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# Correlation of body mass index and physical activity with serum uric acid levels: a cross-sectional study among medical students

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**ABSTRACT**

**Introduction:** Hyperuricemia is increasingly recognized as an early marker of metabolic disturbance among young adults. Body Mass Index (BMI) and physical activity are modifiable determinants that may influence serum uric acid levels, particularly in medical students who are exposed to sedentary academic routines and irregular lifestyle patterns. This study aimed to examine the association between BMI and physical activity levels with serum uric acid levels among medical students at Muhammadiyah University of Semarang.

**Research Methodology:** An analytical observational study with a cross-sectional design was conducted in October 2025 involving 62 medical students selected through purposive sampling. BMI was calculated from measured weight and height; physical activity was assessed using the International Physical Activity Questionnaire–Short Form (IPAQ-SF); and serum uric acid levels were measured by capillary blood analysis. Data were analyzed using descriptive statistics, Spearman's rank correlation test, and multivariable linear regression with a significance level of $\alpha = 0.05$.

**Results:** Most respondents had normal BMI (46.8%), high physical activity levels (53.2%), and normal uric acid levels (67.7%). Significant associations were found between BMI and serum uric acid ($r = -0.286$; $p = 0.024$) and between physical activity and serum uric acid ($r = 0.271$; $p = 0.033$). After adjustment for age and sex, both BMI ($\beta = -0.254$; $p = 0.031$) and physical activity ($\beta = 0.236$; $p = 0.039$) remained independently associated with uric acid levels.

**Conclusion:** BMI and physical activity are significant determinants of serum uric acid levels in early adulthood. These findings support early metabolic screening and lifestyle-based interventions within university settings to prevent future cardiometabolic complications.

**Keywords:** Body Mass Index; Motor Activity; Medical Students; Uric Acid.

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# INTRODUCTION

Hyperuricemia has emerged as a significant metabolic health concern worldwide. Globally, the prevalence of elevated serum uric acid and gout has increased steadily over the past two decades, paralleling the rise in obesity and sedentary lifestyles (Bener et al., 2025). Epidemiological data from Asia indicate that hyperuricemia affects approximately 15–25% of adults, with a growing trend among adolescents and young adults (Cheng et al., 2026). Elevated uric acid is not merely a precursor of gout; it is independently associated with cardiometabolic disorders, including hypertension, insulin resistance, chronic kidney disease, and cardiovascular morbidity. The increasing burden among younger populations signals a shift from a traditionally age-related disorder toward a lifestyle-related metabolic disturbance (Gao et al., 2025).

At the national level, Indonesian Basic Health Research (Riskesdas 2018) reported that approximately 24.7% of the population experienced joint-related disorders associated with hyperuricemia (Hamisah et al., 2022). Although prevalence remains highest among older adults, recent regional reports demonstrate a concerning rise in cases among individuals in productive age groups. In South Sulawesi, prevalence reached 27.7%, reflecting substantial public health implications (Han et al., 2026). This epidemiological transition corresponds to increased consumption of high-purine diets and sugar-sweetened beverages, and reduced physical activity. Young adults, particularly university students, represent a vulnerable subgroup due to behavioral risk factors that accumulate during academic training (J. Li et al., 2024).

At the local institutional level, medical students are exposed to high academic pressure, prolonged sedentary study periods, irregular dietary patterns, and psychological stress (L. Li et al., 2024). Despite possessing knowledge of disease prevention, their lifestyle behaviors may paradoxically predispose them to metabolic disturbances (S. Li et al., 2024). Early metabolic dysregulation during medical education is concerning because this group is expected to serve as future health role models. Therefore, identifying modifiable determinants of uric acid levels in this population has preventive and professional relevance (X. Li et al., 2024).

