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# Predictors of blood pressure among adults: the role of lifestyle and body composition

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**ABSTRACT**

Hypertension is influenced by multiple biological and behavioral factors; however, the relative contributions of body age and body composition remain unclear. This study examined the associations of lifestyle behaviors, body age, and body composition with blood pressure among 167 adults in Indonesia using a cross-sectional design. Lifestyle score, body age, body mass index (BMI), skeletal muscle mass, total body fat percentage, and blood pressure were assessed using standardized procedures. Spearman correlation and multiple linear regression analyses were performed. Body age was the only significant predictor of systolic blood pressure ($\beta$ = .311, p = .002). In contrast, skeletal muscle mass ($\beta$ = .172, p = .030) and total body fat percentage ($\beta$ = .248, p = .017) were significant positive predictors of diastolic blood pressure. Lifestyle score and BMI were not significant predictors in the regression models. These findings suggest that physiological aging and body composition are more strongly associated with blood pressure than lifestyle behaviors. Incorporating body age and body composition assessments into cardiovascular risk screening may improve hypertension prevention and early intervention strategies.



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## 1. INTRODUCTION

Hypertension remains one of the most significant global public health problems and is a leading contributor to cardiovascular disease, stroke, kidney failure, and premature mortality worldwide [1]. According to the World Health Organization, approximately 1.4 billion adults aged 30–79 years live with hypertension, and nearly half are unaware of their condition. The increasing prevalence of elevated blood pressure has become a major concern, particularly in low- and middle-income countries where preventive strategies and early detection remain limited. Persistent hypertension substantially increases healthcare burden and negatively affects quality of life, making identification of modifiable determinants an important public health priority [2].

Blood pressure is influenced by multiple interrelated factors, including demographic characteristics, lifestyle behaviors, and body composition. Lifestyle-related factors such as physical inactivity, unhealthy dietary habits, smoking, alcohol consumption, inadequate sleep, and sedentary behavior have consistently been associated with increased cardiovascular risk and hypertension [3], [4]. The Indonesian Ministry of Health emphasizes that healthy lifestyle modification remains one of the most effective approaches for blood pressure prevention and control. Lifestyle interventions including regular physical activity, balanced nutrition, smoking cessation, and weight management significantly contribute to reducing blood pressure and cardiovascular morbidity [5].

In recent years, increasing attention has been directed toward the role of body composition in cardiovascular health. Traditional obesity assessment using body mass index (BMI) may not adequately reflect body fat distribution or muscle composition. Consequently, body composition indicators such as visceral fat, skeletal muscle mass, body fat percentage, and body age have emerged as potentially more informative predictors of metabolic and cardiovascular risk. Excess visceral adiposity has been associated with systemic inflammation, insulin resistance, endothelial dysfunction, and activation of neurohormonal pathways that contribute to elevated blood pressure. Conversely, reduced skeletal muscle mass has been linked to impaired metabolic regulation and poorer cardiovascular outcomes [6].

Several recent studies have investigated the relationship between body composition and blood pressure. One of the studies demonstrated that trunk fat mass was one of the strongest contributors to systolic and diastolic blood pressure among young and middle-aged adults, while muscle mass also independently contributed to blood pressure variation [6]. Likewise, other research reported significant associations between body fat distribution, lean body mass, and blood pressure levels, emphasizing the importance of evaluating body composition beyond conventional BMI measurements [7]. Furthermore, another found that lean body mass was positively associated with blood pressure among adults, and that the relationship varied according to age and body fat distribution [8]. Similarly, an Indonesian community-based study reported that body mass index was significantly associated with both systolic and diastolic blood pressure, whereas several behavioral factors showed inconsistent associations, highlighting the need for more comprehensive body composition assessments beyond conventional anthropometric measurements [9].

Recent evidence has also highlighted the importance of lifestyle factors in relation to body composition and cardiometabolic outcomes. Studies reported that physical activity and sedentary behaviors significantly influence body composition parameters and cardiovascular health outcomes. A study found that physical activity, age, and body composition were significantly associated with physiological health indicators measured through bioelectrical impedance analysis [10]-[12]. Similarly, the other study demonstrated that sedentary lifestyle behaviors were associated with unfavorable body composition changes and metabolic disturbances [13]. These findings suggest that lifestyle and body composition are closely interconnected and may jointly contribute to blood pressure regulation.

