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# Body mass index, physical activity, and hypertension grade among Prolanis participants

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## Abstract

**Background:** Hypertension is a major cardiovascular condition, and its severity may be associated with modifiable factors such as body mass index (BMI) and physical activity.
**Purpose:** To examine the associations of BMI and physical activity with hypertension grade among Prolanis participants.
**Method:** This analytical correlational study used a cross-sectional design and involved 63 participants drawn from a population of 167 patients with hypertension enrolled in the chronic disease management program (Prolanis) at Kaliwungu Kudus Community Health Centre. BMI was calculated from measured height and weight, physical activity was assessed using the International Physical Activity Questionnaire (IPAQ), and blood pressure was measured using a sphygmomanometer. Data were analyzed using Spearman's rho, with statistical significance set at $p < 0.05$.
**Results:** Overweight was the most frequent BMI category (34 participants, 54.0%), high physical activity was reported by 26 participants (41.3%), and grade I was the most frequent hypertension category (23 participants, 36.5%). BMI was significantly associated with hypertension grade ($r = 0.585$, $p < 0.001$). Physical activity was significantly and inversely associated with hypertension grade ($r = -0.511$, $p < 0.001$).
**Conclusion:** BMI and physical activity were significantly associated with hypertension grade among Prolanis participants. Because the study used a cross-sectional design, the findings indicate associations rather than causal effects.

**Keywords: Body Mass Index; Hypertension; Physical Activity; Primary Health Care.**

## INTRODUCTION

Hypertension remains an important public-health problem and a leading contributor to cardiovascular morbidity and premature mortality. Its occurrence and severity are influenced by both non-modifiable and modifiable factors, including age, body composition, diet, and habitual physical activity (Mills, Stefanescu, & He, 2020; Fuchs & Whelton, 2020; Zhou, Carrillo-Larco, Danaei, Riley, Paciorek, Stevens, & Breckenkamp, 2021; World Health Organization, 2023). National guidance in Indonesia similarly emphasizes the detection and management of elevated blood pressure (Ministry of Health of the Republic of Indonesia, 2023). Local health-service data indicate that the burden of hypertension remains substantial in Central Java and Kudus Regency (Central Java Provincial Government, 2024; Kudus Regency Health Office, 2024).

Body mass index is one modifiable factor that may be associated with blood pressure. Excess body weight increases circulatory demand and has been linked to sympathetic, renal, neurohormonal, and adipose-related mechanisms that promote hypertension (Bann, Scholes, Hardy, & O'Neill, 2021; Shariq & McKenzie, 2020; Powell-Wiley, Poirier, Burke, Després, Gordon-Larsen, Lavie, & American Heart Association Council on Lifestyle and Cardiometabolic Health; Council on Cardiovascular and Stroke Nursing; Council on Clinical Cardiology; Council on Epidemiology and Prevention; and Stroke

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Council, 2021). Indonesian studies have also reported associations between BMI and hypertension or blood pressure (Fitriani, Hutasuhut, & Riansyah, 2022; Gunaidi, Destra, Frisca, & Santoso, 2022; Nugroho & Barkah, 2023).

Physical activity is likewise relevant to blood-pressure regulation. Regular activity and exercise can improve cardiovascular fitness and lower blood pressure, whereas low activity is associated with a higher burden of hypertension (Sharman, Smart, Coombes, & Stowasser, 2019; Laukkanen & Kunutsor, 2021; Bennie, Lee, Brellenthin, & De Cocker, 2020; Saco-Ledo, Valenzuela, Ramirez-Jimenez, Morales, Castillo-Garcia, Blumenthal, & Lucia, 2021). Indonesian studies have similarly reported associations between physical activity and hypertension (Jasmin, Avianty, & Prastia, 2023; Hidayati, 2024; Rizki, Wiatma, Hardinata, & Utama, 2023).

A preliminary study conducted on October 17, 2025 identified 167 patients with hypertension enrolled in Prolanis within the catchment area of Kaliwungu Kudus Community Health Centre. Of the five respondents interviewed and observed, three reported low activity and two reported moderate activity, while three were classified as overweight and two had a normal BMI. Blood-pressure assessment identified four respondents with moderate hypertension and one with severe hypertension. This study therefore aimed to examine the associations of BMI and physical activity with hypertension grade among Prolanis participants at Kaliwungu Kudus Community Health Centre.