Existing literature consistently demonstrates a positive association between Body Mass Index (BMI) and serum uric acid levels (Y. Li et al., 2025). Obesity contributes to hyperuricemia by increasing purine turnover, enhancing xanthine oxidase activity, and reducing renal urate excretion secondary to insulin resistance (Z. Li et al., 2025). Similarly, physical activity has been shown to influence uric acid metabolism by improving insulin sensitivity and renal perfusion (Liao et al., 2024). However, findings regarding the magnitude and direction of these associations in young adults remain inconsistent. Some cross-sectional studies report strong positive correlations between BMI and uric acid. In contrast, others demonstrate weak or non-significant associations after adjusting for confounders such as diet, hydration status, and body composition. Moreover, the relationship between physical activity intensity and uric acid levels appears bidirectional; moderate activity may reduce urate levels, while excessive or strenuous activity may transiently elevate them due to increased ATP degradation (L. Lu et al., 2024).

Importantly, most Indonesian studies have focused on general adult populations, elderly groups, or patients with established hyperuricemia. Empirical evidence specifically examining medical students is limited. Furthermore, few studies simultaneously analyze BMI and physical activity within a single analytical framework in this demographic, thereby limiting the understanding of their combined contribution to early metabolic risk. The explicit research gap lies in the lack of institution-based evidence assessing the correlation between BMI, physical activity levels, and serum uric acid among Indonesian medical students. Without such data, preventive interventions within academic environments lack empirical grounding.

This study offers novelty by focusing on a specific higher-education young adult cohort and by concurrently evaluating anthropometric and behavioral determinants of uric acid levels using validated measurement tools (objective BMI measurement, IPAQ-based activity assessment, and biochemical uric acid testing). By contextualizing findings within a preventive campus health framework, the study extends the existing literature from general population analysis to a profession-specific risk evaluation. Therefore, this study aimed to determine the correlation between body mass index, physical activity levels, and serum uric acid levels among medical students at Muhammadiyah University of Semarang. The findings are expected to provide an evidence base for early metabolic risk screening and lifestyle intervention strategies in academic settings.

# RESEARCH METHODOLOGY

**Research Design**

This study employed an analytical observational design with a cross-sectional approach. The cross-sectional design was selected to examine the correlation between Body Mass Index (BMI), physical activity level, and serum uric acid levels at a single point in time within a defined population. This design is appropriate for identifying associations between exposure variables (BMI and physical activity) and an outcome variable (serum uric acid level) without manipulation or intervention.

**Setting and Participants**

The study was conducted at the Faculty of Medicine, Muhammadiyah University of Semarang, Indonesia, in October 2025. The target population comprised all undergraduate students of Muhammadiyah University of Semarang, while the accessible population included students from the 2024 cohort of the Faculty of Medicine. Inclusion criteria were: (1) aged 18–35 years; (2) registered as active students; (3) willing to participate and sign informed consent; and (4) in stable physical and communicative condition. Exclusion criteria included: (1) current use of uric acid–lowering drugs or aspirin; (2) history of chronic kidney disease; (3) pregnancy or breastfeeding; (4) alcohol consumption within the previous 24 hours; and (5) current fasting at the time of data collection. Sampling was conducted using purposive sampling. Sample size was calculated using the formula for correlation studies (Spearman correlation), assuming a 95% confidence level ($Z\alpha = 1.96$), 80% statistical power ($Z\beta = 0.84$), and an expected correlation coefficient (r) of 0.35. The minimum required sample size was 61.83, which was rounded up to 62 participants.

**Variables and Measurement**

The independent variables were Body Mass Index (BMI) and physical activity level, while the dependent variable was serum uric acid level. BMI was operationally defined as body weight in kilograms divided by height in meters squared ($kg/m^2$). Body weight was measured using a calibrated Omron HN-300T2 digital scale, and height was measured using a Gea stadiometer. Measurements were taken with participants wearing light clothing and no footwear. Physical activity level was measured using the short form of the International Physical Activity Questionnaire (IPAQ-SF), which assesses activity during the previous seven days. Physical activity was expressed in MET-minutes/week and categorized according to IPAQ scoring guidelines. The IPAQ has demonstrated acceptable validity (Spearman rho $\approx 0.30$) and reliability

(Cronbach's alpha > 0.70) in adult populations. Serum uric acid levels were measured from capillary blood samples using a BeneCheck digital biochemical device and expressed in mg/dL. All variables were obtained from primary data.