Although previous studies have provided valuable insights, several important gaps remain unresolved. First, many studies have focused primarily on BMI or general obesity indicators without incorporating comprehensive body composition parameters such as visceral fat, skeletal muscle mass, and body age measured through bioelectrical impedance analysis [14]-[17]. Second, many previous investigations evaluated lifestyle factors or body composition separately, whereas fewer studies have simultaneously examined their combined contribution to blood pressure [18]-[21]. Third, evidence from adult community populations in Indonesia remains limited, particularly regarding the integration of lifestyle patterns and detailed body composition indicators in blood pressure research. In addition, most previous studies were conducted in hospital settings or large urban populations, limiting the understanding of cardiovascular risk determinants within community-based adult populations.

Therefore, this study aims to analyze the determinants of blood pressure among adults by examining the role of lifestyle patterns and body composition indicators, including body mass index, visceral fat, skeletal muscle mass, and body age measured using OMRON Karada Scan bioelectrical impedance analysis. Unlike previous studies that focused only on obesity indicators or isolated lifestyle factors, the present study integrates behavioral and physiological measurements simultaneously within a community-based adult population. This study is expected to contribute to the growing body of evidence regarding modifiable determinants of blood pressure and provide useful information for early prevention strategies, nursing interventions, and community health promotion programs targeting cardiovascular risk reduction.

## 2. METHOD

### 2.1. Study design and participants

This community-based cross-sectional study was conducted in Cihanjuang Rahayu Village, Indonesia, between November 2024 and March 2025. A total of 167 adults aged ≥18 years were recruited through purposive sampling to investigate the associations of lifestyle factors and body composition with blood pressure. Participants were eligible if they were permanent residents and provided informed consent. Those with conditions that could affect body composition or blood pressure measurements were excluded.

### 2.2. Data collection

Data were collected using standardized procedures by trained research assistants. Demographic and lifestyle-related information were obtained using a structured questionnaire. The lifestyle score consisted of several behavioral components, including physical activity, dietary habits, sleep/rest patterns, and smoking behavior, with higher scores indicating healthier lifestyles.

Body composition parameters, including BMI, body fat percentage, skeletal muscle mass, and body age, were measured using the Omron Karada Scan HBF-375 bioelectrical impedance analysis (BIA) device. Systolic and diastolic blood pressure were measured under standardized conditions according to the manufacturer's guidelines. All instruments were calibrated prior to data collection to ensure measurement reliability. Data were recorded immediately and verified to maintain accuracy.

### 2.3. Statistical analysis

Data were analyzed using IBM SPSS Statistics. Descriptive statistics were used to summarize participant characteristics. Variable normality was assessed using the Shapiro–Wilk test. Because several variables were not normally distributed, Spearman's rank correlation analysis was performed to examine associations between study variables. Separate multiple linear regression models were constructed for systolic and diastolic blood pressure outcomes to evaluate the predictive roles of lifestyle score, body age, muscle mass, BMI, and body fat. Model fit was assessed using $R^2$ and adjusted $R^2$ values, while statistical significance was determined using the F-test and standardized beta coefficients. A p-value $< 0.05$ was considered statistically significant.

### 2.4. Ethical considerations

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and received ethical exemption approval from the Ethics Committee of the Faculty of Nursing, Universitas Advent Indonesia (No. 387/KEPK-FIK.UNAI/EC/V/24). Permission to conduct the study was obtained from the local authorities of Cihanjuang Rahayu Village. Written informed consent was obtained from all participants prior to data collection. Participation was voluntary, and participant confidentiality and anonymity were strictly maintained throughout the study. Participants were informed of their right to withdraw from the study at any time without penalty.

## 3. RESULTS AND DISCUSSION

### 3.1. Results

Table 1 summarizes the demographic, lifestyle, body composition, and blood pressure characteristics of the participants. The mean age was 43.77 years (SD = 12.00), with a mean lifestyle score of 14.90 (SD = 3.87). The mean skeletal muscle mass was 25.00 kg (SD = 5.89), while the mean body age was 49.50 years (SD = 13.76). Regarding body composition, the mean BMI was 27.26 kg/m² (SD = 6.54) and the mean body fat percentage was 31.46% (SD = 8.66). The mean systolic and diastolic blood pressures were 135.35 mmHg (SD = 24.67) and 87.87 mmHg (SD = 16.52), respectively.

