



## Association of Glycated Hemoglobin (HbA1c) with Serum Cholesterol in Young Adults

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## ABSTRACT

*This study investigates the potential relationship between glycated hemoglobin (HbA1c) and total serum cholesterol in early adulthood. Employing a cross-sectional analytic design, a total of 72 students were recruited from four universities in Bandar Lampung and Metro City, Lampung Province. Laboratory analyses were performed to evaluate cardiovascular risk through the measurement of HbA1c and serum cholesterol levels. The data showed that most participants had HbA1c and cholesterol values within clinically normal ranges, with low variability across the sample. The mean HbA1c was approximately 5.0%, and average cholesterol was 193.2 mg/dL, both of which fall within healthy thresholds. The association between variables was examined using Pearson's correlation analysis. The findings demonstrated no statistically significant correlation between HbA1c and total cholesterol ( $r = 0.009$ ,  $p = 0.9391$ ), nor between HbA1c and blood pressure ( $r = 0.0118$ ,  $p = 0.9213$ ). Although no significant associations were observed, the results underscore the relevance of early metabolic screening among young adults as a preventive measure to facilitate timely interventions and reduce long-term cardiovascular risk.*

Keywords: HbA1c, cholesterol, blood glucose, university

## ABSTRAK

*Penelitian ini bertujuan mengevaluasi hubungan antara hemoglobin terglikasi (HbA1c) dan kolesterol total serum pada usia dewasa awal. Dengan desain analitik potong lintang, jumlah sampel sebanyak 72 mahasiswa dari empat universitas di Bandar Lampung dan Kota Metro, Provinsi Lampung. Hasil penelitian menunjukkan bahwa sebagian besar responden memiliki HbA1c dan kolesterol dalam rentang normal klinis dengan variasi rendah. Rerata HbA1c sekitar 5,0%, sedangkan kolesterol rata-rata 193,2 mg/dL, keduanya berada dalam normal. Hubungan korelasi diuji menggunakan analisis korelasi Pearson. Hasil penelitian menunjukkan tidak terdapat korelasi yang bermakna secara statistik antara HbA1c dengan kolesterol total ( $r = 0,009$ ;  $p = 0,9391$ ) maupun dengan tekanan darah ( $r = 0,0118$ ;  $p = 0,9213$ ). Meskipun tidak ditemukan asosiasi signifikan, temuan ini menegaskan pentingnya skrining metabolik dini pada dewasa muda untuk mendukung intervensi tepat waktu dan mencegah risiko kardiovaskular jangka panjang.*

Kata kunci: HbA1c, kolesterol, glukosa darah, universitas

## INTRODUCTION

Cardiovascular diseases (CVDs) are the foremost cause of death globally, responsible for nearly 18 million fatalities each year (Di Cisaré *et al.* 2024). Although these conditions are commonly linked to older adults, research has shown that their underlying risk factors often begin much earlier, during adolescence and early adulthood. Poor lifestyle choices such as inactivity, unhealthy eating patterns, smoking, psychological stress, and early metabolic disruptions including elevated blood sugar and lipid abnormalities, can all contribute to CVD development. University students, often assumed to be healthy, are increasingly exhibiting early signs of these risk factors (Yusuf *et al.*, 2020).

The shift to university life frequently leads to lifestyle modifications that can adversely affect metabolic health. Increased academic stress, erratic sleep schedules, reduced physical activity, and a greater intake of high-calorie or processed foods are all common among students. Several studies have identified rising rates of abnormal glycated hemoglobin (HbA1c) and cholesterol levels in this group, suggesting that many may already be on the path toward cardiovascular complications, despite showing no outward symptoms (Alzahrani *et al.*, 2019; Deliëns *et al.*, 2015).

HbA1c, an indicator of average blood glucose over a two to three-month period, is widely used to diagnose and monitor diabetes (American Diabetes Association, 2023; David *et al.* 2024; ). Meanwhile, lipid abnormalities—such as increased total cholesterol, LDL, and triglycerides, play a central role in the progression of atherosclerosis and cardiovascular disease (Lusis, 2020). These two factors, hyperglycemia and dyslipidemia, are biologically connected through shared pathways involving insulin resistance and chronic inflammation (Bergman, 2020).

