

ORIGINAL ARTICLE

Community Diagnosis of Hypertension and Knowledge After Single-Session Health Education in a Peri-Urban Indonesian Primary Care Catchment: A Mixed-Methods Study

Nabella Zahra^{1*}, Deitra Rifqah Oktaviani¹, Alif¹, Tom Surjadi²

¹ Faculty of Medicine, Universitas Tarumanagara, Jakarta, Indonesia

² Department of Public Health, Faculty of Medicine, Universitas Tarumanagara, Jakarta, Indonesia

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CORRESPONDING AUTHOR

Nabella Zahra
nabellazahra02@gmail.com

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ABSTRACT

Background: Hypertension is the leading diagnosis at many Indonesian primary health centers (*Puskesmas*), yet community diagnoses that guide local action rarely standardize site selection or state what their evaluations can establish.

Objective: To report a community diagnosis of hypertension in the *Puskesmas* Teluknaga catchment (Tangerang Regency, Banten) and the knowledge outcome of the education session that followed.

Methods: Routine *Puskesmas* records were combined with village population estimates to compute standardized visit ratios. A mini-survey of 30 *Puskesmas* visitors identified determinants, which were prioritized by non-scoring Delphi and traced by fishbone analysis. Thirty-two adult residents received one lecture with a leaflet and then a knowledge post-test. Pre-test scores were unavailable, so all paired pre/post tables consistent with the post-test were enumerated (exact McNemar tests).

Results: Desa Teluknaga contributed 124 of 491 hypertension visits (25.3%) from 14.6% of the catchment population (rate ratio versus the other six villages 1.98; 95% CI 1.60 to 2.44; $p < 0.001$). Low community knowledge was designated the root cause. Afterwards, 26 of 32 participants scored ≥ 90 (81.3%; 95% CI 64.7 to 91.1). Improvement was significant under every admissible pairing only if 15 or fewer participants had scored ≥ 90 beforehand, and under none if 21 or more had, so knowledge change could not be identified.

Conclusion: Population standardization supported the choice of intervention village. Knowledge after the session was high, but demonstrating an educational effect, and converting knowledge into blood-pressure control, requires retained paired scores, follow-up and repeated interventions supported by community health volunteers (*kader*).

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1. Introduction

Raised blood pressure is the largest single modifiable driver of cardiovascular death worldwide.¹ A pooled analysis of 1,201 population-representative studies found that the number of adults aged 30–79 years with hypertension doubled between 1990 and 2019, to about 1.28 billion. Fewer than one in four affected women and one in five affected men had their blood pressure controlled. Indonesia was among the countries where treatment coverage stayed below one quarter and control below one tenth.² Across the member states of the Association of Southeast Asian Nations, high systolic blood pressure was the leading attributable risk behind 1.66 million cardiovascular deaths in 2021, and Indonesia had the second-highest

age-standardized prevalence of cardiovascular disease in the region.³ Losses occur at every step of the care cascade. In five Asian health and demographic surveillance sites, the Indonesian site treated only 20.8% of its hypertensive residents.⁴ In Cambodia, just 35.8% of treated adults were controlled,⁵ and in urban Lao PDR 39.5% of adults with hypertension were controlled, even though 90.2% had had their blood pressure measured at some point.⁶

In Indonesia, three nationally representative surveys show adult hypertension prevalence rising from 27.9% in 2013 to 31.6% in 2023. Over the same period the proportion with controlled blood pressure moved only from 2.3% to 4.2%, so more than 95% of affected adults remain uncontrolled.⁷ Most cases are never diagnosed. District-level analyses of the 2018 Basic Health

Research survey classified 76.3% of hypertension as undiagnosed.⁸ In the Indonesian Family Life Survey, undiagnosed hypertension was more likely among adults with primary schooling or less (odds ratio [OR] 1.60), among those with low household spending (OR 1.28) and among those without symptoms.⁹ Diagnosis does not guarantee care. Low awareness of treatment was found in 87.1% of hypertensive adults,¹⁰ and 78.9% of respondents with hypertension in the 2023 national health survey were uncontrolled; obesity, non-adherence and lower education were the leading correlates.¹¹ The burden also follows a social gradient and concentrates among lower-income households in both urban and rural areas.¹²

The determinants of this burden are largely modifiable. In the 2023 survey, central obesity was present in 60.1% of adult women and accounted for an estimated 23.8% of their hypertension.¹³ Regular fruit and vegetable intake, by contrast, was associated with lower odds of hypertension (adjusted OR 0.88).¹⁴ Nearly all Indonesian adults eat too few fruits and vegetables, and about one in five carries four or more cardiovascular risk factors.¹⁵ In Jakarta, daily salt and sugar intakes exceed national guidance, and high-sodium, high-fat foods are associated with hypertension.¹⁶ Smoking raises the odds of hypertension nationally,¹⁷ and common mental disorders predict uncontrolled blood pressure in a West Java cohort.¹⁸ Abdominal obesity was the predictor shared by men and women in a Yogyakarta surveillance population with a prevalence of 40%,¹⁹ and diagnosed hypertension is up to 22.6% more frequent in urban than in rural districts.⁸ Place matters as well. In rural Aceh, high salt intake (OR 3.87) and distance from the community health center (OR 2.2) were independently associated with high predicted cardiovascular risk.²⁰

Indonesia's primary-care response to hypertension has three parts. The first is the public primary health center (*Puskesmas*). The second is the community-based integrated post for non-communicable diseases (*Posbindu PTM*), run by trained community volunteers (*kader*). The third is the chronic-disease management program of the national health insurance scheme (PROLANIS). In a quasi-experimental evaluation, community-based programs of this kind increased hypertension screening by 13% in Indonesia.²¹ Even so, Posbindu posts measure blood pressure almost universally but ask fewer than a quarter of attendees about other risk factors,²² and fewer than half of adults referred from Posbindu complete follow-up at the Puskesmas.²³ Inside Puskesmas clinics, two-thirds of treated patients are not at target, and half report regular discretionary salt use.²⁴ Providers describe referral gaps and sub-optimal PROLANIS implementation.²⁵ Patients who have not been told to take their medication regularly are five times more likely to be non-adherent.²⁶ Villages with a Posbindu,

primary-care staff and insurance coverage have fewer residents at high cardiovascular risk.²⁷ When PROLANIS group activities in rural East Java were disrupted during the COVID-19 pandemic, the blood pressure, body mass index and renal function of enrolled hypertensive patients deteriorated.²⁸

Knowledge is the target local teams most often choose when they act on these gaps. In Aceh, most adults aged 40–70 years did not know the leading risk factors, the asymptomatic nature of hypertension or the need for screening, and about 41% had never had their blood pressure or glucose checked.²⁹ In Indonesian primary care, only 53.9% of patients had adequate knowledge,³⁰ and knowledge gaps of varying size are reported from Myanmar, Sri Lanka and Bangladesh.^{31–33} Short educational programs delivered through Puskesmas raise knowledge and attitude scores.^{34,35} Yet knowledge alone predicts self-care poorly ($r=0.155$),³⁰ and access to Posbindu is associated with better knowledge without better practice.³⁶ A community program in Indonesia raised knowledge by 0.29 standard deviations (0.17 in Vietnam), while behavior changed only partly.²¹ Knowledge is therefore a necessary but insufficient step. Whether a given educational activity has moved it at all deserves scrutiny.

Community diagnosis is the structured assessment of a community's health problems, their determinants and the resources available to address them. It is a core component of medical education in Indonesia and elsewhere, where it builds students' orientation toward communities and their understanding of the social determinants of health.^{37–39} Teams commonly combine routine facility data, Blum's paradigm of health determinants, consensus prioritization and fishbone (Ishikawa) root-cause analysis. These methods also underpin priority-setting and quality improvement in primary care.^{40–42} Two methodological weaknesses can limit such work. First, the intervention site is usually chosen on raw case counts, which conflate burden with population size and access to services. Second, evaluations rely on an immediate post-test, which cannot separate learning from prior knowledge, testing effects or ceiling effects.^{43,44} The present study addresses both weaknesses within a single community diagnosis. It tests the site-selection decision against official population denominators and makes explicit, by enumerating every dataset compatible with the reported result, what an immediate post-test can and cannot establish. Puskesmas Teluknaga serves seven villages on the north-western periphery of Greater Jakarta. There, hypertension ranked first among the ten most frequent diagnoses in 2024 and again in January–April 2025. This study aimed to (i) describe the hypertension burden in the Puskesmas Teluknaga catchment and test whether the village selected for intervention retained its excess after population standardization; (ii) identify and prioritize the determinants and root cause of that

burden through a community diagnosis; (iii) describe the resulting educational intervention and its knowledge outcome; and (iv) quantify what the available post-test data can and cannot establish about knowledge change.

2. Methods

2.1. Study design and setting

This was a mixed-methods community diagnosis with a single-group educational intervention, carried out in May–June 2025 within the community-medicine clerkship of the Faculty of Medicine, Universitas Tarumanagara. It combined four elements: a quantitative situation analysis of routine records, a qualitative assessment of determinants, consensus prioritization with root-cause analysis, and a quantitative assessment of knowledge after the intervention. Figure 1 shows the sequence of steps and

the number of people or records at each step. The descriptive components are reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement. The intervention is described item by item according to the Template for Intervention Description and Replication (TIDieR) and detailed in Table 1. Puskesmas Teluknaga is a public primary health center in Teluknaga District, Tangerang Regency, Banten Province, Indonesia. Its catchment comprises seven villages (*desa*): Teluknaga, Kebon Cau, Bojong Renged, Babakan Asem, Kampung Melayu Barat, Kampung Melayu Timur and Kampung Besar. According to Statistics Indonesia (Badan Pusat Statistik, BPS), the combined mid-2024 population was 112,639, and population densities ranged between 3,173 and 9,935 persons per km². The area is densely settled and peri-urban, on the north-western edge of Greater Jakarta.

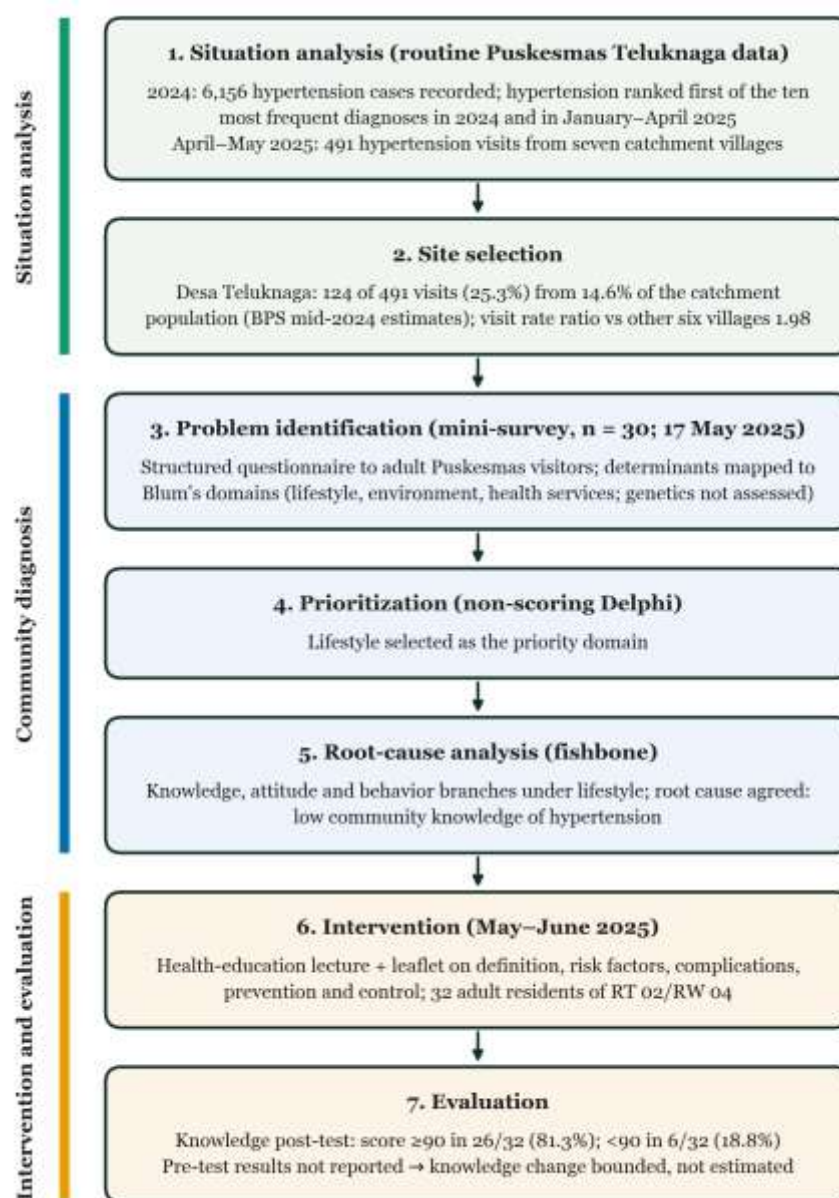


Figure 1. Community-diagnosis process at Puskesmas Teluknaga, from situation analysis to evaluation, with the number of people or records at each step. BPS, Statistics Indonesia.

Table 1. Description of the community-diagnosis activity and the educational intervention (TIDieR items).

Item	Description
Why (rationale)	The community diagnosis identified low community knowledge of hypertension — its definition, symptoms, complications and treatment — as the root cause underlying the lifestyle domain.
What (materials)	Printed leaflet on hypertension distributed to every participant; knowledge questionnaire (0–100 score) administered before and after the session.
What (procedures)	Lecture on hypertension, its risk factors, its complications, and its prevention and control, followed by the knowledge post-test.
Who provided	The author team: medical students in the community-medicine clerkship of the Faculty of Medicine, Universitas Tarumanagara, with a faculty supervisor from the public-health department, in coordination with Puskesmas Teluknaga.
How	Face-to-face group session.
Where	Community setting for residents of neighborhood unit RT 02/RW 04 (Kampung Melayu No. 2), Teluknaga, within the Puskesmas Teluknaga catchment, Tangerang Regency, Banten.
When and how much	One session during May–June 2025; no booster session.
Tailoring	Content addressed the root cause selected in the community diagnosis (low knowledge of hypertension).
Participants	32 adult residents (men and women) who agreed to take part and gave written informed consent.
Outcome assessed	Proportion of participants scoring ≥ 90 on the knowledge post-test (primary outcome).

