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Posyandu Participation Score and Blood Pressure Status among Adults with Hypertension in Surakarta, Indonesia: A Cross-Sectional Study

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ABSTRACT

Background: The association of Posyandu engagement with measured blood pressure control remains uncertain. We examined this association among adults with reported hypertension registered at Posyandu in Banjarsari, Surakarta, Indonesia.
Methods: A cross-sectional study enrolled 400 purposively selected Posyandu-registered adults in six Puskesmas catchment areas from 29 June to 7 August 2026. An eight-item self-report participation score was classified as active at ≥6/8; controlled blood pressure was defined as systolic <140 mmHg and diastolic <90 mmHg at one assessment. The primary complete-case analysis (n=399) adjusted for age, sex, hypertension duration and recorded comorbidity; modified-Poisson regression with robust variance estimated an adjusted prevalence ratio.
Result: Among 400 participants, 246 (61,5%) had controlled blood pressure. Of 399 with a valid Posyandu score, 229 (57,4%) were classified as active. Active versus inactive self-reported participation was associated with controlled blood pressure (adjusted odds ratio=2,014; 95% CI=1,329–3,052; p-value=0,001; adjusted prevalence ratio=1,313; 95% CI=1,110–1,554; p-value=0,001).
Conclusion: Questionnaire-defined Posyandu engagement was associated with blood pressure status in this purposively recruited sample. Actual attendance and sustained blood pressure control were not verified; causality cannot be inferred.

Keywords: Blood pressure control ; Cross sectional studies ; Hypertension ; Posyandu ; Community participation

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Introduction

Hypertension is an established cause of preventable cardiovascular illness, yet achievement of blood pressure targets remains uneven despite effective pharmacological treatment. The World Health Organization identifies a substantial burden of untreated and uncontrolled hypertension worldwide.[1] In practice, a controlled reading reflects more than access to medicines: follow-up continuity, clinical risk, treatment use and social circumstances may all shape the status recorded at a particular visit.[2] These considerations are important when interpreting community-based service use, because an association observed at one time point cannot distinguish the consequences of engagement from the characteristics of people who engage.

Indonesian community programmes offer several possible points of contact for hypertension prevention and follow-up, although Posyandu and Posbindu PTM differ in organisation, service components and target populations. A mixed-methods evaluation of Posbindu documented missed opportunities for hypertension risk-factor screening,[3] while a four-district study found differences in hypertension-related knowledge, attitudes and practices according to access to the programme.[4] Community education and self-monitoring activities have also been described in Indonesian implementation reports.[5],[6] These publications support the relevance of community contact, but do not establish whether the questionnaire-defined Posyandu engagement index used here corresponds to actual visit frequency or is associated with contemporaneous blood pressure status.

An important analytical distinction is between baseline characteristics, correlated self-care behaviours and possible consequences of participation. Age, sex, duration of hypertension and reported comorbidity may relate to both service engagement and blood pressure status, making them conceptually relevant adjustment variables. By contrast, medication-related behaviour, CERDIK practices and family support were measured alongside participation; temporal ordering was not established. Prior Indonesian studies and a cluster-randomised intervention in Nepal examine related but non-identical exposures and outcomes.[7–10] Consequently, simultaneous adjustment for four overlapping self-report scores cannot by itself identify an independent causal pathway or a mediation mechanism.

Surakarta provides a relevant setting for evaluating engagement with primary-care-linked community services. Municipal administrative data report 67,891 people receiving hypertension services in 2025 versus 67,623 in 2024.[11] These figures describe service recipients and must not be treated as the prevalence of hypertension or the sampling frame of eligible adults aged ≥18 years. Data-collection activities were situated in the Banjarsari catchment areas served by Gambirsari, Banyuanyar, Setabelan, Gilingan, Manahan and Nusukan Puskesmas. Local qualitative research describes informal knowledge exchange among older women living with hypertension,[12] while Surakarta policy analysis identifies variation in primary-care implementation and follow-up.[13] Neither study directly tests this survey index against the blood pressure outcome used here.

The objective was to estimate the cross-sectional association between an eight-item self-reported Posyandu engagement category and blood pressure control recorded at a single assessment among Posyandu-registered adults in Banjarsari. The principal estimate was adjusted for age, sex, reported hypertension duration and a recorded comorbidity indicator. Exploratory comparisons examined four concurrent questionnaire domains, a prevalence-ratio model for the common outcome, and alternative assumptions for one invalid item response. We sought evidence of an association, not proof that greater attendance produces blood pressure control.