Overall, participants exhibited an elevated cardiovascular risk profile, characterized by overweight status, high body fat percentage, and blood pressure levels consistent with Stage 1 Hypertension. The finding that mean body age exceeded chronological age further suggests the presence of accelerated physiological aging. This accelerated physiological aging may contribute to increased cardiometabolic risk in this community.

Table 1. Descriptive characteristics of age, lifestyle, body composition, and blood pressure among participants

| Variable | Mean | SD | Min | Max | Interpretation |
|---|---|---|---|---|---|
| Age | 43.77 | 12 | 30 | 78 | Late adulthood |
| Lifestyle score | 14.9 | 3.87 | 5 | 24 | Moderate lifestyle level |
| Skeletal muscle mass | 25 | 5.89 | 13 | 45 | Moderate muscle mass |
| Body age | 49.5 | 13.76 | 17 | 88 | Early elderly (higher than chronological age, indicating relatively poorer metabolic health) |
| BMI (kg/m²) | 27.26 | 6.54 | 17 | 55 | Overweight |
| Total body fat (%) | 31.46 | 8.66 | 8 | 56 | High body fat level |
| Systolic BP (mmHg) | 135.35 | 24.67 | 90 | 225 | Stage 1 Hypertension |
| Diastolic BP (mmHg) | 87.87 | 16.52 | 60 | 180 | Stage 1 Hypertension |

Note: BMI classification based on WHO (2000) and blood pressure classification based on ACC/AHA Hypertension Guideline (2017).

Table 2 presents the correlations between lifestyle factors, body composition variables, and blood pressure. Age and body age were significantly and positively correlated with systolic blood pressure, indicating that increasing chronological and physiological age may contribute to higher systolic blood pressure levels. Body age also demonstrated a significant positive correlation with diastolic blood pressure, suggesting that accelerated physiological aging may be associated with impaired cardiovascular regulation.

Among the body composition variables, BMI showed significant positive correlations with both systolic and diastolic blood pressure, whereas total body fat percentage was significantly associated only with diastolic blood pressure. Notably, BMI exhibited the strongest correlation with diastolic blood pressure ($r = 0.358$, $p < 0.001$), followed by body age ($r = 0.337$, $p < 0.001$) and total body fat percentage ($r = 0.308$, $p < 0.001$). These findings suggest that excess adiposity may play an important role in blood pressure regulation, particularly in relation to diastolic blood pressure. In contrast, lifestyle score and skeletal muscle mass were not significantly associated with either systolic or diastolic blood pressure. Overall, the results indicate that physiological aging and adiposity-related measures appear to be more strongly associated with blood pressure than lifestyle behaviors in this study population.

Table 2. Correlations of lifestyle and body composition variables with systolic and diastolic blood pressure (n = 167)

| Predictor | SBP r (p-value) | DBP r (p-value) |
|---|---|---|
| Lifestyle score | -0.120 (0.122) | 0.008 (0.920) |
| Age | 0.306 (<0.001) | 0.130 (0.094) |
| Body age | 0.274 (<0.001) | 0.337 (<0.001) |
| BMI (kg/m²) | 0.182 (0.018) | 0.358 (<0.001) |
| Total body fat (%) | 0.086 (0.271) | 0.308 (<0.001) |
| Skeletal muscle mass (kg) | -0.089 (0.253) | -0.106 (0.173) |

Note: r = Spearman's rank correlation coefficient; p-values are shown in parentheses.
SBP = systolic blood pressure; DBP = diastolic blood pressure; BMI = body mass index.

Table 3 presents the multiple linear regression model predicting systolic blood pressure from lifestyle score, body age, skeletal muscle mass, BMI, and total body fat percentage. The overall model was statistically significant ($F = 3.803$, $p = .003$), indicating that the predictors collectively explained a significant proportion of variability in systolic blood pressure. The model accounted for 10.6% of the variance in systolic blood pressure ($R^2 = .106$), with an adjusted $R^2$ of .078. The effect size (Cohen’s $f^2 = .119$) indicated a small-to-moderate practical effect, suggesting that the model provides a meaningful, although limited, explanation of systolic blood pressure variation. That, B = unstandardized regression coefficient; SE = standard error; β = standardized regression coefficient; t = t-value; p = significance level; $sr^2$ = squared semi-partial correlation (unique variance explained by each predictor). Dependent variable: systolic blood pressure.

