Exploratory Research in Clinical and Social Pharmacy 16 (2024) 100510

Contents lists available at ScienceDirect

Exploratory Research in Clinical and Social Pharmacy

journal homepage: www.elsevier.com/locate/rcsop

Behavioral factors associated with medication adherence among hypertensive patients using the theoretical domains framework

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ARTICLE INFO

Keywords:
Emotion
Beliefs
Behavioral factors
Adherence
Hypertension

ABSTRACT

Background: Theoretical exploration of the behavioral factors associated with adherence to medication in hypertensive patients has been limited in previous studies.
Objectives: This study aims to understand the associations between demographic and health characteristics and behavioral factors for medication taking, and how these predict medication adherence.
Methods: A cross-sectional survey was conducted in hypertensive outpatients, with a sample size of 399 participants. Behavioral factors predicting medication taking, designed to align with the theoretical domains framework, and the medication adherence scale were used. Behavioral factors were determined using principal component analysis, and their associations with demographic and health characteristics and medication adherence were analyzed using non-parametric statistics.
Results: Four behavioral factors were identified: (F1) negative emotions and beliefs about capabilities, (F2) beliefs about consequences, (F3) knowledge and skills, and (F4) social support. F1 showed a strongest inverse association with medication adherence ($\rho = -0.25$; $p < 0.01$). Significantly higher F1 scores were recorded in hypertensive patients with secondary school or lower education ($p < 0.001$), income less than 4 million VND ($p = 0.03$), who were currently smoking ($p = 0.018$), self-reporting chest pain or discomfort ($p < 0.001$), and of older age ($p < 0.01$).
Conclusions: Certain demographic and health characteristics were significantly associated with emotions and beliefs about capabilities to take medication, which, in turn, was significantly associated with medication adherence. Future research should design interventions that focus on reassuring patients of the need and of their ability to overcome their worries and sadness and reduce their difficulties in using medications.

1. Introduction

Hypertension is the main risk factor for cardiovascular disease, particularly stroke and heart attack, accounting for 31 % of all deaths globally.[1] In Vietnam, national surveys indicate that the overall prevalence of hypertension is 18.4 %.[2] Treatment of hypertension should be continuous, with patients being closely monitored for adherence to treatment.[3] However, non-adherence remains a global issue,[4] including in Vietnam. A study in elderly people with hypertension conducted in Ho Chi Minh City, Vietnam, showed that only 11.7 % of the patients adhered to their medication regimen.[3] Poor medication adherence significantly impacts high blood pressure control, increasing the risk of cardiovascular events, poor renal outcomes, including end-stage renal disease, and all-cause mortality.[5]

The use of behavioral interventions such as dosage simplification, treatment cues/reminders, charts, and pill containers has been shown to

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https://doi.org/10.1016/j.rcsop.2024.100510
Received 20 June 2024; Received in revised form 18 July 2024; Accepted 16 September 2024
Available online 17 September 2024

improve adherence to long-term medications.[6] However, a limitation in the evidence surrounding medication adherence behavior is the lack of integration of behavior change theory across study periods.[7] Furthermore, the impact of interventions can be limited and often yields mixed effects due to the lack of a clear rationale for choosing interventions and the use of inappropriate methods in designing them.[8] Therefore, integrating theory into research can enhance the certainty, rigor, and impact of findings[7] and facilitate the identification of theoretical mechanisms for developing targeted interventions.

The theoretical domains framework (TDF) serves as a lens to explore medication adherence behavior and provides a comprehensive understanding of the key influences on this behavior.[9] The TDF integrates 33 theories of behavior and behavior change into 14 theoretical domains that are relevant to medication-taking behavior.[9] It is utilized to identify factors influencing behaviors such as medication adherence[10] and to pinpoint specific aspects for behavior change, aiding in the design of effective interventions.

Previous studies, including those by Al-Rahami et al. (2015),[11] Morrison et al. (2015),[12] and Zhang et al. (2018),[13] evaluated up to 5 domains related to the TDF, while Yue et al. (2015) researched as many as 7 domains.[14] Importantly, no study has encompassed all 14 domains of the TDF.[15] These domains were not originally based on the TDF and do not align with its specific aims. Instead, these studies primarily focus on the impact of select domains on medication adherence. Moreover, these studies have not investigated differences in domains according to demographic and health characteristics, highlighting a crucial knowledge gap that needs addressing to enhance medication-taking behavior in patients.

The study by Cunningham et al. appears to be one of the rare studies to have used the TDF to explore the determinants of medication-taking behavior, but conducted specifically on patients following percutaneous coronary intervention.[7] The use of the TDF may help design potentially more effective behavior change interventions,[15] but no studies have yet explored this issue in hypertensive patients in Vietnam. Therefore, the purpose of this study is to understand the association between patients' demographic and health characteristics and behavioral factors for medication-taking using the theoretical domains framework, as well as to examine the relationship between these behavioral factors and medication adherence among hypertension patients in Vietnam.