**Data Collection**

Data collection began with an explanation of study objectives and procedures, followed by written informed consent. Anthropometric measurements were conducted in a standardized manner by trained research assistants. Capillary blood samples were obtained aseptically to measure uric acid levels. Participants subsequently completed the IPAQ questionnaire under supervision to minimize recall bias. Quality control measures included calibrating measuring instruments before use, standardized measurement protocols, and double-checking data entry to prevent transcription errors.

**Data Analysis**

Descriptive statistics were used to summarize participant characteristics and study variables, including mean, standard deviation, median, and frequency distribution. Normality testing was performed using the Kolmogorov–Smirnov test. Because at least one variable was not normally distributed, bivariate analysis was conducted using Spearman's rank correlation test. To control for potential confounding variables (age and sex), multivariable linear regression analysis was performed with serum uric acid level as the dependent variable. Regression assumptions were evaluated before model interpretation. All statistical analyses were conducted using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). A two-tailed p-value < 0.05 was considered statistically significant (α = 0.05).

**Ethical Approval**

This study received ethical clearance from the Health Research Ethics Committee (Komite Etik Penelitian Kesehatan/KEPK) of the Faculty of Nursing and Health Sciences, Muhammadiyah University of Semarang, with approval number 083/KE/08/2025. Written informed consent was obtained from all participants before data collection. Confidentiality and participant anonymity were strictly maintained throughout the study.

# RESULT

**Table 1.** Characteristics of Respondents (n = 62)

| Variable | Category | n | % |
|---|---|---|---|
| Age | 17–19 years | 47 | 75.8 |
| | 20–22 years | 15 | 24.2 |
| Sex | Female | 47 | 75.8 |
| | Male | 15 | 24.2 |
| Body Mass Index | Normal | 29 | 46.8 |
| | Overweight/Obese | 26 | 41.9 |
| | Underweight | 7 | 11.3 |
| Physical Activity | High | 33 | 53.2 |
| | Moderate/Low | 29 | 46.8 |
| Uric Acid Level | Normal | 42 | 67.7 |
| | Elevated | 20 | 32.3 |

Most *respondents* were aged 17–19 years (75.8%) and female (75.8%). Nearly half (46.8%) had a normal BMI, while 41.9% were overweight or obese. More than half reported high physical activity (53.2%). Elevated serum uric acid levels were observed in 32.3% of participants.

**Table 2.** Correlation Between BMI, Physical Activity, and Serum Uric Acid Levels

| Independent Variable | r (Spearman) | 95% CI | p-value |
|---|---|---|---|
| Body Mass Index | −0.286 | −0.51 to −0.03 | 0.024 |
| Physical Activity | 0.271 | 0.02 to 0.49 | 0.033 |

**Significant at α = 0.05*

Spearman's correlation analysis demonstrated a statistically significant inverse association between BMI and serum uric acid (r = −0.286; 95% CI: −0.51 to −0.03; p = 0.024). Physical activity level was also significantly correlated with serum uric acid (r = 0.271; 95% CI: 0.02 to 0.49; p = 0.033), showing a weak positive correlation.

**Table 3.** Linear Regression Analysis of Factors Associated with Serum Uric Acid Levels

| Variable | β (Standardized) | 95% CI | p-value |
|---|---|---|---|
| Body Mass Index | −0.254 | −0.48 to −0.02 | 0.031* |
| Physical Activity | 0.236 | 0.01 to 0.44 | 0.039* |
| Age | 0.081 | −0.19 to 0.29 | 0.512 |
| Sex (Male) | 0.142 | −0.17 to 0.38 | 0.284 |

*Model $R^2 = 0.18$*

**Significant at α = 0.05*

After adjustment for age and sex, BMI remained independently associated with serum uric acid levels (β = −0.254; 95% CI: −0.48 to −0.02; p = 0.031). Physical activity also showed an independent association (β = 0.236; 95% CI: 0.01 to 0.44; p = 0.039). Age and sex were not statistically significant predictors. The regression model explained 18% of the variance in serum uric acid levels ($R^2 = 0.18$), indicating that other unmeasured factors may contribute to uric acid variability.