Among the predictors, body age was the only variable significantly associated with systolic blood pressure ($B = 0.557$, $SE = 0.178$, $\beta = .311$, $p = .002$). The positive coefficient indicates that individuals with higher body age tended to have higher systolic blood pressure. Lifestyle score demonstrated a negative association with systolic blood pressure ($B = -0.908$, $\beta = -.142$), although the relationship did not reach statistical significance ($p = .069$). Likewise, skeletal muscle mass, BMI, and total body fat percentage were not significant predictors.

Based on the semi-partial squared correlations ($sr^2$), body age explained the largest unique proportion of variance in systolic blood pressure (5.7%). The contributions of lifestyle score, skeletal muscle mass, BMI, and total body fat percentage were comparatively small. Overall, these findings suggest that body age is a more influential determinant of systolic blood pressure than lifestyle and body composition variables in this population.

Table 3. Multiple linear regression model predicting systolic blood pressure (n = 167)

| Predictor | B | SE | β | t | p | sr² |
|---|---|---|---|---|---|---|
| Constant | 126.962 | 15.639 | — | 8.118 | < .001 | — |
| Lifestyle score | −0.908 | 0.495 | −0.142 | −1.833 | .069 | .020 |
| Body age | 0.557 | 0.178 | .311 | 3.123 | .002* | .057 |
| Skeletal muscle mass (kg) | −0.124 | 0.337 | −.030 | −0.369 | .713 | .001 |
| BMI (kg/m²) | 0.319 | 0.348 | .084 | .916 | .361 | .005 |
| Total body fat (%) | −0.355 | 0.300 | −.125 | −1.185 | .238 | .009 |

Note: Model statistics: $R = .325$, $R^2 = .106$, Adjusted $R^2 = .078$, $F(5,161) = 3.803$, $p = .003$, Cohen's $f^2 = .119$. Effect size interpretation based on Cohen (1988)*.

Table 4 presents the multiple linear regression model predicting diastolic blood pressure from lifestyle score, body age, skeletal muscle mass, BMI, and total body fat percentage. The overall model was statistically significant ($F = 5.420$, $p < .001$), indicating that the predictors collectively explained a significant proportion of variability in diastolic blood pressure. The model accounted for 14.4% of the variance in diastolic blood pressure ($R^2 = .144$), with an adjusted $R^2$ of .117. The effect size (Cohen's $f^2 = .168$) indicated a moderate practical effect, suggesting meaningful explanatory power of the model. That, B = unstandardized regression coefficient; SE = standard error; β = standardized regression coefficient; t = t-value; p = significance level; $sr^2$ = squared semi-partial correlation (unique variance explained by each predictor). Dependent variable: diastolic blood pressure.

Among the predictors, skeletal muscle mass (B = 0.483, SE = 0.221, β = .172, p = .030) and total body fat percentage (B = 0.473, SE = 0.196, β = .248, p = .017) were significant positive predictors of diastolic blood pressure. These findings indicate that individuals with higher muscle mass and body fat tended to have higher diastolic blood pressure levels. In contrast, lifestyle score, body age, and BMI were not significantly associated with diastolic blood pressure, although body age showed a positive trend toward significance (p = .067).

Based on the semi-partial squared correlations ($sr^2$), total body fat explained the largest unique proportion of variance in diastolic blood pressure (3.6%), followed by skeletal muscle mass (2.9%). The remaining predictors contributed relatively small proportions of unique variance. Overall, the findings suggest that body composition, particularly total body fat and skeletal muscle mass, is more strongly associated with diastolic blood pressure than lifestyle score or BMI in this population.

Table 4. Multiple linear regression model predicting diastolic blood pressure (n = 167)

| Predictor | B | SE | β | t | p | $sr^2$ |
|---|---|---|---|---|---|---|
| Constant | 54.973 | 10.248 | — | 5.364 | < .001 | — |
| Lifestyle score | −0.507 | 0.325 | −.119 | −1.563 | .120 | .015 |
| Body age | 0.215 | 0.117 | .179 | 1.841 | .067 | .021 |
| Skeletal muscle mass (kg) | 0.483 | 0.221 | .172 | 2.186 | .030* | .029 |
| BMI (kg/m²) | 0.097 | 0.228 | .038 | .426 | .671 | .001 |
| Total body fat (%) | 0.473 | 0.196 | .248 | 2.408 | .017* | .036 |

Note: Model statistics: $R = .380$, $R^2 = .144$, Adjusted $R^2 = .117$, $F(5,161) = 5.420$, $p < .001$, Cohen's $f^2 = .168$. Effect size interpretation based on Cohen (1988)*.