TIDieR, Template for Intervention Description and Replication; BP, blood pressure; RT/RW, neighborhood and hamlet administrative units.

2.2. Ethical approval

The study protocol received ethical approval from the CMHC Research Center Ethics Committee, Indonesia (Approval No. 2025/8451), before data collection began. Written informed consent was obtained from all participants. Routine Puskesmas data were used only in aggregate form without personal identifiers. The study was conducted in accordance with the Declaration of Helsinki.

2.3. Community-diagnosis framework

The community diagnosis followed six sequential steps. The situation analysis used routine Puskesmas data to identify the priority health problem and the village in which to act. Problem identification used a mini-survey to describe the determinants of the problem. These were organized according to Blum's paradigm into four domains: lifestyle (behavior), environment, health services and heredity. Prioritization used the non-scoring Delphi technique to select one domain for further analysis. Root-cause analysis used a fishbone diagram to trace the selected domain to its underlying cause. The intervention was designed to address that cause. The evaluation used a systems approach (input, process and output), with participants' knowledge after the session as the output indicator.

2.4. Situation analysis and selection of the intervention village

Three routine data sources were reviewed. They were the Puskesmas annual report of the ten most frequent diagnoses for 2024, the corresponding report for January–April 2025, and the number of hypertension visits by village of residence recorded in April–May 2025. Data were extracted from Puskesmas reports with the permission and assistance of Puskesmas staff, and the village counts may include repeat visits by the same patient. The village with the largest number of hypertension visits was selected for the community diagnosis. To test whether that choice reflected burden rather than population size, the April–May 2025 counts were combined with mid-2024 village population

estimates and land areas published by BPS in Kecamatan Teluknaga Dalam Angka 2025. For each village v we computed three quantities. The first was its share of visits. The second was its visit rate per 1,000 population over the two-month window (equation 1). The third was a standardized visit ratio (SVR), defined as the observed number of visits divided by the number expected if visits were distributed across villages in proportion to population, with the catchment total as the internal standard (equation 2). In these equations O_v is the number of visits from village v , P_v its population, $N=491$ the total number of visits and $P=112,639$ the catchment population. The 2024 annual count was expressed per 1,000 catchment residents. The annual report counted case records, whereas the village table counted visits. The two sources were therefore analyzed separately and never pooled.

$$r_v = 1000 \times \frac{O_v}{P_v} \quad (1)$$

$$SVR_v = \frac{O_v}{E_v}, \quad E_v = \frac{NP_v}{P} \quad (2)$$

2.5. Problem identification: mini-survey

On 17 May 2025, a structured questionnaire was administered to 30 adults attending Puskesmas Teluknaga who agreed to take part. It covered respondents' characteristics and their knowledge of hypertension (definition, symptoms, use of antihypertensive drugs and complications). It also covered attitudes (avoidance of salty and fatty foods and offal, and routine blood-pressure checks in the absence of symptoms) and behaviors (frequency of blood-pressure checks, limitation of salt, fat and offal, physical activity and previous attendance at health education). Further items addressed the food environment and food preferences around respondents' homes and the availability of information materials on hypertension. The author team administered the questionnaire. Responses were summarized as qualitative statements and mapped to Blum's four domains. The heredity domain was not assessed.

2.6. Prioritization and root-cause analysis

The domains were prioritized with the non-scoring Delphi technique. In this technique a problem is selected through successive rounds of structured discussion until consensus is reached, without numerical weighting. The selected domain was then analyzed with a fishbone diagram. Its spine represented the domain, and its bones represented the knowledge, attitude and behavior components. Each cause identified in the mini-survey was placed on the relevant bone. The team then agreed by consensus on the underlying cause linking the branches. That cause was designated the root cause and became the target of the intervention.

2.7. Intervention and participants

The intervention was a single face-to-face health-education session. It consisted of a lecture on hypertension, its risk factors, its complications and its prevention and control, supported by a printed leaflet given to every participant (Table 1). The author team delivered it in May–June 2025 to adult residents of neighborhood unit RT 02/RW 04 (Kampung Melayu No. 2) in Teluknaga. Adult men and women who lived in the neighborhood unit and agreed to take part after giving written informed consent were eligible. No further exclusion criteria were applied. Thirty-two residents took part. No booster session or follow-up contact was scheduled. The intervention cohort was distinct from the mini-survey sample in which the determinants had been identified.

2.8. Outcome

Knowledge was assessed with a questionnaire scored from 0 to 100 and administered before and after the session. It covered hypertension, its risk factors, and its prevention and control. The primary outcome was the proportion of participants scoring 90 or more on the post-test, the threshold the team had adopted for good knowledge. As a binary outcome, it does not use the full distribution of scores. Pre-test scores and individual participant characteristics were not available for analysis. Attitude and behavior were not measured after the session.

2.9. Statistical analysis

Proportions are reported with Wilson score 95% confidence intervals (CIs), which perform well at small sample sizes. Clopper–Pearson intervals are reported as a sensitivity check. The post-test proportion was compared with fixed reference values (50%, 70% and 90%) and with knowledge proportions reported in four published studies. Two-sided exact binomial tests were used, with Cohen's h (equation 3) as the effect size. Those studies used different instruments and cut-offs, so the comparisons are descriptive context rather than controlled contrasts. The four comparisons with published proportions are reported with Holm-adjusted p values. A compatibility window, the principal summary, was obtained by identifying the

reference proportions that the observed result significantly exceeded or fell short of in one-sided exact tests. Precision was expressed as the half-width of the Wilson interval. The sample sizes needed for half-widths of 10 and 5 percentage points were calculated from the normal approximation.

$$h = 2 \arcsin \sqrt{p_1} - 2 \arcsin \sqrt{p_2} \quad (3)$$

For the village analysis, visit rates were given exact Poisson 95% CIs, and SVRs were given exact Poisson CIs scaled by the expected count. Each village's share of visits was compared with its share of the population using a two-sided exact binomial test, with Holm adjustment across the seven villages. Chi-square goodness-of-fit tests compared the observed distribution with equal shares and with population-proportional shares, using Cohen's w as the effect size. The population-proportional test was repeated after excluding the intervention village. Rate ratios were estimated with exact conditional binomial CIs, both between the intervention village and the other six villages combined and between the intervention village and the village with the next-highest rate. The probability that the intervention village had the highest underlying visit rate was estimated from 200,000 draws of Jeffreys posterior distributions for each village's rate, $\text{Gamma}(x + 0.5, 1)$ divided by the village population. The association between population density and visit rate across villages was assessed with Spearman's correlation (seven villages; very low power). Over-dispersion relative to a common-rate Poisson model with a log-population offset was checked with the Pearson chi-square to degrees-of-freedom ratio. The village counts are visits rather than persons, and patients under monthly follow-up may contribute two visits in the window. A sensitivity analysis therefore inflated the variance of the log rate ratio and log SVR by dispersion factors of 2 and 3 (Wald intervals) and repeated the ranking analysis with counts divided by the same factors. All tests were two-sided with $\alpha=0.05$, and p values are reported to three decimal places. Analyses were performed in Python 3 with SciPy 1.18.1 and statsmodels 0.15.0.

2.10. Sensitivity analysis over unobserved pre-test results

Pre-test scores were unavailable, so the paired cross-classification of pre-test and post-test status (≥ 90 or < 90) was not observed. Knowledge change could therefore not be estimated directly. Instead, every paired 2×2 table consistent with the observed post-test margin (26 participants ≥ 90 and 6 < 90) was enumerated. The unknown number of participants scoring ≥ 90 at pre-test, k , was varied from 0 to 32. For each k , every admissible number of participants scoring ≥ 90 on both occasions, a (from $\max[0, k - 6]$ to $\min[26, k]$), was considered, giving 189 admissible tables. The net change in the proportion scoring ≥ 90 is given by equation 4. Each table was analyzed with the exact

McNemar test (equation 5), in which b and c are the numbers of participants who moved above and below the threshold, respectively. For each k we report the range of p values, the number of tables reaching $p < 0.05$ and the net change in the proportion scoring ≥ 90 . A conclusion was regarded as robust only if it held in every admissible table. If the attainable range included both significant and non-significant results, the data were regarded as unable to identify the change. This is a sensitivity analysis over the space of datasets consistent with the observed post-test, not an estimate of the paired results.

$$\Delta = \frac{26 - k}{32} \quad (4)$$

$$p = \min \left\{ 1, 2 \sum_{i=0}^{\min(b,c)} \binom{b+c}{i} \left(\frac{1}{2} \right)^{b+c} \right\} \quad (5)$$

Admissible tables are counted, not weighted by plausibility. To indicate which pre-test scenarios are plausible, the pre-test count was given beta-binomial prior distributions centered on baseline knowledge proportions from published studies (12.1%, 37.5%, 53.9% and 80.0%) and, separately, a uniform distribution. Under each, the probability that improvement would be significant in every, some or no admissible pairing was calculated.^{30,33,45,46} Those studies defined adequate knowledge less stringently than a score of 90 or more. The priors are therefore likely to overstate baseline success, and the resulting probabilities of demonstrable improvement are conservative.

2.11. Sample-size planning for follow-up studies

To inform the next stage of work, sample sizes were calculated for two designs. The first was a paired pre/post study analyzed with the exact McNemar test, using Connor's formula for assumed proportions of improving and declining pairs. The second was a

cluster-randomized trial of kader-led education with systolic blood pressure as the outcome. For the trial, the individually randomized sample size was inflated by the design effect DE (equation 6), where m is the cluster size and ICC the intraclass correlation coefficient, so that the required number per arm is the individually randomized number multiplied by DE ($\alpha = 0.05$, power 0.80). Connor's formula is a normal approximation, so the paired sample sizes were verified by exact power calculation, enumerating the binomial distribution of discordant pairs and increasing the sample size until exact power reached 0.80.

$$DE = 1 + (m - 1) \times ICC \quad (6)$$

3. Results

3.1. Burden of hypertension and selection of the intervention village

Puskesmas Teluknaga recorded 6,156 hypertension cases in 2024, equivalent to 54.7 case records per 1,000 catchment residents, and hypertension was the most frequent diagnosis in both 2024 and January–April 2025. In April–May 2025 there were 491 hypertension visits from the seven catchment villages; their distribution, population denominators, visit rates and standardized visit ratios are detailed in Table 2. Desa Teluknaga accounted for 124 visits (25.3%; 95% CI 21.6 to 29.3), although it contained 14.6% of the catchment population; the next-largest contributors were Kebon Cau (83 visits; 16.9%) and Bojong Renged (73 visits; 14.9%). As shown in Figure 2, Desa Teluknaga was the only village whose share of visits clearly exceeded its share of the catchment population, whereas Kampung Melayu Timur and Kampung Besar fell clearly below theirs.

Table 2. Hypertension visits to Puskesmas Teluknaga by village of residence, April–May 2025, with population-standardized visit rates and standardized visit ratios.

Village	Population, mid-2024	Share of population, %	Area, km ²	Density, per km ²	Hypertension visits, n	Share of visits, % (95% CI)	Visits per 1,000 population (95% CI)	SVR (95% CI)	p (Holm)
Teluknaga	16,406	14.6	3.16	5,192	124	25.3 (21.6 to 29.3)	7.56 (6.29 to 9.01)	1.73 (1.44 to 2.07)	<0.001
Kebon Cau	18,499	16.4	2.44	7,582	83	16.9 (13.8 to 20.5)	4.49 (3.57 to 5.56)	1.03 (0.82 to 1.28)	1.000
Bojong Renged	17,632	15.7	2.05	8,601	73	14.9 (12.0 to 18.3)	4.14 (3.25 to 5.21)	0.95 (0.74 to 1.19)	1.000
Babakan Asem	14,007	12.4	2.15	6,515	68	13.8 (11.1 to 17.2)	4.85 (3.77 to 6.15)	1.11 (0.86 to 1.41)	1.000
Kampung Melayu Barat	12,518	11.1	1.26	9,935	52	10.6 (8.2 to 13.6)	4.15 (3.10 to 5.45)	0.95 (0.71 to 1.25)	1.000
Kampung Melayu Timur	18,761	16.7	2.00	9,380	47	9.6 (7.3 to 12.5)	2.51 (1.84 to 3.33)	0.57 (0.42 to 0.76)	<0.001

Village	Population, mid-2024	Share of population, %	Area, km ²	Density, per km ²	Hypertension visits, n	Share of visits, % (95% CI)	Visits per 1,000 population (95% CI)	SVR (95% CI)	p (Holm)
Kampung Besar	14,816	13.2	4.67	3,173	44	9.0 (6.7 to 11.8)	2.97 (2.16 to 3.99)	0.68 (0.50 to 0.91)	0.025
Catchment total	112,639	100.0	17.73	6,353	491	100.0	4.36	1.00 (reference)	—

Population and area: Statistics Indonesia (BPS), Kecamatan Teluknaga Dalam Angka 2025 (mid-2024 estimates). Share of visits with Wilson score 95% CI; rates per 1,000 population over the two-month window with exact Poisson 95% CI. SVR, standardized visit ratio = observed visits / visits expected if visits were distributed in proportion to population (exact Poisson 95% CI). *p*: two-sided exact binomial test of each village's share of visits against its share of population, Holm-adjusted across seven villages. Teluknaga denotes Desa Teluknaga (the village), not the Puskesmas or the district.

