

Hypertension in young adults: BMI, genetic and physical in-activity predictors in a university students in Indonesia

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Abstract. Hypertension is increasingly affecting young adults worldwide, including university students experiencing lifestyle transitions and psychological stress. However, evidence on hypertension prevalence and related risk factors among Indonesian university populations remains limited. This study aimed to investigate hypertension prevalence and associated risk determinants among students in Yogyakarta, Indonesia. A cross-sectional study was conducted among 100 students aged 15–24 years at Universitas 'Aisyiyah Yogyakarta using cluster sampling. Data were collected through questionnaires covering socio-demographic characteristics, family health history, and lifestyle behaviours. Physical activity was measured using the Global Physical Activity Questionnaire (GPAQ). Blood pressure was assessed using a validated digital sphygmomanometer, and body mass index was calculated from anthropometric measurements. Statistical analyses included descriptive analysis, Kendall Tau correlations, and multivariate logistic regression at $\alpha = 0.005$. Hypertension prevalence was 38%, predominantly stage I. Significant associations were identified with family history of hypertension ($p = 0.001$) and insufficient physical activity ($p = 0.003$), while demographic factors showed no correlation. Logistic regression indicated genetic predisposition (OR = 1.493) and low physical activity (OR = 1.784) as independent predictors. These findings highlight the need for targeted campus-based health interventions promoting lifestyle modification to reduce early cardiovascular risk.

1 Introduction

Non-Communicable Diseases (NCDs) continue to be a major global health burden with a profound impact on morbidity, mortality, and health expenditures. Among cardiovascular conditions, hypertension stands out as a major contributor and is often labeled as the “silent killer” because of its asymptomatic nature in early stages while leading to severe complications such as stroke, ischemic heart disease, renal failure, and other vascular problems if left untreated [1]. Globally, the World Health Organization (WHO) estimated that hypertension is responsible for approximately 8.5 million deaths annually, most of which

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are attributable to cardiovascular complications [2]. The geographical variation in prevalence reflects inequities in prevention, control, and health system readiness. For instance, the prevalence of hypertension is highest in Africa (27%), while the Americas report the lowest (18%).

In Indonesia, the prevalence of hypertension has risen steadily, from 25.8% in 2013 to 34.1% in 2018 among adults aged 18 years and older, according to the National Basic Health Research Survey [3]. This increase of 8.3% within five years demonstrates a significant public health concern. In Yogyakarta, the prevalence is equally alarming. The 2021 DIY Health Profile reported that more than 251,000 residents aged ≥ 15 years were living with hypertension, with Sleman Regency recording the second-highest burden, affecting around 88,555 individuals. These figures highlight the urgent need for effective strategies tailored to local contexts. Hypertension risk factors are generally categorized into two groups: non-modifiable factors, including age, sex, and genetic predisposition; and modifiable factors, such as dietary habits, physical inactivity, smoking, obesity, and comorbidities like diabetes [2]. Recent studies have underscored the strong association between modern lifestyle changes and hypertension prevalence. Diets high in sodium and saturated fat remain critical contributors.

Interestingly, the epidemiology of hypertension is shifting toward younger populations. Adolescents and young adults are increasingly exposed to sedentary lifestyles, fast food consumption, and stress-related factors that predispose them to hypertension earlier in life [4]. According to the Indonesian Central Bureau of Statistics (BPS), the productive age group (15–64 years) is essential for sustaining economic productivity. However, the increasing prevalence of hypertension in this age group may reduce workforce performance and increase healthcare costs [5].

The Indonesian context also reflects this concern. Despite high national and provincial prevalence, limited research has specifically examined hypertension among adolescents and young adults, especially within university populations. This gap is crucial because late adolescence and early adulthood represent critical developmental stages that shape long-term health trajectories [6]. Risk factors encountered at this stage may have cumulative effects, influencing health outcomes across the life course. This perspective is reinforced by the Life Course Health Development Theory, which posits that early exposures and behaviors significantly determine future health risks and outcomes [7]. In addition, the Health Promotion Model [8] provides a valuable framework for understanding how health-related behaviors can be influenced and modified in structured environments, such as universities. Universities serve not only as educational institutions but also as social and behavioral ecosystems where health promotion interventions can be effectively implemented. However, despite the recognition of these theoretical frameworks, empirical evidence from Indonesia remains scarce. Most national studies have concentrated on the general adult population or elderly groups, leaving adolescents and university students understudied [9]. These findings point to an urgent need for localized studies in Indonesia that address this emerging risk group.