Methods

A. Study Design, Setting and Participants.

This observational cross-sectional analysis used 400 coded records of adults

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with reported hypertension and Posyandu registration from six Puskesmas catchment areas in Banjarsari, Surakarta: Gambirsari, Banyuanyar, Setabelan, Gilingan, Manahan and Nusukan. The recorded fieldwork period was 29 June–7 August 2026. Eligibility was age ≥18 years, reported hypertension, Posyandu registration, ability to communicate and written informed consent. All 400 retained records had a blood pressure category, but the exact number of Posyandu sites, sampling frame, eligible residents approached, refusals and pre-entry exclusions was not preserved. The reported municipal count of 67,891 service recipients concerns individuals aged ≥15 years and is not a denominator for this sample. Recruitment was purposive; a Slovin-based target of 398 had been used for recruitment planning, but its nominal 5% error is not a valid precision claim for non-probability sampling. The 154 uncontrolled outcomes were considered alongside seven predictor degrees of freedom in the primary model, without a documented prospective analytical sample-size calculation. The participation route of respondents scoring inactive and independent source verification of diagnosis and prescription status were not recoverable, limiting assessment of selection bias.

B. Measurements and Variable Definitions.

The database coded blood pressure as controlled (1) if systolic pressure was <140 mmHg and diastolic pressure <90 mmHg at one assessment, and uncontrolled (0) otherwise. This threshold is a pragmatic study definition rather than a universal target: WHO guidance identifies circumstances requiring more intensive blood pressure management.[14] Individual systolic and diastolic values were not archived in the available analysis file, and neither repeated readings nor verification of device model, cuff size, calibration, posture, resting period, measurement interval, assessor training or medication timing could be established. The outcome therefore represents one recorded classification, not sustained clinical control. Posyandu engagement was computed from eight yes/no responses (yes=1, no=0) on visits, blood pressure checks, education, consultation, session completion, attendance without symptoms, schedule knowledge and absence-related history. Scores ≥6 of 8 were called active; this is a study-specific questionnaire category, not confirmed register attendance. A separate blank observation form specified ≥4 visits over six months, but respondent-level visit records were unavailable and that definition was not used in this analysis. Other study-specific categories were medication-related score ≥6/8, CERDIK practices ≥8/10 and family support ≥6/8. Their thresholds and the direction of all item codes, particularly absence-related wording, lacked independent validation.

C. Instrument Assessment.

The researcher-developed instrument comprised 34 binary items organised into Posyandu engagement (8), medication-related behaviour (8), CERDIK practices (10) and family support (8). It was administered as a self-report instrument; documentation of a uniform recall interval, prescription eligibility, formal expert content validation and a full development protocol was not available. An earlier 30-record pilot reported item correlations of 0,378–0,543 against r=0,361 and a combined Cronbach alpha of 0,879. However, that global alpha combines distinct constructs and cannot establish the reliability of each domain; corrected item–total coefficients and independence of pilot participants from the main sample could not be confirmed. Recalculated domain-specific alpha values in the n=399 primary analytic sample were 0,403, 0,395, 0,515 and 0,272, respectively. These estimates do not support treating the scores as established unidimensional reflective scales. Because Posyandu items mix service contact, knowledge and counselling, the intended reflective-versus-formative nature of the index should also be specified before applying alpha as a definitive quality criterion. In the absence of construct validation, the categorical scores are operational indicators rather than

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validated measures of attendance, adherence or support.