2. Methods

2.1. Study design and sampling

A cross-sectional survey using a printed questionnaire was conducted in hypertensive outpatients at a rural health center in Vinh Long, Vietnam, over a 2-month period from April to May 2024. The health center is a public enterprise unit under the authority of the health department, where besides performing functions like diagnosis and treatment similar to hospitals, it also provides specialized technical services in preventive healthcare, functional recovery, food safety, population health, and other medical services. It was estimated that 385 participants were needed to achieve a margin of error of 5 % with a confidence level of 95 %. Ultimately, this study included 399 participants, indicating an adequate sample size.

2.2. Participant recruitment

Participants in this study were recruited using convenience sampling techniques based on volunteerism. The study was approved by the Medical Ethics Council of Can Tho University of Medicine and Pharmacy, Can Tho, Vietnam. Before enrollment, all patients provided written informed consent after having received a full explanation of the study. Responses were anonymous and researchers did not have access to participants' clinical details. Over a 2-month period, excluding Saturdays and Sundays, which equates to 45 days, consecutive patients diagnosed with hypertension were invited to participate until the first 10 participants each day had been enrolled. Data were collected using a printed questionnaire, and participants were interviewed by a trained data collector in the medication dispensing waiting area at the health center.

2.3. Measurements

The questionnaire used in this study was based on previous research,[7,16,17] and consisted of three sections.

In the first section, behavioral factors for medication-taking were evaluated using 19 attitudinal items developed by Cunningham et al. (2022), ensuring a comprehensive exploration of key aspects related to medication-taking behavior based on the TDF.[7] Subsequently, the questionnaire was translated into Vietnamese and assessed for content and face validity to ensure its appropriateness, clarity, and suitability in the Vietnamese context. Iterative revisions were made, achieving consensus on content through discussions with hospital pharmacists and clinicians. Additionally, back translation was performed to validate the quality of the translation and to ensure the retention of all key points from the original questionnaire. Feedback from a pilot test with a convenient sample of 10 patients from the study population resulted in minor adjustments to question wording and format. Pilot study responses were not included in the main sample. Internal consistency, as reported in previous research, ranged from 0.64 to 0.85 using Cronbach's alpha.[7] Responses to each item were quantified using a 5-point Likert scale, ranging from 'strongly disagree' to 'strongly agree'.

The second section of the questionnaire measured patient medication adherence using the Vietnamese Version of the General Medication Adherence Scale (GMAS), validated by Nguyen et al. (2021).[17] Consisting of 11 items, each with response options ranging from 'always' (0 points) to 'never' (3 points). The medication adherence score was calculated as the sum score of these items, with higher scores indicating greater adherence. Cronbach's alpha for internal consistency, reported in previous research, ranged from 0.67 to 0.73.[17]

The third section collected patient demographic characteristics, including gender, age, living arrangements, employment, education level, and monthly individual income. Health-related characteristics also included duration of hypertension, chronic comorbidities, current smoking and alcohol consumption, polypharmacy, self-assessment of health condition, self-reported chest pain or discomfort, number of doctor visits for personal health issues in the past 3 months, number of hospital admissions in the past 3 months, number of pharmacy visits for medication purchases and medication or health counseling in the past 3 months, and psychological distress using the PHQ-4. The PHQ-4 scale, comprising 4 questions assessing depression (Patient Health Questionnaire-2 item, PHQ-2) and anxiety (Generalized Anxiety Disorder 2-item, GAD-2). This study used the Vietnamese version of the PHQ-4 scale. Previous research has reported the Cronbach's alpha of this scale to be 0.9.[16] Each question was rated on a scale from 'not at all' (0 points) to 'nearly every day' (3 points). Scores for each scale were calculated as the sum of item scores, with higher scores indicating more severe psychological distress.

2.4. Data analysis

Data were analyzed using IBM SPSS version 22.0. Descriptive statistics including frequency, percentage, median, and interquartile range (IQR) were used to present distributions of the variables. Principal component analysis (PCA) with varimax rotation was applied to the 19-item questionnaire on behavioral determinants for medication taking to identify a reduced number of interrelated components. Sample suitability for PCA was assessed using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. During factor extraction, the number of retained factors was determined based on the following conditions: (i) eigenvalues greater than one, (ii) factors

located above the inflection point of the eigenvalue curve on the scree plot, (iii) factors each containing two or more items, and (iv) the relevance of the selected factors to the domains of the TDF. A cutoff for significant factor loading of 0.45 was chosen. Each factor's Cronbach's alpha was required to reach 0.7 or higher to indicate acceptable reliability. Factor scores were determined using the median and interquartile range (IQR).

