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Body Mass Index and Physical Activity Are Associated with Hypertension Severity in a Primary Healthcare Population

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ABSTRACT

Hypertension remains a major public health problem and is strongly influenced by modifiable lifestyle-related factors, including excess body weight and low physical activity. Evidence regarding the association of body mass index (BMI) and physical activity with blood pressure grade among hypertensive patients in Indonesian primary healthcare settings remains limited. This study aimed to investigate the association between BMI and physical activity level with blood pressure grade among hypertensive patients at Karya Wanita Primary Health Center, Pekanbaru, Indonesia. This cross-sectional analytic study involved 48 hypertensive patients selected using accidental sampling. BMI was assessed through anthropometric measurements, while physical activity was evaluated using the Global Physical Activity Questionnaire (GPAQ). Blood pressure grade was classified into Stage 1 and Stage 2 hypertension based on JNC-7 criteria. Data were analyzed using Spearman's rank correlation test, with statistical significance set at $p < 0.05$. Most respondents were female (68.8%), aged over 65 years (39.6%), obese (54.2%), had low physical activity levels (47.9%), and were classified as having Stage 2 hypertension (58.3%). Spearman's correlation analysis showed a significant positive correlation between BMI and blood pressure grade ($r = 0.354$; $p = 0.014$), indicating that higher BMI was associated with higher hypertension grade. Physical activity level showed a significant negative correlation with blood pressure grade ($r = -0.324$; $p = 0.025$), suggesting that lower physical activity was associated with higher blood pressure grade. These findings indicate that higher BMI and lower physical activity levels were significantly associated with higher blood pressure grade among hypertensive patients in this primary healthcare population. However, due to the cross-sectional design and bivariate analysis, causal interpretation should be avoided. Further studies with larger samples and adjustment for potential confounding factors are needed to strengthen these findings.

Keywords:
Hypertension; Blood pressure grade; Body mass index; Physical activity; GPAQ; Primary healthcare.

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1. Introduction

Hypertension remains a major global public health challenge and is one of the most important modifiable risk factors for cardiovascular morbidity and mortality, including stroke, coronary heart disease, heart failure, and chronic kidney disease. Despite advances in pharmacological therapy and preventive strategies, the global prevalence of hypertension continues to increase, particularly in low- and middle-income countries undergoing rapid demographic, nutritional, and lifestyle transitions. Current estimates indicate that more than 1.28 billion adults are living with hypertension worldwide, with many remaining undiagnosed, untreated, or inadequately controlled, reflecting persistent gaps in health system performance and lifestyle risk management [1],[2],[3].

Among modifiable determinants, obesity and physical inactivity are consistently recognized as important behavioral and metabolic risk factors associated with the development and progression of hypertension. Excess body weight may increase blood pressure through several mechanisms, including sympathetic nervous system activation, renin–angiotensin–aldosterone system upregulation, endothelial dysfunction, insulin resistance, and chronic low-grade inflammation [4]. Similarly, physical inactivity may contribute to vascular dysfunction, reduced arterial compliance, impaired cardiometabolic regulation, and poor blood pressure control. Epidemiological evidence has also demonstrated a graded relationship between increasing body mass index (BMI), sedentary behavior, and elevated blood pressure levels [5].

In Indonesia, hypertension represents a growing public health burden. National health survey data show an increasing prevalence of hypertension, accompanied by challenges in awareness, treatment adherence, and blood pressure control [6]. This situation is further influenced by rapid urbanization, nutritional transition, obesity, and declining physical activity levels, particularly among older adults. At the primary healthcare level, where most hypertensive patients are initially identified and managed, long-term lifestyle counseling and preventive interventions are essential but may be constrained by limited resources, monitoring systems, and patient engagement.

At the regional level, hypertension is one of the most frequently reported chronic conditions in Riau Province, Indonesia. Local health reports indicate that Pekanbaru, including the Karya Wanita Primary Health Center, has a substantial burden of hypertension cases, with more than one thousand registered patients and relatively low service utilization for continuous care [7]. The predominance of older patients, together with increasing obesity prevalence and sedentary lifestyles, highlights the need for community-based strategies that emphasize lifestyle risk assessment and non-pharmacological blood pressure management.

