

Health Beliefs, Medication Adherence, and Blood-Pressure Control in Rural Bangladeshi Hypertension: An Exploratory Sequential Mixed-Methods Study

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Research Article

Keywords: Hypertension, Medication adherence, Health Belief Model, Mixed methods, Mediation analysis, Bangladesh, Rural health, Behavioural science

Posted Date: June 16th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10002032/v1>

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Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at BMC Public Health on September 7th, 2026. See the published version at <https://doi.org/10.1186/s12889-026-29353-2>.

Abstract

Background

Hypertension control remains poor in low and middle income countries, including Bangladesh, where medication adherence is often suboptimal. How patients' health beliefs translate into adherence and blood pressure control in rural settings is poorly understood. We examined how the six Health Belief Model (HBM) constructs relate to medication adherence and, in turn, systolic blood pressure among rural Bangladeshi adults with hypertension.

Methods

We conducted an exploratory sequential mixed-methods study in Kamalganj, north-east Bangladesh (October 2025–February 2026). The qualitative phase comprised 28 sessions (16 in-depth interviews, 10 key-informant interviews, 2 focus group discussions) analysed by directed content analysis using the HBM as a deductive framework. A content-validated 38-item HBM questionnaire was administered alongside the Bangladesh Medication Adherence Scale (BMAS) to 461 hypertensive adults in a community-based cross-sectional survey. Six covariate-adjusted PROCESS Model 4 analyses tested HBM construct → adherence → systolic blood pressure pathways. Qualitative and quantitative components were integrated through joint displays and meta-inferences.

Results

Three qualitative themes emerged: Health Risk Appraisal, Treatment Decision Appraisal, and Activity and Agency. Blood pressure was controlled in 41.4% of participants and adherence was optimal in 44.2%. Perceived Barriers ($\beta = 0.375$) and Self-Efficacy ($\beta = 0.304$) were the strongest independent predictors of adherence (both $p < 0.001$). Cross-sectional decomposition revealed three distinct patterns: statistical mediation through adherence (Perceived Barriers, Cues to Action); an adherence-independent association for Self-Efficacy ($c' = -6.41$ mmHg, 95% CI -12.68 to -0.14 ; hypothesis-generating); and non-significant pathways for Susceptibility, Severity, and Benefits. Treatment-seeking was symptom-driven and socioeconomic status was a strong moderator. Belief endorsement alone did not predict outcome.

Conclusions

Hypertension control in rural Bangladesh is driven less by patient knowledge than by structural conditions. Reducing structural barriers and cultivating domain-specific self-efficacy are the principal modifiable levers for improving control.

Background

Hypertension remains a major preventable risk factor for cardiovascular disease and premature death worldwide, affecting nearly 1.28 billion adults aged 30–79 years [1, 2]. Despite the availability of effective treatment, fewer than one in five hypertensive adults achieve adequate blood pressure control globally. In low- and middle-income countries (LMICs), control remains especially poor, particularly in rural populations [3].

Bangladesh reflects this pattern, with hypertension affecting an estimated 20–25% of adults and the prevalence steadily increasing [4]. The Bangladesh STEPS Survey 2018 reported blood pressure control in only about 14% of

hypertensive individuals, with substantially lower rates in rural settings [5]. Multicenter studies confirm a persistent treatment-to-control gap, as only one-third of treated adults achieve target blood pressure despite the widespread availability of first-line antihypertensive medicine at public health facilities [6, 7].

Medication adherence is a key determinant of blood-pressure control across health systems [8]. WHO estimates suggest approximately half of patients with chronic conditions in LMICs do not take medications as prescribed, and non-adherence rates of 40–60% have been documented in LMIC settings. Within Bangladesh, sub-optimal adherence has been reported in more than half of treated rural hypertensive adults [7, 9]. Although structural barriers such as treatment cost, medicine supply, and geographic access are important, adherence is also strongly influenced by patients' perceptions, beliefs, and concerns regarding hypertension and its treatment [10].

The Health Belief Model (HBM) is one of the most widely studied frameworks for chronic-disease related health behaviour [10]. It includes six core constructs: perceived susceptibility (belief that one is personally at risk), perceived severity (belief that the condition has serious consequences), perceived benefits (belief that a recommended action will reduce that risk), perceived barriers (practical and psychological obstacles to action), cues to action (internal or external triggers that prompt behaviour), and self-efficacy (belief in one's own ability to carry out the action) [10]. Among these, perceived barriers have consistently emerged as the strongest predictor of health behaviour in many studies [10, 11], while HBM-based interventions have shown measurable improvements in medication adherence and blood pressure control in LMIC settings [12, 13]. However, no primary HBM-based study has yet been conducted among the Bangladeshi hypertensive population [14], and it remains unclear which constructs exert the greatest influence in rural communities with relatively high awareness but persistently poor blood pressure control.

The present study, therefore, used an exploratory sequential mixed methods design to examine how the six HBM constructs influence systolic blood pressure through medication adherence among rural hypertensive adults in Bangladesh. The study first explored patient, family, and provider perspectives qualitatively, then conducted a mediation analysis using data from a community-based survey.

Methods

Study design

This study adopted an exploratory sequential mixed-methods design (QUAL→QUAN) as described by Creswell and Plano Clark [15], and was implemented in four phases: an initial qualitative inquiry to develop a context-specific understanding of HBM constructs; the development of a 38-item HBM questionnaire informed by literature review and qualitative findings; a community-based cross-sectional survey; and the integration of qualitative and quantitative findings using joint displays and meta-inferences. The reporting of the study adhered to the STROBE guidelines for the cross-sectional component and was complemented by the GRAMMS and COREQ checklists for the mixed-methods and qualitative phases, respectively.

Study setting and population

Both the qualitative and quantitative phases were conducted in Kamalganj upazila (sub-district), Moulvibazar district, north-east Bangladesh (Sylhet division), a predominantly rural area. Eligible participants were adults aged ≥ 18 years with previously diagnosed or newly identified hypertension. Individuals who were not permanent residents

of the study area and those who were unable to participate in interviews because of severe physical or cognitive impairments were excluded from the study.

Qualitative phase

The qualitative phase was conducted from October to November 2025 and participants were selected using purposive sampling. A total of 28 sessions were held comprising 16 in-depth interviews (30–60 min), 10 key informant interviews (45–75 min), and 2 focus group discussions (60–90 min; one male, one female). Semi-structured guides explored experiences of hypertension diagnosis, perceived causes and consequences, treatment beliefs, barriers to adherence, family influences, and self-management practices.

All sessions were conducted in Bangla, audio-recorded, transcribed verbatim, and translated into English. Recruitment continued until thematic saturation was reached after about 22 sessions, with six additional interviews conducted to confirm saturation.

Two analysts independently coded transcripts using directed qualitative content analysis (Hsieh and Shannon, 2005) [16], with the six HBM constructs providing the deductive framework for category development, following the procedural steps of Graneheim and Lundman (2004) [17]. Meaning units were identified from each transcript, condensed while preserving core meaning, and labelled with codes; codes were grouped into sub-categories and categories aligned with HBM constructs, from which three main themes were derived. Trustworthiness was ensured through triangulation, member checking with five informants, peer debriefing, an audit trail, and a reflexive journal [18].

Instruments

The survey proforma comprised four segments: (1) sociodemographic and lifestyle variables (age, sex, education, marital status, occupation, socioeconomic status, physical activity, salt intake, fruit and vegetable consumption, smoking, and smokeless tobacco use); (2) clinical data (hypertension duration, diabetes, family history, current medications, and anthropometry); (3) the 38-item HBM questionnaire; and (4) the Bangladesh Medication Adherence Scale (BMAS).

