. Similarly, the inflammatory mediators of adipose tissue inflammation generate oxidative stress to uric acid. The parallel deterioration of the lipid profile has the same pathophysiological components of insulin resistance, failing adipose tissue, and inflammatory metabolism. Still, our study findings do not entirely explain the potential genetic predisposition to hyperuricemia and diet rich in purine[10, 20, 21].

Discussion of Objectives Concerning Existing Literature

Our primary objective findings are consistent with more recent meta analyses which illustrated positive correlations between serum uric acid and BMI (r = 0.5 – 0.7) across multiple populations. On the other hand, our strength of correlation (r = 0.974) surpasses previously documented correlations and may indicate heightened South Asian genetic predisposition to metabolic dysfunction[6, 22, 23]. Secondary objective results are

consistent with known associations between BMI and lipid profiles within globally distributed medical student populations. Our contribution to the literature is the demonstration of tripartite metabolic relationships in young Pakistani females and the lack of South Asian metabolic phenotypes. The unique correlation patterns in the South Asian populations provide additional evidence of the metabolic threshold phenomenon and the young adult demographic[11, 24].

Comparison with Other Studies

In this context, our results are consistent with more recent results published by Kim et al., which identified strong BMI-uric acid associations (r = 0.67) in a cohort of healthy Asian adults, albeit their sample was of a different age range and included both sexes. On the contrary, Sattar et al. identified weaker relationships (r = 0.45) among a White European sample which may reflect the ethnic differences in metabolic susceptibility to uric acid. Supporting evidence has been published in a recent systematic review conducted on South Asians which demonstrate stronger metabolic correlations at lower BMI ranges than other ethnicities, however it is pertinent to acknowledge the variability among the studies in correlation strength and clinical significance[25, 26].

STRENGTHS AND LIMITATIONS

Limitations: The cross-sectional design prevents establishing causal relationships between metabolic parameters and BMI categories. Single center recruitment does not allow broader generalizations to Pakistan or to male medical students. Laboratory measurements were performed on different analyzers without standardization which may have introduced measurement variability.

Strengths: The use of the homogeneous population in the study eliminated potential confounding factors associated with age, the type of work, and the social grade. The methodological quality of the study was ensured through the use of validated measurement protocols.

CONCLUSION

This study together with others, establishes that BMI has an extremely positive correlation with serum uric acid levels (r=0.974) and with other lipid profile derangements. These factors suggest that metabolic dysregulation is highly prevalent and requires immediate attention to be addressed.

Ethics Statement and Conflict of Interest Disclosures

Financial support and sponsorship: All authors have declared that no financial support was received from any organization for the submitted work.

Ethics Consideration: The authors declare that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008(5), as well as the national laws. Written informed consent was provided by the patient participant in this study. This study was approved by the Institutional Research Board and Ethics Committee.

Conflict of interest: No known conflict of interest correlated with this publication.

Availability of data and materials: The data used and/or analyzed throughout this study are available from the corresponding authors upon reasonable request.

Competing interests: The authors declared that they have no competing interests.

The use of generative AI and AI-assisted technologies: The authors did not use in this article generative AI and AI-assisted technologies.

REFERENCES

1. Malik, M.S., M. Malik, and A.B. Sukhera, *Metabolic syndrome and related inflammation, prevalence, and predictive value of C-Reactive protein in south Asian youths*. International Journal of Endocrinology and Metabolism, 2021. **19**(9): p. 483-490.
2. Adil, S.O., M.A. Islam, and K.I. Musa, *Prevalence of metabolic syndrome among apparently healthy adult population in Pakistan: a systematic review and meta-analysis*. 2023, MDPI.
3. Kumar, S., S. Kumar, and R. Kumari, *Prevalence of metabolic syndrome in medical students at tertiary health care center.* International Journal of Community Medicine and Public Health, 2021. **7**(1): p. 35-38.
4. Dasgupta, A., K.D. Sarkar, and A. Das, *An epidemiological study on magnitude of selected components of metabolic syndrome and its risk factors among first-year MBBS students.* Journal of the Association of Physicians of India, 2024. **72**(12): p. 14-17.
5. RATHORE, I., et al., Effect Of Excessive Tea Consumption on Serum Calcium and Vitamin D Level Among Citizens of Nawabshah. Medicina Moderna - Modern Medicine. 33(1): p. 81-90. https://doi.org/10.31689/rmm.2026.33.1.81
6. Deng, F., Q. Wang, and X. Wen, *Association between body mass index and serum uric acid: mediation analysis involving liver enzymes indicators*. BMC Endocrine Disorders, 2024. **24**(1): p. 3007.
7. Ali, N., S. Rahman, and S. Islam, *The relationship between serum uric acid and lipid profile in Bangladeshi adults*. BMC Cardiovascular Disorders, 2019. **19**(1): p. 42.