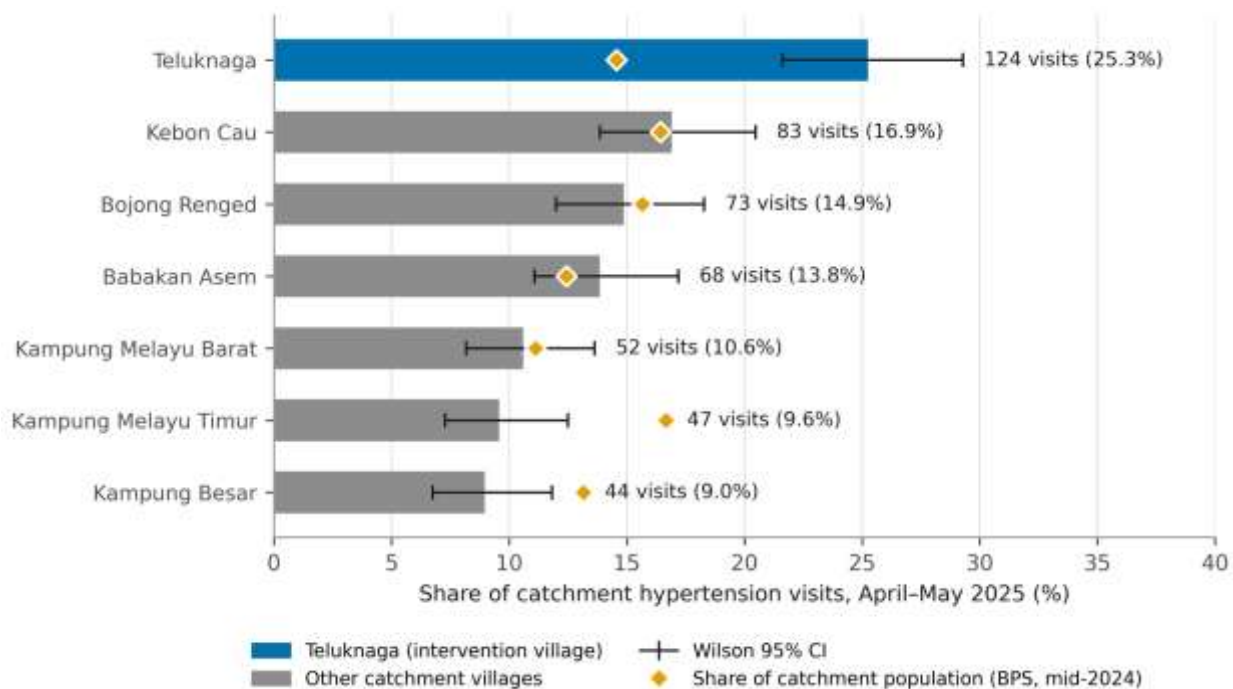


Figure 2. Share of hypertension visits by village of residence (bars, Wilson 95% CI) compared with each village's share of the catchment population (diamonds), April-May 2025 (n=491 visits). Teluknaga denotes Desa Teluknaga (the village), not the Puskesmas or the district.

After standardization for population size, the visit rate in Desa Teluknaga was 7.56 per 1,000 residents (95% CI 6.29 to 9.01) over two months, compared with 3.81 per 1,000 in the other six villages combined (rate ratio 1.98; 95% CI 1.60 to 2.44; $p<0.001$), as detailed in Table 3, and its rate exceeded that of the village with the next-highest rate, Babakan Asem (4.85 per 1,000), by a factor of 1.56 (95% CI 1.15 to 2.12; $p=0.003$). The SVR for Desa Teluknaga was 1.73 (95% CI 1.44 to 2.07), the

highest of the seven villages, as shown in Figure 3. Two villages had fewer visits than their population would predict: Kampung Melayu Timur (SVR 0.57; 95% CI 0.42 to 0.76; Holm-adjusted $p<0.001$) and Kampung Besar (SVR 0.68; 95% CI 0.50 to 0.91; Holm-adjusted $p=0.025$). The remaining four villages had SVRs between 0.95 and 1.11, with intervals including 1 (Table 2).

Table 3. Tests of the village distribution of hypertension visits and sensitivity of the main comparisons to repeat visits by the same patients.

Analysis	Main analysis	Dispersion factor 2	Dispersion factor 3
A. Distribution of visits			
2024 hypertension case records, <i>n</i> (per 1,000 residents)	6,156 (54.7)	—	—
Goodness of fit vs equal shares	$\chi^2(6)=66.0$; $w=0.37$; $p<0.001$	—	—
Goodness of fit vs population-proportional shares	$\chi^2(6)=61.0$; $w=0.35$; $p<0.001$	—	—
Same, excluding Desa Teluknaga	$\chi^2(5)=18.2$; $p=0.003$	—	—
Visit rate, other six villages, per 1,000	3.81	—	—
Spearman ρ , population density vs visit rate	-0.32 ; $p=0.482$	—	—
Common-rate Poisson model, Pearson χ^2/df	10.2	—	—
B. Comparisons of Desa Teluknaga, rate ratio or SVR (95% CI)			

Analysis	Main analysis	Dispersion factor 2	Dispersion factor 3
Rate ratio vs other six villages	1.98 (1.60 to 2.44); $p<0.001$	1.98 (1.49 to 2.64); $p<0.001$	1.98 (1.39 to 2.82); $p<0.001$
Rate ratio vs Babakan Asem (next-highest rate)	1.56 (1.15 to 2.12); $p=0.003$	1.56 (1.02 to 2.37); $p=0.038$	1.56 (0.93 to 2.60); $p=0.090$
SVR, Desa Teluknaga	1.73 (1.44 to 2.07)	1.73 (1.35 to 2.22)	1.73 (1.28 to 2.35)
SVR, Kampung Melayu Timur	0.57 (0.42 to 0.76)	0.57 (0.38 to 0.86)	0.57 (0.35 to 0.94)
SVR, Kampung Besar	0.68 (0.50 to 0.91)	0.68 (0.45 to 1.03)	0.68 (0.41 to 1.14)
Posterior probability that Desa Teluknaga has the highest rate	0.998	0.975	0.929

Main analysis: exact conditional binomial CIs for rate ratios and exact Poisson CIs for SVRs. Dispersion factors 2 and 3 inflate the variance of the log rate ratio and log SVR to allow for two or three visits per patient within the two-month window (Wald intervals); posterior probabilities under the same factors use counts divided by the factor. w, Cohen's w; SVR, standardized visit ratio.

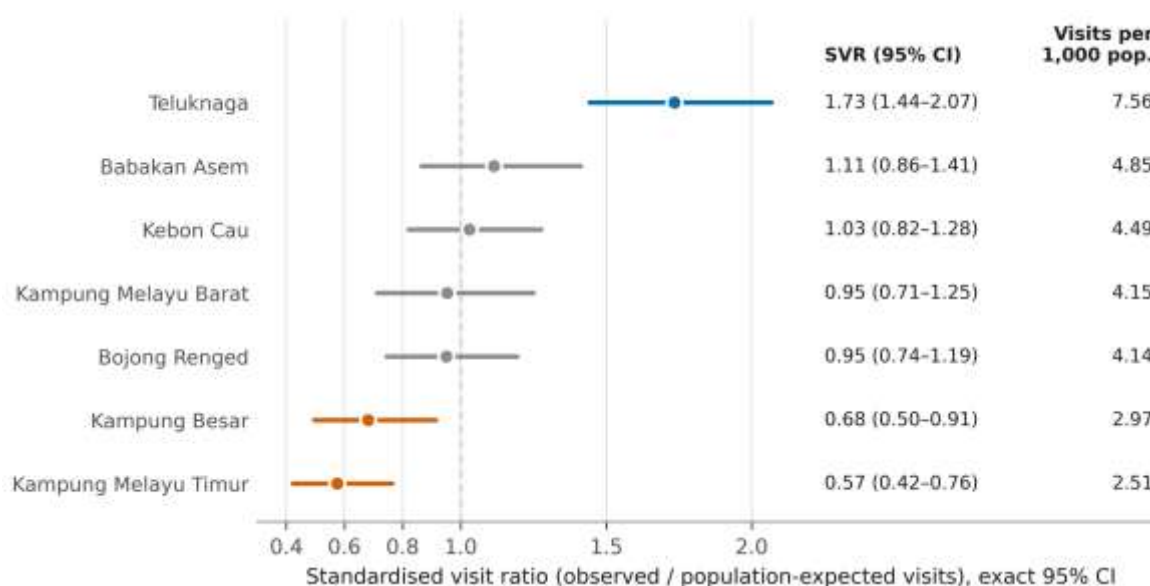


Figure 3. Standardized visit ratios for hypertension by village with exact 95% CI; values above 1 indicate more visits than expected from population size. Blue, intervention village; red, villages with fewer visits than expected. Teluknaga denotes Desa Teluknaga (the village), not the Puskesmas or the district.

As summarized in the upper panel of Table 3, the distribution of visits departed from equal shares ($\chi^2(6)=66.0$; $p<0.001$; Cohen's $w=0.37$) and from population-proportional shares ($\chi^2(6)=61.0$; $p<0.001$; $w=0.35$). Heterogeneity persisted after Desa Teluknaga was excluded ($\chi^2(5)=18.2$; $p=0.003$). The posterior probability that Desa Teluknaga had the highest underlying visit rate of the seven villages was 0.998. Visit rates were not correlated with population density (Spearman $\rho=-0.32$; $p=0.482$), and a common-rate Poisson model was strongly over-dispersed (Pearson $\chi^2/df=10.2$).

The lower panel of Table 3 shows that allowing for repeat visits did not remove the excess in Desa Teluknaga. With variance inflated by a dispersion factor of 2, the rate ratio against the other six villages was 1.98 (95% CI 1.49 to 2.64) and the SVR 1.73 (95% CI 1.35 to 2.22); with a factor of 3 the corresponding intervals were 1.39 to 2.82 and 1.28 to 2.35. The posterior probability that Desa Teluknaga had the highest rate fell to 0.975 and 0.929, respectively. Its lead over Babakan Asem was less secure (rate ratio 1.56; 95% CI 1.02 to 2.37 with a factor of 2 and 0.93 to 2.60 with a factor of 3). The visit deficit in Kampung

Melayu Timur persisted under both factors (SVR 0.57; 95% CI 0.38 to 0.86 and 0.35 to 0.94), whereas the interval for Kampung Besar included 1 under both (0.45 to 1.03 and 0.41 to 1.14).

3.2. Determinants of the hypertension burden

The mini-survey identified determinants in three of Blum's four domains; they are mapped in Figure 4 and listed with their program implications in Table 4. In the lifestyle domain, respondents did not know the definition of hypertension, its symptoms, how antihypertensive drugs are used or its complications; some disagreed that salty and fatty foods and offal should be avoided or that blood pressure should be checked routinely in the absence of symptoms; and some checked their blood pressure less often than monthly, did not limit salt, fat or offal, or rarely exercised, while most had never attended health education on hypertension. In the environment domain, many vendors sold instant, fried, high-salt and high-fat foods near respondents' homes, and most respondents preferred salty and fried food. In the health-service domain, few posters or leaflets on hypertension were available in the catchment area. The heredity domain was not assessed.

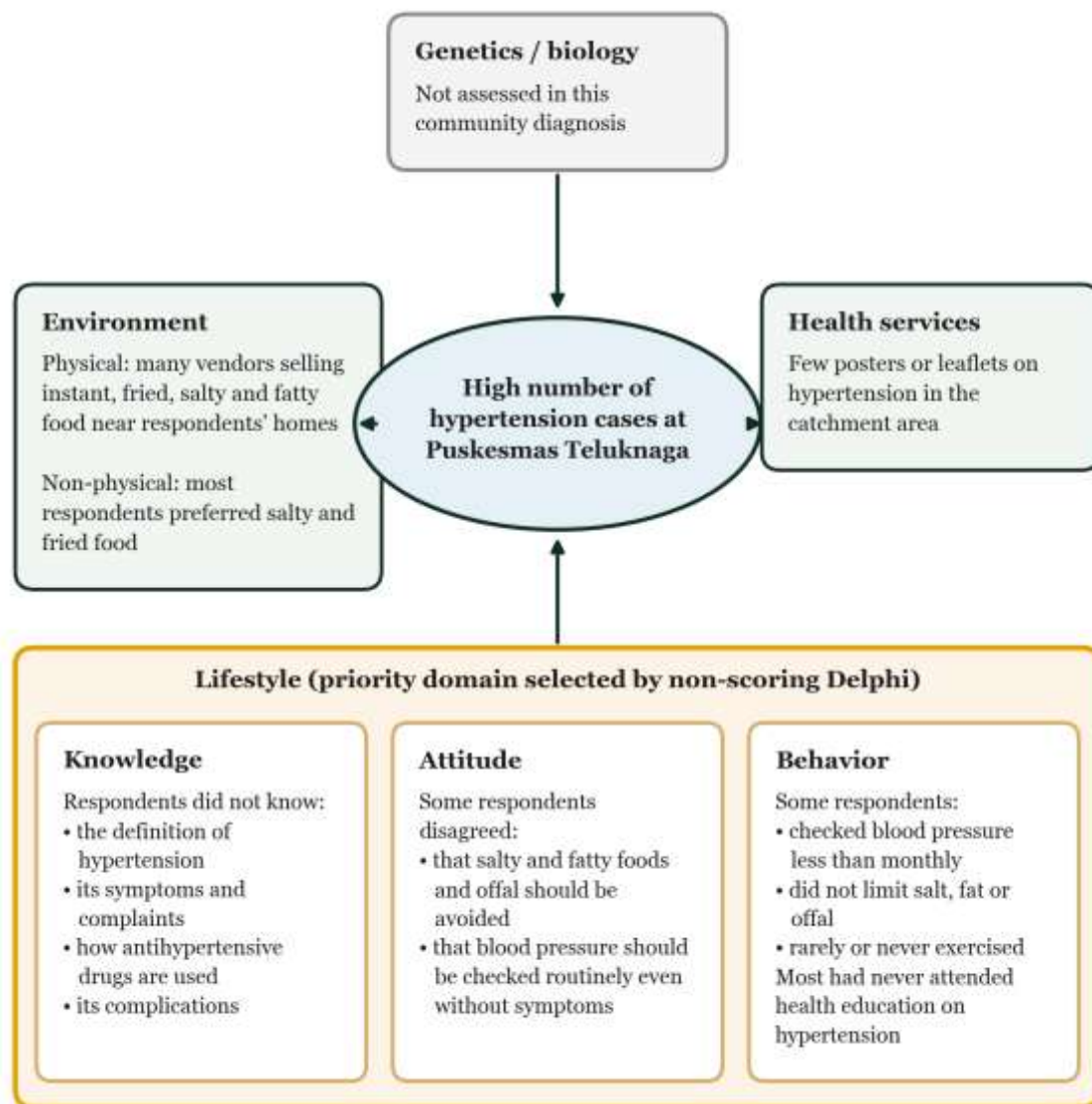


Figure 4. Determinants of the hypertension burden mapped to Blum's four domains from the mini-survey of 30 Puskesmas visitors.