Socioeconomic status was measured with the Modified Kuppuswamy Scale [19], with income brackets, occupation, and education categories adapted by the investigators for the Bangladesh context using the national consumer price index, inflation adjustments, and Bangladesh Bureau of Statistics classifications; scores were collapsed for analytic parsimony into Upper, Middle, and Lower categories.

HBM questionnaire. Items were generated from a structured review of published HBM scales, qualitative findings, and clinical experience. A 10-expert panel reviewed approximately 50 candidate items over two rounds; items achieving an item-level Content Validity Index ≥ 0.78 were retained [20]. The final 38-item scale covers six constructs: Perceived Susceptibility (seven items), Severity (six), Benefits (six), Barriers (seven, reverse-coded), Cues to Action (six), and Self-Efficacy (six), with an S-CVI/Ave of 0.90 (Additional file 1: Table S1). Items were translated into Bangla, back-translated, and pre-tested in 20 hypertensive adults. The questionnaire was interviewer-administered by trained research assistants through face-to-face interviews; each item is rated on a 3-point scale (Agree / Not sure / Disagree). Representative items include “Mental stress can cause high blood pressure” (Perceived Susceptibility), “The cost of hypertension treatment is a burden” (Perceived Barriers), and “I take my medication exactly as the doctor prescribed” (Self-Efficacy); the full questionnaire is in Additional file 1: Table S2. Internal consistency

(Cronbach's α) ranged 0.63–0.77 across five constructs (Additional file 1: Table S1); the Perceived Severity subscale yielded $\alpha = 0.29$, reflecting near-universal ceiling endorsement (80–95% per item), and was retained on grounds of content validity and qualitative convergence.

Bangladesh Medication Adherence Scale (BMAS). Adherence was measured with the validated 9-item BMAS [21], comprising three factors (Behavioural, Economic, Cognitive); scores range 0–27; adherence categories were derived using k-means cluster analysis: poor (0–14), moderate (15–20), and good (21–27). For binary analyses, optimal adherence was defined as BMAS ≥ 21 .

Quantitative phase

A community-based cross-sectional survey was conducted between December 2025 and February 2026. The sample size was calculated using the formula $n = Z^2pq/d^2$, assuming a 95% confidence level ($Z = 1.96$), an expected prevalence of 50%, and a margin of error of 5%. The estimated sample size of 384 was adjusted for a design effect of 1.2 and a 10% allowance for non-response, yielding a target sample of 507 participants. Of the 501 eligible adults approached, 461 (92.0%) provided informed consent and completed face-to-face interviews in their homes or community facilities. Data were collected using a structured questionnaire administered through Computer-Assisted Personal Interviewing (CAPI) on the REDCap electronic data capture platform. Participant flow for both study phases is shown in Fig. 1.

Blood pressure measurement. Blood pressure was measured using a validated automated sphygmomanometer (OMRON HEM-7120). Participants were seated comfortably and rested for at least five minutes before the first measurement. Two blood pressure readings were then obtained at five-minute intervals. The average of readings was used for analysis. Blood pressure control was defined as a mean systolic blood pressure < 140 mmHg and a mean diastolic blood pressure < 90 mmHg [30].

Statistical analysis

Continuous variables were summarised as mean and standard deviation (SD) for normally distributed data and as median and interquartile range (IQR) for skewed distributions. Categorical variables were summarised using frequencies and percentages. Bivariate analyses were performed using independent-samples t-tests, one-way analysis of variance (ANOVA), Pearson's or Spearman's correlation coefficients, and chi-square tests, as appropriate. Effect sizes (Cohen's d , η^2 , and Cramér's V) and 95% confidence intervals were reported where applicable. Multiple linear and logistic regression analyses were conducted to identify predictors of medication adherence and blood pressure control. Missing data were handled using listwise deletion.

Inter-construct Spearman correlations ranged from $p = 0.01$ to 0.72, with the strongest correlation observed between Perceived Susceptibility and Perceived Benefits (Additional file 1: Table S3); despite this pair, all multivariable VIFs remained < 2.4 , well below the conventional threshold of 5, supporting joint entry of the six constructs. Six covariate-adjusted PROCESS Model 4 mediation analyses [22] tested each HBM construct (X) $\rightarrow$ BMAS continuous score (M) $\rightarrow$ mean systolic blood pressure (Y), using 5000 bootstrap resamples and 95% bias-corrected confidence intervals; an indirect effect was considered significant when the bootstrap confidence interval (CI) excluded zero. Covariates (sex, age, socioeconomic status, BMI, hypertension duration, diabetes) were applied on both paths. Given the pre-specified six-construct framework, we report uncorrected bootstrap CIs but interpret only effects whose CIs exclude zero by a substantive margin; a Benjamini–Hochberg-adjusted sensitivity analysis is reported in Additional file 1: Table S4. All analyses used IBM SPSS Statistics v31 and PROCESS macro v4.2; $\alpha = 0.05$, two-sided. Sex was

included as a covariate in all multivariable and mediation models; no formal sex-by-construct interaction was pre-specified, in line with the SAGER guidelines for observational studies. As a pre-specified sensitivity analysis, four further covariate-adjusted PROCESS Model 4 analyses tested whether the Self-Efficacy–systolic-blood-pressure association was mediated by individual lifestyle behaviours—fruit intake, vegetable intake, added-salt intake, and physical activity—each entered as a single mediator in place of adherence, using the same covariates, 5000 bootstrap resamples, and 95% bias-corrected confidence intervals (Additional file 1: Table S8).

Ethics

The study was approved by the Institutional Review Board of Bangladesh Medical University (original approval: BSMMU/2023/6516, 29 April 2023; addendum: BMU/2025/14636(A), 04 October 2025). All data were collected after the addendum approval. Written informed consent was obtained from all participants.

Results

Qualitative phase: three main themes

Twenty-eight interviews took place in the qualitative phase (16 in-depth interviews, 10 key informant interviews, and 2 focus group discussions). Three main themes were deductively identified and mapped to HBM constructs (Table 1). A detailed theme-generation matrix is provided in Additional file 1: Table S5.

Table 1

Qualitative theme generation using directed content analysis – meaning units, condensed meaning units, codes, sub-categories, categories, and themes (N = 28).

Illustrative quotation	Meaning Unit	Condensed Meaning Unit	Code	Sub-category	category	Theme
"My mother had it before me. So she suffered from high blood pressure. Many people, especially the elders, believe that if there is a hereditary disease, it runs in the family." – IDI_15	Informant links own hypertension to mother's history; community believes that hereditary diseases run in families.	Family history accepted as a marker of personal susceptibility.	Belief in familial inheritance	Family history as risk marker	Perceived Susceptibility	A. Health Risk Appraisal
"I might have a stroke and die from high blood pressure. I will just pass away, or else I might have a stroke, and my arms and legs will be paralyzed." – IDI_13	Informant fears death or permanent paralysis as consequences of uncontrolled hypertension.	Stroke, paralysis, and death perceived as feared consequences of hypertension.	Fear of catastrophic complications	Awareness of life-threatening consequences	Perceived Severity	
"No matter how hard you work, you will have to take medicine. Eat eggs, eat meat, eat good foods, and there is no problem. You will have to	Informant believes regular medication is indispensable regardless of diet or exertion, and advocates keeping medicine available at all times.	Continuous medication perceived as non-negotiable benefit.	Unconditional belief in medication benefit	Perceived benefit of medication	Perceived Benefits	B. Treatment Decision Appraisal
IDI = in-depth interview; KII = key informant interview; Illustrative quotations are verbatim excerpts selected to represent the meaning units identified during analysis. Meaning units were identified as text segments relevant to the study aim, condensed while preserving core meaning, and labelled with codes prior to grouping into sub-categories, categories, and themes.						