Current studies highlight growing concern about cardiometabolic health among young adults. For example, a Malaysian study found that over half of university students had moderate to high risk for developing CVD, based on behavioral and physiological markers (Abdullah et al., 2024; Azzani et al. 2024). Similar findings were reported in West Africa and the United States, where significant numbers of students showed elevated HbA1c and lipid levels, even without any clinical signs of illness (Ouattara et al., 2023; Fernhall et al., 2014). Furthermore, recent findings indicate that even a few nights of insufficient sleep can trigger inflammatory markers associated with heart disease in healthy young adults (Patel et al., 2025; Brandão et al. 2025).

Due to the often silent progression of metabolic disorders in youth and the lack of regular health screening in this age group, identifying early markers such as HbA1c and serum cholesterol is crucial. Doing so may allow for preventive strategies to be implemented before serious health outcomes develop.

This research investigates the potential link between HbA1c levels and serum cholesterol in young adults. By analyzing this relationship, the study aims to determine whether HbA1c could serve as an early signal of lipid imbalances and overall cardiovascular risk in university-aged individuals. The research was carried out across four universities in Lampung Province, including Muhammadiyah Metro University, STIKES Panca Bakti, STIKES Baitul Hikmah, and Poltekkes Kemenkes Tanjungkarang. These institutions are situated in two distinct regions: Bandar Lampung and Metro City. By involving both the provincial capital and a non-capital area, this study explore potential differences in risk patterns that may be influenced by regional characteristics. This study aimed to determine the association of HbA1c and total cholesterol among young adults.

## **METHOD**

This research is an analytical observational study using a cross-sectional design. A total of 72 respondents were selected through random sampling from four different universities located in Bandar Lampung and Metro City. Screening for cardiovascular disease risk factors involved laboratory examinations of HbA1c levels and total cholesterol. The inclusion criteria were: (1) university students who were willing to participate as respondents, (2) willing to fast for 8 hours prior to blood sample collection, and (3) willing to complete the research questionnaire. The exclusion criteria were: (1) students who were not willing to participate as respondents, and (2) students who agreed to participate but did not comply with the 8-hour fasting requirement. Examination of HbA1c was performed using the Enzymatic method, while total cholesterol was analyzed using the Enzymatic CHOD-PAP (Cholesterol Oxidase–Phenol Aminophenazone) method. Descriptive statistics and correlation tests were conducted using SPSS software.

## **RESULTS AND DISCUSSION**

The rising prevalence of cardiovascular risk factors among young adults has emerged as a growing public health concern. Although university students are generally considered a low-risk group, they are frequently exposed to lifestyle behaviors such as irregular eating patterns, insufficient physical activity, disrupted sleep, and persistent academic stress. These conditions may trigger subtle metabolic alterations that precede clinical disease, underscoring the importance of assessing early biomarkers like glycated hemoglobin (HbA1c) and serum cholesterol in this population.

The present study aimed to examine the association between HbA1c, a reliable marker of long-term glycemic control, and total cholesterol, a major determinant of cardiovascular risk. Pearson's correlation analysis demonstrated no statistically significant relationship between HbA1c and total cholesterol ( $r = 0.009$ ,  $p = 0.9391$ ), nor between HbA1c and blood pressure ( $r = 0.0118$ ,  $p = 0.9213$ )

(Figure 1). These minimal correlation coefficients suggest that within this cohort, there was little to no linear association between the measured variables.