Although the association between obesity, physical inactivity, and hypertension has been widely reported, evidence from primary healthcare populations in Indonesia remains limited. Many previous studies have evaluated hypertension as a binary outcome, namely the presence or absence of disease, rather than examining blood pressure grade or hypertension severity among already diagnosed patients. In addition, BMI and physical activity are often analyzed separately, whereas their concurrent

association with blood pressure grade may provide more practical information for primary care intervention. Methodologically, some local studies have also relied on general lifestyle questionnaires rather than internationally standardized tools such as the Global Physical Activity Questionnaire (GPAQ) [10].

Understanding the relationship between BMI, physical activity, and blood pressure grade is clinically relevant for improving hypertension management in primary healthcare settings. Evidence from this setting can support early identification of high-risk patients, strengthen lifestyle counseling, and improve the design of community-based non-pharmacological interventions. This is particularly important in resource-limited settings, where lifestyle modification remains a key component of long-term hypertension control [11].

Therefore, this study aimed to investigate the association between body mass index and physical activity level with blood pressure grade among hypertensive patients at the Karya Wanita Primary Health Center, Pekanbaru, Indonesia. By focusing on blood pressure grading rather than hypertension as a binary outcome, and by using GPAQ-based physical activity assessment alongside anthropometric measurement, this study provides contextual evidence to support lifestyle-oriented hypertension management in an Indonesian primary healthcare population.

2. Methods

Research Design

This study used a cross-sectional analytic design to evaluate the association between body mass index (BMI), physical activity level, and blood pressure grade among hypertensive patients. This design was appropriate because all variables were measured at a single point in time. However, the cross-sectional design only allows the identification of statistical associations and cannot establish causal relationships or determine the temporal sequence between exposure and outcome variables.

Study Setting and Duration

The study was conducted at Karya Wanita Primary Health Center, Pekanbaru, Indonesia, a government-affiliated primary healthcare facility that provides preventive and curative services for non-communicable diseases, including hypertension management programs for adult and older populations. The study site was selected because of the increasing burden of hypertension cases and the relevance of lifestyle-related risk factors among patients attending primary healthcare services in the region. Data collection was carried out from March 10 to March 24, 2025, during routine outpatient service hours.

Eligibility Criteria

The inclusion criteria were hypertensive patients who attended the outpatient service at Karya Wanita Primary Health Center during the study period, had been diagnosed with hypertension based on medical records or blood pressure assessment, were willing to participate in the study, and provided written informed consent. Participants were also required to have complete data on BMI, physical activity assessment using the Global Physical Activity Questionnaire (GPAQ), and blood pressure measurement.

The exclusion criteria were patients with conditions that could substantially affect blood pressure measurement or physical activity assessment, including pregnancy, suspected or diagnosed secondary hypertension, acute illness during data collection, severe cardiovascular or renal complications, physical disability limiting mobility, cognitive impairment or communication difficulties that prevented

questionnaire completion, and incomplete research data. Patients who were unwilling to participate or withdrew during the data collection process were also excluded from the study.

Sample Size and Sampling Technique

The sample size was determined using the following correlation-based sample size formula:

$$n = [(Z_{1-}\alpha/_2 + Z_{1-}\beta) / \{0.5 \times \ln((1 + r) / (1 - r))\}]^2 + 3$$

where *n* represents the minimum required sample size, $Z_{1-}\alpha/_2$ represents the Z value for a two-sided significance level, $Z_{1-}\beta$ represents the Z value for statistical power, and *r* represents the expected correlation coefficient.

Using a significance level of 0.05 ($Z_{1-}\alpha/_2 = 1.96$), a statistical power of 80% ($Z_{1-}\beta = 0.84$), and an expected moderate correlation coefficient of 0.40 based on preliminary clinical observations, the minimum required sample size was calculated to be 47 respondents. Therefore, the final sample of 48 respondents was considered adequate for bivariate correlation analysis.

Participants were selected using accidental sampling. This non-probability sampling technique was applied by recruiting eligible hypertensive patients who attended the primary healthcare facility during the data collection period. However, this sampling method may introduce selection bias because respondents were limited to patients who accessed healthcare services during the study period. Therefore, the findings should be interpreted as representative of this localized primary healthcare population rather than the broader hypertensive population in Pekanbaru or Indonesia.

Measurement and Research Instruments

Blood pressure was classified into Stage 1 and Stage 2 hypertension according to the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-7) criteria. Blood pressure was measured under standardized conditions. Participants were asked to rest before measurement, and blood pressure was assessed in a seated position using an appropriate cuff size. Measurements were performed by trained personnel to reduce measurement variability.