## RESEARCH METHOD

This study used a quantitative analytical correlational design with a cross-sectional approach and was conducted at Kaliwungu Kudus Community Health Centre, Central Java, Indonesia. The study population comprised 167 patients with hypertension enrolled in the chronic disease management program (Prolanis), and the final sample comprised 63 participants.

Participants were selected using purposive sampling from registered Prolanis patients with hypertension at Kaliwungu Kudus Community Health Centre. The inclusion criteria were as follows: registration as an active Prolanis participant with a diagnosis of hypertension; systolic blood pressure of 140 mmHg or higher and/or diastolic blood pressure of 90 mmHg or higher at screening; age of 18 years or older; ability to communicate and complete the study procedures; and willingness to participate by providing written informed consent. The exclusion criteria were acute illness at the time of data collection, inability to stand safely for anthropometric measurement, incomplete questionnaire or blood-pressure data, and withdrawal before completion of the assessment.

BMI was calculated as weight in kilograms divided by height in meters squared (kg/m²) and categorized as underweight (<18.5 kg/m²), normal (18.5–24.9 kg/m²), or overweight (≥25.0 kg/m²). Physical activity was assessed using the short-form International Physical Activity Questionnaire (IPAQ-SF). Activity was categorized as low when the criteria for moderate or high activity were not met, as moderate when participants achieved at least 600 MET-min/week, and as high when they achieved at least 3,000 MET-min/week. Blood pressure was measured using a calibrated aneroid sphygmomanometer after participants had rested in a seated position for at least 5 minutes, with the arm supported at heart level and an appropriately sized cuff. Two measurements were obtained approximately 1–2 minutes apart and averaged for analysis. Hypertension was classified as grade I (140–159/90–99 mmHg), grade II (160–179/100–109 mmHg), or grade III (≥180 and/or ≥110 mmHg). The sphygmomanometer underwent routine calibration before data collection, and the cuff, valve, and gauge were checked before use.

Categorical variables were summarized using frequencies and percentages. The associations of BMI and physical activity with hypertension grade were assessed using Spearman's rho, with statistical significance set at $p < 0.05$. The following ordinal coding was applied: BMI (underweight = 1, normal = 2, overweight = 3), physical activity (light = 1, moderate = 2, high = 3), and hypertension grade (grade I = 1, grade II = 2, grade III = 3). Under this coding, the Spearman coefficient for physical activity and hypertension grade was $r = -0.511$ ($p < 0.001$), indicating that higher physical-activity categories were associated with lower hypertension grades.

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## RESEARCH RESULTS

A total of 63 participants were included. Table 1 presents the verified participant characteristics and main study variables available in the manuscript.

**Table 1. Participant characteristics and study variables (N = 63)**

| Variable | Results, n (%) |
|---|---|
| **Age, years, Mean ± SD (range)** | **58.84 ± 10.77 (38-77)** |
| ≤45 years | 8/12.7 |
| 46–55 years | 17/27.0 |
| 56–65 years | 21/33.3 |
| >65 years | 17/27.0 |
| **Gender** | |
| Male | 28/44.4 |
| Female | 35/55.6 |
| **Highest educational level** | |
| Primary school | 15/23.8 |
| Junior high school | 23/36.5 |
| Senior high school | 23/36.5 |
| Bachelor's degree | 2/3.2 |
| **Employment status** | |
| Unemployed | 17/27.0 |
| Farmer | 9/14.3 |
| Trader | 14/22.2 |
| Labourer | 15/23.8 |
| Private-sector employee | 8/12.7 |
| **Body mass index** | |
| Underweight | 6/9.5 |
| Normal | 23/36.5 |
| Overweight | 34/54.0 |
| **Physical activity** | |
| Low | 14/22.2 |
| Moderate | 23/36.5 |

As presented in Table 1, most participants were female (35 participants, 55.6%). Overweight was the most frequent BMI category (34 participants, 54.0%), high physical activity was reported by 26 participants (41.3%), and grade I was the most frequent hypertension category (23 participants, 36.5%).