The distributions of factor scores across demographic and health characteristics were assessed using the Mann-Whitney *U* test for binary categorical variables and the Kruskal-Wallis H test for categorical variables with three or more values. Correlations were examined (i) between factor scores themselves, (ii) between factor scores and continuous demographic and health variables, and (iii) between factor scores and medication adherence scores using Spearman's correlation coefficient (ρ). This study used the following correlation thresholds: an absolute value of ρ of 0.4 or higher indicates a strong association, 0.2 to less than 0.4 indicates a moderate association, and less than 0.2 indicates a weak association.[18]

3. Results

3.1. Demographic and health characteristics

A total of 450 survey responses were collected, with 51 incomplete responses, leaving 399 complete responses for analysis. The majority of participants were women (59 %) with a median age (IQR) of 64 (12) years, living with a spouse (80.9 %), receiving a monthly individual income less than 4 million VND (69.1 %). Most had chronic comorbidities (69.2 %), currently did not smoke (76.9 %), and currently did not consume alcohol (71.7 %). The median (IQR) duration of hypertension was 7 (8) years, as presented in Table 1. The prevalence of depression, anxiety, distress, and medication adherence among hypertensive patients is described in Fig. 1.

3.2. Principal component analysis

Upon initial factor rotation, five factors with eigenvalues greater than 1 were identified. Three variables were subsequently eliminated, namely Q_4 (i.e., question 4), Q_5, and Q_{13}, due to each having factor loadings exceeding 0.45 and loading onto two factors simultaneously. Following the removal of these variables, a second round of factor rotation revealed five factors with eigenvalues greater than 1. However, factor 5 consisted of only one variable, Q_{11}, leading to its elimination as well.

In the final factor rotation results (see Table 2), four factors with eigenvalues greater than 1 were obtained. The scree plot indicated an inflection point at the fifth component, suggesting that retaining four components above this inflection point was appropriate. Additionally, parallel analysis, represented by the line connecting percentile eigenvalue points in Fig. 2, also supported retaining four factors as they exceeded this line.

Consequently, a four-factor solution was deemed suitable for this study's dataset. Each variable loaded onto a single factor with a factor loading of higher than 0.45, indicating satisfactory model fit. Together, these factors explained 58.7 % of the total variance. From the original 19 variables, PCA retained 15 suitable variables, organized into four factors: (1) negative emotions and beliefs about capabilities, (2) beliefs about consequences, (3) knowledge and skills, and (4) social support. The Cronbach's alpha coefficients for the four factors were 0.72, 0.66, 0.79, and 0.70 respectively.

3.3. Associations between demographics, health characteristics, and behavioral factors

Patients with secondary school education or lower ($p < 0.001$), income below 4 million VND ($p = 0.03$), who were currently smoking ($p = 0.018$), and self-reporting chest pain or discomfort ($p < 0.001$) had significantly higher scores on the scale indicating negative emotion and beliefs about capabilities in taking medication compared to others (Table 3). Patients without chronic comorbidities ($p = 0.006$) and not currently drinking alcohol ($p < 0.001$) had significantly higher scores on the scale indicating beliefs about consequences in taking medication compared to others. Patients living with a husband or wife ($p = 0.047$), employed ($p < 0.001$), with incomes of 8 million VND or higher ($p < 0.001$), without chronic comorbidities ($p < 0.001$), and without polypharmacy ($p = 0.002$) had significantly higher scores on knowledge and skills in taking medication compared to others. Patients with college/intermediate or higher education ($p = 0.002$), without chronic comorbidities ($p = 0.002$), not currently smoking ($p = 0.006$), and not currently drinking alcohol ($p = 0.002$) had significantly higher scores on social support in taking medication compared to others.

Table 1
Participants' demographic and health characteristics ($n = 399$).

Characteristics		n	%
Demographics			
Gender	Women	235	59.0
	Men	163	41.0
Age (year)	≤ 49	23	5.8
	50–59	100	25.1
	60–69	166	41.6
	70–79	84	21.1
	≥ 80	26	6.5
	Median (IQR)	64	12
Living arrangements	Lives alone	18	4.5
	Wife or husband	322	80.9
	Relatives	58	14.6
Employment	Employed	85	21.3
	Unemployed	90	22.6
	Homemaker	152	38.1
	Retired	72	18.0
Education level	Elementary school or lower	271	67.9
	Secondary school	65	16.3
	College or intermediate	42	10.5
	University or higher	21	5.3
Monthly income (million VND)	< 4	275	69.1
	4–8	105	26.4
	≥ 8	18	4.5
Health related characteristics			
Duration of hypertension	Median (IQR)	7	8
Chronic comorbidity	No	123	30.8
	Yes	276	69.2
Current smoking status	No	307	76.9
	Yes	92	23.1
Current drinking status	No	286	71.7
	Yes	113	28.3
Number of medications currently prescribed	Median (IQR)	5	2
Polypharmacy	No	168	42.1
	Yes	231	57.9
Self-rated health status	Median (IQR)	3	1
Self-reported chest pain or discomfort	No	232	58.4
	Yes	165	41.6
Number of doctor visits for own health issues in the past 3 months	Median (IQR)	2	2
Number of hospital admissions in the past 3 months	Median (IQR)	0	0
Number of pharmacy visits to purchase medication in the past 3 months	Median (IQR)	1	2
Number of pharmacy visits for medication/health consultation in the past 3 months	Median (IQR)	0	1
PHQ-2 depression score	Median (IQR)	1	2
GAD-2 anxiety score	Median (IQR)	0	2
PHQ-4 disstress score	Median (IQR)	1	2

Note: IQR: Interquartile range; VND: Vietnamese dong; PHQ-2: Patient Health Questionnaire 2-item; GAD-2: Generalized Anxiety Disorder 2-item; PHQ-4: Patient Health Questionnaire 4-item.