D. Statistical analysis and data integrity.

The outcome event was controlled blood pressure (1). One Posyandu item for respondent 143 was coded 11 instead of the allowed 0/1; its source answer could not be established, so this record was excluded from the primary exposure-related analysis (n=399) without imputing a response. All 400 records remained in descriptive outcome summaries. For respondent 307, the stored family-support total of 0 was inconsistent with seven affirmative component items and one negative item; the derived total was reconciled to 7 and the support category to good. We report group denominators, row percentages and crude odds ratios (ORs) with 95% confidence intervals. The primary logistic model estimated the association of Posyandu category with control status, adjusting for age (18–44 reference; 45–59; ≥60 years), sex (male reference), hypertension duration (<1 year reference; 1–5; >5 years), and any recorded comorbidity (none reference). These covariates were selected conceptually rather than by univariate p-value screening. Since 61,5% of participants had the outcome, modified-Poisson regression with HC0 sandwich variance provided an adjusted prevalence ratio (PR) using the same covariates. Sensitivity analyses fitted alternative item-0 and item-1 scenarios for respondent 143 (n=400), plus a separate exploratory logistic model of the four questionnaire categories. Model convergence, interval widths and variance inflation factors were examined. The models were implemented in Python using statsmodels, NumPy and SciPy, with the complete-case sample and sensitivity recodings specified above. All results are presented as associations with two-sided p values and 95% confidence intervals. No Posyandu-site identifiers were preserved for cluster-robust estimation, and no prescription data permitted a treatment-adjusted model.

The composite questionnaire indices were not interchangeable with clinical or administrative measures: neither time-stamped visit logs, medication dispensing or refill data, nor consistently time-anchored patient reports were available for validation. The low domain-specific alpha values, heterogeneous item wording and study-specific thresholds raise the possibility of non-differential or differential misclassification; the direction of any resulting bias cannot be determined from these data. The four-domain regression was therefore exploratory and not a test of mediation or independent treatment effects.

E. Ethics and Study Chronology.

The institutional report lists ethics approval from the Health Research Ethics Committee, Universitas Muhammadiyah Purwokerto (KEPK/UMP/266/VI/2026), dated 28 June 2026. The recorded start of data collection was 29 June 2026 and the end was 7 August 2026, followed by analysis and report preparation through 28 August 2026. Written consent was obtained from study participants and anonymised codes were used for analysis. Individual measurement timestamps were not preserved in the analysis file.

Result

A. Participants and data completeness.

The coded dataset comprised 400 participants, including 216 aged ≥60 years, 258 women and 174 with hypertension duration of 1–5 years. All 400 had a binary blood pressure classification and the reported demographic and clinical categories. The Posyandu index contained one out-of-range item (respondent 143, code 11); consequently 399, not 400, were included in the primary exposure-related analysis. The original answer was unavailable, and no value was imputed in that primary analysis. A family-support total for respondent 307 was reconciled against its eight component responses and changed from 0 to 7; those item values were available. No other missing outcome or coded analysis category was identified among the retained records. The numbers approached, screened, eligible, declining participation, or excluded before data entry were not archived and cannot be reliably reconstructed into a participant-flow

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diagram. Comorbidity was recorded as a single mutually exclusive category, so co-existing conditions may be underrepresented.

Table 1. Participant Characteristics

Characteristic	Category	n (%)
Age (years)	18–44	28 (7,0%)
	45–59	156 (39,0%)
	≥60	216 (54,0%)
Sex	Male	142 (35,5%)
	Female	258 (64,5%)
Educational level	No formal education	140 (35,0%)
	Primary school	132 (33,0%)
	Junior high school	60 (15,0%)
	Senior high school	52 (13,0%)
	Diploma	9 (2,3%)
	Bachelor's degree	7 (1,7%)
Occupation	Unemployed	128 (32,0%)
	Farmer	8 (2,0%)
	Laborer	59 (14,8%)
	Trader	93 (23,2%)
	Government/Private employee	34 (8,5%)
	Self-employed	46 (11,5%)
	Others	32 (8,0%)
Duration of hypertension	<1 year	64 (16,0%)
	1–5 years	174 (43,5%)
	>5 years	162 (40,5%)
History of comorbidities	None	196 (49,0%)
	Diabetes mellitus	96 (240%)
	Heart disease	44 (11,0%)
	Stroke	24 (6,0%)
	Others	40 (10,0%)

Note: Categories of recorded comorbidity were mutually exclusive in the available file. Co-existing illnesses may therefore have been incompletely represented. Source: original study-coded respondent characteristics (n=400).

Variable distributions. Blood pressure was classified as controlled for 246/400 (61,5%) and uncontrolled for 154/400 (38,5%). Among 399 participants with a valid eight-item Posyandu score, 229 (57,4%) met the ≥6/8 threshold and 170 (42,6%) did not. Across all 400 participants, 220 (55,0%) met the study-specific medication score threshold, 219 (54,8%) met the CERDIK threshold and 218 (54,5%) met the family-support threshold after reconciling respondent 307. Thus, Posyandu proportions use n=399, whereas the other distributions in Table 2 use n=400.