**Table 2. Body mass index and physical activity by hypertension grade (N = 63)**

| Variable | Grade I | Grade II | Grade III | p-value | *r* |
|---|---|---|---|---|---|
| **Body mass index** | | | | | |
| Underweight | 4 (6.3) | 2 (3.2) | 0 (0.0) | <0.001 | 0.585 |
| Normal | 15 (23.8) | 6 (9.5) | 2 (3.2) | | |
| Overweight | 4 (6.3) | 13 (20.6) | 17 (27.0) | | |
| **Total** | 23 (36.5) | 21 (33.3) | 19 (30.2) | | |

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| | | | | | |
|---|---|---|---|---|---|
| **Physical activity** | | | | | |
| Low | 1 (1.6) | 1 (1.6) | 12 (19.0) | <0.001 | -0.511 |
| Moderate | 8 (12.7) | 11 (17.4) | 4 (6.4) | | |
| High | 14 (22.2) | 9 (14.3) | 3 (4.8) | | |
| **Total** | 23 (36.5) | 21 (33.3) | 19 (30.2) | | |

Table 2 demonstrates the distribution of BMI and physical activity across hypertension grades. BMI showed a moderate positive association with hypertension grade ($r$ = 0.585, $p$ < 0.001). Grade III hypertension was concentrated in the overweight group, whereas none of the participants in the underweight group had grade III hypertension.

Physical activity was significantly and inversely associated with hypertension grade (r = -0.511, p < 0.001). Grade III hypertension predominated among participants reporting low activity, whereas grade I hypertension was more common among those reporting high activity. Higher physical-activity categories were therefore associated with lower hypertension grades in the ordinal analysis.

## DISCUSSION

The findings indicate significant associations of BMI and physical activity with hypertension grade. Higher BMI categories were concentrated in the higher hypertension grades, whereas physical activity showed the opposite pattern. These results suggest that body composition and habitual activity are relevant to hypertension severity in this Prolanis population, although the bivariate cross-sectional analysis cannot establish independent or causal effects (Bann et al., 2021; Shariq et al., 2020; Powell-Wiley et al., 2021; Fitriani et al., 2022; Gunaidi et al., 2022; Nugroho et al., 2023).

A plausible mechanism for this association is the greater circulatory demand imposed by excess body mass. Increased blood volume, sympathetic activity, neurohormonal activation, renal sodium handling, and adipose-derived mediators may all contribute to higher arterial pressure over time (Shariq et al., 2020; Powell-Wiley et al., 2021). The present cross-sectional data, however, cannot establish whether an elevated BMI preceded or contributed to a higher hypertension grade.

Physical activity was also significantly associated with hypertension grade. Grade III hypertension was more frequent among participants reporting low activity, while grade I hypertension was more frequent among those reporting high activity. This pattern is consistent with evidence that regular physical activity and exercise support blood-pressure control (Sharman et al., 2019; Laukkanen et al., 2021; Bennie et al., 2020; Saco-Ledo et al., 2021) and with Indonesian findings (Jasmin et al., 2023; Hidayati, 2024; Rizki et al., 2023).

The inverse correlation for physical activity was consistent with the cross-tabulated distribution. When physical activity was coded from light (1) to high (3) and hypertension from grade I (1) to grade III (3), the Spearman analysis yielded $r$ = -0.511 ($p$ < 0.001). This direction indicates that a higher level of physical activity was associated with a lower hypertension grade in this sample.

The findings should be interpreted cautiously for several reasons. The cross-sectional correlational design cannot establish temporal sequence or causality. Participants were recruited from a single health centre and a single Prolanis population, which limits generalizability. Physical activity was self-reported and may therefore be affected by recall and social-desirability bias. The analysis was bivariate and did not adjust for age, gender, diet, smoking, comorbidity, medication use, or other potential confounders. Operational details that are not available in the verified study record should be completed by the authors before submission.

## CONCLUSION

BMI and physical activity were significantly associated with hypertension grade among Prolanis participants. A higher BMI was associated with a higher hypertension grade, while physical activity showed a moderate inverse association with hypertension grade ($r$ = -0.511, $p$ < 0.001), indicating that higher activity categories were associated with lower hypertension grades. These findings should be interpreted as associations rather than as causal effects.

## SUGGESTION

Future studies should use probability-based or multicenter sampling, clearly defined BMI and physical-activity classifications, standardized blood-

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pressure measurement procedures, and multivariable analyses that account for age, gender, diet, smoking, comorbidities, and antihypertensive medication. Prospective designs would help to clarify the temporal relationships between body composition, physical activity, and blood-pressure severity.

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