Illustrative quotation	Meaning Unit	Condensed Meaning Unit	Code	Sub-category	category	Theme
keep your medicine with you." — IDI_09						
"In terms of money, I need to take medicine worth at least twenty five taka daily. I can't take it all the time, I need money, I don't have any income." — IDI_06	Informant cannot afford daily medication costs of approximately Tk 25, leading to irregular intake.	Daily medication cost unaffordable on limited/no income.	Financial barrier to medication	Economic barriers	Perceived Barriers	
"I'm talking about Ranjan Kumar... His blood pressure was so bad that he couldn't even stand up or sit down on his own. Now he has to be lifted up and lowered down; what a problem." — IDI_13	Informant observes the severe physical disability and loss of independence of a peer due to high blood pressure	Observing a peer's severe hypertension-related disability	Peer disability observation as cue	Peer cues	Cues to Action	C. Activity and Agency
"Yes, I mean, eight out of ten people can take medicine on their own; maybe two of them are a little	Provider estimates that most patients can self-administer medication but a minority of older patients lack the cognitive setup for	Most patients capable of self-medication; elderly or low literacy patients lack capacity for independent adherence.	Varied medication self-management capacity	Medication adherence self-efficacy	Self-Efficacy	
IDI = in-depth interview; KII = key informant interview; Illustrative quotations are verbatim excerpts selected to represent the meaning units identified during analysis. Meaning units were identified as text segments relevant to the study aim, condensed while preserving core meaning, and labelled with codes prior to grouping into sub-categories, categories, and themes.						

Illustrative quotation	Meaning Unit	Condensed Meaning Unit	Code	Sub-category	category	Theme
<i>older; they're not mentally set up that way (to take medicine)."</i> — KII_02	independent adherence.					
<i>IDI = in-depth interview; KII = key informant interview; Illustrative quotations are verbatim excerpts selected to represent the meaning units identified during analysis. Meaning units were identified as text segments relevant to the study aim, condensed while preserving core meaning, and labelled with codes prior to grouping into sub-categories, categories, and themes.</i>						

Theme A — Health Risk Appraisal. Informants generally accepted hypertension as a serious condition, although younger informants reported initial difficulty accepting the diagnosis. Family history and stress — particularly from financial difficulty and daily life pressures — were cited as the main risk factors, and stroke and premature death were the complications most vividly invoked. Most participants, however, acted on their awareness only when symptoms appeared, rather than managing their condition proactively: medication was often taken when symptoms were felt and stopped once they resolved.

Theme B — Treatment Decision Appraisal. Informants endorsed regular blood-pressure monitoring, healthy diet, tobacco avoidance, and conventional medical treatment, though belief in conventional medicine coexisted with parallel use of traditional remedies. Perceived barriers were the most prominent and consistent theme: medication cost and supply discontinuity at public facilities were near-universally cited, reinforced by distance and time constraints.

Theme C — Activity and Agency. Cues to action operated mainly through interpersonal channels, including doctor's advice, family reminders, peer observation, and community gatherings, while symptom-driven care-seeking was widespread. Self-efficacy varied across domains: confidence in symptom recognition, help-seeking, and medication-taking was strong, often supported by family reminders, whereas confidence in dietary modification, regular exercise, and routine blood-pressure monitoring was lower.

Quantitative phase: participant profile

A total of 461 adults were enrolled. The sample was predominantly older (mean age 58.0 years, SD 14.3), female (57.5%), and of low socioeconomic status. Mean SBP was 141.5 mmHg (SD 19.5) and mean DBP 86.4 mmHg (SD 12.0); blood pressure was controlled in 41.4% of participants and optimal medication adherence in 44.2%. Full characteristics are in Table 2.

Table 2
Sociodemographic, lifestyle, clinical, and outcome characteristics of participants (N = 461)

Variable	Category	n	%
<i>Sociodemographic</i>			
Age (years)	Mean (SD) = 58.0 (14.3); range 18–95	—	—
	18–29	11	2.4
	30–59	219	47.5
	≥ 60	231	50.1
Sex	Male	196	42.5
	Female	265	57.5
Religion	Muslim	395	85.7
	Hindu	66	14.3
Education	No formal education	145	31.5
	Primary	243	52.7
	Secondary or higher	73	15.8
Socioeconomic status (Kuppuswamy, 3-category)	Upper	41	8.9
	Middle	100	21.7
	Lower	320	69.4
Marital status	Married	335	72.7
	Widowed	110	23.9
	Other	16	3.5
<i>Lifestyle</i>			
Salt intake	Low-salt behaviour	356	77.2
	High-salt behaviour	105	22.8
Physical activity	Adequate (≥ 5 days/week)	199	43.2
	Inadequate	262	56.8
Fruit intake	Adequate (≥ 5 days/week)	37	8.0
	Inadequate	424	92.0
Vegetable intake	Adequate (≥ 5 days/week)	395	85.7
	Inadequate	66	14.3
<i>N = 461. Some percentages do not sum to 100 because of rounding or small categories not shown. BMAS = Bangladesh Medication Adherence Scale (score range 0–27; optimal adherence ≥ 21). Adherence percentages are valid percent (n = 446; 15 cases missing adherence data); all other percentages are of the full sample (N = 461).</i>			

Variable	Category	n	%
Smoking	Non-smoker	386	83.7
	Smoker	75	16.3
Smokeless tobacco use	Yes	376	81.6
	No	85	18.4
<i>Clinical</i>			
BMI (kg/m ²)	Mean (SD) = 24.0 (4.2); range 12.8–39.8	—	—
BMI category	Underweight (< 18.5)	35	7.6
	Normal (18.5–24.9)	157	34.1
	Overweight (25.0–29.9)	100	21.7
	Obese (≥ 30.0)	169	36.7
Hypertension duration (years)	Mean (SD) = 9.1 (7.3); range 0.1–55	—	—
Family history of hypertension	Present	309	67.0
	Absent / not known	152	33.0
Antihypertensive medication	Currently taking	445	96.5
	Not taking	16	3.5
Medication regimen	Monotherapy	383	83.1
	Polytherapy	40	8.7
	Unknown	38	8.2
Diabetes status	Present	122	26.5
	Absent	339	73.5
<i>Outcomes</i>			
Systolic BP (mmHg)	Mean (SD) = 141.5 (19.5)	—	—
Diastolic BP (mmHg)	Mean (SD) = 86.4 (12.0)	—	—
Blood pressure control (< 140/90 mmHg)	Controlled	191	41.4
	Uncontrolled	270	58.6
Medication adherence (BMAS)	Optimal (≥ 21)	197	44.2
	Moderate (15–20)	179	40.1
	Poor (0–14)	70	15.7
<i>N = 461. Some percentages do not sum to 100 because of rounding or small categories not shown. BMAS = Bangladesh Medication Adherence Scale (score range 0–27; optimal adherence ≥ 21). Adherence percentages are valid percent (n = 446; 15 cases missing adherence data); all other percentages are of the full sample (N = 461).</i>			

Bivariate associations

Socioeconomic status was the most consistent correlate of HBM constructs, significantly associated with five of six (all $p \leq 0.001$) and most strongly with Perceived Barriers ($\eta^2=0.16$) (Table 3). Five constructs correlated positively with BMAS adherence; Perceived Severity was the only non-significant correlate. BMAS total score correlated negatively with mean SBP ($\rho=-0.113$, $p = 0.017$). Optimal medication adherence rose steeply across socioeconomic categories — from 32.5% in the lower category to 65.3% in the middle and 82.5% in the upper category ($\chi^2(2) = 58.7$, $p < 0.001$; Cramér's $V = 0.36$). Beyond socioeconomic status, religion, education level, and vegetable intake were each significantly associated with five of six HBM constructs, and diabetes status with four; full bivariate statistics are reported in Additional file 1: Table S6.