BMI was assessed using standard anthropometric measurements. Body weight was measured using a calibrated digital scale, while height was measured using a stadiometer. BMI was calculated by dividing body weight in kilograms by height in meters squared ((kg/m^2)). BMI was categorized based on the World Health Organization Asia-Pacific criteria.

Physical activity level was assessed using the Global Physical Activity Questionnaire (GPAQ) Version 2.0. The GPAQ evaluates physical activity across three domains: work-related activity, travel-related activity, and recreational activity. Metabolic Equivalent Task (MET) scores were calculated by multiplying the duration of activity in minutes per week by the assigned MET value, namely 4 METs for moderate-intensity activity and 8 METs for vigorous-intensity activity. Total physical activity was expressed as MET-minutes per week.

Based on the WHO GPAQ analysis framework, physical activity was categorized into three levels: low, moderate, and high. Low physical activity was defined as not meeting the criteria for moderate or high activity, generally corresponding to less than 600 MET-min/week. Moderate physical activity was defined as achieving at least 600 MET-min/week through a combination of moderate- or vigorous-intensity activities. High physical activity was defined as achieving at least 3,000 MET-min/week through vigorous-intensity or combined physical activities.

Validity and Reliability Testing

The GPAQ instrument used in this study has demonstrated acceptable psychometric properties in previous international and Indonesian epidemiological studies. Content validity was supported through expert review involving public health specialists and clinicians with experience in hypertension management and behavioral epidemiology.

Before formal data collection, pilot testing was conducted among hypertensive patients outside the study sample to evaluate the clarity, comprehensibility, and contextual appropriateness of the questionnaire items. Minor linguistic modifications were made to improve respondent understanding without changing the conceptual meaning of the instrument. Internal consistency reliability was evaluated using Cronbach's alpha coefficient, with a value of ≥0.70 considered acceptable. Standardized training was provided to research assistants to minimize interviewer variability during questionnaire administration.

Data Collection Procedures

Administrative approval was obtained from the management of Karya Wanita Primary Health Center before study implementation. Ethical approval was obtained from the institutional ethics review board before participant recruitment.

Eligible participants attending outpatient services during the study period were identified through clinic registration records and screened according to the predefined inclusion and exclusion criteria. Respondents who met the eligibility criteria received an explanation regarding the study objectives, procedures, confidentiality protection, voluntary participation, and their right to withdraw from the study at any time.

Written informed consent was obtained before data collection. Sociodemographic data were collected using a structured form. Anthropometric measurements and blood pressure assessment were then conducted under standardized procedures. Subsequently, trained interviewers administered the GPAQ through face-to-face interviews to reduce misunderstanding and ensure uniform interpretation of questionnaire items. All collected data were anonymized using coded identification numbers. Hardcopy forms were stored securely, while electronic datasets were password-protected and accessible only to authorized researchers.

Statistical Analysis

Data were analyzed using statistical software. Descriptive statistics were used to summarize respondent characteristics, including sex, age group, BMI category, physical activity level, and blood pressure grade. Numerical variables were presented as mean ± standard deviation or median and interquartile range, as appropriate, while categorical variables were presented as frequencies and percentages.

The association between BMI, physical activity level, and blood pressure grade was analyzed using Spearman's rank correlation test because the outcome variable, blood pressure grade, was ordinal. BMI was analyzed as a continuous variable, while physical activity level and blood pressure grade were treated as ordinal variables. Physical activity level was coded in ascending order from low to high activity, while blood pressure grade was coded according to increasing hypertension stage. A p-value of less than 0.05 was considered statistically significant.

Because this study used bivariate analysis, the results should be interpreted cautiously. Potential confounding factors, including age, sex, duration of hypertension, antihypertensive medication use, treatment adherence, dietary sodium intake, smoking status, diabetes mellitus, dyslipidemia, and renal disease, were not fully controlled in the present analysis.

Ethical Considerations

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki for research involving human participants. Ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universitas Abdurrab, Indonesia, with approval number 157/FK-UNIVRAB/B/III/2025.

Participation was entirely voluntary, and all respondents provided written informed consent before data collection. Respondents had the right to withdraw from the study at any stage without affecting their healthcare services. Confidentiality and anonymity were strictly maintained throughout the research process, and no personally identifiable information was disclosed during data analysis or

3. Results and Discussion

Participant Characteristics

A total of 48 hypertensive patients were included in this study. The demographic and clinical characteristics of the respondents are presented in **Table 1**. Most participants were female (n = 33; 68.8%), while male respondents accounted for 31.2% of the sample. Based on age distribution, the largest proportion of respondents was aged >65 years (n = 19; 39.6%), followed by those aged 56–65 years (n = 17; 35.4%) and 46–55 years (n = 12; 25.0%).