Table 2. Distributions of Coded Study Variables

Variable	Category	n (%)
Self-reported Posyandu participation	Inactive (<6/8)	170 (42,6% of 399)
	Active (≥6/8)	229 (57,4% of 399)
Medication adherence	Non-adherent	180 (45,0%)
	Adherent	220 (55,0%)
CERDIK healthy lifestyle behaviors	Poor	181 (45,3%)
	Good	219 (54,8%)

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Continued Table 2. Distributions of Coded Study Variables

Variable	Category	n (%)
Family support	Poor	182 (45,5%)
	Good	218 (54,5%)
Blood pressure control	Uncontrolled	154 (38,5%)
	Controlled	246 (61,5%)

Crude associations. Complete-case Posyandu score status was associated with blood pressure control at the single assessment (OR=1,945; 95% CI=1,291–2,930; *p-value*=0,001; n=399). Medication adherence (OR=1.720; 95% CI=1,145–2,583; *p-value*=0,009), CERDIK score (OR=1,620; 95% CI=1,080–2,431; *p-value*=0,019) and the corrected family-support category (OR=1,663; 95% CI=1,108–2,496; *p-value*=0,014) also showed positive crude associations (each n=400). These findings represent associations between recorded categories, not the effectiveness of services, medicines or interventions.

Table 3. Crude Associations with Controlled Blood Pressure

Comparison	Controlled n/N (%)	OR (95% CI); p
Posyandu self-report category	Inactive: 89/170 (52,4%) | Active: 156/229 (68,1%)	1,945 (1,291–2,930) *p-value*=0,001
Medication adherence	Non-adherent: 98/180 (54,4%) | Adherent: 148/220 (67,3%)	1,720 (1,145–2,583) *p-value*=0,009
CERDIK-related behaviour	Poor: 100/181 (55,2%) | Good: 146/219 (66,7%)	1,620 (1,080–2,431) *p-value*=0,019
Family support	Poor: 100/182 (54,9%) | Good: 146/218 (67,0%)	1,663 (1,108–2,496) *p-value*=0,014

Note: Denominator is each exposure group, and the outcome event is controlled blood pressure (coded 1). Odds ratios compare the second category with the first (reference) category. The Posyandu comparison excludes the invalid exposure record (n=399); other comparisons use n=400. Pearson chi-square p values are without continuity correction.

Primary adjusted analysis and sensitivity models. In the 399-person complete-case sample, the baseline-covariate logistic model estimated AOR=2,014 (95% CI=1,329–3,052; p=0,001) for active versus inactive questionnaire-defined Posyandu engagement. The robust modified-Poisson adjusted prevalence ratio was 1,313 (95% CI=1,110–1,554; *p-value*=0,001). In a separate exploratory model containing the four questionnaire categories, the Posyandu AOR was 2,985 (95% CI=1,088–8,193; *p-value*=0,034); the other questionnaire-domain estimates were imprecise. Collinearity was pronounced (VIF 5.14 for Posyandu, 18,44 for medication, 13,45 for CERDIK and 14,30 for family support). Sensitivity models using n=400 with respondent 143 assumed to have answered 1 versus 0 produced similar baseline-covariate estimates, whereas the four-domain result crossed *p-value*=0,05 under alternative item coding. Accordingly, the primary interpretation emphasizes the n=399 clinical-covariate model and robust prevalence ratio.

Table 4. Exploratory Four-Domain Logistic Regression

Comparison	AOR (95% CI)	*p-value*
Active vs inactive Posyandu participation	2,985 (1,088–8,193)	0,034
Adherent vs non-adherent medication use	1,713 (0,249–11,789)	0,584
Good vs poor CERDIK-related behavior	0,404 (0,077–2,130)	0,285

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Table 4. Exploratory Four-Domain Logistic Regression

Comparison	AOR (95% CI)	*p-value*
Good vs poor family support	0,895 (0,172–4,667)	0,895

Note: Event=controlled blood pressure (1); reference categories were inactive, non-adherent, poor CERDIK and poor family support. Each estimate adjusts for the other three questionnaire categories, not for age, sex, duration or comorbidity. High VIFs (5,14–18,44) and broad confidence intervals indicate unstable coefficients; no causal or mediation interpretation is justified.