Table 4. Determinants of the hypertension burden identified in the mini-survey (n=30), organized by Blum's domains, and their program implications.

Domain / component	Finding	Program implication
Lifestyle — knowledge	Respondents did not know the definition of hypertension, its symptoms, the use of antihypertensive drugs, or its complications.	Target of the educational intervention (root cause selected by fishbone analysis).
Lifestyle — attitude	Some respondents disagreed that salty and fatty foods and offal should be avoided, or that blood pressure should be checked routinely in the absence of symptoms.	Attitudinal messages on asymptomatic risk and dietary restriction; attitude not measured after the intervention.
Lifestyle — behavior	Some respondents checked blood pressure less often than monthly, did not limit salt, fat or offal, and rarely or never exercised; most had never attended health education on hypertension.	Monthly BP monitoring through Posbindu; salt-reduction and activity counselling; behavior not measured after the intervention.
Environment — physical	Many vendors selling instant, fried, high-salt and high-fat foods near respondents' homes.	Food-environment action beyond the scope of an individual-level intervention.
Environment — non-physical	Most respondents preferred salty and fried food.	Taste-preference change requires repeated, family-level dietary counselling.
Health services	Few posters or leaflets about hypertension in the catchment area.	Information, education and communication materials at the Puskesmas and Posbindu.
Genetics / biology	Not assessed.	Family history to be recorded in future surveys.

Findings are summarized as qualitative statements ('some', 'most'). BP, blood pressure; Posbindu, integrated community post for non-communicable diseases.

3.3. Prioritization and root cause

The non-scoring Delphi process selected the lifestyle domain as the priority. In the fishbone analysis, the behavior branch held three causes (low fruit and vegetable intake with little physical activity; frequent consumption of salty and fatty food; and irregular blood-pressure checks), the knowledge branch held three (unawareness of the signs, symptoms and risks of

hypertension, of its complications, and of the need for lifelong regular treatment), and the attitude branch held three (acceptance of salty and fatty food and offal, disagreement with lifelong regular medication, and disagreement with routine blood-pressure checks), as illustrated in Figure 5. The team attributed every cause to insufficient knowledge of hypertension, and low community knowledge was designated the root cause.

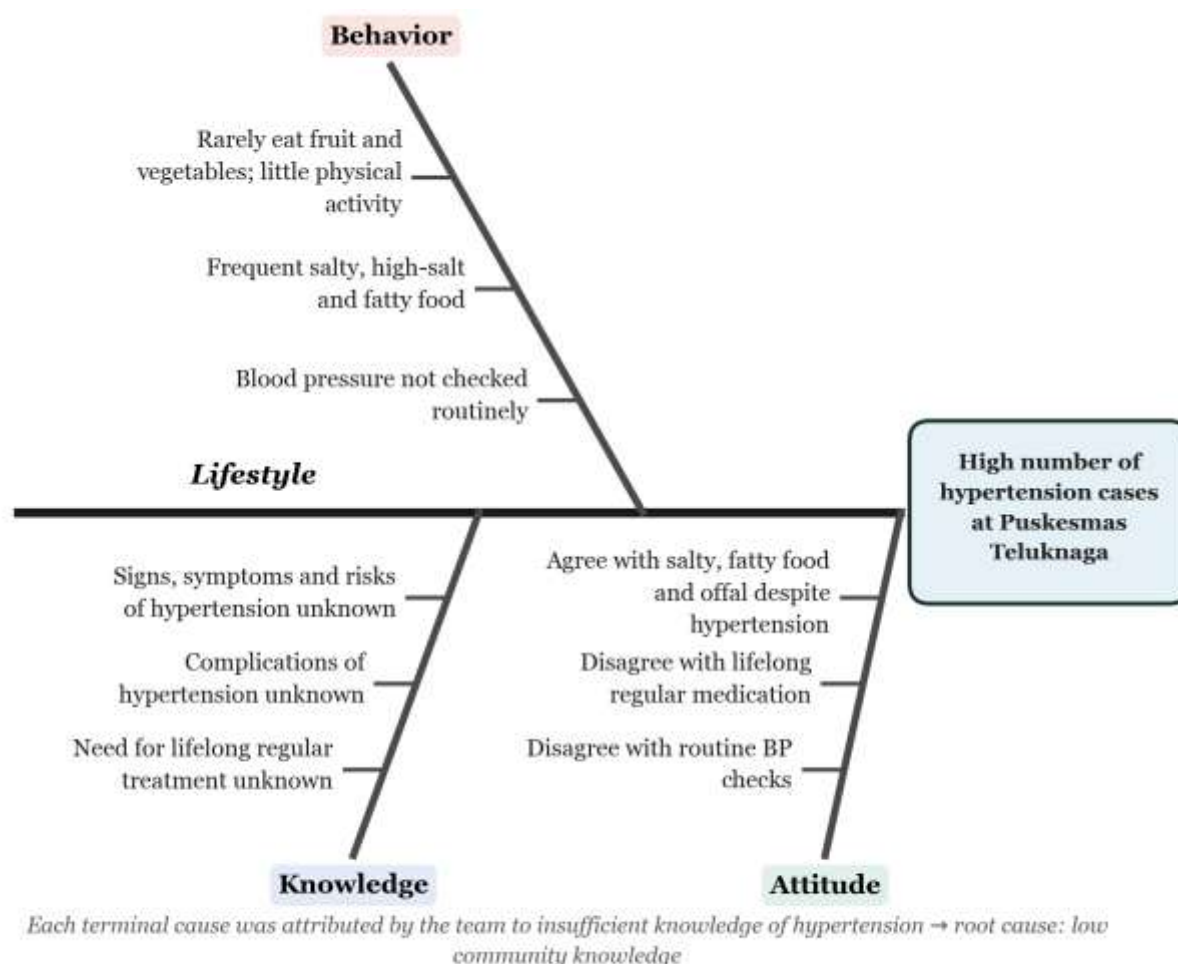


Figure 5. Fishbone (Ishikawa) analysis of the lifestyle domain: knowledge, attitude and behavior branches converging on low community knowledge as the root cause.

3.4. Knowledge after the educational session

All 32 participants completed the post-test. Twenty-six scored 90 or more (81.3%; Wilson 95% CI 64.7 to 91.1; Clopper–Pearson 95% CI 63.6 to 92.8) and six scored below 90 (18.8%; 95% CI 8.9 to 35.3), as detailed in Table 5. The Wilson interval had a half-width of 13.2 percentage points; estimating the proportion to within 10 or 5 percentage points would require 59 or 235

participants, respectively. The observed proportion exceeded a 50% benchmark ($p < 0.001$; Cohen's $h = 0.68$) but did not differ significantly from 70% ($p = 0.182$; $h = 0.26$) or 90% ($p = 0.129$; $h = -0.25$). In one-sided exact tests, the result significantly exceeded any reference proportion of 66% or less and fell significantly short of any proportion of 92% or more, a compatibility range displayed by the p -value function in Figure 6.

Table 5. Knowledge post-test outcome (n=32): precision and descriptive comparison with reference proportions.

Measure	Estimate	95% CI	Exact p	Cohen's h	Holm p
Participants scoring ≥ 90 , n/N (%)	26/32 (81.3)	64.7 to 91.1	—	—	—
Participants scoring < 90 , n/N (%)	6/32 (18.8)	8.9 to 35.3	—	—	—
Clopper–Pearson interval for the proportion ≥ 90	81.3%	63.6 to 92.8	—	—	—
Half-width of the Wilson interval	± 13.2 percentage points	—	—	—	—
vs 50% (majority benchmark)	81.3% vs 50.0%	—	< 0.001	0.68	—
vs 70%	81.3% vs 70.0%	—	0.182	0.26	—
vs 90%	81.3% vs 90.0%	—	0.129	-0.25	—
vs adequate knowledge, Indonesian primary care ³⁰	81.3% vs 53.9%	—	0.002	0.60	0.006
vs good knowledge after education, Tunisian RCT ⁴⁵	81.3% vs 63.6%	—	0.043	0.40	0.085
vs positive knowledge, rural Bangladesh ⁴⁶	81.3% vs 80.0%	—	1.000	0.03	1.000
vs sufficient knowledge (HK-LS), Bangladesh ³³	81.3% vs 37.5%	—	< 0.001	0.93	< 0.001
Compatibility window: reference values significantly exceeded / not reached (one-sided exact)	$\leq 66\%$ / $\geq 92\%$	—	< 0.05	—	—

Wilson score interval unless stated. Exact *p*: two-sided exact binomial test of 26/32 against each reference proportion. Holm *p*: Holm adjustment across the four comparisons with published proportions. Literature proportions used different instruments and cut-offs and are shown as context, not as controlled comparisons; the compatibility window is the principal summary. HK-LS, Hypertension Knowledge-Level Scale; RCT, randomized controlled trial.

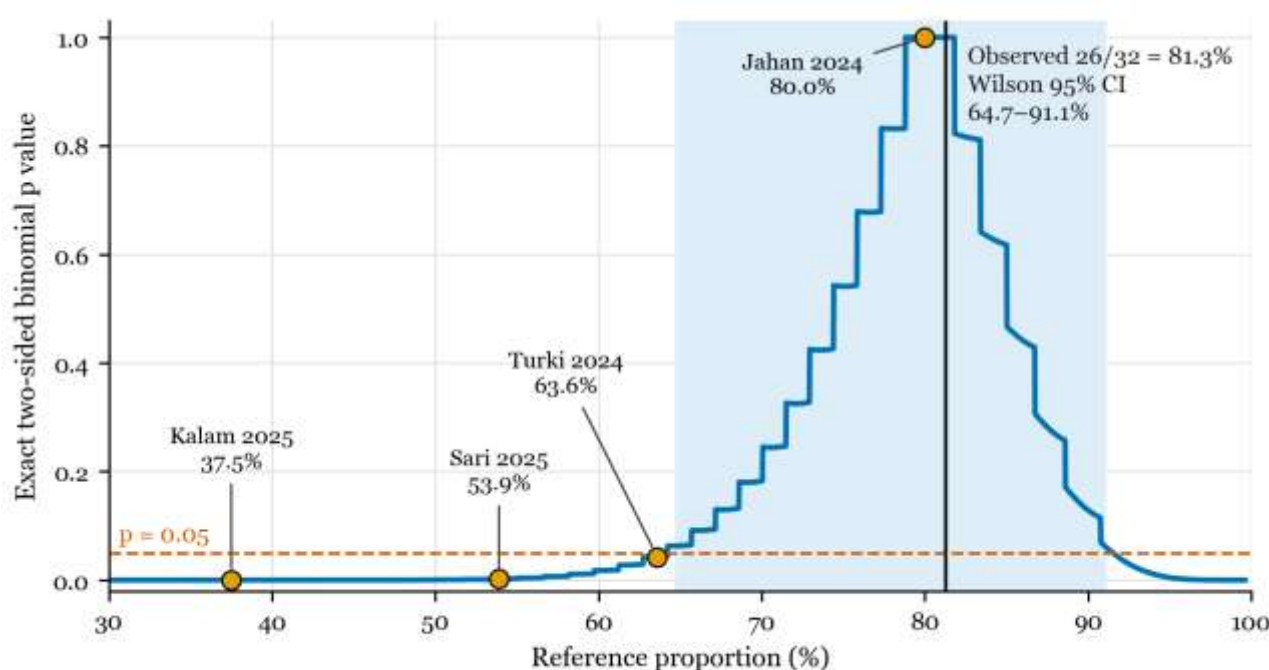


Figure 6. Exact binomial *p*-value function for the post-test result (26 of 32 scoring ≥ 90) across reference proportions; shading shows the Wilson 95% CI. Orange points mark knowledge proportions reported in other studies, which used different instruments and cut-offs.

3.5. Sensitivity analysis of knowledge change

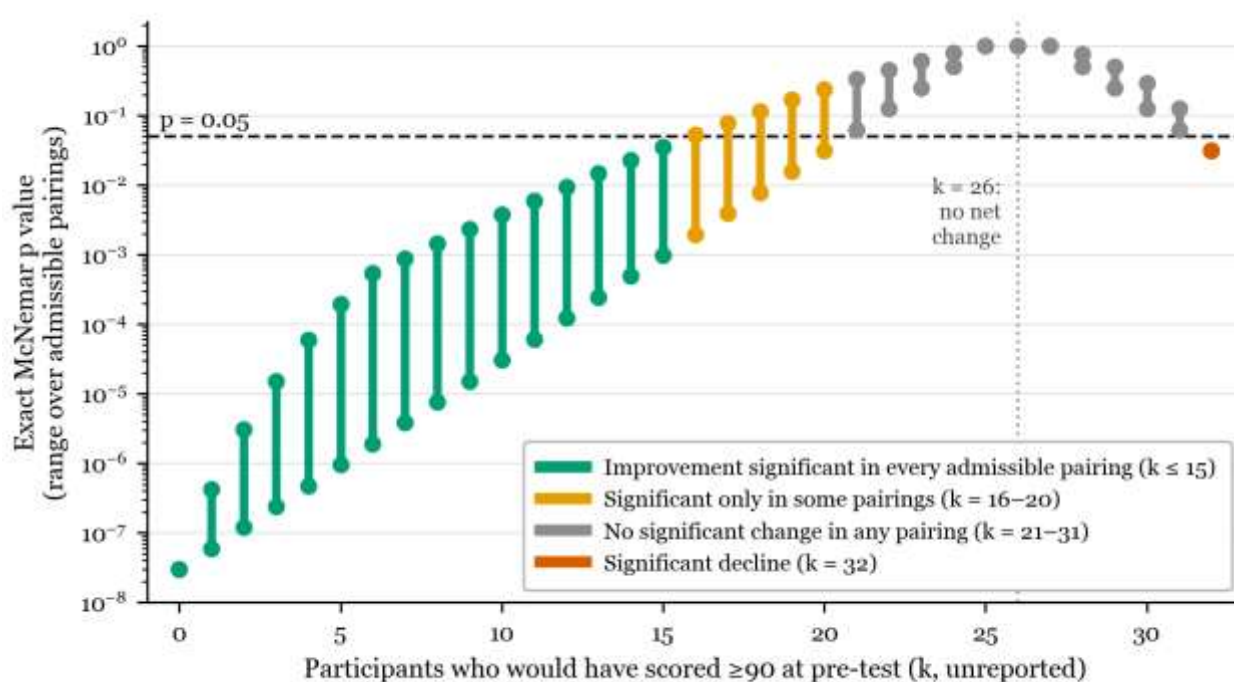
Across the 189 paired tables consistent with the post-test result, the evidence for a change in knowledge depended entirely on the unobserved pre-test count, as detailed in Table 6 and shown in Figure 7. If 15 or fewer participants ($\leq 46.9\%$) had scored 90 or more at pre-test, improvement was significant in every admissible table (largest $p=0.035$ at $k=15$). If 16 to 20 participants had done so, improvement was significant in some

tables but not others; at $k=20$, for example, one of seven admissible tables reached significance (p range 0.031 to 0.238). If 21 or more participants had already scored 90 or more, no admissible table showed a significant change, and if all 32 had done so, the post-test would represent a significant decline ($p=0.031$). The attainable results therefore ranged from significant improvement to significant decline, and the available data could not identify whether knowledge changed.