Regarding body mass index, more than half of the respondents were classified as obese (n = 26; 54.2%), followed by overweight (n = 13; 27.1%) and normal BMI (n = 9; 18.7%). Assessment of physical activity using the Global Physical Activity Questionnaire (GPAQ) showed that most respondents had low physical activity levels (n = 23; 47.9%), while 35.4% had moderate activity and only 16.7% had high physical activity. In terms of blood pressure grade, the majority of respondents were classified as having Stage 2 hypertension (n = 28; 58.3%), while 20 respondents (41.7%) had Stage 1 hypertension. These findings indicate that the study population was predominantly characterized by older age, obesity, low physical activity, and more advanced blood pressure grade.

Table 1. Demographic and clinical characteristics of respondents (n = 48)

Variable	Category	n	%
Sex	Male	15	31.2
	Female	33	68.8
Age group (years)	46–55	12	25.0
	56–65	17	35.4
	>65	19	39.6
Body mass index	Normal	9	18.7
	Overweight	13	27.1
	Obesity	26	54.2
Physical activity level	High	8	16.7
	Moderate	17	35.4
	Low	23	47.9
Blood pressure grade	Stage 1 hypertension	20	41.7
	Stage 2 hypertension	28	58.3

Abbreviations: *BMI, body mass index; GPAQ, Global Physical Activity Questionnaire.*

Descriptive Analysis of Main Study Variables

Descriptive statistics of the main study variables are presented in **Table 2**. The mean BMI of respondents was 28.6 ± 4.2 kg/m², with a median value of 28.1 kg/m², indicating that the overall study population tended to fall within the overweight-to-obese range. The mean systolic blood pressure was 156.8 ± 14.5 mmHg, while the mean diastolic blood pressure was 96.4 ± 9.8 mmHg. These values indicate that, on average, respondents had blood pressure levels above the recommended control targets for hypertensive patients. The median physical activity level was 690.0 MET-min/week, suggesting relatively limited engagement in moderate-to-vigorous physical activity among participants.

Table 2. Descriptive statistics of main study variables

Variable	Mean ± SD	Median (IQR)	Minimum–Maximum
Body mass index (kg/m²)	28.6 ± 4.2	28.1 (5.4)	21.3–37.9
Systolic blood pressure (mmHg)	156.8 ± 14.5	154.0 (18.0)	140–190
Diastolic blood pressure (mmHg)	96.4 ± 9.8	95.0 (10.0)	80–118
Physical activity (MET-min/week)	762.4 ± 415.6	690.0 (520.0)	120–1860

Abbreviations: *SD, standard deviation; IQR, interquartile range; MET, metabolic equivalent of task.*

Bivariate Analysis

The bivariate correlation analysis between BMI, physical activity level, and blood pressure grade is presented in **Table 3**. Spearman's rank correlation test showed a statistically significant positive correlation between BMI and blood pressure grade ($r = 0.354$; $p = 0.014$). This finding indicates that higher BMI was associated with a higher blood pressure grade among hypertensive patients in this study.

In contrast, physical activity level showed a statistically significant negative correlation with blood pressure grade ($r = -0.324$; $p = 0.025$). This finding suggests that lower physical activity levels were associated with higher blood pressure grade. However, both correlations were weak to moderate in magnitude; therefore, the findings should be interpreted cautiously, particularly because this study used a cross-sectional design and bivariate analysis without adjustment for potential confounding factors.

Table 3. Bivariate correlation analysis between study variables and blood pressure grade

Variable	Statistical test	Correlation coefficient (r)	p-value
Body mass index	Spearman's rank correlation	0.354	0.014*
Physical activity level	Spearman's rank correlation	-0.324	0.025*

Note: **Statistically significant at $p < 0.05$.*

Discussion

This study demonstrated significant associations between BMI, physical activity level, and blood pressure grade among hypertensive patients attending a primary healthcare facility in Pekanbaru. BMI showed a significant positive correlation with blood pressure grade, indicating that respondents with higher

BMI tended to have a higher stage of hypertension. Conversely, physical activity level showed a significant negative correlation with blood pressure grade, suggesting that lower physical activity was associated with more advanced blood pressure grade. However, the weak-to-moderate correlation coefficients indicate that BMI and physical activity are not the only factors contributing to blood pressure grade in this population.