Various global efforts have been made to reduce hypertension rates and the complications it causes. The WHO and the United Nations launched the Global Action Plan for the Prevention and Control of NCDs (2013–2030), which targets a 25% reduction in the prevalence of hypertension by 2025 through strategies to reduce salt consumption, promote physical activity, and strengthen primary health care services based on early detection [2]. International organizations such as the World Hypertension League are also actively campaigning for World Hypertension Day every year to raise global public awareness.

Indonesia has responded by launching the national GERMAS (Healthy Living Community Movement) program, which encourages healthy behaviors through physical activity, a balanced diet, and regular health checkups. In addition, the Ministry of Health has

developed Posbindu PTM as an early detection service for non-communicable disease risk factors at the community level. Efforts also come from the private sector and universities through the Healthy Campus program. Government programs for campus health promotion are mainly carried out through the Healthy Campus and Health Promoting University (HPU) programs supported by the Ministry of Health. These programs cover various aspects of health, such as physical activity, balanced nutrition, mental health, drug-free and violence-free areas, and reproductive health, with the aim of creating a campus environment that supports a healthy lifestyle for the younger generation. The Healthy Campus program strives to encourage each faculty to promote health on campus which provides sports facilities, healthy canteens, and student health counseling services. However, gaps are still evident, especially among adolescents and young adults, who are often overlooked as the main targets of health interventions. In fact, sedentary lifestyles, consumption of fast food, and academic pressure make students particularly vulnerable to hypertension.

Given this background, the present study seeks to address a critical research gap by focusing on university students in Yogyakarta, Indonesia. Specifically, the study aims to assess the prevalence of hypertension and examine its associated risk factors—including both modifiable and non-modifiable determinants—among adolescents and young adults in a university setting. Understanding these relationships is expected to inform targeted health promotion programs and preventive interventions in higher education institutions, thereby contributing to the national agenda of reducing the burden of non-communicable diseases.

The purpose of this study is to analyze the prevalence of hypertension and factors that are related to the students at Universitas 'Aisyiyah Yogyakarta in order to determine the cause.

2 Methods

To find out how common hypertension and its risk factors are among people at a university, this study used a cross-sectional survey approach. The study was carried out at Universitas 'Aisyiyah Yogyakarta's Faculty of Health Sciences. There were 100 responders in the productive age range (15-64 years) after cluster sampling was used to choose participants. The Universitas 'Aisyiyah Yogyakarta Research Ethics Committee granted ethical approval (Approval No. 1629/KEP-UNISA/V/2023). Before any data was collected, each participant gave their written informed consent.

Both modifiable risk factors (residence, occupation, body mass index [BMI], smoking behaviors, dietary patterns, and physical activity) and non-modifiable risk factors (age, sex, genetic history, and place of origin) were gathered. A standardized questionnaire was used to evaluate the demographic and lifestyle features of the respondents. The International Physical Activity Questionnaire (IPAQ) was used to quantify physical activity, and a semi-quantitative food frequency questionnaire tailored to the Indonesian setting was used to evaluate dietary patterns. In accordance with WHO recommendations for standardized measurement techniques, blood pressure was taken using a validated digital sphygmomanometer Omron HEM-7130. This device has been validated according to the European Society of hypertension International Protocol (ESH-IP) and meets the accuracy standards set by the Association for medical Instrumentation (AAMI) and the British Hypertension Society (BHS) protocol. Quality control measures were implemented throughout the study period from University Aisyiyah Yogyakarta, including regular battery monitoring and replacement, and training of all measurement personnel on proper technique. BMI was calculated using the standard method (kg/m^2) based on measurements of height and body weight.

Statistical software (SPSS version XX, IBM Corp., Armonk, NY, USA) was used to analyze the data. The study population's characteristics were summed up using descriptive statistics, which include means, standard deviations, and frequencies. Using the Kendall Tau

correlation test for categorical data, bivariate analysis was performed to evaluate relationships between independent factors and hypertension status. A p-value of less than 0.05 was deemed statistically significant. Binary logistic regression was used in multivariate analysis to find independent predictors of hypertension while accounting for possible confounding variables.

3 Results and discussion

Table 1. Demographic distribution of the study population.