Table 3

Bivariate associations of HBM constructs with their strongest sociodemographic correlate and with total BMAS adherence score (N = 446–461)

HBM construct	Strongest sociodemographic correlate	Test (effect size)	p	ρ with BMAS adherence	p
Perceived Susceptibility (PSP)	Socioeconomic status (3-cat ANOVA)	$\eta^2 = 0.053$	< 0.001	+ 0.488	< 0.001
Perceived Severity (PSV)	Smoking status (t-test)	$d = 0.39$	0.010	−0.044	0.353
Perceived Benefits (PBF)	Socioeconomic status (3-cat ANOVA)	$\eta^2 = 0.030$	< 0.001	+ 0.442	< 0.001
Perceived Barriers, rev. (PBR)	Socioeconomic status (3-cat ANOVA)	$\eta^2 = 0.139$	< 0.001	+ 0.645	< 0.001
Cues to Action (CA)	Socioeconomic status (3-cat ANOVA)	$\eta^2 = 0.067$	< 0.001	+ 0.316	< 0.001
Self-Efficacy (SE)	Socioeconomic status (3-cat ANOVA)	$\eta^2 = 0.068$	< 0.001	+ 0.542	< 0.001
<i>Sociodemographic correlate column shows the variable with the largest effect size in bivariate testing. η^2 = eta-squared (ANOVA effect size); d = Cohen's d (t-test effect size); ρ = Spearman's rho. Sample sizes range N = 446–461 (pairwise complete).</i>					

Multivariable regression

Multivariable linear regression with BMAS total score as outcome was significant ($F(18, 424) = 29.33$, $p < 0.001$; adjusted $R^2=0.536$). Perceived Barriers was the strongest independent predictor ($\beta = 0.375$, $p < 0.001$), followed by Self-Efficacy ($\beta = 0.304$, $p < 0.001$), Perceived Severity ($\beta=-0.116$, $p = 0.002$); Perceived Benefits, Cues to Action, and Susceptibility were not significant (Table 4). Continuous BMAS independently predicted SBP ($B = -0.425$ mmHg per point, $\beta=-0.104$, $p = 0.037$), confirmed by logistic regression (Additional file 1: Table S7).

Table 4

Multivariable linear regression — HBM constructs and selected covariates on continuous BMAS adherence score (N = 443)

Predictor	B	SE	β	t	p	95% CI	VIF
<i>HBM constructs</i>							
Perceived Barriers, rev. (PBR)*†	4.201	0.495	0.375	8.482	< 0.001	[3.228, 5.175]	1.857
Self-Efficacy (SE)*	4.271	0.557	0.304	7.673	< 0.001	[3.177, 5.365]	1.495
Perceived Severity (PSV)‡	-2.464	0.783	-0.116	-3.147	0.002	[- 4.003, - 0.925]	1.285
Perceived Susceptibility (PSP)	0.933	0.575	0.081	1.623	0.105	[- 0.197, 2.063]	2.376
Perceived Benefits (PBF)	0.941	0.684	0.066	1.375	0.170	[- 0.404, 2.285]	2.185
Cues to Action (CA)	-0.542	0.456	-0.050	-1.189	0.235	[- 1.439, 0.354]	1.676
<i>Sociodemographic and clinical covariates</i>							
Socioeconomic status	0.814	0.281	0.108	2.892	0.004	[0.261, 1.367]	1.331
BMI category	0.354	0.170	0.073	2.086	0.038	[0.020, 0.688]	1.163
Fruit intake adequacy	1.341	0.605	0.076	2.215	0.027	[0.151, 2.531]	1.121
Smoking status	-0.688	0.512	-0.051	-1.344	0.180	[- 1.694, 0.318]	1.392
Smokeless tobacco use	0.775	0.429	0.062	1.806	0.072	[- 0.068, 1.618]	1.110
Religion	0.809	0.471	0.059	1.716	0.087	[- 0.118, 1.735]	1.111
Age	0.018	0.013	0.052	1.402	0.162	[- 0.007, 0.043]	1.328
Hypertension duration	0.019	0.023	0.029	0.818	0.414	[- 0.027, 0.065]	1.168
Vegetable intake	0.383	0.521	0.026	0.735	0.463	[- 0.641, 1.407]	1.234
Salt intake	0.411	0.392	0.035	1.048	0.295	[- 0.360, 1.182]	1.074
Multivariable linear regression with continuous BMAS adherence score as outcome (N = 443; listwise deletion). Model fit: $F(18, 424) = 29.33, p < 0.001$; adjusted $R^2 = 0.536$. * Independently significant predictor ($p < 0.05$). † Strongest independent predictor. ‡ Severity is significant in the adjusted model despite a non-significant bivariate correlation with adherence, indicating a suppressor pattern. B = unstandardised coefficient; β = standardised coefficient; VIF = variance inflation factor (all < 2.4).							

Predictor	B	SE	β	t	p	95% CI	VIF
Diabetes status	0.091	0.375	0.008	0.243	0.808	[- 0.646, 0.828]	1.121
Sex (female vs male)	0.214	0.394	0.022	0.544	0.587	[- 0.560, 0.988]	1.501

*Multivariable linear regression with continuous BMAS adherence score as outcome (N = 443; listwise deletion). Model fit: $F(18, 424) = 29.33$, $p < 0.001$; adjusted $R^2 = 0.536$. * Independently significant predictor ($p < 0.05$). † Strongest independent predictor. ‡ Severity is significant in the adjusted model despite a non-significant bivariate correlation with adherence, indicating a suppressor pattern. B = unstandardised coefficient; β = standardised coefficient; VIF = variance inflation factor (all < 2.4).*

Mediation analysis

Six covariate-adjusted PROCESS Model 4 mediation analyses identified three distinct association patterns (Table 5; Fig. 2).

Table 5
PROCESS Model 4 mediation analyses – effect of each HBM construct on systolic blood pressure via BMAS adherence score (N = 444)

HBM construct (X)	Path a (X → M)	Path b (M → Y)	Direct c' (X → Y)	Indirect (a × b) [95% BootCI]	Pattern
Perceived Barriers, rev. (PBR)	6.61***	-0.67**	4.65 (NS)	-4.45* [- 8.20, - 1.00]	Full mediation
Self-Efficacy (SE)	7.17***	-0.17 (NS)	-6.41*	-1.22 [- 4.51, 1.93]	Direct effect only
Perceived Susceptibility (PSP)	4.13***	-0.45*	0.50 (NS)	-1.86 [- 3.76, 0.007]	Not significant (CI ≈ 0)
Cues to Action (CA)	1.93***	-0.45*	0.70 (NS)	-0.87* [- 1.88, - 0.06]	Full mediation
Perceived Benefits (PBF)	5.09***	-0.36 (NS)	-2.57 (NS)	-1.82 [- 4.21, 0.44]	Behavioural effect only
Perceived Severity (PSV)	-0.27 (NS)	-0.43*	-1.47 (NS)	0.11 [- 0.66, 1.14]	No mediation

*PROCESS Model 4 (Hayes, 2022); M = BMAS continuous adherence score; Y = mean systolic blood pressure (mmHg). Covariates on both paths: age, sex, socioeconomic status, BMI, hypertension duration, diabetes (analytic N = 444; 5000 bootstrap resamples; 95% bias-corrected CIs). * 95% CI excludes zero (significant); ** $p < 0.01$; *** $p < 0.001$; NS = not significant.*

Channel one – Full statistical mediation through adherence. Perceived Barriers significantly predicted adherence (path a $B = 6.61$, $p < 0.001$), which lowered SBP (path b $B = -0.675$, $p = 0.007$); the indirect effect was significant ($B = -4.45$; 95% CI - 8.20 to - 1.00) and the direct effect non-significant ($c' = 4.65$, $p = 0.099$), consistent with full mediation. Cues to Action showed the same pattern (indirect $B = -0.87$; 95% CI - 1.88 to - 0.06).