This study identified statistically significant associations among medical students between Body Mass Index (BMI), physical activity level, and serum uric acid levels. Although the majority of respondents had normal BMI and uric acid levels, a considerable proportion (41.9%) were classified as overweight/obese, indicating early metabolic vulnerability within this young adult population. Bivariate analysis demonstrated weak but significant correlations between BMI (r = −0.286; p = 0.024) and physical activity (r = 0.271; p = 0.033) with serum uric acid levels. Multivariable linear regression analysis confirmed that both BMI (β = −0.254; p = 0.031) and physical activity (β = 0.236; p = 0.039) remained independently associated with uric acid levels after adjustment for age and sex, while these covariates were not significant predictors. Overall, the findings suggest that anthropometric status and behavioral factors contribute modestly to variations in serum uric acid among medical students. However, the relatively low model explanatory power ($R^2 = 0.18$) suggests that additional determinants, such as dietary intake, hydration status, and genetic predisposition, may play a substantial role in uric acid metabolism in this population.

# DISCUSSION

This study identified statistically significant associations among medical students between Body Mass Index (BMI), physical activity level, and serum uric acid levels. Although most respondents had normal uric acid concentrations, a substantial proportion were classified as overweight or obese, indicating early metabolic vulnerability in a relatively young academic population. Both BMI and physical activity demonstrated weak but significant associations with serum uric acid, and these relationships persisted after adjustment for age and sex. However, the regression model's overall explanatory power was modest, suggesting that additional biological and behavioral determinants contribute to uric acid variability.

Uric acid is the end product of purine metabolism and is regulated by hepatic production and renal excretion (M. Lu et al., 2024). Excess adiposity contributes to hyperuricemia primarily through insulin resistance, which increases renal tubular urate reabsorption by upregulating urate transporters. Adipose tissue also promotes chronic low-grade inflammation and oxidative stress, potentially enhancing xanthine oxidase activity and purine turnover (Luo et al., 2024). Within this framework, BMI serves as a proxy for metabolic load. Nevertheless, the weak association observed in this study suggests that, among young adults, compensatory renal and metabolic mechanisms may still function effectively (Ma et al., 2025). Early metabolic alterations may not yet translate into marked biochemical disturbances. Moreover, BMI does not differentiate between fat and lean mass; thus, in a population that includes physically active individuals, misclassification could attenuate the strength of the association (Maloberti et al., 2024).

Physical activity exerts complex effects on uric acid metabolism. Moderate and regular activity improves insulin sensitivity, enhances endothelial function, and increases renal perfusion, thereby facilitating urate clearance (Ness et al., 2025). Conversely, high-intensity or prolonged exercise may transiently elevate uric acid levels due to accelerated ATP degradation and lactate accumulation, which competes with urate for renal excretion (Schaefer et al., 2025). The positive but weak association found in this study may reflect heterogeneous patterns of activity intensity and hydration status among students. Large epidemiological studies from East Asia, Europe, and North America consistently demonstrate a positive association between overweight/obesity and hyperuricemia (Shi et al., 2025). Several population-based studies report that individuals with elevated BMI have two- to four-fold higher odds of developing hyperuricemia compared with those of normal weight. Mendelian randomization analyses further support a potential causal relationship between adiposity and serum urate levels (Sylvia Bawilin & Suprapto, 2025).

In Indonesia, previous research has largely concentrated on community adults, elderly populations, or patients with established metabolic disorders. These studies generally report stronger correlations than those identified in the present research (Jiaying Wang et al., 2025). The relatively weaker associations observed here may be attributable to the younger age structure of participants, lower cumulative metabolic burden, and differences in lifestyle composition within a university environment (Jirun Wang et al., 2025). The convergence between this study and international evidence lies in confirming that anthropometric status and lifestyle behavior are relevant determinants of uric acid metabolism. This finding reinforces the conceptualization of hyperuricemia as part of the broader metabolic syndrome spectrum rather than an isolated biochemical abnormality (X. Wang et al., 2025).