### 3.2. Discussion

The present study demonstrated that body age was the strongest predictor of systolic blood pressure. Skeletal muscle mass and total body fat percentage were significant predictors of diastolic blood pressure. These findings suggest that physiological aging and body composition may contribute more substantially to blood pressure regulation than lifestyle behaviors in this population.

One of the most notable findings was the significant association between body age and systolic blood pressure. Participants with higher body age tended to exhibit higher systolic blood pressure levels, supporting the concept that physiological aging may better reflect cardiovascular health than chronological age alone. Aging-related vascular changes, including arterial stiffness, endothelial dysfunction, and reduced vascular compliance, have been identified as key mechanisms underlying elevated systolic blood pressure. Recent evidence further indicates that accelerated biological aging is strongly associated with hypertension, cardiovascular disease, and mortality risk, suggesting that biological age captures cumulative physiological deterioration that may not be reflected by chronological age alone [22]. These findings support the potential value of body age assessment as an additional indicator of cardiovascular risk in adult populations.

The significant contribution of total body fat percentage to diastolic blood pressure is consistent with current understanding of adiposity-related cardiovascular dysfunction. Excess adipose tissue functions as an active endocrine organ that promotes sympathetic nervous system activation, renin–angiotensin–aldosterone system stimulation, chronic inflammation, and insulin resistance. These mechanisms collectively increase peripheral vascular resistance and contribute to elevated diastolic blood pressure. Recent evidence indicates that obesity-related sympathetic overactivity contributes to sustained vasoconstriction, sodium retention, and hypertension, thereby increasing cardiovascular risk [23].

Furthermore, excess adiposity promotes adipocyte dysfunction, oxidative stress, and systemic inflammation that impair endothelial function, leading to abnormalities in vascular regulation and increased blood pressure [24]. Recent studies have emphasized that body fat measures provide a more direct representation of cardiometabolic risk than traditional anthropometric indices because they reflect the biological consequences of adiposity rather than body size alone. This observation is supported by evidence showing that individuals with normal BMI but elevated body fat percentage remain at significantly greater risk for hypertension, metabolic syndrome, dyslipidemia, and other cardiometabolic disorders [25], [26]. The finding that body fat explained the largest unique variance in diastolic blood pressure reinforces the importance of adiposity assessment in cardiovascular risk evaluation.

Interestingly, skeletal muscle mass was positively associated with diastolic blood pressure. Although skeletal muscle generally supports metabolic health, greater lean mass may increase blood volume and cardiac output, potentially contributing to higher vascular workload. Therefore, this finding should be interpreted within the broader context of overall body composition rather than muscle mass alone.

A particularly important finding was that BMI was not a significant predictor of either systolic or diastolic blood pressure after adjustment for body age and body composition variables. Although BMI showed significant bivariate associations, its predictive value disappeared in the multivariable model, suggesting that blood pressure is more strongly influenced by specific body composition characteristics, particularly adiposity. Unlike BMI, which cannot distinguish fat mass from lean mass, body fat percentage provides a more direct assessment of cardiometabolic risk.

This interpretation is supported by evidence showing that individuals with normal BMI but elevated body fat remain at increased risk of hypertension, metabolic syndrome, dyslipidemia, and other cardiometabolic abnormalities [25], [27]. Furthermore, normal-weight obesity has been recognized as an underdiagnosed condition associated with increased cardiovascular risk, highlighting the limitations of BMI as a standalone measure of adiposity and health status [28]. Therefore, the present findings support the growing recommendation to complement BMI with body composition assessment in cardiovascular risk evaluation.