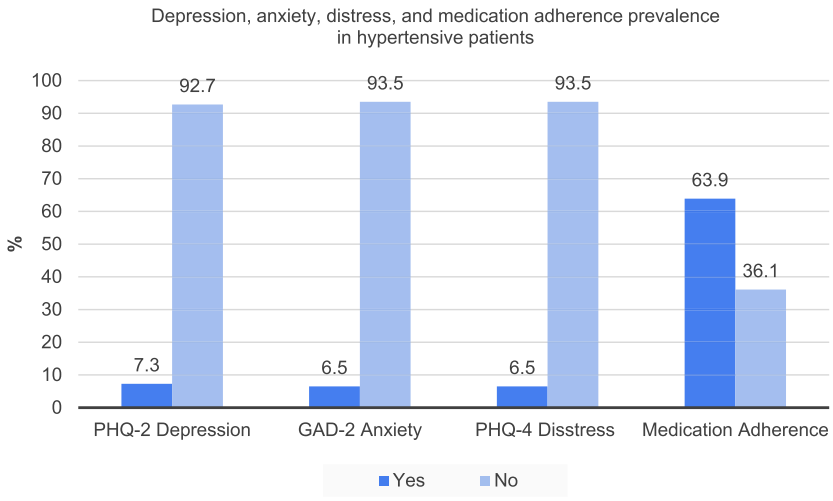

Fig. 1. Depression, anxiety, distress, and medication adherence prevalence in hypertensive patients (PHQ-2 score ≥ 3, GAD-2 score ≥ 3, and PHQ-4 score ≥ 6, and mediacation adherence score ≥ 27). *Note:* PHQ-2: Patient Health Questionnaire 2-item; GAD-2: Generalized Anxiety Disorder 2-item; PHQ-4: Patient Health Questionnaire 4-item.

There was a moderate positive correlation between age and negative emotion and beliefs about capabilities in taking medication ($\rho = 0.27$; $p < 0.01$). Additionally, self-rated health status showed a moderate positive correlation with knowledge and skills in taking medication ($\rho = 0.30$; $p < 0.01$), whereas a moderate negative correlation was found between knowledge and skills and age ($\rho = -0.35$; $p < 0.01$), number of doctor visits for own health issues ($\rho = -0.31$; $p < 0.01$), number of hospital admissions in the past 3 months ($\rho = -0.29$; $p < 0.01$) (Fig. 3).

3.4. Associations between behavioral factors and medication adherence

Exploring the correlations between these factors themselves (Table 4) revealed a moderate positive correlation between beliefs about consequences and social support in taking medication ($\rho = 0.22$; $p < 0.01$). When examining the correlation between the four factors and medication adherence, beliefs about consequences in taking medication showed a moderate positive correlation with medication adherence ($\rho = 0.20$; $p < 0.01$), whereas negative emotion and beliefs about capabilities in taking medication exhibited a moderate negative correlation with medication adherence ($\rho = -0.25$; $p < 0.01$).

4. Discussion

The study participants in our research share certain demographic characteristics with those in the study by Ha et al. on hypertensive patients in rural Vietnam. Specifically, there is a similarity in the proportion of women between our study and Ha et al.'s study (59.0 % vs. 59.3 %), those with education below secondary school (67.9 % vs. 60.0 %), and mean age (64.1 vs. 65.8).[19] Compared to another study by Nguyen et al. on a rural population in Vietnam, our study is similar in terms of mean age (64.1 vs. 67.0) and the proportion of men (41.0 % vs. 45.0 %).[20] Additionally, our study is also comparable to Nguyen et al.'s study on patients with hypertension in Northern Vietnam regarding the proportion of men (41.0 % vs. 44.1 %) and comorbidity rates (69.2 % vs. 70.2 %).[21]

PCA of behavioral factors related to medication taking identified four distinct factors: (F1) negative emotions and beliefs about capabilities, (F2) beliefs about consequences, (F3) knowledge and skills, and (F4) social support. These factors were named to align with corresponding domains in TDF.[10] In terms of content, the factors identified in this study are nearly identical to those found in Cunningham et al. (2023).[7] However, the present study identified one additional factor compared to Cunningham et al. (2023),[7] specifically splitting their factor 'aspects relating to activities and support in medication taking' into two separate factors in our study: 'beliefs about consequences' and 'social support', consistent with the TDF. Additionally, based on the thematic content of items within the factor, 'emotion and beliefs about capabilities' was renamed to 'negative emotions and beliefs about capabilities' in the present study. Therefore, our study evaluated four factors, which may provide a more detailed approach in studying behavioral factors related to medication adherence.