Table 5. Primary and Coding-Sensitivity Estimates for Posyandu Participation

Model & coding	Estimate (95% CI)	p
Primary clinical-covariate AOR [n=399]	2,014 (1,329–3,052)	0,001
Primary robust adjusted PR [n=399]	1,313 (1,110–1,554)	0,001
Exploratory four-domain AOR [n=399]	2,985 (1,088–8,193)	0,034
Clinical-covariate AOR [R143=1, n=400]	2,026 (1,337–3,069)	<0,001
Clinical-covariate AOR [R143=0, n=400]	1,990 (1,314–3,012)	0,001
Four-domain AOR [R143=1, n=400]	2,990 (1,089–8,209)	0,034
Four-domain AOR [R143=0, n=400]	2,593 (0,994–6,764)	0,051
Robust adjusted PR [R143=1, n=400]	1,315 (1,112–1,556)	0,001
Robust adjusted PR [R143=0, n=400]	1,306 (1,105–1,543)	0,002

Note: Primary complete-case models excluded respondent 143 (n=399) because an item was coded 11 (outside the valid 0/1 range). The n=400 sensitivity scenarios recoded this one item as either 1 or 0; neither value has been verified from source records. Clinical-covariate models adjusted for age group, sex, hypertension duration and any recorded comorbidity. Four-domain models adjusted for the other three questionnaires. PR was estimated by modified-Poisson regression with robust HC0 variance. The threshold-crossing four-domain p values are not evidence of a qualitative change in effect.

Table 6. Domain-Specific Internal Consistency

Domain (items)	Pilot α	Main α
Posyandu participation (k=8)	0,740	0,403
Medication adherence (k=8)	0,698	0,395
CERDIK behaviours (k=10)	0,774	0,515
Family support (k=8)	0,733	0,272

Note: Domain-specific Cronbach alpha values were calculated among the 399 participants with valid Posyandu exposure data. The pilot comprised 30 records; independence of the pilot from the main sample was not verifiable. The originally reported combined alpha of 0,879 across 34 items from four different domains does not validate any individual scale. For the mixed-content Posyandu index, interpretation of internal consistency also depends on whether the items were intended to represent one reflective construct or a formative service-engagement index.

Discussion

A. Self-reported Posyandu participation and blood pressure status

The principal result was an association between questionnaire-defined Posyandu engagement and a single blood pressure control classification. Among the 399 valid exposure records, active versus inactive engagement showed an adjusted OR of 2,014 (95% CI=1,329–3,052). With 61,5% classified as controlled, the OR should not be interpreted as a twofold prevalence increase; the adjusted PR was 1,313 (95% CI=1,110–1,554), indicating a more modest relative prevalence contrast. Both estimates remained observational. Neither analysis demonstrates that additional visits were made, that those

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visits changed subsequent care, or that better blood pressure control persisted beyond the assessment. The exploratory four-domain OR (2,985; 95% CI=1,088–8,193) had markedly lower precision, weakening any inference based on comparing the size of these coefficients.

The distinction between this exposure and previous interventions is essential. Indonesian Posbindu implementation research identified missed screening opportunities,[3] while a separate four-district study described differences in knowledge and health practices by programme access.[4] The Nepal trial evaluated a structured community-health-worker package with follow-up and blood pressure monitoring,[10] whereas the current study recorded neither a standardized intervention nor validated visit counts. Surakarta policy research concerns programme implementation rather than an individual questionnaire score.[13] Thus these studies offer plausible health-system context without directly corroborating a causal effect of the specific index examined here.

A positive association is epidemiologically plausible because repeated service contact can facilitate monitoring, treatment advice and referral. An equally plausible explanation is that participants with greater health literacy, more continuous treatment access or better self-care report more engagement and are also more likely to have controlled readings. Restriction to Posyandu registrants may further select people already connected with services. The eight-item index combines behaviour with knowledge of schedules and counselling, and the low internal consistency (alpha=0,403) reduces confidence that its dichotomised total represents a single stable exposure. The study therefore cannot resolve reverse causation, self-report bias or unmeasured confounding.