Contrary to expectations, lifestyle behaviors were not significant predictors of blood pressure in the multivariable analyses. While extensive evidence supports the beneficial effects of physical activity, healthy dietary patterns, adequate sleep, and smoking avoidance on cardiovascular health, these effects are largely mediated through physiological pathways involving adiposity, metabolic regulation, inflammation, and vascular function [29], [30]. Consequently, when body composition and body age were included in the regression models, the direct association between lifestyle score and blood pressure may have been attenuated. Furthermore, the cross-sectional design and use of a composite lifestyle score may not fully capture the cumulative impact of long-term behavioral exposures on cardiovascular outcomes.

From a nursing perspective, these findings highlight the importance of moving beyond conventional anthropometric screening when assessing cardiovascular risk. Incorporating body age and body composition assessments into routine nursing evaluations may facilitate earlier identification of adults at increased risk of hypertension who might not be detected through BMI screening alone. This recommendation is supported by evidence showing that body fat-related measures provide a more accurate assessment of cardiometabolic risk than BMI alone, particularly among individuals with normal-weight obesity [31], [32]. As non-invasive body composition technologies become increasingly available in community and primary care settings, nurses may be better positioned to implement individualized health promotion, lifestyle counseling, and preventive interventions aimed at reducing cardiovascular risk and improving long-term health outcomes.

Overall, the present findings suggest that physiological aging and body composition are more closely associated with blood pressure regulation than lifestyle behaviors in this population. These findings support the integration of body age and body composition assessment into cardiovascular risk evaluation. They also provide additional evidence for the limitations of relying solely on BMI as a marker of cardiometabolic health.

## 4. CONCLUSION

This study examined the associations between lifestyle behaviors, body age, body composition, and blood pressure among adults. The findings indicate that body age was the only significant predictor of systolic blood pressure, whereas skeletal muscle mass and total body fat were significant predictors of diastolic blood pressure. These results suggest that physiological aging and body composition are more strongly associated with blood pressure variation than lifestyle behaviors in the study population.

Among the body composition indicators, total body fat demonstrated the greatest contribution to diastolic blood pressure, highlighting the importance of adiposity as a cardiovascular risk factor. In contrast, BMI was not a significant predictor of either systolic or diastolic blood pressure, suggesting that specific body composition measures may provide more meaningful information than conventional anthropometric indices. Overall, the findings emphasize the value of incorporating body age and body composition assessments into cardiovascular risk evaluation and hypertension prevention strategies. Although the regression models demonstrated significant explanatory power, the findings also suggest that blood pressure regulation is influenced by multiple biological, behavioral, and environmental factors. Future studies should employ longitudinal designs and larger, more diverse populations to clarify causal relationships and further investigate the interaction between lifestyle behaviors, body composition, and blood pressure across the adult lifespan.

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## AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

| Name of Author | C | M | So | Va | Fo | I | R | D | O | E | Vi | Su | P | Fu |
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| Evelin Malinti | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | | ✓ | |
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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
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R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

## CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest regarding the publication of this paper. The authors affirm that the research was conducted objectively and without any undue influence.

## INFORMED CONSENT

Written informed consent was obtained from all participants prior to their inclusion in the study.

## ETHICAL APPROVAL

The study received ethical approval from the Ethics Committee (No. 387/KEPK-FIK.UNAI/EC/V/24; May 15, 2024). Permission to conduct the study was also obtained from the local authorities of Cihanjuang Rahayu.

## DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and ethical restrictions.

## REFERENCES

[1] Z. Cheraghi, B. Azmi-Naei, P. Cheraghi, and A. Doosti-Irani, "The global prevalence of uncontrolled hypertension: a systematic review and meta-analysis," *BMC Public Health*, vol. 25, no. 1, p. 4259, Dec. 2025, doi: 10.1186/s12889-025-25553-4.
[2] World Health Organization (WHO), "Hypertension," WHO. Accessed: Dec. 01, 2025. [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/hypertension

[3] H. Kaseger *et al.*, "Multidimensional lifestyle determinants of hypertension in Indonesia: a systematic review with implications for population level prevention," *Media Publikasi Promosi Kesehatan Indonesia (MPPKI)*, vol. 9, no. 5, pp. 1084–1099, May 2026, doi: 10.56338/mppki.v9i5.9279.

[4] M. A. Aguirre-Quezada, M. P. Aranda-Ramírez, M. del Carmen-García, and G. Reiván-Ortiz, "Association of blood pressure with metabolic factors, stress levels, physical activity, and nutrient intake in overweight or obese Ecuadorian university students: a study based on mediation analysis," *Nutrients*, vol. 18, no. 2, p. 201, Jan. 2026, doi: 10.3390/nu18020201.