Channel two – Direct association bypassing adherence. Self-Efficacy significantly predicted adherence (path a $B = 7.17$, $p < 0.001$), but the indirect effect on SBP was non-significant ($B = -1.22$; 95% CI - 4.51 to 1.93). The direct effect was significant ($c' = -6.41$, $p = 0.045$), indicating an adherence-independent association.

Channel three — Inert pathways. Susceptibility and Benefits each significantly predicted adherence (path a $p < 0.001$), and Severity did not (path a NS); none produced a significant indirect or direct effect on SBP. Because six constructs were tested in parallel, the indirect effects are interpreted as a pre-specified, hypothesis-driven family rather than as confirmatory tests; the two indirect effects whose 95% bootstrap confidence intervals excluded zero (Perceived Barriers and Cues to Action) should therefore be read as the most robust signals, and all indirect effects are interpreted with appropriate caution given the number of models examined. In the lifestyle-mediator sensitivity analyses, none of the four behaviours mediated the Self-Efficacy–systolic-blood-pressure association; all indirect effects were non-significant and the direct effect remained stable (Additional file 1: Table S8 and Figure S8).

Integration of qualitative and quantitative findings

Construct-level integration. Construct-level joint displays produced predominantly convergent patterns across all six HBM constructs, with one expansive pattern for Perceived Severity where qualitative data explained the quantitative ceiling anomaly. Full construct-level findings and convergence classifications are presented in Table 6.

Table 6

Construct-level joint display integrating qualitative and quantitative findings, with convergence classification

HBM construct	Qualitative finding	Quantitative finding	Convergence / inference
Perceived Susceptibility (PSP)	Most informants accept the diagnosis; younger informants struggle more. Family history and stress are widely cited as causes.	78.1% endorse personal risk; indirect effect on SBP via adherence not significant (CI ≈ 0); path a significant but clinically inert.	<i>CONVERGENT – high awareness in both phases but no measurable translation to SBP. Awareness is necessary but insufficient.</i>
Perceived Severity (PSV)	Stroke, paralysis, and death universally feared; coexists with symptom-driven denial when patients feel well.	PSV mean 2.80 (highest); $\alpha = 0.29$ (ceiling); did not significantly predict adherence ($B = -0.27$, NS) or SBP.	<i>EXPANSIVE – qualitative explains why fear-without-efficacy does not translate to behaviour or outcome.</i>
Perceived Benefits (PBF)	Strong belief in treatment; diet and exercise endorsed in principle but inconsistently applied; parallel traditional remedies.	95.0% endorse doctor's advice; PBF $\rightarrow$ adherence path significant (path a $p < 0.001$) but indirect effect on SBP not significant; clinically inert mediation pathway.	<i>CONVERGENT – belief predicts adherence but stops short of SBP because behaviour is interrupted symptomatically.</i>
Perceived Barriers, rev. (PBR)	Cost, distance, drug stockouts, time, and limited family support cited as dominant obstacles; structural, not psychological.	PBR is the strongest predictor of adherence ($\beta = 0.375$); largest indirect effect on SBP ($B = -4.45$, CI $[-8.20, -1.00]$).	<i>CONVERGENT (full) – the dominant modifiable lever in both phases; structural barriers operate as expected.</i>
Cues to Action (CA)	Cues operate interpersonally: doctor's advice, family reminders, peer observation, community gatherings; symptoms also a cue.	90.5% endorse doctor's advice as primary cue; significant indirect effect on SBP via adherence ($B = -0.87$, CI $[-1.88, -0.06]$).	<i>CONVERGENT – interpersonal cues are operative; mass-media cues are weak in both phases.</i>
Self-Efficacy (SE)	Domain-specific: confident in medication-taking, less so in diet and exercise; some patients describe broader self-management.	SE has a direct effect on SBP ($c' = -6.41$, $p = 0.045$) not fully mediated by adherence – adherence-independent pathway.	<i>CONVERGENT (mechanism-level) – qualitative describes broader self-management; quantitative confirms it operates beyond medication adherence alone.</i>
<i>Convergence classification follows Creswell & Plano Clark (2018): CONVERGENT = qualitative and quantitative findings agree; EXPANSIVE = qualitative explains a quantitative anomaly; SILENT (not used here) = one phase did not capture the construct.</i>			

Study-level meta-inferences. Six meta-inferences emerged from integrating the construct-level findings across both strands.

(1) Treatment-seeking was symptom-driven. Across both phases, hypertension was experienced as an episodic rather than continuous condition – medication was taken when symptoms were felt and stopped once they resolved. This pattern was consistent across qualitative accounts and aligned with the quantitative finding that cues to action operated primarily through interpersonal and symptomatic triggers rather than sustained internal motivation.

- (2) The HBM operated as a multi-channel framework, not a single belief-to-outcome pipeline. The connection from belief to clinical outcome was neither uniform nor symmetrical. Some constructs were associated with blood-pressure control through adherence, one bypassed adherence entirely, and three were clinically inert despite significantly predicting adherence.
- (3) Structural barriers were the most influential modifiable factor. Perceived Barriers accounted for the largest share of variance in adherence ($\beta = 0.375$), converging with qualitative accounts of cost, supply discontinuity, and distance as the dominant obstacles.
- (4) Socioeconomic status functioned as a master structural constraint. Socioeconomic status did not simply correlate with adherence — it conditioned whether health beliefs could translate into behaviour. Lower-SES participants held strong beliefs but faced structural gates — cost, supply discontinuity, and distance — that prevented those beliefs from being acted upon. The quantitative signal was consistent: SES was strongly associated with both Perceived Barriers ($\eta^2=0.16$) and adherence ($p = 0.201$). This positions SES not as a background covariate but as a moderator of the entire HBM pathway.
- (5) Self-efficacy operated as a domain-specific multi-skill rather than a single construct. Self-Efficacy was the only construct associated with blood pressure independently of medication adherence. Qualitative data confirmed that self-efficacy in one domain — such as medication-taking — did not necessarily extend to others such as dietary modification or self-monitoring, suggesting it is a multi-skill construct.
- (6) Belief endorsement did not predict clinical outcome. Perceived Susceptibility, Severity, and Benefits predicted adherence significantly yet produced no statistically significant pathway to blood-pressure control. Awareness was near-ceiling yet clinical outcomes remained poor.