Several factors may explain the divergence in effect size and direction. First, age likely acts as a moderating variable; metabolic dysregulation accumulates longitudinally, and early adulthood represents a transitional stage. Second, unmeasured confounders, particularly dietary purine intake, sugar-sweetened beverage consumption, hydration patterns, sleep deprivation, and psychological stress, may have diluted the observed associations (Yu et al., 2025). Third, the cross-sectional design captures a single time point and may not reflect chronic exposure patterns (Zhao et al., 2024). These contextual elements suggest that uric acid regulation in young adults is multifactorial and dynamic. Conceptually, this study supports a life-course approach to metabolic risk assessment. Hyperuricemia should not be viewed solely as a disease of aging, but rather as a condition influenced by modifiable behaviors that begin in early adulthood. Early metabolic screening in university settings may identify subclinical risk before progression to overt gout, hypertension, or renal dysfunction (Zheng et al., 2025).

At the institutional level, universities, particularly medical faculties, should integrate structured health promotion programs that include periodic metabolic monitoring, nutritional education, and facilitated physical activity. Medical students occupy a dual role as learners and future healthcare providers; cultivating healthy behavioral norms during training may have long-term professional and societal impact. From a public health systems perspective, preventive strategies targeting young adults align with cost-effective disease prevention models. Addressing modifiable risk factors early may reduce the future healthcare burden associated with cardiometabolic and renal complications.

**Strengths and Limitations**

This study has notable strengths, including the use of objective anthropometric measurements and biochemical testing, as well as validated instruments for physical activity assessment. The simultaneous evaluation of anthropometric and behavioral variables within a defined academic cohort enhances contextual relevance. However, several limitations must be acknowledged. The cross-sectional design precludes causal inference. The sample was derived from a single institution and cohort, limiting generalizability. Important confounding variables such as dietary intake, hydration status, genetic predisposition, and stress were not measured. The modest $R^2$ indicates that substantial variance remains unexplained.

Additionally, BMI's inability to distinguish between fat and muscle mass may have introduced measurement bias. This study contributes to the understanding that metabolic risk factors associated with uric acid levels may begin to manifest during early adulthood. By situating hyperuricemia within a behavioral and institutional context, the findings underscore the importance of preventive strategies in academic environments and extend existing literature beyond older or clinically diagnosed populations.

# CONCLUSION

This study aimed to examine the correlation between Body Mass Index (BMI), physical activity levels, and serum uric acid levels among medical students at Muhammadiyah University of Semarang. The findings demonstrate that both BMI and physical activity are significantly associated with serum uric acid levels, even after adjustment for age and sex. Although the strength of these associations was modest, the results indicate that anthropometric status and lifestyle behaviors contribute to variations in uric acid metabolism in early adulthood.

These findings underscore the importance of early identification of metabolic risk in university settings. Preventive strategies should include routine metabolic screening, structured physical activity programs, and nutrition education targeting weight management and healthy dietary patterns. Institutional policies that promote active campus environments and periodic health monitoring may help reduce long-term risks of hyperuricemia and related cardiometabolic complications. Future longitudinal studies incorporating dietary intake and genetic factors are recommended to strengthen causal inference and refine targeted interventions.

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This research received no external funding and was conducted independently by the authors.

**Conflict of Interest**

The authors declare that there are no conflicts of interest regarding the publication of this study.

## Authors’ Contributions

Shaula Arabia conceptualized the study, conducted data collection, performed data analysis, and drafted the manuscript. Arif Rahman contributed to the study design, supervised the research process, and critically revised the manuscript for important intellectual content. Yanuarita Tursinawati contributed to methodological guidance, data interpretation, and final manuscript review. All authors read and approved the final version of the manuscript.

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