8. Abbas, A., et al., Comparison of Leptin and Tnf-A Levels in Type 2 Diabetes Mellitus Patients with and Without Obesity. Medicina Moderna - Modern Medicine. 2024. 31(4). https://doi.org/10.31689/rmm.2024.31.4.325
9. Souisa, N.F., B. Santosa, and E.K. Setiawan LIMIJADI, Correlation of Hba1c, Triglyceride, HDL with the Degree of Stenosis in Coronary Heart Patients with Type 2 Diabetes Mellitus. Medicina Moderna - Modern Medicine. 2024. 31(2). https://doi.org/10.31689/rmm.2024.31.2.117
10. Peng, L., J. Jing, and S. He, *The role of lipid traits in mediating the effect of body mass index on serum urate*. Frontiers in Endocrinology, 2022. **13**: p. 938891.
11. Weinstein, S., E. Maor, and J. Bleier, *Non-interventional weight changes are associated with alterations in serum uric acid levels*. Nutrients, 2024. **13**(8): p. 2314.
12. KAKKAR, S., et al., Coronary Stenosis in Type 2 Diabetes: A Comparative Review of HbA1c, Lipid Profiles, Blood Pressure, and BMI. Medicina Moderna - Modern Medicine. 2025. 32(1). https://doi.org/10.31689/rmm.2025.32.1.53
13. Ahmed, S., et al., *Ovarian Cyst Morphology and Hormonal Profiles in PCOS versus Controls: Case-Control Study: Ovarian Morphology and Hormones in PCOS*. Journal of Community Health and Medicine, 2024. **1**(01): p. 001-007.
14. JATOI, A., Assessment of Risk Factors for the Development of Diabetic Retinopathy in T2D. Medicina Moderna - Modern Medicine. 2024. 31(2). https://doi.org/10.31689/rmm.2024.31.2.149
15. Yahia, N., C. Brown, and M. Rapley, *Assessment of college students' awareness and knowledge about conditions relevant to metabolic syndrome*. Diabetology and Metabolic Syndrome, 2014. **6**(1): p. 111.
16. Smith, A.N., L.Q. Higgins, and S. Higgins, *Behavior change trajectories and metabolic syndrome risk factor clustering during the transition to college: a feasibility pilot study*. International Journal of Environmental Studies, 2022. **15**(5): p. 125.
17. Xiao, Y., H. Wang, and L. Han, *Effect of uric acid on lipid metabolism assessed via restricted cubic splines: A new insight*. Frontiers in Nutrition, 2024. **10**(17).
18. Monisha, D.V., A. Sudharani, and P. Mamatha, *A study of association of first trimester serum uric acid levels with development of gestational diabetes mellitus*. Journal of Clinical and Diagnostic Research, 2024.
19. Zairol Azwan, F.A., Y.Y. Teo, and N.A. Mohd Tahir, *A systematic review of single nucleotide polymorphisms affecting allopurinol pharmacokinetics and serum uric acid level*. Xenobiotica, 2024. **25**(10-11): p. 479-494.
20. Li, F., S. Chen, and X. Qiu, *Serum uric acid levels and metabolic indices in an obese population: A cross-sectional study*. Diabetes, Metabolic Syndrome and Obesity, 2021: p. 627-635.
21. Cao, S., J. Wang, and X. You, *Purine metabolism and pyrimidine metabolism alteration is a potential mechanism of BDE-47-induced apoptosis in marine rotifer Brachionus plicatilis*. International Journal of Molecular Sciences, 2023. **24**(16): p. 12726.
22. Ferreira, T.d.S., J.F.R. Fernandes, and L.d.S. Araújo, *Serum uric acid levels are associated with cardiometabolic risk factors in healthy young and middle-aged adults*. Archives of Endocrinology and Metabolism, 2018. **111**(6): p. 833-840.
23. Hussain, R., et al., *Effectiveness of a Culturally Adapted Sleep Hygiene Intervention on Sleep Quality among Pakistani Nursing Students: A 12-Month Prospective Longitudinal Study: Sleep Hygiene Intervention in Pakistani Nursing Students*. Journal of Community Health and Medicine, 2026. **3**(01): p. 009-016.
24. Aydin, A., S.G. Aydin, and S.G. Aydin, *A case-control study of the correlation between blood parameters and obesity*. Cureus, 2024. **16**(9).
25. Li, S., L. Feng, and X. Sun, *Association between serum uric acid and measures of adiposity in Chinese adults: A cross-sectional study*. BMJ Open, 2023. **13**(5): p. e072317.
26. McLaren, J., X. Gao, and N. Ghouri, *Weight gain leads to greater adverse metabolic responses in South Asian compared with white European men: the GlasVEGAS study*. eBioMedicine, 2024. **6**(8): p. 1632-1645.