WHO HEARTS addresses risk-based management and continuity of primary-care treatment, not validation of the present questionnaire index.[15] The original contribution of this study is the identification of a hypothesis-generating relationship in a defined local Posyandu sample, together with a direct demonstration that inferences depend on how engagement is measured and modelled. A stronger future test would compare the questionnaire against dated attendance registers and examine whether measured engagement precedes serial systolic and diastolic outcomes after accounting for baseline medication use and severity.

B. Medication adherence with blood pressure control

In the crude analysis, a higher medication-related questionnaire score was associated with control (OR=1,720; 95% CI=1,145–2,583). After simultaneous adjustment for the other three questionnaire scores, the estimate was highly imprecise (AOR=1,713; 95% CI=0,249–11,789; *p-value*=0,584). The domain alpha of 0,395 suggests limited score coherence, although interpretation depends on the intended construct. In addition, a medication-related affirmative response was not matched to a verified prescription, dose, refill or timing record. The data consequently provide no defensible estimate of a medication-taking effect and cannot be used to conclude that adherence is unimportant.

The treated-patient follow-up study in Bangladesh assessed medication adherence and blood pressure control with a different clinical data structure, while the Kathmandu cross-sectional study identified determinants of adherence rather than testing this four-score model.[16,17] These findings are complementary, not directly comparable effect estimates. A future analysis should first document prescription eligibility and use a validated adherence instrument anchored to a defined recall period, rather than interpreting the current composite as a verified exposure.

The attenuation of the medication estimate between crude and simultaneous-score models is compatible with shared questionnaire content, collinearity, imprecision or residual clinical confounding. Because the model did not control for treatment intensity, medication class, baseline pressure or verified adherence, the disappearance of conventional statistical significance must not be described as evidence that medication behaviour is unrelated to blood pressure.

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C. CERDIK healthy lifestyle behaviors with blood pressure control

The CERDIK questionnaire category had a positive crude association with controlled pressure (OR=1,620; 95% CI=1,080–2,431), but its four-domain adjusted estimate was unstable and in the opposite direction (AOR=0,404; 95% CI=0,077–2,130; *p-value*=0,285). This reversal does not demonstrate that healthier behaviour increases uncontrolled pressure. Instead, the wide interval, substantial VIF, low alpha (0,515) and uncertain timing of behavioural reports all indicate that the model cannot distinguish an independent lifestyle effect from overlapping self-report domains. Neither statistical interaction nor mediation was evaluated.

Indonesian research describes variations in Posbindu-related knowledge and practices and reports feasible education or self-monitoring activities,[4–6] but programme implementation and knowledge gain are not the same endpoint as a verified change in systolic or diastolic pressure. A 2025 qualitative literature synthesis of community-based health promotion also identified enabling conditions for community participation; it was not a prospective test of CERDIK adherence or a validation study of the score used here.[18] The current categorical association should therefore be regarded as preliminary until item content, recall windows and cutoffs are evaluated against behavioural or clinical reference measures.

Population surveillance in the United States has demonstrated that blood pressure control estimates depend on population and measurement context.[19] In the present coding-sensitivity analysis, classifying respondent 143 as item=1 produced a clinical-covariate AOR of 2,026 (95% CI=1,337–3,069), versus 1,990 (95% CI=1,314–3,012) under item=0; the corresponding adjusted PRs were 1,315 and 1.306. The four-domain estimates were more sensitive to that assumption. These comparisons support the relative stability of the primary clinically adjusted association but do not repair uncertainty over the invalid item or establish causal ordering among the four constructs.

D. Family support with blood pressure control

The corrected family-support category showed a positive crude association with controlled pressure (OR=1,663; 95% CI=1,108–2,496), whereas the simultaneous four-domain estimate was nearly uninformative (AOR=0,895; 95% CI=0,172–4,667; *p-value*=0,895). With a domain alpha of 0,272, the questionnaire does not provide strong evidence of one coherent reflective support construct. The corrected total for respondent 307 should be understood as an auditable derivation from available item responses, not confirmation that the family-support instrument itself was validated. The present data cannot determine the absence, presence or direction of an independent family-support effect.

A family self-management randomised trial in Indonesia assessed a defined intervention with caregivers and observed effects on blood pressure and sodium-consumption adherence, while other observational studies and reviews consider self-care or social barriers in differing populations.[10,20–24] These sources offer plausible pathways linking family context, treatment routines and service contact; their study designs and exposures do not license inference that the current family-support index mediated the Posyandu association.