Table 6. Sensitivity analysis over all paired pre-test/post-test tables consistent with the observed post-test result (26 of 32 scoring ≥ 90).

Pre-test ≥ 90 (k of 32)	Admissible tables	Net change in % scoring ≥ 90	Exact McNemar p (range)	Tables with $p < 0.05$, n (%)	Interpretation
0	1	+81.3 pp	<0.001 to <0.001	1 (100)	Improvement in every pairing
5	6	+65.6 pp	<0.001 to <0.001	6 (100)	Improvement in every pairing
10	7	+50.0 pp	<0.001 to 0.004	7 (100)	Improvement in every pairing
13	7	+40.6 pp	<0.001 to 0.015	7 (100)	Improvement in every pairing
15	7	+34.4 pp	<0.001 to 0.035	7 (100)	Improvement in every pairing
16	7	+31.3 pp	0.002 to 0.052	6 (86)	Improvement in some pairings only
17	7	+28.1 pp	0.004 to 0.078	5 (71)	Improvement in some pairings only
18	7	+25.0 pp	0.008 to 0.115	3 (43)	Improvement in some pairings only
19	7	+21.9 pp	0.016 to 0.167	2 (29)	Improvement in some pairings only
20	7	+18.8 pp	0.031 to 0.238	1 (14)	Improvement in some pairings only
21	7	+15.6 pp	0.062 to 0.332	0 (0)	No significant change
23	7	+9.4 pp	0.250 to 0.607	0 (0)	No significant change
26	7	+0.0 pp	1.000 to 1.000	0 (0)	No significant change
29	4	-9.4 pp	0.250 to 0.508	0 (0)	No significant change
32	1	-18.8 pp	0.031 to 0.031	1 (100)	Decline in every pairing

The pre-test count k was not available, so every value of k (0–32) and every admissible allocation of concordant and discordant pairs was enumerated (189 tables in total); selected k are shown; all 33 values of k are listed in Supplementary Table S1. Net change = $(26 - k)/32$. Exact McNemar test, two-sided. Improvement is significant in every admissible pairing for $k \leq 15$, in some pairings for $k = 16-20$, and in none for $k \geq 21$; $k = 32$ implies a significant decline. pp, percentage points. [Author query: Supplementary Table S1 was not supplied; provide it or add the full 33-row table to the article]

**Figure 7.** Range of exact McNemar p values across every paired pre-test/post-test table consistent with the observed post-test, by the unreported number of participants scoring ≥ 90 at pre-test (k).

The plausibility of these scenarios depended on the assumed baseline, as shown in Figure 8. With no prior information (uniform distribution), the probability that improvement would be significant in every admissible pairing was 48.5%, in some pairings only 15.2% and in none 36.4%. With a baseline centered on 12.1% the

probability of robust improvement was effectively 100%, and with a baseline of 37.5% it was 86.6%. With a baseline of 53.9%, it was 29.0%, with 55.6% for improvement in some pairings only and 15.4% for none. With a baseline of 80.0%, the probability that no pairing would show improvement was 98.0%.

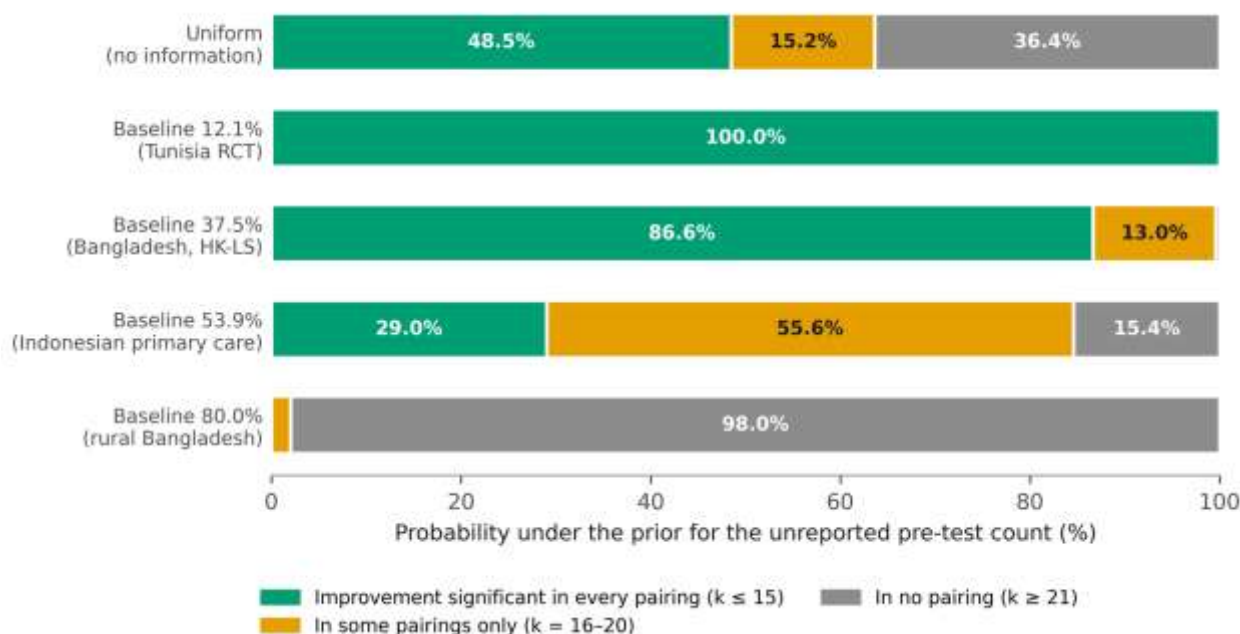


Figure 8. Probability that improvement in the proportion scoring ≥ 90 would be significant in every, some or no admissible pairing, under prior distributions for the unreported pre-test count centered on published baseline knowledge proportions. Because the published studies defined adequate knowledge less stringently than a score of 90 or more, the priors are likely to overstate baseline success.

4. Discussion

This community diagnosis at Puskesmas Teluknaga produced four findings. First, hypertension was the leading diagnosis in the catchment, and the village chosen for intervention on the basis of raw visit counts retained a twofold excess after standardization for population size, a result that persisted when the variance was inflated for repeat visits. Second, the determinants identified spanned lifestyle, the food environment and the availability of information, and the team designated low community knowledge as the root cause. Third, after a single lecture with a leaflet, four in five participants scored 90 or more on the knowledge post-test, a level comparable to or above that reported elsewhere. Fourth, without pre-test scores the post-test could not show that the session changed knowledge. Depending on how many participants already knew the material, the same post-test is compatible with a large improvement, with no change or with a decline.

4.1. Site selection: burden, population and access

Community-diagnosis reports commonly select the village with the most cases, but raw counts rank villages partly by size. In this catchment the largest village by population was Kampung Melayu Timur, which contributed the second-fewest visits (Table 2). Desa Teluknaga ranked fourth by population yet first by visits. Population standardization therefore strengthened rather than overturned the original choice. A posterior probability of 0.998 that Desa Teluknaga had the highest visit rate, remaining above

0.92 when repeat visits were allowed for (Table 3), makes the selection defensible if the aim is to act where service use for hypertension is concentrated. If the aim were instead to reach residents with unmet need, the villages with the lowest visit rates would be the more natural targets. The lead of Desa Teluknaga over the next village was also not secure once repeat visits were considered. A visit rate is nevertheless a measure of service use, not of prevalence. Distance to a facility lowers hypertension awareness among poor older adults in rural India by 8% at 10 km,⁴⁷ distance to the community health center is independently associated with high cardiovascular risk in rural Aceh,²⁰ and travel distances to Puskesmas in Maluku average almost 9 km by land.⁴⁸ Within a peri-urban catchment of about 18 km² the distances are short, but proximity, transport and familiarity with the Puskesmas could still raise use among residents of the village nearest the facility. The lack of correlation between visit rate and population density argues against crowding as the explanation, but the location of the Puskesmas and the road distance from each village were not available to test proximity directly.

The two villages with fewer visits than expected deserve as much attention as the village with more. Kampung Melayu Timur and Kampung Besar had visit rates 43% and 32% below population expectation, although only the deficit in Kampung Melayu Timur was stable when repeat visits were allowed for (Table 3). Three explanations are possible. National estimates indicate that three-quarters of hypertension is undiagnosed and that undiagnosed cases concentrate

among adults with little schooling and low spending.^{8,9} A low visit rate could therefore reflect under-detection. It could equally reflect care sought from private practitioners, clinics, auxiliary health posts or a neighboring Puskesmas, or a genuinely lower prevalence. Routine Puskesmas data cannot distinguish these explanations, but targeted screening can. Community-based programs increase screening.²¹ A high yield of new diagnoses would point to under-detection, whereas a high proportion of residents already treated elsewhere would point to alternative providers. Villages with a Posbindu and primary-care staff also have fewer residents at high cardiovascular risk.²⁷ The 2024 figure of 54.7 case records per 1,000 residents cannot be converted into the proportion of hypertensive residents in care, because case records may include repeat visits. With national prevalence near 30% among adults,⁷ it is nevertheless compatible with the national cascade, in which fewer than one in four adults with hypertension is treated.^{4,7}

4.2. Determinants in context

The determinants recorded in Teluknaga mirror national data. Preference for salty and fried food and the density of vendors selling it echo the Jakarta finding that salt intake exceeds national guidance and that high-sodium, high-fat foods are associated with hypertension.¹⁶ They also echo the national picture in which almost every adult eats too few fruits and vegetables.¹⁵ Irregular blood-pressure monitoring and limited physical activity match the patterns in Surabaya primary care, where 87.7% of patients were insufficiently active and half used discretionary salt regularly.²⁴ The finding that most respondents had never attended health education on hypertension, and that information materials were scarce, agrees with the evaluation of 475 Posbindu posts in which fewer than a quarter of attendees were asked about risk factors.²² Central obesity, smoking and mental distress, which national and regional studies identify as major contributors,^{13,17,18} were not assessed in the mini-survey. Their omission is a gap in the determinant assessment rather than evidence of their absence.

The attitude findings are of special interest. Some respondents rejected routine blood-pressure checks in the absence of symptoms, a belief that maps directly onto the national finding that adults without symptoms, and those who feel healthy, are about twice as likely to be undiagnosed.⁹ In Aceh, the most common reason for never having had a blood-pressure check was not feeling ill.²⁹ Disagreement with lifelong medication fits the 87.1% of Indonesian hypertensive adults with low awareness of treatment¹⁰ and with the finding that only 28.5% of hypertensive adults in Aceh were highly adherent.⁴⁹ Attitudes can also move in the opposite direction from knowledge. In four Indonesian districts, access to Posbindu was associated with better knowledge but lower attitude scores (adjusted OR 0.6).³⁶ An intervention aimed at knowledge alone may

therefore leave the attitudes that block screening and adherence unchanged.

4.3. The root-cause analysis

Designating low knowledge as the root cause was a reasonable judgment but not an empirical identification. In the fishbone diagram every cause on the behavior and attitude branches was attributed to insufficient knowledge, so the analysis converged on knowledge by construction. Fishbone analysis is most useful when its branches represent independent categories of cause. In quality-improvement projects in Indian primary care it identified structural causes, such as the absence of a record-keeping policy and the lack of a system for tracking missed follow-up visits. These causes were then addressed with measurable effect, raising monthly hypertension follow-up from 21% to 37% or record availability from 0% to 100%.^{41,42} In Teluknaga, the environment and health-service domains also contained structural causes, namely the food environment and the scarcity of information materials, that a knowledge-focused intervention cannot address. Similarly, the non-scoring Delphi technique is efficient for a student team, but formal Delphi studies use defined panels, several rounds and explicit agreement thresholds, as in the three-round Indonesian expert panel that prioritized Posbindu and integrated non-communicable disease services in primary care⁴⁰ or the modified Delphi that set the United Kingdom's hypertension research priorities.⁵⁰ Documenting the panel, the rounds and the agreement rule would make future community diagnoses reproducible.

A further feature of the design weakens the link between diagnosis and intervention. The knowledge, attitude and behavior gaps were identified in 30 adults attending the Puskesmas. The session, by contrast, was delivered to 32 residents of one neighborhood unit whose baseline knowledge was not described. Puskesmas attenders include people already under treatment, who may know more about hypertension than the general population, or less if they are newly diagnosed. Residents of a single neighborhood unit may differ from both, and the claim that the session was tailored to the identified gaps therefore rests on the assumption that the two groups share them. Drawing the problem-identification sample from the same households as the intervention cohort would remove this uncertainty. So would administering the mini-survey items to intervention participants before the session.