Discussion

This community-based mixed-methods study of 28 qualitative interviews and 461 hypertensive adults in rural Bangladesh examined how the constructs of the Health Belief Model relate, individually and collectively, to medication adherence and blood-pressure control. Across six covariate-adjusted cross-sectional mediation analyses, the constructs fell into three statistically distinct association patterns with systolic blood pressure: full statistical mediation through adherence; an adherence-independent direct association; and a set of non-significant pathways. Because the data are cross-sectional, these patterns describe how the variables co-vary rather than establishing the direction of effect; we therefore frame the three-pattern structure as an empirically grounded hypothesis. To our knowledge, this patterning has not been previously described in a Bangladeshi hypertensive cohort.

Hypertension awareness and disease-related beliefs were endorsed at or near ceiling, yet only 41.4% of participants had controlled blood pressure and 44.2% reached optimal medication adherence. These figures are substantially higher than the 14% population-level control rate from the 2018 Bangladesh STEPS Survey [5], reflecting the expected enrichment of a treated cohort, and are broadly consistent with treated-cohort estimates from Bangladesh [6, 7] and the wider LMIC literature [8, 9].

Treatment-seeking in this population was symptom-driven rather than prevention-driven, consistent with Leventhal's Common-Sense Model of illness self-regulation [23], and with reports from hypertensive patients across South Asia, sub-Saharan Africa, and parts of Latin America [24, 25]. The qualitative phase illustrated this concretely: patients interpreted a normal blood-pressure reading not as reassurance to continue treatment, but as justification to

discontinue it – and 77.4% of survey respondents endorsed symptom-driven self-monitoring. This episodic experience of a largely asymptomatic chronic disease is a recurring theme in hypertension management across low- and middle-income settings, and represents a fundamental challenge to sustained medication adherence.

Prior HBM applications in hypertension have largely treated constructs as interchangeable predictors of adherence, without distinguishing whether they operate through behaviour or through independent mechanisms [11, 14]. The present findings challenge this unitary model. Although all six HBM constructs predicted adherence, not all translated that behaviour into a measurable reduction in blood pressure – and one construct was associated with the clinical outcome without adherence as an intermediary at all. This three-channel pattern, in which constructs differ not only in content but in their association with the outcome, has not been previously demonstrated in a Bangladeshi hypertensive cohort and extends prior HBM applications that stopped at adherence as a terminal outcome [11, 14].

Perceived Barriers was the strongest modifiable correlate of both adherence and blood pressure. The qualitative phase named the barriers concretely – medication cost, distance to the Upazila Health Complex, periodic drug stock-outs, time pressure, and limited family support – and the quantitative phase ranked them, with Perceived Barriers producing the largest indirect effect on SBP across all six constructs ($B = -4.45$; 95% CI -8.20 to -1.00). This is consistent with the foundational HBM literature, in which Janz and Becker reported barriers to be the single strongest construct in nearly nine of ten studies reviewed [10], and with comparable LMIC evidence from China, Ethiopia, and Ghana, where barriers – particularly medication cost and access – were the dominant adherence determinants [12, 13]. What distinguishes the present finding is its specificity: the barriers in this rural Bangladeshi setting were overwhelmingly structural (cost, supply, transport, time) rather than individual (forgetfulness, side-effect fears). Underneath this sat a clear socioeconomic gradient: lower-SES participants held strong beliefs but faced structural gates that prevented those beliefs from being acted upon. SES was associated with five of six HBM constructs ($\eta^2=0.139$ for Perceived Barriers), and optimal adherence rose from 32.5% in the lowest SES category to 82.5% in the upper category ($\chi^2(2) = 58.7$, $p < 0.001$). Comparable SES gradients in hypertension control have been documented across LMICs, where wealth and education repeatedly emerge as the strongest sociodemographic determinants of treated-cohort control [3, 7, 26]. SES therefore operated not around the HBM but under it, conditioning the strength of the two constructs that did the most analytic work in lowering blood pressure.

The most theoretically distinctive observation was that Self-Efficacy was associated with lower systolic blood pressure independently of adherence; given the cross-sectional design and the borderline direct effect, we interpret this as a hypothesis-generating signal rather than an established mechanism. This pattern is consistent with Bandura's foundational position that self-efficacy supports a broad portfolio of self-management behaviours rather than a single behaviour [27], and with Lorig and Holman's chronic-disease self-management framework, in which efficacious patients engage in dietary modification, physical activity, monitoring, and timely help-seeking [28]. The qualitative findings showed that participants had strong confidence in visiting the physician and taking medications correctly. However, their confidence was weak in doing structured exercise and remembering medications independently. This suggests that self-efficacy in this population is not a single trait but a cluster of distinct capabilities – and that blood-pressure control depends not only on medication-taking but on the broader lifestyle behaviours that self-efficacy enables, including dietary salt reduction, weight regulation, and stress management. Notably, none of the four lifestyle behaviours we examined accounted for this effect (Additional file 1: Table S8). Self-efficacy predicted several of the behaviours – for example, it was associated with greater vegetable intake and lower added-salt intake – yet the behaviours did not themselves predict systolic blood pressure, so the self-efficacy association was not transmitted through any single measured behaviour. This is consistent with self-efficacy operating as a broad, domain-general self-management capacity rather than through one specific behaviour,

although the operative mechanism remains to be identified. To our knowledge, this adherence-independent association of self-efficacy with systolic blood pressure has not been previously demonstrated in a Bangladeshi hypertensive cohort.

Belief endorsement alone did not guarantee clinical outcome. Susceptibility, Severity, and Benefits were each endorsed at near-ceiling and significantly predicted adherence, yet none produced a measurable reduction in systolic blood pressure. In a high-awareness setting, the limiting factor is not belief strength but the structural and practical conditions that determine whether belief can be translated into sustained action [10, 11] – a pattern the Extended Parallel Process Model anticipates for fear-based constructs [29]. Notably, Perceived Severity showed a negative independent association with adherence ($\beta = -0.116$, $p = 0.002$), suggesting that, for some patients, high severity perception may accompany fatalistic appraisal rather than motivated action – a pattern consistent with the god-locus illness narratives identified in our qualitative phase [25] and with fear-control responses described in threat-appraisal theory [29]. These findings suggest that awareness-raising interventions, while necessary, are insufficient on their own; the gap between belief and clinical outcome may only be closed by addressing the structural barriers and self-efficacy deficits that govern whether beliefs are acted upon.

These findings have direct implications for hypertension programmes in Bangladesh and comparable low-resource settings. Awareness-raising campaigns alone are insufficient: with susceptibility and severity already near-ceiling, further investment in disease-awareness messaging is unlikely to yield additional gains in blood-pressure control. Structural barriers – medication cost, drug shortages, and transport difficulties – should be addressed at programme level through subsidised or community-based medication supply, rather than assuming that patient knowledge will overcome structural constraints. Clinician interactions should move beyond information delivery towards brief, structured self-efficacy counselling, reinforcing patients' capacity to maintain a daily medication routine, manage side effects, and self-monitor. Cue-based strategies – symptom-monitoring reminders, scheduled follow-up contacts, and peer-support groups – can activate the cue-to-action pathway identified as a key mediating channel in this study. Together, these constitute a behaviour-change architecture that the HBM supports but that awareness-only public-health messaging fails to operationalise.

Strengths and limitations

Strengths include the integrated mixed-methods architecture, use of culturally validated instruments (BMAS and the 38-item HBM questionnaire), and PROCESS Model 4 mediation across all six constructs with joint-display integration.