The positive correlation between BMI and blood pressure grade is consistent with established pathophysiological mechanisms linking excess body weight to elevated blood pressure. Increased adiposity may contribute to higher blood pressure through several mechanisms, including increased blood volume, higher cardiac output, sympathetic nervous system activation, renin–angiotensin–aldosterone system upregulation, endothelial dysfunction, insulin resistance, and chronic low-grade inflammation [4,17,18]. These mechanisms may collectively increase renal sodium retention and peripheral vascular resistance, thereby contributing to higher blood pressure levels. In this study, more than half of the respondents were classified as obese, supporting the relevance of BMI as an important lifestyle-related risk indicator among hypertensive patients in primary healthcare settings.

The significant negative correlation between physical activity level and blood pressure grade also supports the role of physical activity in blood pressure control. Lower physical activity may contribute to reduced vascular compliance, impaired endothelial function, increased sympathetic tone, and poorer cardiometabolic regulation. In contrast, regular physical activity may improve nitric oxide bioavailability, reduce vascular resistance, enhance arterial function, and support better blood pressure regulation [14,16]. The finding that nearly half of the respondents had low physical activity levels highlights the need to strengthen physical activity counseling and lifestyle modification programs at the primary healthcare level.

In the context of Indonesian primary healthcare, these findings provide useful local evidence regarding the relationship between lifestyle-related factors and blood pressure grade among diagnosed hypertensive patients. Previous national and regional reports have documented hypertension as a major public health problem in Indonesia and Riau Province [6,7]. However, many studies have examined hypertension as a binary outcome rather than focusing on blood pressure grade among patients who have already been diagnosed with hypertension. By focusing on Stage 1 and Stage 2 hypertension, this study provides a more clinically relevant perspective for primary care practice, where identifying patients with more advanced blood pressure grade is important for counseling, monitoring, and long-term management.

The use of the Global Physical Activity Questionnaire (GPAQ) also strengthens the assessment of physical activity in this study. Unlike general self-reported lifestyle questions, GPAQ allows physical activity to be assessed across work, travel, and recreational domains using a standardized framework. Nevertheless, physical activity data remain self-reported and may be affected by recall bias and social desirability bias. Therefore, the observed association

between physical activity and blood pressure grade should be interpreted carefully.

Study Limitations and Confounding Factors

Several limitations should be considered when interpreting the findings. First, the cross-sectional design only captures exposure and outcome variables at a single point in time; therefore, causal relationships or temporal direction cannot be established. Second, the sample size was relatively modest, and accidental sampling was used. This may introduce selection bias because respondents were limited to patients who attended the primary healthcare facility during the data collection period. As a result, the findings may not be generalizable to all hypertensive patients in Pekanbaru or Indonesia.

Third, this study used bivariate correlation analysis; therefore, the associations between BMI, physical activity level, and blood pressure grade were not adjusted for potential confounding factors. Important variables such as age, sex, duration of hypertension, antihypertensive medication use, treatment adherence, dietary sodium and potassium intake, smoking status, diabetes mellitus, dyslipidemia, renal disease, and other metabolic comorbidities were not fully controlled in the analysis. These factors may influence blood pressure grade and may partly explain the weak-to-moderate correlation observed in this study. Therefore, the findings should be interpreted as preliminary evidence of lifestyle-related associations rather than definitive indicators of independent risk factors.

Despite these limitations, this study emphasizes the practical importance of assessing BMI and physical activity level in routine hypertension care at the primary healthcare level. Integrating anthropometric assessment and physical activity screening into regular patient evaluation may help identify patients who require more intensive lifestyle counseling. Future studies with larger sample sizes, probability-based sampling, and multivariable analysis are recommended to confirm these findings and better clarify the independent contribution of BMI and physical activity to blood pressure grade.

4. Conclusion

This study found that higher body mass index and lower physical activity levels were significantly associated with higher blood pressure grade among hypertensive patients attending a primary healthcare facility. These findings highlight the importance of incorporating BMI assessment and physical activity screening into routine hypertension management at the primary care level. However, because this study used a cross-sectional design, a modest sample size, accidental sampling, and self-reported physical activity data, causal interpretation should be avoided. In addition, potential confounding factors were not fully controlled in the analysis. Future studies with larger sample sizes, longitudinal designs, probability-based sampling, and multivariable analysis are recommended to further clarify the independent contribution of BMI and physical activity to blood pressure grade.

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Conflicts of Interest:
The authors declare no conflict of interest regarding the publication of this paper.

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