4.4. Interpreting the post-test result

A post-test proportion of 81.3% is high when set against other reports, although the comparisons are not like for like. In the descriptive exact tests detailed in Table 5, the Teluknaga proportion exceeded the 53.9% with adequate knowledge in Indonesian primary care³⁰ (Holm-adjusted $p=0.006$; $h=0.60$) and

the 37.5% with sufficient knowledge on an adapted Hypertension Knowledge-Level Scale (HK-LS) in Bangladesh³³ (Holm-adjusted $p < 0.001$; $h = 0.93$). It did not differ after adjustment from the 63.6% who reached good knowledge after a structured program in Tunisia⁴⁵ (unadjusted $p = 0.043$; Holm-adjusted $p = 0.085$), and it matched the 80.0% with positive knowledge in rural Bangladesh⁴⁶ ($p = 1.000$). In Sri Lanka the mean knowledge score was 57%, with 36% of adults scoring below half.³² In the Tunisian trial, only 11.4% of controls reached good knowledge,⁴⁵ and in Agra the proportion with good knowledge of dietary salt rose from 4% to 42% one month after nurse counselling.⁵¹ In a Malang Puskesmas, a short educational program improved HK-LS scores among patients with uncontrolled hypertension,³⁴ and in Surabaya a virtual campaign improved knowledge and attitude.³⁵ These comparisons differ in instrument, threshold, population and timing. The Teluknaga post-test was administered immediately after the lecture, covered exactly the lecture's content and used a cut-off chosen by the team. The comparison studies used validated scales, often weeks later.

The central methodological finding is that the post-test, on its own, cannot show that the session worked. The tipping-point analysis makes this precise: improvement is demonstrable only if no more than 15 of the 32 participants already scored 90 or more before the session. Whether that condition held cannot be known without the pre-test, but external evidence bears on its plausibility. Baseline proportions of good knowledge range from 12.1% in Tunisia to 80% in rural Bangladesh,^{45,46} and the prior-scenario analysis translates that range into probabilities: improvement under every pairing is almost certain if the Teluknaga baseline resembled the Tunisian or Bangladeshi hypertensive populations, about one chance in three if it resembled Indonesian primary-care patients, and essentially excluded if it resembled the rural Bangladeshi cohort. Those studies used thresholds less stringent than 90 of 100, so these probabilities are, if anything, pessimistic. A baseline below 47% is therefore reasonable but not assured, particularly because the Teluknaga participants were recruited

from a single neighborhood unit rather than from the mini-survey sample in which knowledge gaps were identified. Three further mechanisms can raise immediate post-test scores without durable learning. Taking a pre-test can sensitize participants to the questions, although a Solomon four-group study found that this did not explain post-test gains.⁴³ Ceiling effects compress apparent change when baseline knowledge is high.⁴⁴ Above all, knowledge measured immediately after a session decays. In Malaysia, knowledge after education fell by three months though it remained above baseline,⁵² and in Brazil scores fell significantly between the immediate post-test and three-month follow-up.⁵³ Reporting the immediate post-test as evidence of effectiveness, as community-diagnosis reports often do, therefore overstates what has been shown.

4.5. From knowledge to blood-pressure control

Even a demonstrated gain in knowledge would be only the first step in a long causal chain that runs from knowledge through attitude and behavior to blood-pressure control and clinical outcomes, as outlined in Figure 9. The present study measured only the first link. The targets of hypertension education are behavioral, and their effects on blood pressure are well documented. Behavioral salt-reduction programs lower urinary sodium and systolic pressure,^{54,55} central obesity accounts for about a quarter of hypertension among Indonesian women,¹³ and obesity and non-adherence are among the strongest correlates of uncontrolled hypertension in the national survey.¹¹ Each pathway requires sustained behavior change, and the evidence shows that knowledge does not reliably produce it. In rural Bangladesh, 80% of hypertensive adults had positive knowledge, yet overnight urinary sodium remained high.⁴⁶ In Indonesian primary care, knowledge was not significantly associated with self-care,³⁰ and in Surabaya a virtual campaign improved knowledge without changing practice.³⁵ A quasi-experimental evaluation in Indonesia and Vietnam found that community programs raised knowledge and screening. Knowledge gains were only partly reflected in behavior, with a reduction in systolic blood pressure of 0.13 standard deviations.²¹

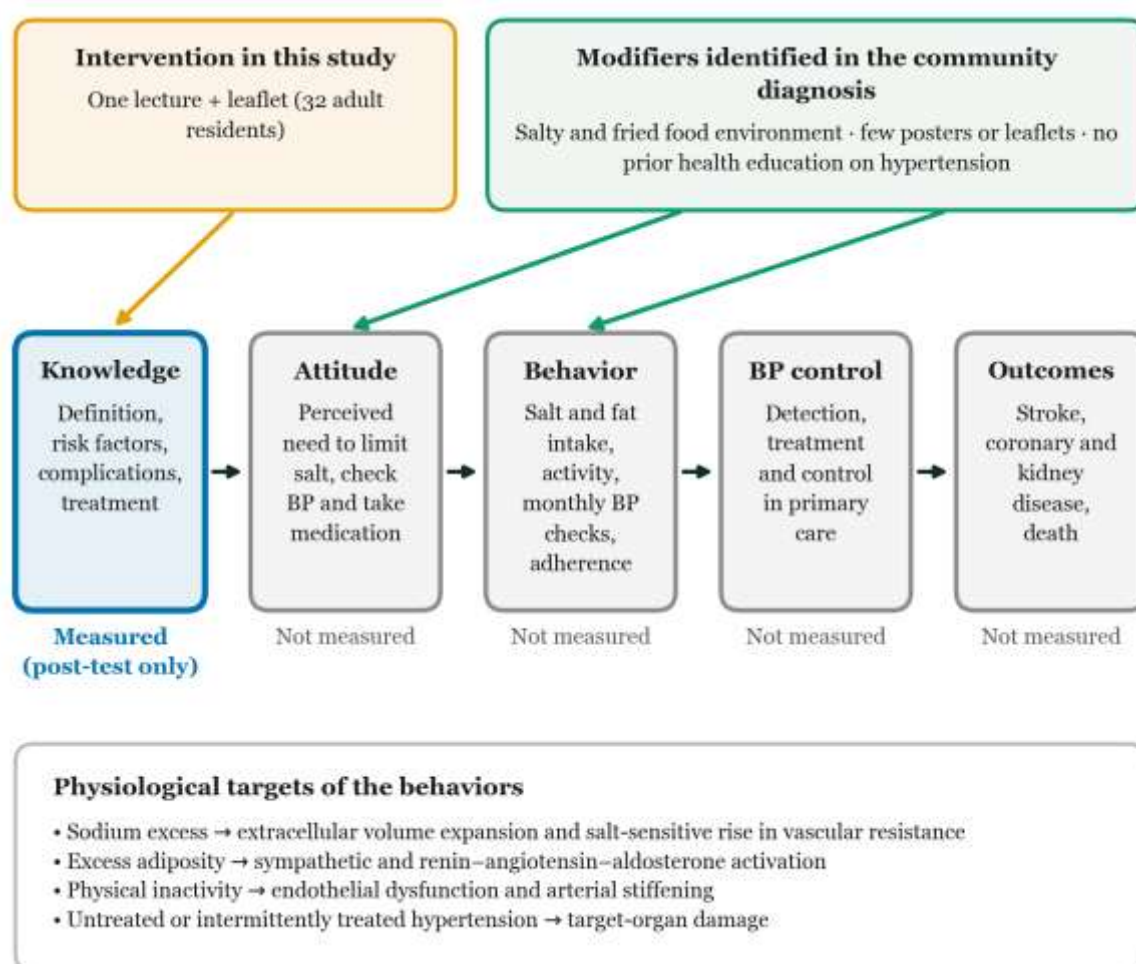


Figure 9. Pathway from knowledge to clinical outcomes, showing the single step measured in this study, the modifiers found in the community diagnosis, and the established physiological targets of the behaviors concerned, shown schematically. BP, blood pressure; IEC, information, education and communication.

Interventions that do lower blood pressure share features absent from a single lecture: repetition, personal contact, family involvement and links to treatment. In rural Indonesia, a family self-management program delivered over 24 weeks improved systolic and diastolic blood pressure and sodium adherence.⁵⁶ An eight-week self-management program in Belitung reduced systolic pressure with an effect size of 0.71,⁵⁷ and a behavior-tailored intervention improved self-care and lowered blood pressure.⁵⁸ In Yogyakarta, a mobile-health program improved early blood-pressure control although knowledge rose equally in both arms.⁵⁹ In Thailand, a teach-back health-literacy program reduced systolic pressure by 6.97 mmHg.⁶⁰ Pooled estimates point the same way: education-based community trials reduce systolic pressure by 6.42 mmHg, with larger effects in programs lasting six months or more,⁶¹ nurse-led self-management lowers it by 7.60 mmHg,⁶² and health-literacy interventions in older adults by 6.90 mmHg.⁶³ Salt-reduction education yields smaller but consistent effects. A home-cook program in China reduced urinary sodium by 337 mg per day and systolic pressure by 2.0 mmHg.⁵⁵ A community salt-monitoring program in Thailand reduced systolic pressure by 13.5 versus 9.5

mmHg,⁶⁴ and a meta-analysis of behavioral salt-reduction trials found a systolic reduction of 1.17 mmHg.⁵⁴

Community health workers are the most scalable vehicle for such programs. The COBRA-BPS cluster-randomized trial ran in 30 rural communities of Bangladesh, Pakistan and Sri Lanka, and its program, led by community health workers, cost US\$6.42–10.65 per participant in its first year and US\$2,270–4,080 per disability-adjusted life-year averted, making it cost-effective in all three countries.⁶⁵ Village-doctor-led care in rural China achieved blood pressure below 130/80 mmHg in 57.0% versus 19.9% of participants,⁶⁶ and community-health-worker home visits in urban Nepal improved control (OR 1.5) while raising knowledge and lowering salt intake.⁶⁷ In Zimbabwe, a health-literacy program of community-health-worker sessions plus home visits achieved blood-pressure control in 62% of participants versus 41% of controls.⁶⁸ A systematic review of community-health-worker programs in low- and middle-income countries found consistent improvements in blood pressure, linkage to care and adherence.⁶⁹ The Indonesian SMARThealth model, which equips community health workers with

decision-support technology, cost US\$4,288 per disability-adjusted life-year averted.⁷⁰ Two cautions follow. The benefit of a 12-month community-health-worker lifestyle program in Nepal had disappeared five years later.⁷¹ The effect of a dietary intervention in northern Thailand, clear at six months, was no longer detectable at twelve.⁷² Gains last only while programs continue.

4.6. Implications for Puskesmas Teluknaga and for Indonesian primary care

For Puskesmas Teluknaga, the findings support three practical steps. First, the hypertension program can use population-standardized visit rates, rather than counts, to allocate outreach, directing screening toward Kampung Melayu Timur and Kampung Besar, where visits fall well below expectation. Second, education in Desa Teluknaga should be repeated and linked to the Posbindu PTM and the kader network, which already reach many adults but miss risk-factor counselling²² and lose more than half of referrals before Puskesmas follow-up.²³ The structural determinants identified also have remedies within the Puskesmas mandate: the scarcity of information materials can be corrected directly. The food environment can be addressed through healthy-food messaging with households and food vendors during Posbindu sessions and village health-promotion activities, which complement rather than replace education. Third, clinic encounters are an underused educational opportunity: patients who are not told to take their medication regularly are five times more likely to be non-adherent.²⁶ The deterioration of blood pressure among PROLANIS participants when group activities were interrupted during the COVID-19 pandemic suggests how quickly gains may be lost when regular contact stops.²⁸ Information materials, the gap identified in the health-service domain, are likely to be inexpensive and can be placed in the Puskesmas, Posbindu and the village office.

At the regional level, the Teluknaga findings reflect a wider pattern. In Southeast Asia, cascades in Cambodia, Lao PDR and Indonesian surveillance sites lose most patients between diagnosis and control,⁴⁻⁶ and national

Indonesian data show that urban and wealthier groups do better at every step.⁷ Peri-urban catchments such as Teluknaga, on the edge of a metropolitan region, combine urban food environments with populations that may not share urban advantages in diagnosis and treatment. Primary-care providers in Jakarta describe staff shortages and referral gaps that limit chronic-disease care.²⁵ The national survey shows that education and obesity are the strongest correlates of poor control.¹¹ Community diagnoses that identify such local patterns are valuable precisely because national averages conceal them.

4.7. Community diagnosis as education and as evidence

Community diagnosis is also a teaching method. In Japan it improved medical students' rural self-efficacy and their knowledge of the social determinants of health.³⁷ In Thailand, training village health volunteers to support students' community diagnoses raised the volunteers' knowledge of the method,³⁸ and an Indonesian rapid assessment found that physicians working in underserved areas need precisely the skills that community diagnosis teaches: community surveillance, systems thinking and the use of data.³⁹ Community health needs assessments elsewhere similarly identify hypertension and diabetes as leading community priorities.⁷³ The present analysis suggests a short set of minimum reporting items that would turn clerkship community diagnoses into publishable evidence without increasing their cost. The items and their purposes are listed in Table 7. The most consequential are population denominators for site selection, documentation of the prioritization panel and its rules, retention of individual pre-test and post-test scores linked by a code, and a short delayed retest. Faculty supervising clerkships could adopt these items as an assessment rubric, so that each cohort's community diagnosis also contributes reusable local evidence. Validated knowledge instruments are available in regional languages, with Cronbach's α of 0.72 for the Vietnamese and 0.82 for the Thai versions of the HK-LS.^{74,75} An Indonesian version has been used in Puskesmas research.³⁴

Table 7. Proposed minimum reporting items for clerkship-based community diagnoses and the purpose of each.

Component	Minimum item	Purpose
Situation analysis	Case or visit counts with period, counting unit (visits or persons) and population denominators	Separates burden from population size and access; allows standardized rates and ratios
Problem identification	Sampling frame, number surveyed, instrument items and item-level frequencies	Quantifies each determinant with a confidence interval
Prioritization	Method, panel composition, number of rounds, agreement rule and criteria	Makes the priority decision reproducible
Root-cause analysis	Branch categories, causes on each branch and the decision rule for the root cause	Distinguishes judgment-based from data-based root causes
Intervention	TIDieR items, including date, duration, provider and materials	Enables replication and interpretation of dose
Outcome measurement	Instrument items, scoring, threshold rationale and reliability	Allows validity, reliability and ceiling effects to be judged
Evaluation design	Coded, linked individual pre-test and post-test scores; delayed retest	Identifies change and retention rather than post-test level alone
Analysis	Proportions with 95% CI; paired tests on continuous scores; effect sizes	Conveys precision and magnitude, not only significance

Component	Minimum item	Purpose
Ethics and data	Approval body and number, consent, aggregate data and code availability	Accountability and reuse of local evidence

TIDieR, Template for Intervention Description and Replication.