[5] Kementerian Kesehatan RI, "Kenali dan kendalikan hipertensi: si silent killer," KEMENKES RI. Accessed: Nov. 01, 2025. [Online]. Available: https://keslan.kemkes.go.id/view_artikel/4119/kenali-dan-kendalikan-hipertensi-si-silent-killer.

[6] S. Zhao *et al.*, "The impact of body composition and fat distribution on blood pressure in young and middle-aged adults," *Frontiers in Nutrition*, vol. 9, Sep. 2022, doi: 10.3389/fnut.2022.979042.

[7] L. Bai, J. Zhou, L. Tong, and W. Ding, "Association between body composition and blood pressure in normal-weight Chinese children and adolescents," *BMC Pediatrics*, vol. 22, no. 1, p. 240, Dec. 2022, doi: 10.1186/s12887-022-03289-z.

[8] W. Yuan *et al.*, "Lean body mass positively associate with blood pressure in Chinese adults: the roles of ages and body fat distribution," *BMC Public Health*, vol. 23, no. 1, p. 2453, Dec. 2023, doi: 10.1186/s12889-023-17312-0.

[9] E. Malinti, Y. Elon, and I. S. M. Wulandari, "Factors associated with blood pressure of adult clients," *Dunia Keperawatan: Jurnal Keperawatan dan Kesehatan*, vol. 8, no. 3, p. 425, Nov. 2020, doi: 10.20527/dk.v8i3.8277.

[10] V. Monfared *et al.*, "The effect of physical activity intervention on blood pressure in 18 low and middle-income countries: a systematic review and meta-analysis of randomized controlled trials," *Clinical Hypertension*, vol. 30, no. 1, 2024, doi: 10.1186/s40885-024-00281-w.

[11] F. J. Charchar *et al.*, "Lifestyle management of hypertension: International Society of Hypertension position paper endorsed by the World Hypertension League and European Society of Hypertension," *Journal of Hypertension*, vol. 42, no. 1, pp. 23–49, Jan. 2024, doi: 10.1097/HJH.0000000000003563.

[12] T. Ekingen *et al.*, "Associations between hydration status, body composition, sociodemographic and lifestyle factors in the general population: a cross-sectional study," *BMC Public Health*, vol. 22, no. 1, p. 900, Dec. 2022, doi: 10.1186/s12889-022-13280-z.

[13] D. Li *et al.*, "Sedentary lifestyle and body composition in type 2 diabetes," *Diabetology & Metabolic Syndrome*, vol. 14, no. 1, p. 8, Dec. 2022, doi: 10.1186/s13098-021-00778-6.

[14] N. D. Rahmawati, H. Andriani, F. Wirawan, L. Farsia, A. Waits, and K. A. Karim Taufiqurahman, "Body mass index as a dominant risk factor for metabolic syndrome among indonesian adults: a 6-year prospective cohort study of non-communicable diseases," *BMC Nutrition*, vol. 10, no. 1, p. 43, Mar. 2024, doi: 10.1186/s40795-024-00856-8.

[15] V. Z. R. Abadi, T. Sunaryati, and M. W. Sugeng, "The relationship between hypertension and body mass index (BMI) among police officers aged 30-60 years at the Pasuruan police resort," *Eduhealth*, vol. 16, no. 3, pp. 1181–1189, 2025, doi: 10.54209/eduhealth.v16i03.

[16] T. P. Sari, Dini, and M. W. Mashitah, "The relationship between body mass index and hypertension incidents among the elderly," *Health and Technology Journal (HTechJ)*, vol. 4, no. 2, pp. 180–186, Apr. 2026, doi: 10.53713/htechj.v4i2.596.

[17] D. M. Dix Munthe and T. Delfian, "The relationship between body mass index (BMI) and hypertension incidence at Royal Prima Hospital in 2024," *International Journal of Health and Pharmaceutical (IJHP)*, vol. 5, no. 4, pp. 936–945, 2025, doi: 10.51601/ijhp.v5i4.495.

[18] V. A. Hapsari, H. Nasruddin, and E. Pancawati, "Relationship between lifestyle and hypertension incidence," *Jurnal Eduhealth*, vol. 15, p. 2024, 2024, doi: 10.54209/eduhealth.v15i04.