Some limitations should be noted. First, because this was a cross-sectional study, the temporal ordering assumed in the mediation models (beliefs → adherence → blood pressure) cannot be verified, and the indirect and direct effects should be read as cross-sectional decompositions of association rather than as causal pathways; we cannot confirm cause-and-effect relationships. Reverse causation is also possible: long-term uncontrolled blood pressure might change people's beliefs, and ongoing non-adherence might reduce self-confidence. However, our qualitative findings support the proposed pathway (beliefs → adherence → blood pressure). A reverse-direction sensitivity analysis (Additional file 1: Table S4) yielded indirect effects approximately three orders of magnitude smaller than the forward-direction effects ($|B| \leq 0.0013$ vs $|B|$ up to 4.45), providing further reassurance that the modelled direction is the operative one. Second, the study was conducted in a single rural sub-district in Sylhet division, a region with distinctive demographic and socioeconomic features (high out-migration, a remittance economy, and a sizeable Hindu minority); although the sample's age, sex, and socioeconomic profile are broadly comparable to national rural estimates, generalisability to other rural regions and to urban populations remains to be established.

and should be tested through multi-site replication. Third, the perceived severity subscale showed limited internal consistency ($\alpha = 0.29$) owing to near-universal ceiling endorsement, and inferences involving severity should be interpreted with caution. Fourth, adherence was self-reported, and the true non-adherence rate is plausibly higher than the 55.8% observed. Fifth, HBM, BMAS, and SBP were collected at the same visit; while SBP is an objective measure, single-occasion self-report on the predictor and mediator may inflate the belief–adherence association. Sixth, the lifestyle behaviours examined as candidate mediators of the self-efficacy effect were measured by brief single-item self-reports; in particular, added-salt intake is a crude proxy for total dietary sodium, which is most accurately assessed by 24-hour urinary sodium excretion, and fruit, vegetable, and physical-activity exposures were captured as weekly-frequency reports. The null mediation findings should therefore be read as evidence against these specific measured pathways rather than against a dietary or activity mechanism in general.

Recommendations for future research

Three priorities follow directly from the present findings. First, a longitudinal cohort study with repeated measurement of beliefs, adherence, and clinical outcomes would establish temporal precedence and enable formal tests of the multi-channel mediation model – ideally with structural equation modelling that accommodates measurement error and bidirectional pathways. Second, a cluster-randomised trial of a mediation-prioritised intervention that combines structural-barrier reduction with domain-specific self-efficacy training would provide a prospective test of the framework and a culturally tailored evidence base for scale-up. Third, multi-site replication across Bangladesh's eight divisions, and in comparable South Asian and LMIC settings, would establish whether the three-pathway pattern is a feature of the HBM itself or of this specific cultural and structural context.

Conclusions

Hypertension control in rural Bangladesh appears to be shaped less by what patients know than by the conditions under which they live. Beliefs are abundant, but blood-pressure control remains low because structural barriers, socioeconomic constraints, and a symptom-driven understanding of the disease interrupt the path from belief to behaviour. The HBM is most useful here when read as a multi-channel framework, and intervention design should address the material and structural conditions that constrain self-management at least as much as the beliefs that motivate it.

Abbreviations

ANOVA

Analysis of variance

BMAS

Bangladesh Medication Adherence Scale

BMI

Body mass index

BMU

Bangladesh Medical University

CAPi

Computer-Assisted Personal Interviewing

CI

Confidence interval

COREQ

Consolidated Criteria for Reporting Qualitative Research

CVI

Content Validity Index

DBP

Diastolic blood pressure

GRAMMS

Good Reporting of A Mixed Methods Study

HBM

Health Belief Model

IQR

Interquartile range

IRB

Institutional Review Board

LMIC

Low- and middle-income country

REDCap

Research Electronic Data Capture

SAGER

Sex and Gender Equity in Research

SBP

Systolic blood pressure

SD

Standard deviation

SES

Socioeconomic status

S-CVI/Ave

Scale-level Content Validity Index, average

STEPS

WHO STEPwise approach to NCD risk-factor surveillance

STROBE

Strengthening the Reporting of Observational Studies in Epidemiology

VIF

Variance inflation factor

WHO

World Health Organization.

Declarations

Ethics approval and consent to participate

The study was approved by the Institutional Review Board of Bangladesh Medical University (BMU; formerly Bangabandhu Sheikh Mujib Medical University), under Reference No. BSMMU/2023/6516 (original approval, 29 April 2023) and Reference No. BMU/2025/14636(A) (amended approval, 04 October 2025). All participants provided informed written consent (or witnessed thumb-impression where literacy was limited). All methods were carried out in accordance with the Declaration of Helsinki.

Human Ethics and Consent to Participate declarations

The study was approved by the Institutional Review Board of Bangladesh Medical University (BMU; formerly Bangabandhu Sheikh Mujib Medical University), Dhaka, Bangladesh, under Reference No. BSMMU/2023/6516 (original approval, 29 April 2023) and Reference No. BMU/2025/14636(A) (amended approval, 04 October 2025). All participants provided informed written consent (or witnessed thumb-impression where literacy was limited). All methods were carried out in accordance with the Declaration of Helsinki.

Clinical trial number

Clinical trial number: not applicable.

Consent for publication

Not applicable; no individually identifiable data are reported.

Availability of data and materials

The datasets generated and analysed during the current study are not publicly available in order to protect participant confidentiality, but the de-identified individual participant data, data dictionary, study protocol, statistical analysis plan, and PROCESS syntax are available from the corresponding author (MTI) on reasonable request, subject to approval by the Bangladesh Medical University IRB and a signed data access agreement, for non-commercial research. Qualitative transcripts are not shared to protect confidentiality.

Competing interests

The authors declare that they have no competing interests.

Funding

This research was funded by Bangladesh Medical University (formerly Bangabandhu Sheikh Mujib Medical University), Grant No. BSMMU/2023/13314(11), dated 31 October 2023. The funder had no role in study design, data collection, analysis, interpretation, or the decision to submit the manuscript for publication. The work was conducted as part of the corresponding author's PhD programme.

Authors' contributions

MTI: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft. MAH: Investigation, Data curation, Writing – review & editing. MKU: Methodology, Validation, Formal analysis, Writing – review & editing. MC: Investigation, Data curation. SMA: Conceptualization, Supervision, Writing – review & editing. All authors read and approved the final manuscript.

Acknowledgements

Not applicable.

Use of large language models

Claude (Anthropic) assisted with language editing of the manuscript and submission documents and with the technical rendering of Figs. 1 and 2. All data, analyses, interpretations, and scientific conclusions are solely the work

of the authors, and all AI-assisted content was verified by the corresponding author. The tool does not meet authorship criteria and is not listed as an author.