4.8. Research agenda

The community diagnosis points to a sequence of studies, summarized with their designs, outcomes and required sample sizes in Table 8. The first is a paired evaluation of the existing session with individual scores retained. If 30% of participants improve and 5% decline across the ≥ 90 threshold, 45 participants give 80% exact power to detect the change with the exact McNemar test, and 92 are needed if 20% improve. A retest at three months would measure retention and requires 168 participants to detect net decay of 10 percentage points. The continuous paired scores should be analyzed as well, with the Wilcoxon signed-rank test and the mean change with its 95% CI, so that

the conclusion does not hinge on a single threshold. The second is a cluster-randomized trial of repeated, kader-led education linked to Posbindu monitoring, with neighborhood units as clusters and systolic blood pressure at 12 months as the outcome. Detecting a 5 mmHg difference with a standard deviation of 15 mmHg, 30 adults per cluster and an ICC of 0.05 requires 348 participants (12 clusters) per arm, falling to 225 (8 clusters) per arm if the ICC is 0.02. The third is a village-level analysis of 12 months of visit data against road distance from the Puskesmas, which would test whether the excess in Desa Teluknaga reflects proximity. Each study is feasible within the Puskesmas and clerkship system.

Table 8. Research agenda arising from the community diagnosis: designs, outcomes and required sample sizes.

Question	Design	Primary outcome	Assumptions ($\alpha=0.05$, power 0.80)	Required sample
Does a single session change knowledge?	Paired pre/post with retained individual scores and 3-month retest	Proportion scoring ≥ 90 (exact McNemar)	Improvement in 30% vs decline in 5% of pairs	45 participants
			Improvement in 20% vs decline in 5% of pairs	92 participants
Is knowledge retained?	Same cohort, retest at 3 months	Change from immediate post-test	Decline in 15% vs gain in 5% of pairs	168 participants
Does kader-led repeated education lower blood pressure?	Cluster-randomized trial, RT as cluster, 30 adults per cluster	Systolic BP at 12 months	Difference 5 mmHg, SD 15, ICC 0.05 (design effect 2.45)	348 per arm (12 clusters per arm)
			Difference 5 mmHg, SD 15, ICC 0.02 (design effect 1.58)	225 per arm (8 clusters per arm)
			Difference 3 mmHg, SD 15, ICC 0.05 (design effect 2.45)	963 per arm (33 clusters per arm)
Why do Teluknaga residents use the Puskesmas more?	Village-level analysis of visits (and unique patients) against road distance and population, all catchment villages, 12 months	Visit rate ratio per km	Seven villages $\times$ 12 monthly counts (84 village-months)	Routine data only; no new recruitment
How precise is the post-test estimate?	Descriptive survey of the RT/RW population	Proportion scoring ≥ 90	Expected 81%, half-width ± 10 or ± 5 points	59 or 235 participants

McNemar sample sizes from exact power calculation (Connor's normal approximation gives 42, 85 and 155, with exact power of 0.76 to 0.77); secondary analysis of continuous paired scores by Wilcoxon signed-rank test with mean change and 95% CI. Cluster trial from the two-sample comparison of means inflated by the design effect $1 + (m - 1) \times \text{ICC}$. BP, blood pressure; ICC, intraclass correlation coefficient; RT, neighborhood unit.

4.9. Strengths and limitations

The study has several strengths. Site selection was tested against official population denominators with exact methods, and multiple comparisons were adjusted. The excess of the intervention village over the rest of the catchment persisted under every check, including variance inflation for repeat visits. Determinants were organized in a recognized framework and traced explicitly to the intervention. The educational outcome was reported with exact intervals and compared transparently with external benchmarks. The absence of pre-test data was handled by enumerating every compatible dataset rather than by assuming one, so the limits of the evidence are quantified rather than asserted.

The limitations are serious. Pre-test scores and individual characteristics were not available, so knowledge change could not be estimated, and no

participant characteristics or multivariable analyses could be reported. The knowledge questionnaire was not validated, its items and scoring are not reported, and the ≥ 90 threshold was set by the team. The post-test was immediate, so it reflects recall rather than retention, and attitude, behavior and blood pressure were not measured. The mini-survey of 30 Puskesmas visitors was a convenience sample of service users. Its findings were recorded qualitatively without item frequencies, and its respondents were not the intervention participants, whose baseline gaps were therefore assumed rather than measured. The Delphi panel, its rounds and its agreement rule were not documented, and the heredity domain was not assessed. Village visit counts measure service use rather than prevalence and may include repeat visits. The 2024 and April–May 2025 counts may use different counting units, care obtained outside the Puskesmas was not captured, and the population denominators are

mid-2024 estimates. Finally, the intervention was delivered to one neighborhood unit, which limits generalizability within Desa Teluknaga.

5. Conclusion

In the Puskesmas Teluknaga catchment, hypertension was the leading diagnosis. After standardization for population, Desa Teluknaga had a visit rate twice that of the other villages (rate ratio 1.98; 95% CI 1.60 to 2.44), a finding that held when repeat visits were allowed for and supported its selection as the intervention site. Kampung Melayu Timur, by contrast, showed a visit deficit. It may reflect under-detection or care sought elsewhere. The community diagnosis designated low knowledge as the root cause within a broader set of dietary, environmental and service determinants. After one lecture with a leaflet, 81.3% of participants (95% CI 64.7 to 91.1) scored 90 or more on the knowledge post-test. The effect of the session on knowledge cannot be established, though: without pre-test data, improvement is demonstrable only if no more than 15 of 32 participants already had good knowledge. Puskesmas Teluknaga should use population-standardized rates to target outreach and screening, repeat education through Posbindu and kader networks, and link it to blood-pressure monitoring and treatment. Future community diagnoses should retain paired individual scores and a delayed retest. The next step is a cluster-randomized trial of kader-led education with blood pressure as the outcome.

Declarations

Declaration of generative AI and AI-assisted technologies in the writing process

The authors confirm that no generative artificial intelligence (AI) tools were used at any stage of preparing this manuscript.

Author contributions (CRediT)

N.Z.: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft. D.R.O.: Investigation, Data curation, Writing – review & editing. A.: Investigation, Data curation, Writing – review & editing. T.S.: Supervision, Methodology, Validation, Writing – review & editing. All authors approved the final manuscript.

Conflict of interest

The authors declare no conflict of interest.

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Ethical approval and informed consent

The study protocol received ethical approval from the CMHC Research Center Ethics Committee, Indonesia (Approval No. 2025/8451), before data collection began, and was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants. Routine Puskesmas data

were used only in aggregate form without personal identifiers.

Consent for publication

Not applicable; no identifiable individual data are reported.

Data availability

Only aggregate data were analyzed; the aggregate data underlying the tables and figures are included in the article. The analysis code is available from the corresponding author on reasonable request.

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References

1. Vaduganathan M, Mensah GA, Turco JV, et al. The Global Burden of Cardiovascular Diseases and Risk: A Compass for Future Health. *J Am Coll Cardiol*. 2022;80(25):2361-2371. doi:10.1016/j.jacc.2022.11.005
2. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: a pooled analysis of 1201 population-representative studies with 104 million participants. *Lancet*. 2021;398(10304):957-980. doi:10.1016/S0140-6736(21)01330-1
3. GBD 2021 ASEAN Cardiovascular Diseases Collaborators. The epidemiology and burden of cardiovascular diseases in countries of the Association of Southeast Asian Nations (ASEAN), 1990-2021: findings from the Global Burden of Disease Study 2021. *Lancet Public Health*. 2025;10(6):e467-e479. doi:10.1016/S2468-2667(25)00087-8
4. Geldsetzer P, Tan MM, Dewi FS, et al. Hypertension care in demographic surveillance sites: a cross-sectional study in Bangladesh, India, Indonesia, Malaysia, Viet Nam. *Bull World Health Organ*. 2022;100(10):601-609. doi:10.2471/BLT.22.287807
5. Chham S, Buffel V, Van Olmen J, et al. The cascade of hypertension care in Cambodia: evidence from a cross-sectional population-based survey. *BMC Health Serv Res*. 2022;22(1):838. doi:10.1186/s12913-022-08232-7
6. Loss G, Wallenborn JT, Sinantha-Hu M, et al. Evaluating the Hypertension Cascade of Care in Adults in Urban Lao PDR: Evidence From the VITERBI Cohort Study. *Vasc Health Risk Manag*. 2025;21:109-123. doi:10.2147/VHRM.S506857
7. Muharram FR, Widyahening IS, Danaei G. Hypertension care performance in Indonesia: evidence from three waves of nationally representative cross-sectional surveys. *BMJ Open*. 2025;15(12):e109588. doi:10.1136/bmjopen-2025-109588
8. Oktamianti P, Kusuma D, Amir V, et al. Does the Disparity Patterning Differ between Diagnosed and Undiagnosed Hypertension among Adults? Evidence from Indonesia. *Healthcare (Basel)*. 2023;11(6):816. doi:10.3390/healthcare11060816
9. Mahwati Y, Nurrika D, Latief K. The Determinants of Undiagnosed Hypertension Among Indonesian Adults: A Cross-sectional Study Based on the 2014-2015 Indonesia Family Life Survey. *J Prev Med Public Health*. 2022;55(1):60-67. doi:10.3961/jpmph.21.500
10. Khoiry QA, Alfian SD, Abdulah R. Modifiable and Non-modifiable Factors Associated with Low Awareness of Hypertension Treatment in Indonesia: A Cross-Sectional Population-Based National Survey. *Glob Heart*. 2022;17(1):56. doi:10.5334/gh.1143

11. Alfian SD, Sholihah S, Griselda M, et al. Beyond medication: factors contributing to uncontrolled hypertension from the 2023 Indonesian health survey. *Hypertens Res.* 2026;49(7):2004-2016. doi:10.1038/s41440-026-02648-y
12. Mashuri YA, Ng N, Santosa A. Socioeconomic disparities in the burden of hypertension among Indonesian adults - a multilevel analysis. *Glob Health Action.* 2022;15(1):2129131. doi:10.1080/16549716.2022.2129131
13. Helda, Rakhmawati E, Aulia F, et al. Association between central obesity and hypertension among women aged > 18 years based on the 2023 Indonesian health survey. *Women Health.* 2026;66(6-7):347-356. doi:10.1080/03630242.2026.2718838
14. Apriza Yanti C, Susanti E, Djuwita R, et al. Analysis of demographic factors and consumption habits on hypertension in the adult population in Indonesia: (Health Indonesian survey 2023). *J Public Health Res.* 2026;15(3):22799036261474134. doi:10.1177/22799036261474134
15. Arsyad DS, Westerink J, Cramer MJ, et al. Modifiable risk factors in adults with and without prior cardiovascular disease: findings from the Indonesian National Basic Health Research. *BMC Public Health.* 2022;22(1):660. doi:10.1186/s12889-022-13104-0
16. Sakir NAI, Hwang SB, Park HJ, et al. Associations between food consumption/dietary habits and the risks of obesity, type 2 diabetes, and hypertension: a cross-sectional study in Jakarta, Indonesia. *Nutr Res Pract.* 2024;18(1):132-148. doi:10.4162/nrp.2024.18.1.132
17. Alfaqeeh M, Alfian SD, Abdulah R. Factors Associated with Hypertension Among Adults: A Cross-Sectional Analysis of the Indonesian Family Life Survey. *Vasc Health Risk Manag.* 2023;19:827-836. doi:10.2147/VHRM.S438180
18. Wurisastuti T, Suryaputri IY, Mubasyiroh R, et al. Role of common mental disorders in uncontrolled hypertension: a longitudinal study in Bogor City, Indonesia. *Korean J Fam Med.* 2026;47(1):81-88. doi:10.4082/kjfm.24.0026
19. Defianna SR, Santosa A, Probandari A, et al. Gender Differences in Prevalence and Risk Factors for Hypertension among Adult Populations: A Cross-Sectional Study in Indonesia. *Int J Environ Res Public Health.* 2021;18(12):6259. doi:10.3390/ijerph18126259
20. Fitri NK, Maria Nainggolan BW, Saragih YB, et al. Housing distance, salt intake and cardiovascular risk in rural Aceh Tamiang: Insights utilizing the WHO 10-year non-laboratory assessment. *Int J Cardiol Cardiovasc Risk Prev.* 2026;28:200560. doi:10.1016/j.ijcrp.2025.200560
21. Fritz M, Grimm M, My Hanh HT, et al. Effectiveness of community-based diabetes and hypertension prevention and management programmes in Indonesia and Viet Nam: a quasi-experimental study. *BMJ Glob Health.* 2024;9(5):e015053. doi:10.1136/bmjgh-2024-015053
22. Widyarningsih V, Febrinasari RP, Pamungkasari EP, et al. Missed opportunities in hypertension risk factors screening in Indonesia: a mixed-methods evaluation of integrated health post (POSBINDU) implementation. *BMJ Open.* 2022;12(2):e051315. doi:10.1136/bmjopen-2021-051315
23. Marthoenis M, Yenni R, Sudharsanan N. Follow-up After Posbindu NCD Screening in Indonesia: Sociodemographic Predictors of Primary Care Engagement. *Public Health Nurs.* 2026;43(4):1086-1089. doi:10.1111/phn.70117
24. Setiadi AP, Febriandini A, Trinanda E, et al. Knowing the gap: medication use, adherence and blood pressure control among patients with hypertension in Indonesian primary care settings. *PeerJ.* 2022;10:e13171. doi:10.7717/peerj.13171
25. Hustrini NM, Susalit E, van Diepen M, et al. Perceived barriers to management of patients with diabetes mellitus and hypertension in primary care centers in Indonesia. *Front Health Serv.* 2026;5:1715125. doi:10.3389/frhs.2025.1715125
26. Alfian SD, Candradewi SF, Griselda M, et al. Association Between Receiving Medication Information and Adherence to Antihypertensive Medication: Findings from the 2023 Indonesian Health Survey. *Patient Prefer Adherence.* 2025;19:4141-4151. doi:10.2147/PPA.S557301
27. Sujarwoto S, Maharani A, Praveen D, et al. Healthcare access and socio-demographic determinants of estimated 10-year risk of cardiovascular diseases in Indonesia: A population-based study. *PLoS One.* 2025;20(8):e0318112. doi:10.1371/journal.pone.0318112
28. Salamah S, Khafiyya AN, Ramadhani R, et al. Outcomes of the Indonesian Chronic Disease Management Program (PROLANIS) in Patients with Hypertension During the COVID-19 Pandemic in Rural Areas: A Preliminary Evaluation Study. *Med Sci Monit.* 2023;29:e939797. doi:10.12659/MSM.939797
29. Marcus ME, Reuter A, Rogge L, et al. Hypertension and diabetes screening uptake in adults aged 40-70 in Indonesia: a knowledge, attitudes, and practices study. *BMC Glob Public Health.* 2025;3(1):44. doi:10.1186/s44263-025-00157-7
30. Sari EA, Mirwanti R, Herliani YK, et al. Self-Care Behavior Based on Knowledge of Patients with Hypertension: A Cross-Sectional Study. *Vasc Health Risk Manag.* 2025;21:17-24. doi:10.2147/VHRM.S489688
31. Pardoel ZE, Lensink R, Postma M, et al. Knowledge on hypertension in Myanmar: levels and groups at risk. *Open Res Eur.* 2023;2:13. doi:10.12688/openreseurope.14415.2
32. Ranasinghe P, Weerasekara P, Manchanayake M, et al. Knowledge, attitudes, and practices related to hypertension among Sri Lankans: an online cross-sectional survey. *BMC Public Health.* 2025;25(1):2376. doi:10.1186/s12889-025-23592-5
33. Kalam A, Wang P, Haile GB, et al. Assessing hypertension knowledge and its association with sociodemographic variables among hypertensive patients in Bangladesh. *Sci Rep.* 2025;15(1):43414. doi:10.1038/s41598-025-17415-1
34. Kurnia AD, Melizza N, Ruhyanudin F, et al. The Effect of Educational Program on Hypertension Management Toward Knowledge and Attitude Among Uncontrolled Hypertension Patients in Rural Area of Indonesia. *Community Health Equity Res Policy.* 2022;42(2):181-188. doi:10.1177/0272684X20972846
35. Andrianto A, Ardiana M, Nugraha RA, et al. Impact of the virtual anti-hypertensive educational campaign towards knowledge, attitude, and practice of hypertension management during the COVID-19 pandemic. *World J Cardiol.* 2022;14(12):626-639. doi:10.4330/wjc.v14.i12.626
36. Mashuri YA, Widyarningsih V, Premanawasti A, et al. Differences in knowledge, attitude, and practice regarding hypertension by access to a community-based screening program (POSBINDU): A cross-sectional study from four districts in Indonesia. *PLoS One.* 2024;19(5):e0303503. doi:10.1371/journal.pone.0303503
37. Hasebe K, Shikino K, Kawaguchi K, et al. Community diagnosis as a transformative learning approach to enhance medical students' community orientation and understanding social determinant of health: a mixed-methods study. *BMC Med Educ.* 2026;26(1):209. doi:10.1186/s12909-026-08574-4
38. Khuancharee K, Suwanchatchai C, Rattanamongkolgul S. Effect of enhancing village health volunteer ability to promote engaged community-based interprofessional education. *Int J Med Educ.* 2025;16:75-83. doi:10.5116/ijme.67ab.5af9