Variable	Options	Frequency (n)	Percentase (%)
Age	- 18-24 year	59	59
	- 25-34 year	41	41
Gender	- Woman	56	56
	- Man	44	44
Origin	- Java	75	75
	- Kalimantan	6	6
	- Sumatera	14	14
	- NTB	1	1
Residence	- NTT	4	4
	- Yogyakarta	25	25
	- Sleman	61	61
	- Bantul	12	12
	- Gunung Kidul	0	0
BMI	- Kulon progo	2	2
	- Underweight	7	7
	- Normal	28	28
	- Overweight	17	17
	- Obesitas I	46	46
Genetic	- Obesitas II	2	2
	- Yes	55	55
Physical Activity	- No Historical Family	45	45
	- Not Active	46	46
	- Medium Active	44	44
	- Active HEPA/Heavy	16	16
Total		100	100

As we can see at Table 1, that the sociodemographic characteristics of respondents demonstrated that the majority were within the younger age group of 18–24 years (59%), while 41% were aged 25–30 years. In terms of gender distribution, female participants were more prevalent (56%) compared to males (44%). Most respondents originated from Java (75%), with smaller proportions from other regions, including the lowest representation from West Nusa Tenggara (1%). A positive family history of hypertension was reported by 55% of participants, indicating a substantial genetic predisposition, while 45% did not report such a history.

With regard to modifiable risk factors, 61% of respondents resided in Sleman, reflecting the geographical concentration of the sample. The distribution of occupational status showed that students comprised the largest group (34%), followed closely by lecturers and administrative staff (33%). Body mass index (BMI) analysis revealed that nearly half of the participants were classified as obese class I (46%), whereas only 2% were categorized as obese class II. Smoking behavior was relatively low, with only 18% of respondents reporting smoking habits, compared to 82% who did not smoke. Dietary assessment indicated that 41% of respondents had moderately adequate dietary patterns, while only 19% reported a good

dietary pattern. In terms of physical activity, most respondents engaged in moderate-intensity activity (44%), whereas high-intensity activity was reported by only 16%.

Taken together, these findings highlight that the majority of participants were young adults with considerable exposure to modifiable risk factors such as obesity, suboptimal diet, and insufficient physical activity. This suggests the importance of targeted health promotion efforts within university settings to mitigate the risk of hypertension and related non-communicable diseases at an early stage of adulthood.

Table 2. Mean blood pressure of the study population.

Hipertension Level	Frequency (n)	Percentase (%)
Normal	28	28
Pra Hipertensi	34	34
Hipertension I	38	38
Hipertension II	0	0
Total	100	100

The distribution of blood pressure status among respondents stated at Table 2, its revealed that only 28% of participants were classified within the normal range, indicating less than one-third of the study population maintained optimal blood pressure levels. A substantial proportion, 34%, fell into the pre-hypertension category, suggesting that more than one in three respondents were already at elevated risk of progressing to hypertension if preventive measures were not adopted. Notably, the highest prevalence was observed in stage I hypertension, affecting 38% of participants, while no cases of stage II hypertension were recorded in this study.

These findings highlight an alarming trend in which a considerable proportion of young adults in the university environment are already experiencing elevated blood pressure or are on the trajectory toward hypertension. While sample size (n=100) provided adequate statistical power (Lemeshow formula: 95% CI, 10% precision). Multivariate logistic regression controlled for confounders, with variables selected for biological plausibility. Single-site recruitment limits generalizability, though findings align with regional university studies (28-32% prevalence). Cross-sectional design precludes causality. Future multi-site longitudinal research is recommended. The dominance of pre-hypertension and stage I level underscores the silent but significant burden of cardiovascular risk factors in this population. The absence of stage II hypertension may reflect the relatively young age of participants, but the high proportion of early hypertension stages suggests that without effective health promotion, progression to more severe stages is highly plausible over time. This reinforces the urgency for targeted interventions, including lifestyle modification programs, regular screening, and the integration of university-based health promotion strategies to address hypertension risk at an early age.

Table 3. Distribution of the study population into normal, prehypertensive and hypertensive according to age, gender, origin, residence, genetic, and physical activity.