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Figures

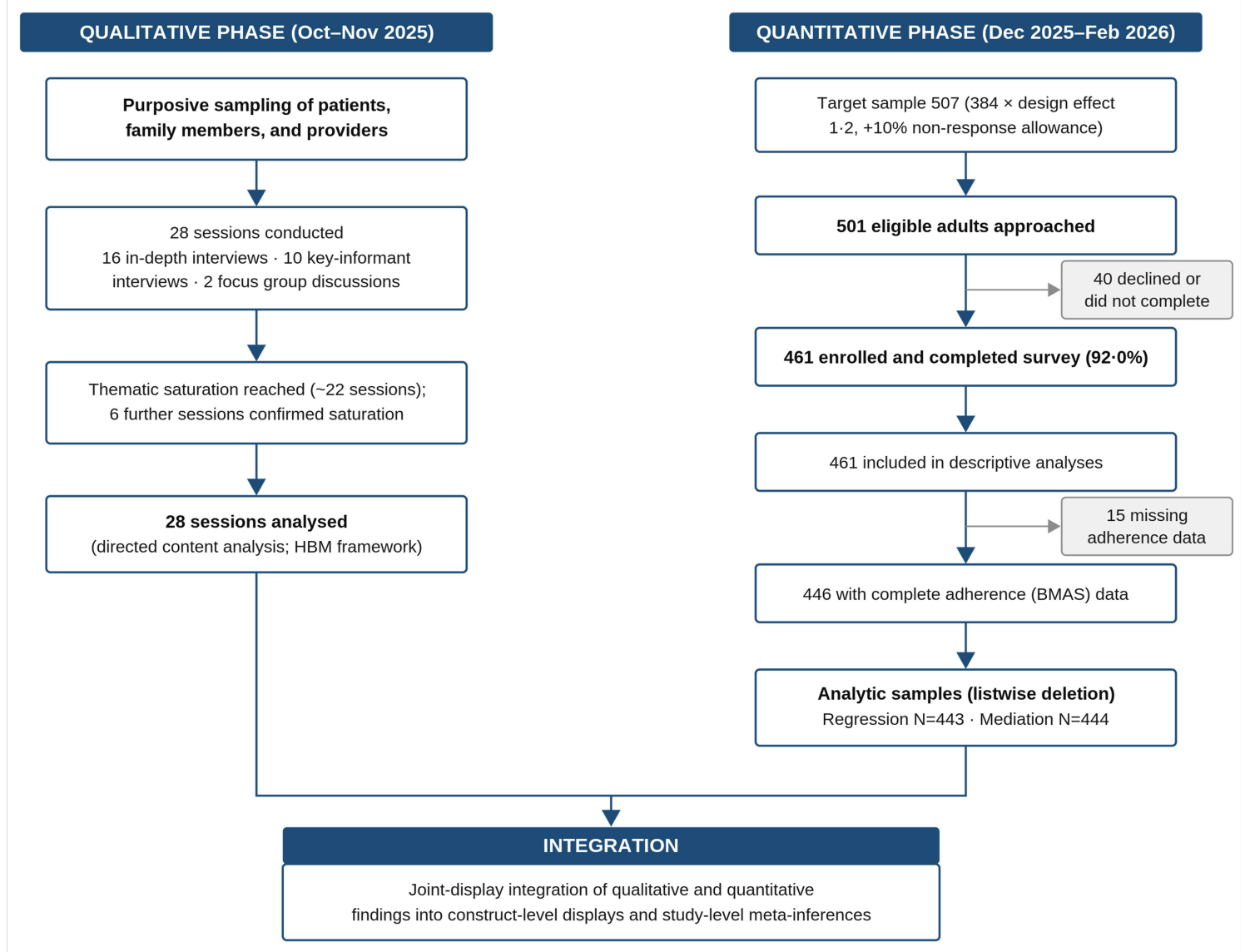


Figure 1

Participant flow in the exploratory sequential mixed-methods study.

HBM = Health Belief Model; BMAS = Bangladesh Medication Adherence Scale. The qualitative phase used purposive sampling to thematic saturation; the quantitative phase enrolled 461 of 501 eligible adults approached (92.0%). Analytic N varies (443–444) across multivariable models owing to listwise deletion of missing covariate data. Grey boxes indicate exclusions.

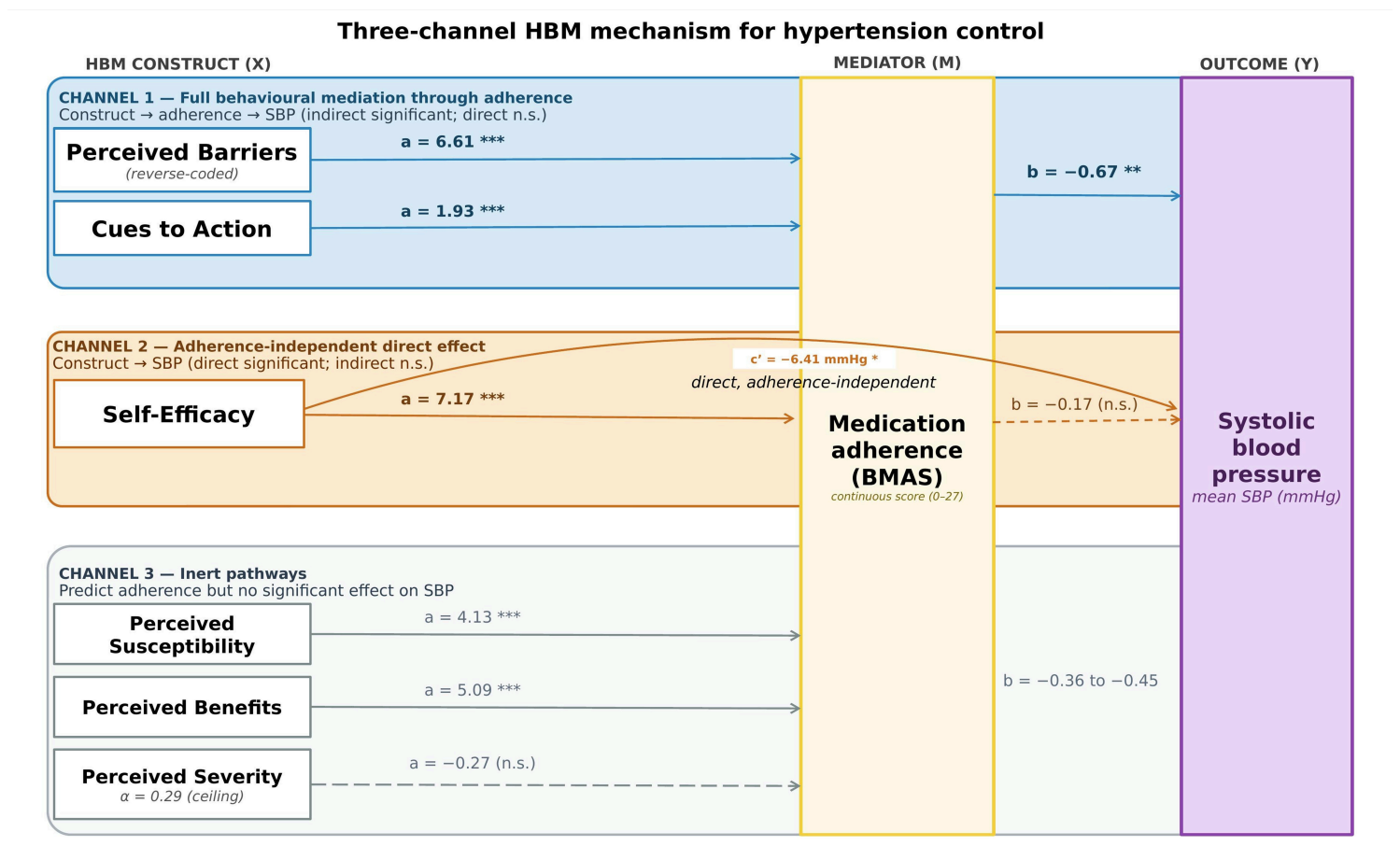


Figure 2

Three-channel framework — pathways from six HBM constructs to systolic blood pressure via BMAS medication adherence (N = 444).

Path a = construct to BMAS adherence; Path b = adherence to systolic blood pressure; c' = direct effect of construct on SBP. Solid arrows = statistically significant paths; dashed arrows = non-significant paths. BMAS = Bangladesh Medication Adherence Scale; SBP = systolic blood pressure; HBM = Health Belief Model. *p<0.05; p<0.01; *p<0.001; NS = not significant. PROCESS Model 4 (Hayes, 2022); 5000 bootstrap resamples.

Supplementary Files

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