Previous research has reported that participants with lower levels of education had lower positive attitudes toward medication than those with higher levels of education.[22] This finding aligns with the current study, where individuals with lower educational attainment scored significantly higher on negative emotions and beliefs about their capabilities compared to others. Furthermore, a weak negative correlation was observed between education level and concerns, indicating that individuals with higher education levels tended to score lower on concerns.[23] Patients with lower educational levels, compared to those with higher education, perceived medication effects as harmful and believe they are overused.[24] Poor socioeconomic status, including education, is also a risk factor for mental health issues such as anxiety and worry.[25] Additionally, as the majority of participants in this study were older and had lower levels of education, they may have had heightened concerns about medication use.

It is anticipated that individuals with comorbidities may require greater care and consequently receive more support.[26] However, the findings of the present study suggest the opposite: individuals without chronic comorbidities reported higher social support scores, consistent with the findings of Yilmaz et al. (2017).[27] Furthermore, our study also observed that higher levels of education were associated with increased awareness of social support, aligning with the results of Yilmaz et al. (2017)[27] and Duc et al. (2021).[28] For older adults, those with higher education are more likely to maintain consistently positive perceptions about available support.[29] Additionally, it could be because elderly individuals with academic degrees receive more social support.[30] These reasons may be appropriate to explain the findings of our study, as the majority of participants were also elderly.

Other studies have indicated a decline in medication-related knowledge with increasing age, a trend also observed in our study.[31] Elderly individuals are less likely to comprehend certain medication-

Table 2
Factor loading, Cronbach's alpha, and percent of explained variance of extracted behavioral factors.

Code	Behavioral factors for medication taking	Factor (factor loading)			
		1	2	3	4
	Factor 1 – Negative emotion and beliefs about capabilities				
Q_7	Taking and using my medicines is very difficult	0.84			
Q_{17}	I feel worried about taking and using my medicines	0.78			
Q_8	I need help from others to take and use my medicines as prescribed	0.69			
Q_{19}	I feel sad about having to take and use so many medicines	0.55			
	Factor 2 – Beliefs about consequences				
Q_{10}	If I take or use my medicines as prescribed, this will be appreciated by my doctors		0.78		
Q_{18}	I feel comfortable about taking and using my medicines		0.67		
Q_9	If I take or use my medicines as prescribed then my health will improve		0.65		
Q_{12}	Taking and using my medicines fits in with my daily activities		0.57		
Q_6	I am taking and using my medicines as intended by the doctors		0.46		
	Factor 3 – Knowledge and skills				
Q_2	I know how to take and use my medicines properly			0.91	
Q_1	I know how to get the best from my medicines			0.91	
Q_3	I have been told how to take my medicines to get the best out of them			0.61	
	Factor 4 – Social support				
Q_{15}	Doctors, pharmacists and other health workers are willing to listen to my problems with taking and using my medicines				0.77
Q_{16}	I can count on support from family and friends to help me take and use my medicines				0.74
Q_{14}	I can count on support from doctors, pharmacists and other health workers to take and use my medicines as prescribed				0.73
	Cronbach's alpha (α)	0.72	0.66	0.79	0.70
	Percent of explained variance (%)	15.58	15.28	14.39	13.49

Note: Principal component analysis with varimax rotation was used; only factor loadings with an absolute value greater than 0.4 are displayed; Q: question.

related information, possibly due to age-related cognitive decline, which can lead to inappropriate medication use.[32] Additionally, our study found that individuals with higher education and higher monthly incomes exhibited better medication knowledge, consistent with previous research.[32] Education level plays a crucial role in understanding medications;[33] individuals with higher education levels typically have access to more health information and engage more in reading about medications compared to those with lower education levels. Moreover, individuals with higher incomes are more likely to visit healthcare providers regularly, which enhances their knowledge about medication use. Furthermore, higher incomes may often be associated with higher education levels, contributing to better medication knowledge.[32]

It is notable that medication adherence showed an inverse relationship with knowledge and skills in our study, contrary to the typical positive association found in literature on adherence.[34] However, this relationship was weakly established in our findings. Similarly, social support also demonstrated a weak correlation with adherence. The positive impacts of social support on medication adherence have been emphasized, yet there are still inconsistent research findings regarding the association between medication adherence and general perceptions of social support. While some studies highlight the beneficial role of social support received from family and friends in enhancing adherence, others indicate no significant association between perceived support and adherence.[35] This suggests that knowledge and skills, as well as social support, are not critical factors predicting treatment adherence, indicating the presence of other important factors influencing this behavior. Adherence to medication is a complex phenomenon influenced by multiple factors, and successful therapy outcomes depend on considering various influencing variables.[36] Therefore, when evaluating adherence, it is essential to account for these diverse factors rather than relying on a single determinant.