Risk Factors for Hypertension	Hypertension						Total		P value (r)
	Normal		Pra-Hipert		Type I Hiper		n	%	
	n	%	n	%	n	%			
Age									
- 18-24 year	10	10	11	11	19	19	59	59	0.272
- 25-34 year	14	14	21	21	14	14	41	41	
Genetic									
- Woman	17	17	18	18	21	21	56	56	0.706
- Man	11	11	16	16	17	17	44	44	
Origin									
- Java	22	22	26	26	27	27	75	75	0.431

Risk Factors for Hypertension	Hypertension						Total		P value (r)
	Normal		Pra-Hipert		Type I Hiper		n	%	
	n	%	n	%	n	%			
- Kalimantan	2	2	2	2	2	2	6	6	
- Sumatera	2	2	6	6	6	6	14	14	
- NTB	0	0	0	0	1	1	1	1	
- NTT	2	2	0	0	2	2	4	4	
Residence									0.488
- Yogyakarta	7	7	9	9	9	9	25	25	
- Sleman	16	16	25	25	20	20	61	61	
- Bantul	5	5	0	0	7	7	12	12	
- Kulon Progo	0	0	0	0	2	2	2	2	
BMI									0.017*
- Underweight	4	4	3	3	0	0	7	7	
- Normal	8	8	12	12	8	8	28	28	
- Overweight	5	5	6	6	6	6	17	17	
- Obesitas I	10	10	13	13	23	23	46	46	
- Obesitas II	1	1	0	0	1	1	2	2	
Genetic:									0.000*
- Yes	6	6	18	18	29	29	55	55	
- No	20	20	16	16	9	9	45	45	
Physical Activity									0.003*
- Not active	8	8	12	12	20	20	40	40	
- Medium Active	12	12	14	14	18	18	44	44	
- Active HEPA/Heavy	8	8	8	8	0	0	16	16	
Total	28	28	34	34	38	38	100	100	

Table 3 shows that the analysis revealed age, sex, origin, and place of residence were not significantly associated with hypertension ($p > 0.05$). These findings are consistent with other studies in Vietnam and Indonesia, which have shown that at younger ages, sociodemographic variables exert less influence compared with behavioral and lifestyle-related risk factors [9]. Although population-based research often reports a higher prevalence of hypertension in men than women, such differences may be less apparent in university settings where students share similar routines, dietary exposures, and psychosocial stressors [10]. This suggests that at least in young adult populations, lifestyle modification may be a more critical focus than sociodemographic targeting. Several explanations are possible: the unique challenges of campus life, including academic stress, irregular sleep, and easy access to high-sodium and high-fat foods, are likely to contribute to elevated blood pressure in this population. Recent evidence also suggests that the rising burden of hypertension among young adults is strongly associated with modern sedentary lifestyles and increased consumption of processed food [4]. This highlights that youth and early adulthood are no longer “protected” stages of life; instead, they represent a critical window for the development of chronic disease risk.

The analysis of associations between individual characteristics and hypertension among respondents at the Faculty of Health Sciences, Universitas ‘Aisyiyah Yogyakarta, demonstrated a clear distinction between demographic and lifestyle-related factors. Sociodemographic variables, including age ($p=0.272$), gender ($p=0.706$), place of origin ($p=0.431$), and domicile ($p=0.488$), were not significantly correlated with hypertension ($p>0.05$). This indicates that demographic characteristics may have a limited explanatory role in the onset of hypertension among this relatively young population. In contrast, significant associations were identified for three key risk factors: body mass index (BMI), genetic predisposition, and physical activity. Bivariate testing revealed that BMI ($p=0.017$), family history of hypertension ($p=0.001$), and physical activity ($p=0.005$) were all significantly

related to hypertension incidence. These findings are consistent with global evidence highlighting obesity, hereditary risk, and insufficient activity as major contributors to cardiovascular morbidity in younger adults.

Table 4. Regression analysis

Variabel	Estimate	<i>p value</i>	95% CI
BMI	1.832	0.017	-3,112 - 3,078
Genetic	1.493	0.001	0,642 - 2,344
Physical Activity	1.784	0.005	0.486 - 3.025

To further explore the strength of these associations, multivariate logistic regression analysis was performed at Table 4. The results confirmed that BMI (Estimate=1.832; 95% CI: -3.112 to 3.078; $p=0.017$), genetic predisposition (Estimate=1.493; 95% CI: 0.642–2.344; $p=0.010$), and physical activity (Estimate=1.784; 95% CI: 0.486–3.025; $p=0.005$) were independent predictors of hypertension in this cohort. Among these, BMI showed the highest estimate value, underscoring the strong contribution of excess weight to blood pressure elevation, while BMI, genetic factors and insufficient physical activity further amplified the risk, with students who reported a family history of hypertension being nearly 1.5 times more likely to develop the condition ($p = 0.001$). This aligns with previous evidence emphasizing the heritable nature of blood pressure regulation [11]. This finding aligns with previous evidence that obesity is a key determinant of early-onset hypertension, even in younger populations [1]. The physiological mechanisms may include increased sympathetic activity, insulin resistance, and vascular remodeling, all of which accelerate the progression toward hypertension.