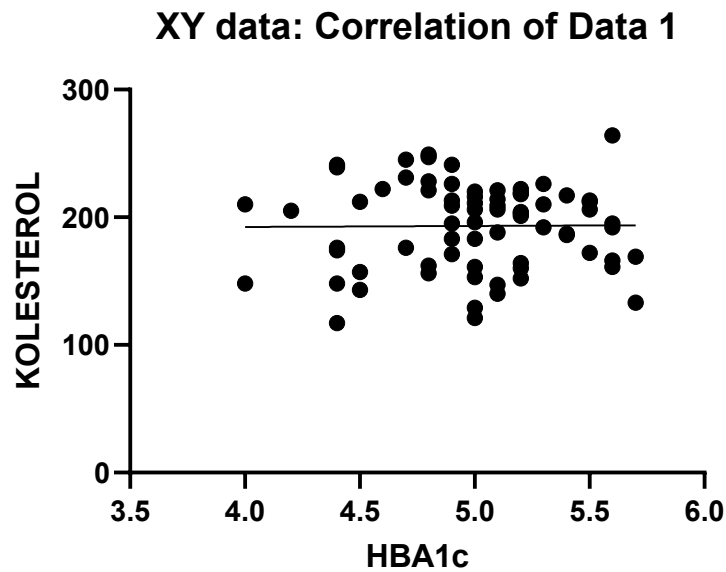


Figure 1 Correlation between HbA1c and Cholesterol

A plausible explanation for these findings lies in the metabolic characteristics of the sample. Most participants exhibited HbA1c and cholesterol values within the clinically normal range, with limited variability across individuals. The mean HbA1c was approximately 5.0%, while the mean cholesterol level was 193.2 mg/dL, both of which are considered healthy (Table 1). The relatively small standard deviations further indicate a homogenous study population, thereby reducing the potential for detecting meaningful correlations.

Table 1 Distribution of Cholesterol and HbA1c

	Cholesterol (mg/mL)	HbA1c (%)
Minimum	117	4
Median	202	5
Maximum	264	5,7
Mean	193	5
Std. Deviation	33	0,4

From a physiological standpoint, the absence of correlation aligns with expectations in young, healthy individuals. At this stage of life, metabolic regulation is generally preserved, with intact insulin sensitivity and compensatory mechanisms that maintain homeostasis. In contrast, stronger associations between HbA1c and lipid levels are typically observed in older adults or individuals with impaired glucose tolerance, where prolonged metabolic stress disrupts normal regulation.

Evidence from prior studies supports this interpretation. For example, Ahmed et al. (2021) and Lin et al. (2023) reported that in adults younger than 30 years, HbA1c and lipid levels often display weak or no significant relationships, whereas stronger associations emerge in older or prediabetic populations. These findings suggest that the interplay between glycemic status and lipid imbalance becomes more evident over time with cumulative metabolic stress.

The cross-sectional design of this study presents an inherent limitation, as data collected at a single time point cannot capture longitudinal changes in metabolic parameters. Future research employing longitudinal approaches would be more suitable for detecting gradual metabolic shifts and emerging patterns of cardiometabolic interaction.

Additionally, several confounding factors that influence both glucose and lipid metabolism, such as body mass index (BMI), dietary intake, physical activity, smoking, and genetic predisposition, were not included in this study. Accounting for these variables in subsequent investigations could provide a more comprehensive understanding of metabolic health in young adults.

Despite the absence of statistically significant associations, the findings emphasize the importance of early health monitoring. Even in populations that appear healthy, routine screening for HbA1c and cholesterol can help identify individuals at potential risk before disease develops. Proactive health promotion, preventive strategies, and regular monitoring may therefore play a pivotal role in reducing the long-term burden of cardiometabolic disease.

In summary, this study did not identify significant correlations between HbA1c and total cholesterol or blood pressure. However, the findings underscore the importance of continued surveillance of metabolic health among young adults. The lack of correlation likely reflects the current physiological resilience of this group, rather than the absence of future risk. Longitudinal studies that incorporate broader lifestyle and clinical variables will be essential to better understand the trajectory of cardiometabolic risk in this critical age group.

## **LIMITATION OF THE STUDY**

This study is subject to several limitations. The use of a cross-sectional approach limits the ability to draw conclusions about causality or observe metabolic trends over time. The relatively small and demographically narrow sample, focused on students from a few institutions in Lampung Province, may not reflect broader young adult populations. Furthermore, important variables such as body composition, lifestyle behaviors, and family history were not included, which could have influenced the observed relationships. The reliance on single-point laboratory results may also fail to represent participants' long-term metabolic status. Future research should consider a longitudinal design with a larger, more diverse sample and include key health and lifestyle factors.

## **CONCLUSIONS AND SUGGESTIONS**

This study found no significant correlation between HbA1c, cholesterol, or blood pressure, likely reflecting the current metabolic stability of young adults. However, low variability in health markers and physiological resilience may obscure potential associations. Long-term, lifestyle-adjusted studies are needed to clarify the early development of cardiometabolic risk in this population

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## **ETHICAL CONSIDERATIONS**

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## Conflict of Interest Statement

No conflict of interest

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