The present research identified a moderate negative correlation ($\rho = -0.25$; $p < 0.01$) between negative emotions and beliefs about capabilities related to medication adherence. This suggests that difficulties in managing the burden of medication contribute to negative emotions,[37] which, in turn, hinder adherence. Patients' emotional experiences with medications significantly influence their adherence behavior, with those facing greater emotional burden being less likely to adhere to their prescribed regimen.[37] This finding aligns with Awad et al. (2020), who emphasized the impact of medication burden on adherence levels.[38]

Patient beliefs about medications significantly influence treatment adherence and represent a potentially modifiable factor for enhancing adherence.[39] Studies in patients with chronic illnesses consistently show that stronger perceptions of medication necessity and fewer concerns about treatment correlate with higher adherence rates.[39,40] Our study also supports this notion, revealing a moderate positive correlation between beliefs about consequences and adherence ($\rho = 0.20$; $p < 0.01$). Level of belief in the importance of medication to one's life determines the level of adherence, underscoring the critical role of assessing patients' trust in their medications for treatment to be successful.[40] Healthcare providers should actively address patients' beliefs about medication to improve adherence. Evidence suggests that beliefs can be positively altered through low-intensity interventions, leading to improved adherence.[41] Furthermore, because this effect is not large, with the moderate correlation coefficient found in the present study, it is necessary to incorporate additional behavioral strategies, such as habit formation, to increase intervention effectiveness and improve adherence.

Interestingly, scores on the negative emotions and beliefs about capabilities scale correlated more strongly with medication adherence than with beliefs about consequences. This suggests that there may be a greater need to focus on reassuring patients to overcome their anxiety and sadness related to medication use, and to alleviate their practical difficulties in medication management, rather than solely emphasizing the benefits of medication taking.[23] Pharmacists and clinicians should implement tailored counseling approaches to help patients cope with negative emotions when taking medication. It is therefore crucial to proactively identify factors influencing negative emotions and beliefs about capabilities, and to introduce targeted interventions. These interventions could involve enhancing patient education about medications, emphasizing their importance, and addressing negative perceptions to alleviate concerns and enhance medication adherence.

4.1. Recommendations for practice

Leaders of healthcare facilities should establish mechanisms and policies to facilitate the integration of counseling and psychological support services into routine care for patients undergoing hypertension treatment. This can help patients alleviate the emotional burdens associated with medication adherence.

Clinicians and pharmacists should educate patients about the necessity and benefits of medication to reinforce their confidence in the treatment. The information provided should be clear and concise to help patients make informed decisions about their medication regimen.

Enhancing social support, such as the involvement of family and

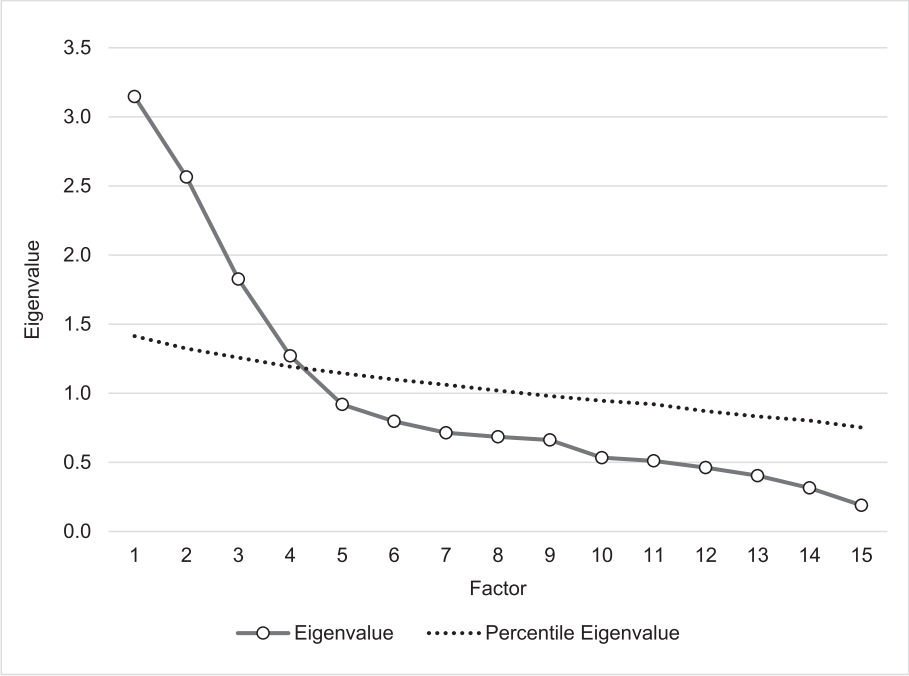

Fig. 2. Scree plot and Parallel analysis.

Table 3
Differences in behavioral factor scores among participants by demographic and health characteristics.