Family support could encourage attending a community service, following medication instructions or maintaining a healthier routine. Alternatively, greater healthcare access, disease severity or socioeconomic circumstances could influence both family involvement and the observed outcome. As each questionnaire domain and blood pressure classification was recorded contemporaneously, temporal precedence was not determined. No interaction term or formal causal mediation analysis was estimated.

The most defensible interpretation is therefore that family-related questionnaire responses and pressure status covaried in the unadjusted sample, but an independent association was not estimated precisely. Future research should measure distinct types of support using content-validated items, assess

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their timing relative to care seeking and treatment, and examine clinical outcomes without treating all self-reported domains as exchangeable covariates.

E. Implications for Community-Based Hypertension Management

For services in Banjarsari, the study highlights a practical measurement gap: programme engagement is often discussed as visit frequency, while this dataset captures a mixed self-report index. A feasible first step for future quality improvement is to standardise attendance dates, blood pressure readings, referral actions and follow-up records across Posyandu and primary-care pathways. Such records would permit an evaluation of continuity of care rather than assume that questionnaire category itself measures service effectiveness. Any immediate recommendation to increase attendance should be framed as a programme hypothesis, not as a demonstrated treatment effect.

A prospective follow-up design could enroll participants from a defined registry that includes frequent and infrequent attenders, ascertain diagnosis and treatment at baseline, record all antihypertensive prescriptions and adherence with validated measures, and obtain repeated systolic/diastolic measurements using a documented protocol. Site identifiers would allow appropriate cluster-aware inference, and a prespecified measurement model could distinguish a formative engagement index from reflective behavioural scales. These improvements would test whether objectively documented service contact predicts later pressure outcomes while making selection, reverse causation and measurement error more transparent.

F. Study limitations

The analysis was based on a purposive sample of Posyandu registrants in selected Banjarsari catchment areas, without a complete eligible population list or participant-flow record. Consequently, nonresponse, selection into registration and underrepresentation of infrequent attenders cannot be quantified. The exposure was a heterogeneous eight-item self-report index with an unvalidated cut-off rather than register-confirmed visits. Its low main-sample alpha and those of the other questionnaire domains reduce confidence in treating each category as a validated unidimensional construct. The electronic data held only a single binary pressure classification, without individual readings, repeat measurements or auditable device and measurement procedures; sustained clinical control cannot be evaluated. Clinical diagnosis, prescribed medication, treatment timing, baseline severity and multiple simultaneous comorbidities were not independently confirmed. No site identifiers were available for clustered-variance estimation. Age, sex, duration and recorded comorbidity were included in the primary model, but education, socioeconomic position, access to treatment and other potential confounders could still bias the association. One invalid questionnaire code required complete-case exclusion and sensitivity scenarios, and a separate inconsistent derived total was reconciled from item data. Because all variables were observed at one time point, causality, mediation and temporal ordering remain unresolved. These constraints apply especially to the imprecise four-domain model and limit extrapolation to the wider hypertensive population.

Conclusions

In this sample of 400 Posyandu-registered adults with reported hypertension in Banjarsari, 246 (61,5%) were classified as having controlled blood pressure at one assessment. Among 399 valid Posyandu questionnaire records, the higher engagement category was associated with controlled status after adjustment for age, sex, reported duration of hypertension and recorded comorbidity (AOR=2,014; 95% CI=1,329–3,052; adjusted PR=1,313; 95% CI=1,110–1,554). This supports further study of community-service engagement as a measurable aspect of hypertension care, but it neither confirms actual attendance frequency nor demonstrates a causal effect on sustained blood pressure control. Future studies require documented visits, stronger measurement validity and repeated clinical assessments.

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Author contributions (CRediT)

W. R. Sukmaningsih: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review and editing, Supervision, manuscript approval. E. Ismawatie: Formal analysis. D. Rahayuningsih: Investigation. N. D. Ramadhani: Investigation.

Data availability

The analyses were based on anonymised coded records from 400 participants, with 399 complete cases for the primary exposure-related analysis. Participant-level data are not publicly deposited because of confidentiality considerations. Requests for access and related statistical documentation may be addressed to the corresponding author and are subject to participant consent, ethics approval and institutional authorisation.

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