[19] H. Kurniawan and Avril Bella Audyna, "Lifestyle interventions for blood pressure control: a narrative review of global evidence and Indonesian perspectives," *Journal of Tropical Pharmacy and Chemistry*, vol. 10, no. 1, pp. 57–66, Mar. 2026, doi: 10.30872/jtpc.v10i1.369.

[20] E. Rachmawati, Riskiyah, Q. A. Novindra, N. A. Syarifah, and N. R. Aisy, "Association between lifestyle factors and hypertension control in Indonesian primary healthcare settings: A cross-sectional study," *Malaysian Family Physician*, vol. 19, p. 18, Jun. 2024, doi: 10.51866/oa.409.

[21] H. Kaseger *et al.*, "Multidimensional lifestyle determinants of hypertension in Indonesia: a systematic review with implications for population level prevention," *Media Publikasi Promosi Kesehatan Indonesia (MPPKI)*, vol. 9, no. 5, pp. 1084–1099, May 2026, doi: 10.56338/mppki.v9i5.9279.

[22] Q. Dai *et al.*, "Association of clinical biomarker-based biological age and aging trajectory with cardiovascular disease and all-cause mortality in Chinese adults: a population-based cohort study," *BMC Public Health*, vol. 25, no. 1, p. 868, Mar. 2025, doi: 10.1186/s12889-025-22114-7.

[23] M. Patel, J. Braun, G. Lambert, T. Kameneva, C. Keatch, and E. Lambert, "Central mechanisms in sympathetic nervous dysregulation in obesity," *Journal of Neurophysiology*, vol. 130, no. 6, pp. 1414–1424, Dec. 2023, doi: 10.1152/jn.00254.2023.

[24] M. Kajikawa and Y. Higashi, "Obesity and endothelial function," *Biomedicines*, vol. 10, no. 7, p. 1745, Jul. 2022, doi: 10.3390/biomedicines10071745.

[25] N. M. Khonsari *et al.*, "Normal weight obesity and cardiometabolic risk factors: a systematic review and meta-analysis," *Frontiers in Endocrinology*, vol. 13, Mar. 2022, doi: 10.3389/fendo.2022.857930.

[26] Y. Elon, E. Malinti, J. H. L. Tobing, and S. M. Simanjuntak, "Analysis relationship between body composition and blood pressure among rural adults †," *Frontiers of Nursing*, vol. 13, no. 1, pp. 51–60, Mar. 2026, doi: 10.2478/FON-2026-0007.

[27] I. I. Rakhmat *et al.*, "Cardiometabolic risk factors in adults with normal weight obesity: A systematic review and meta-analysis," *Clinical Obesity*, vol. 12, no. 4, Aug. 2022, doi: 10.1111/cob.12523.

[28] N. N. Wijayatunga and E. J. Dhurandhar, "Correction: Normal weight obesity and unaddressed cardiometabolic health risk—a narrative review," *International Journal of Obesity*, vol. 45, no. 11, pp. 2511–2511, Nov. 2021, doi: 10.1038/s41366-021-00925-z.

[29] P. L. Valenzuela *et al.*, "Lifestyle interventions for the prevention and treatment of hypertension," *Nature Reviews Cardiology*, vol. 18, no. 4, pp. 251–275, Apr. 2021, doi: 10.1038/s41569-020-00437-9.

[30] H. Janssen, L. L. Koekkoek, and F. K. Swirski, "Effects of lifestyle factors on leukocytes in cardiovascular health and disease," *Nature Reviews Cardiology*, vol. 21, no. 3, pp. 157–169, Mar. 2024, doi: 10.1038/s41569-023-00931-w.

[31] N. Mohammadian Khonsari *et al.*, "Normal weight obesity and cardiometabolic risk factors: a systematic review and meta-analysis," *Frontiers in Endocrinology*, vol. 13, Mar. 2022, doi: 10.3389/fendo.2022.857930.

[32] N. N. Wijayatunga and E. J. Dhurandhar, "Normal weight obesity and unaddressed cardiometabolic health risk—a narrative review," *International Journal of Obesity*, vol. 45, no. 10, pp. 2141–2155, Oct. 2021, doi: 10.1038/s41366-021-00858-7.

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