Characteristics		F1: Negative emotion and beliefs about capabilities		F2: Beliefs about consequences		F3: Knowledge and skills		F4: Social support	
		Mean rank	*p* value	Mean rank	*p* value	Mean rank	*p* value	Mean rank	*p* value
Gender[†]	Women	200.67	0.799	202.62	0.367	194.69	0.241	196.31	0.420
	Men	197.81		195.01		206.44		204.09	
Living arrangements[†]	Lives alone	221.89	0.390	209.28	0.627	155.06	**0.047**	219.44	0.373
	Wife/husband or relatives	198.97		199.56		202.12		199.08	
Employment[†]	Employed	209.77	0.358	200.18	0.982	251.52	**<0.001**	192.74	0.426
	Unemployed/homemaker/retired	197.36		199.95		186.05		201.97	
Education[†]	Secondary school or lower	209.29	**<0.001**	197.86	0.234	192.55	**<0.001**	193.60	**0.002**
	College/intermediate or higher	150.43		211.40		239.71		234.15	
Monthly income (million VND)[‡]	<4	209.03	**0.030**	195.07	0.056	184.24	**<0.001**	195.29	0.380
	4–8	180.59		214.94		226.62		210.40	
	≥8	164.22		177.08		274.44		200.25	
Chronic comorbidity[†]	No	194.79	0.529	217.15	**0.006**	230.43	**<0.001**	222.00	**0.002**
	Yes	202.32		192.36		186.44		190.19	
Current smoking status[†]	No	192.82	**0.018**	203.11	0.171	195.98	0.136	207.16	**0.006**
	Yes	223.96		189.63		213.42		176.09	
Current drinking status[†]	No	199.80	0.953	209.11	**<0.001**	195.98	0.194	209.16	**0.002**
	Yes	200.51		176.94		210.17		176.82	
Polypharmay[†]	No	203.41	0.599	207.37	0.130	218.17	**0.002**	207.33	0.188
	Yes	197.52		194.64		186.79		194.67	
Self-reported chest pain or discomfort[†]	No	170.31	**<0.001**	203.25	0.224	199.76	0.854	200.56	0.697
	Yes	239.34		193.02		197.93		196.81	

Note: IQR: Interquartile range; VND: Vietnamese dong.
[†] Mann–Whitney U test.
[‡] Kruskal-Wallis H Test.

relatives of patients with hypertension, can still play a crucial role in improving treatment adherence for some patients. This is particularly important for elderly hypertensive patients, where clinicians and pharmacists can leverage this support.

Behavioral strategies such as habit formation, medication reminders, and support systems should be incorporated to reinforce adherence. Techniques like setting regular medication schedules using timers or phone apps, and using pill reminder boxes can enhance adherence behaviors.

4.2. Limitations

The study's findings may be limited in generalizability due to data collected from a single geographic area in Vietnam. However, employing a sufficiently large sample size may have helped to mitigate this limitation. Although the reliability of Factor 2, 'Beliefs about consequences', was only 0.66, which is lower than the commonly recommended threshold of 0.7 for Cronbach's alpha, some guidelines suggest thresholds as low as 0.6, which may be acceptable for certain purposes.[42] In a similar study focusing on patients undergoing post-