39. Seborg PH, Pardosi J, Goldman RE, et al. Identifying Physician Public Health Competencies to Address Healthcare Needs in Underserved, Border, and Outer Island Areas of Indonesia: A Rapid Assessment. *Teach Learn Med.* 2025;37(3):363-374. doi:10.1080/10401334.2024.2353573
40. Pamungkasari EP, Balgis B, Koot J, et al. Identifying relevant diabetes and hypertension control management guidelines in primary healthcare and community settings in Indonesia: A Delphi survey. *PLoS One.* 2024;19(11):e0310295. doi:10.1371/journal.pone.0310295
41. Bharadwaj R, Kaviprawin M, Neelkanth N, et al. Improving follow-up visits among individuals with hypertension: Quality Improvement project in the District Hospital, Seoni, Madhya Pradesh, India, 2021-2022. *BMJ Open Qual.* 2025;14(1):e003124. doi:10.1136/bmjopen-2024-003124
42. Chandra A, Kaur R, Bairwa M, et al. Monitoring of Non-communicable Diseases in a Primary Healthcare Setting in India: A Quality Improvement Initiative. *Cureus.* 2023;15(4):e38132. doi:10.7759/cureus.38132
43. Hassani Nia N, Karami S, Shahraki F, et al. Structured reflective sessions enhance knowledge and clinical skills in operating room technology students: a Solomon four-group study. *BMC Med Educ.* 2025;26(1):121. doi:10.1186/s12909-025-08431-w
44. Tay PKC, Anderson T, Ying JSJ, et al. Evaluation of a digital Dementia Game to promote public awareness about dementia in Singapore. *BMC Public Health.* 2025;25(1):1873. doi:10.1186/s12889-025-22988-7
45. Turki F, Turki I, Jedidi J, et al. The effect of therapeutic education program on hypertensive Tunisian patients' knowledge: a randomized controlled trial. *Ann Med Surg (Lond).* 2024;86(11):6561-6567. doi:10.1097/MS9.0000000000002628
46. Jahan Y, Rahman MM, Moriyama M. Baseline knowledge about hypertension and sociodemographic factors related to salt intake behavior among hypertensive individuals in a rural community of Bangladesh: Substudy of a randomized controlled trial. *J Family Med Prim Care.* 2024;13(2):451-457. doi:10.4103/jfmpc.jfmpc_130_23
47. Lefebvre B, Mukhopadhyay A, Ratra V. Who bears the distance cost of public primary healthcare? Hypertension among the elderly in rural India. *Soc Sci Med.* 2025;366:117613. doi:10.1016/j.socscimed.2024.117613
48. Leosari Y, Uelmen JA, Carney RM. Spatial evaluation of healthcare accessibility across archipelagic communities of Maluku Province, Indonesia. *PLoS Glob Public Health.* 2023;3(3):e0001600. doi:10.1371/journal.pgph.0001600
49. Andala S, Sofyan H, Hasballah K, et al. Knowledge and acceptance associated with medication adherence among hypertension individuals in Aceh province, Indonesia. *Heliyon.* 2024;10(7):e29303. doi:10.1016/j.heliyon.2024.e29303
50. Swift PA, Arnold A, Heagerty A, et al. Setting the UK research priorities for hypertension using a modified Delphi approach: a British and Irish Hypertension Society Initiative with Support from the British Heart Foundation Clinical Research Collaborative. *J Hypertens.* 2026;44(3):454-460. doi:10.1097/HJH.0000000000004223
51. Jain P, Murali S, Mariam Jacob Q, et al. An educational intervention for improving knowledge, attitude, and practice of dietary salt intake among individuals with hypertension in public sector secondary care facilities, Agra, India, 2021. *J Clin Hypertens (Greenwich).* 2024;26(6):735-739. doi:10.1111/jch.14817
52. Teoh BC, Syed Sulaiman SA, Tan BE. Knowledge of cardiovascular disease risk in rheumatoid arthritis patients before and after educational intervention from a Southeast Asia country: Malaysia. *Arch Rheumatol.* 2021;36(1):63-71. doi:10.46497/ArchRheumatol.2021.7726
53. Filho JCO, Santos FB, Oliveira LSR, et al. School-based cardiopulmonary resuscitation training for high school students in Brazil: a pre-post educational intervention with 3-month follow-up. *Braz J Anesthesiol.* 2026;76(5):844787. doi:10.1016/j.bjane.2026.844787
54. Xun R, Gao Y, Zhen S, et al. Effects of Behavioral Interventions for Salt Reduction on Blood Pressure and Urinary Sodium Excretion: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Glob Heart.* 2023;18(1):65. doi:10.5334/gh.1281
55. Zhang X, Zhang P, Shen D, et al. Effect of home cook interventions for salt reduction in China: cluster randomised controlled trial. *BMJ.* 2023;382:e074258. doi:10.1136/bmj-2022-074258
56. Susanto T, Hernawati S, Yunanto RA, et al. Family Self-management Program for Hypertension Management and Sodium Consumption Adherence: A Parallel Randomized Control Trial Among Family Caregivers and People With Hypertension. *J Res Health Sci.* 2024;24(4):e00628. doi:10.34172/jrhs.2024.163
57. Aungsuroch Y, Polsook R, Anuruang S, et al. How a Self-Management Program Affects Blood Pressure Among Indonesians with Hypertension: A Quasi-Experimental Study. *Iran J Nurs Midwifery Res.* 2022;27(3):229-235. doi:10.4103/ijnmr.IJNMR_244_20
58. Usman AM, Kosasih CE, Pramukti I, et al. Effectiveness of BHATIN (Behavior-Tailored Intervention) for Self-Care Management and Clinical Biomarkers Among Patients with Hypertension: A Quasi Experimental Study. *J Multidiscip Healthc.* 2026;19:1-18. doi:10.2147/JMDH.S598078
59. Widyastuti CS, Dinarti LK, Aulawi K, et al. Effectiveness of mHealth on self-care profile and blood pressure among patients with hypertension in Indonesia: A single-blind randomized controlled trial. *Belitung Nurs J.* 2025;11(3):294-304. doi:10.33546/bnj.3760
60. Tesamut L, Sungwan P, Somrit J. The Effects of a Health Literacy Promotion Program on Health Behaviors and Blood Pressure Levels Among Uncontrolled Hypertensive Patients: A Quasi-Experimental Study. *J Prim Care Community Health.* 2026;17:21501319251412653. doi:10.1177/21501319251412653
61. Nweke M, Govender N, Appiah B, et al. Multi-pronged biobehavioural intervention strategies for prevention and control of hypertension: A systematic review of education-based community trials. *SAGE Open Med.* 2026;14:20503121261444673. doi:10.1177/20503121261444673
62. Adzitey SP, Akimanimpaye F, Crowley T. Effectiveness of nurse-led hypertension self-management interventions: A mixed-methods systematic review and meta-analysis. *Int J Nurs Sci.* 2026;13(2):217-225. doi:10.1016/j.ijnss.2026.02.016
63. Yu J, Shi N, Zhao J, et al. Effectiveness of Health Literacy Interventions for Blood Pressure Control, Medication Adherence, and Self-Efficacy In Older Adults With Hypertension: A Systematic Review and Meta-Analysis. *J Eval Clin Pract.* 2026;32(2):e70419. doi:10.1111/jep.70419
64. Sonuch P, Aekplakorn W, Pomsanthia N, et al. Community-based intervention for monitoring of salt intake in hypertensive patients: A cluster randomized controlled trial. *PLoS One.* 2024;19(11):e0311908. doi:10.1371/journal.pone.0311908
65. Finkelstein EA, Krishnan A, Naheed A, et al. Budget impact and cost-effectiveness analyses of the COBRA-BPS multicomponent hypertension management programme in rural communities in Bangladesh, Pakistan, and Sri Lanka.

- Lancet Glob Health. 2021;9(5):e660-e667. doi:10.1016/S2214-109X(21)00033-4
66. Sun Y, Mu J, Wang DW, et al. A village doctor-led multifaceted intervention for blood pressure control in rural China: an open, cluster randomised trial. *Lancet*. 2022;399(10339):1964-1975. doi:10.1016/S0140-6736(22)00325-7
 67. Bhattarai S, Skovlund E, Shrestha A, et al. Impact of a community health worker led intervention for improved blood pressure control in urban Nepal: an open-label cluster randomised controlled trial. *Lancet Reg Health Southeast Asia*. 2024;29:100461. doi:10.1016/j.lansea.2024.100461
 68. Katena NA, Shamu S, Fana GT, et al. Evaluating the outcomes of a community-based health literacy intervention for hypertension and diabetes in Harare, Zimbabwe: a cluster randomized controlled trial. *BMC Prim Care*. 2026;27(1):223. doi:10.1186/s12875-026-03335-0
 69. Mbuthia GW, Magutah K, Pellowski J. Approaches and outcomes of community health worker's interventions for hypertension management and control in low-income and middle-income countries: systematic review. *BMJ Open*. 2022;12(4):e053455. doi:10.1136/bmjopen-2021-053455
 70. Angell B, Lung T, Praveen D, et al. Cost-effectiveness of a mobile technology-enabled primary care intervention for cardiovascular disease risk management in rural Indonesia. *Health Policy Plan*. 2021;36(4):435-443. doi:10.1093/heapol/czab025
 71. Thapa R, Zengin A, Neupane D, et al. Sustainability of a 12-month lifestyle intervention delivered by community health workers in reducing blood pressure in Nepal: 5-year follow-up of the COBIN open-label, cluster randomised trial. *Lancet Glob Health*. 2023;11(7):e1086-e1095. doi:10.1016/S2214-109X(23)00214-0
 72. Yokokawa H, Yuasa M, Nedsuwan S, et al. An impact of dietary intervention on blood pressures among diabetic and/or hypertensive patients with high cardiovascular disorders risk in northern Thailand by cluster randomized trial. *J Gen Fam Med*. 2021;22(1):28-37. doi:10.1002/jgf2.379
 73. Madloul H, Sadoon N, Kamel M, et al. Findings of a Community Health Needs Assessment Survey in Al Najaf Governorate Iraq: A Snapshot of Al Marashda's Health Status. *Cureus*. 2024;16(6):e61935. doi:10.7759/cureus.61935
 74. Nguyen TH, Nguyen HH, Huynh AM, et al. Vietnamese version of the Hypertension Knowledge-Level Scale (HK-LS): Translation and validation. *J Cardiovasc Thorac Res*. 2024;16(1):38-44. doi:10.34172/jcvtr.31855
 75. Jariyasakulwong P, Wattanakitkrileart D, Pongthavornkamol K, et al. Factors Influencing Self-Care Practices and Blood Pressure Among Individuals with Uncontrolled Hypertension: A Cross-Sectional Study. *Patient Prefer Adherence*. 2025;19:1-17. doi:10.2147/PPA.S497555