Genetic predisposition or family health story (Estimate = 1.493; $p = 0.010$) also emerged as a significant predictor, reinforcing the notion that family history contributes substantially to cardiovascular risk. Genetic predisposition was defined as self-reported family history of hypertension in first-degree relatives, without independent medical record verification due to logistical and privacy constraints. Several studies have documented that individuals with a parental history of hypertension are more likely to develop the condition, independent of lifestyle factors [12]. While genetic risk is non-modifiable, its identification remains critical for early screening and targeted prevention in high-risk groups such as young adults in academic environments. Studies in sub-Saharan Africa also indicate that family history doubles the risk of hypertension among young adults, independent of lifestyle. Mechanistically, genetic susceptibility may operate through alterations in the renin-angiotensin-aldosterone system, impaired sodium handling, and heightened vascular reactivity to stress.

Physical activity demonstrated an inverse association with hypertension (Estimate = 1.784; $p = 0.005$), indicating that insufficient activity increases the likelihood of developing high blood pressure. This supports prior research showing that sedentary lifestyles reduce vascular elasticity and impair metabolic regulation, thereby elevating blood pressure risk. The protective role of regular physical activity is especially relevant in university settings, where academic demands often contribute to sedentary behavior and reduced engagement in structured exercise. Physical activity was also another significant determinant, with inactive students almost twice as likely to present with hypertension compared to their more active peers ($p = 0.005$). This is in line with a robust body of evidence demonstrating the antihypertensive effects of regular exercise through improved endothelial function, arterial compliance, and metabolic regulation [1]. Recent meta-analyses confirm that even moderate-intensity physical activity significantly lowers systolic and diastolic blood pressure among young adults.

Similar trends are observed in Asian student populations. Research in China and Thailand found that lower activity levels were directly associated with higher blood pressure, reinforcing that the university setting can amplify sedentary behavior risks [13]. In Indonesia, students with low activity levels were significantly more likely to develop hypertension [14]. These findings underscore the need for campus-based interventions—such as promoting organized sports, creating supportive physical environments, and integrating health education into curricula—to reduce sedentary patterns and encourage sustainable active lifestyles. Interestingly, sociodemographic characteristics such as age, gender, and place of origin did not demonstrate significant associations in this study. This suggests that, within relatively homogeneous university populations, modifiable behavioral and biological risk factors outweigh demographic influences.

Evidence from Indonesia further supports this conclusion: students with hypertensive parents were more likely to develop pre-hypertension or hypertension in early adulthood [15]. These findings reinforce the importance of incorporating family history into screening protocols, particularly in youth populations where hypertension may otherwise remain undetected. Early identification of at-risk individuals can guide tailored health promotion strategies on campus, including counseling and preventive check-ups. Taken together, these results highlight that while sociodemographic factors showed no measurable effect, genetic predisposition and physical inactivity are crucial predictors of hypertension among university students. This aligns with the Life Course Health Development Theory, which posits that risk factors accumulated in adolescence and early adulthood strongly shape long-term health outcomes. Universities, therefore, represent strategic environments for preventive interventions, offering opportunities for routine screening, health counseling, and structured wellness programs.

The study makes a novel contribution by focusing on hypertension risk factors in Indonesian university students, a group often overlooked in national surveys and global literature. However, limitations must be acknowledged. The cross-sectional design precludes causal inference, and the relatively small sample size ($n = 100$) may limit generalizability. Nonetheless, this study provides an important step in documenting hypertension prevalence in young adult populations and sets the stage for larger, longitudinal research.

4 Conclusion

This study found a fairly high prevalence of hypertension among university students. Analysis showed that BMI, genetic factors and physical activity were significantly associated with the incidence of hypertension, while age, gender, region of origin, and place of residence showed no significant association. These findings underscore the urgent need for early preventive measures in university settings, particularly through Health Promotion University Programs through routine screening, health education, and campus-based lifestyle interventions that promote regular physical activity and healthy dietary habits.

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