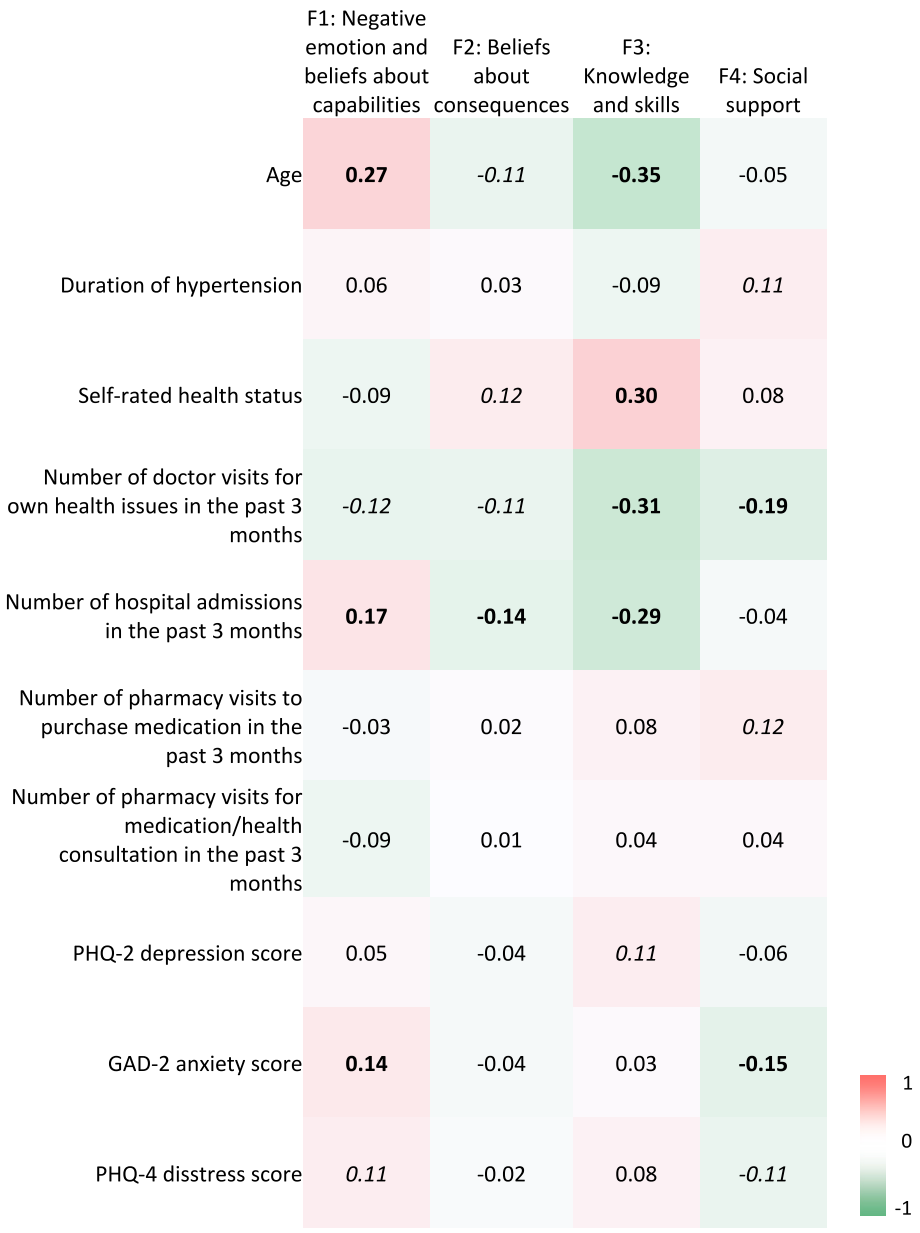

Fig. 3. Spearman's rho correlation between demographic and health characteristics and behavioral factors of medication taking. *Note:* Italicized values are significant at the 0.05 level; bolded values are significant at the 0.01 level. PHQ-2: Patient Health Questionnaire 2-item; GAD-2: Generalized Anxiety Disorder 2-item; PHQ-4: Patient Health Questionnaire 4-item.

Table 4
Correlation between behavioral factors of medication taking and medication adherence.

Factor	Behavioral factors for medication taking	Overall		Correlation				
		Median (IQR)	Range	Factor 1	Factor 2	Factor 3	Factor 4	Mediacation adherence
1	Negative emotion and beliefs about capabilities	3 (1)	1–5	1	0.10†	−0.13‡	−0.06	−0.25‡
2	Beliefs about consequences	4 (0)	2–5		1	0.12†	0.22‡	0.20‡
3	Knowledge and skills	4 (1)	1–5			1	0.08	−0.11†
4	Social support	4 (0)	2–5				1	0.18‡

Note: The factor scores are the median scores of their items (higher scores indicate higher levels of the behavioral factors; e.g., higher beliefs about consequences scores indicate stronger beliefs held by participants), whereas the adherence score is the sum of its items (higher scores indicate greater adherence).
† Correlation is significant at the 0.05 level.
‡ Correlation is significant at the 0.01 level.

percutaneous coronary intervention, Cunningham et al. (2022) also encountered a TDF domain with a Cronbach's alpha below 0.7,[7] suggesting that Factor 2 can be deemed acceptable within the context of the current study. Due to a lack of time, inconvenience at the survey site, and no access to participants' clinical details, information such as blood pressure values and hypertension control were not explored in the

current study. Future research should include these variables and assess their relationship with patient adherence. The types of comorbidities were not identified in detail in our patient sample. Using more detailed questions should be considered in future studies to gather comprehensive data on chronic comorbidities. This study focuses only on participants from a rural healthcare facility and has not included urban healthcare facilities. Therefore, the generalizability of our findings may be limited to patients with similar characteristics in rural healthcare settings in Vietnam.

5. Conclusions

Of the four behavioral factors related to medication taking examined, negative emotions and beliefs about capabilities in taking medication showed the strongest correlations with medication adherence. Patients with secondary school education or lower, income less than 4 million VND, who were currently smoking, and who self-reported chest pain or discomfort exhibited significantly higher scores on negative emotions and beliefs about capabilities. Pharmacists and clinicians should prioritize interventions aimed at reassuring patients to help them overcome anxiety and sadness associated with medication use, particularly addressing any challenges they face in medication administration.

Funding

There was no external funding for this research.

Availability of data and material

The data that support the findings of this study are available from the corresponding author (i.e., upon reasonable request).

CRediT authorship contribution statement

Van De Tran: Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Thi My Loan Vo:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Quang Loc Duyen Vo:** Writing – review & editing, Writing – original draft, Methodology. **Minh Trung Nguyen:** Writing – review & editing, Writing – original draft, Resources, Investigation. **Minh Cuong Nguyen:** Writing – review & editing, Writing – original draft, Resources, Investigation. **Rebecca Susan Dewey:** Writing – review & editing, Writing – original draft. **Thi Hai Yen Nguyen:** Writing – review & editing, Writing – original draft, Methodology.

Declaration of competing interest

The authors have no conflicts of interest to declare.

Acknowledgements

We acknowledge the Can Tho University of Medicine and Pharmacy, Tam Binh District Health Center, Vinh Long for their collaboration in this study.

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