ORIGINAL RESEARCH

Factors Influencing Medication Adherence in Elderly Patients with Hypertension: A Single Center Study in Western China

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Purpose: To develop and empirically test a conceptual model that explains the factors influencing antihypertensive medication adherence behavior in elderly patients in a city in western China.

Patients and Methods: The conceptual model was based on the Theory of Planned Behavior and the Health Belief Model and was empirically tested using cross-sectional survey data from Nanchong City, a city in western China, collected between October and December 2020. Data were analyzed using structural equation modeling.

Results: Behavioral intentions were the main predictor of medication adherence behavior (path coefficient of 0.353). Perceived benefits and perceived barriers directly (path coefficient = 0.201 and −0.150, respectively), and indirectly (path coefficient = 0.118 and −0.060) through behavioral intentions, influenced medication adherence behavior. Perceived susceptibility (path coefficient = 0.390) and perceived severity (path coefficient = 0.408) influenced behavioral attitudes, which influenced behavioral intentions (path coefficient = 0.298).

Conclusion: The conceptual model demonstrates a robust ability to predict and explain medication adherence behavior among elderly patients with hypertension, facilitating the adoption and maintenance of changes in adherence behavior and the potential for preventing disease progression and improving quality of life.

Keywords: compliance, theory of planned behavior, health belief model, elderly patients, China

Introduction

As the global burden of disease shifts from infectious to non-communicable diseases, and with the extension of life expectancy and changes in lifestyle, the prevalence of hypertension in China continues to rise, posing a major health challenge.[1,2] In China, as many as 245 million people suffer from hypertension, which accounts for 24% of all deaths and 14% of disability-adjusted life years.[3] The prevalence of hypertension among Chinese adults has reached 29.6%.[4]

Hypertension is a concern in China due to poor patient awareness and adherence to treatment, leading to low rates of hypertension treatment and control. Treatment and control rates significantly increased from 12.1% and 2.8% in 1991 to 40.7% and 15.3% in 2012–2015,[5,6] and decreased to 34.6% and 12.0% in 2018, although changes in monitoring methods and an expanding treatment population may have resulted in biased estimations.[7] Non-adherence to medication is a widespread problem, with rates ranging from 30% to 50%,[8,9] and is closely linked to poor clinical outcomes and escalating healthcare costs.[10] Hypertension is preventable and controllable,[11] and the efficacy of antihypertensive medication depends on a patient's adherence; therefore, improving antihypertensive medication adherence has become a priority in China.

A comprehensive understanding of the factors that impact medication adherence in patients with hypertension in China represents an important first step to improving blood pressure control. Currently, medication adherence in patients with hypertension in China has been evaluated in observational studies that considered patients' demographic and clinical characteristics, type of drug and frequency of hospital visits.[12,13] The objective of the present study was to extend these findings and develop and empirically test an innovative conceptual model to explain the factors influencing antihypertensive medication adherence in elderly patients from an urban environment in western China. The conceptual model was based on assumptions derived from the Theory of Planned Behavior (TPB)[14] and the Health Belief Model (HBM).[15] The TPB and HBM are conventional tools used to predict behavior. The TPB states that social norms, behavioral attitudes and perceived behavioral control predict intentions. The HBM explains and predicts health-related behavior. The HBM states that the implementation of a health-related behavior is influenced by an individual's perceived threat from a disease, and whether adopting a health-related behavior will be effective in mitigating that threat. The HBM includes six components: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues-to-action, and self-efficacy.[16] The TPB and HBM were developed to characterize the factors that underlie behavior and do not account for other variables that factor into behavior, such as fear, mood, or past experience. Both the TPB and HBM were developed to characterize the factors that underlie behavior. The objective of the present study was to extend these findings and develop and empirically test an innovative conceptual model to explain the factors influencing antihypertensive medication adherence in representative of elderly patients from a highly urban environment in western China.

Materials and Methods
Innovative Conceptual Model
The TPB and HBM are limited as their main components have a weak effect size and the theories have low predictive capability.[17] The TPB assumes that the primary determinant of behavioral intentions is an individual's attitudes about the likelihood that a behavior will have the expected outcome. When considering medication adherence behavior, behavioral attitudes to medication adherence are influenced by perceived outcomes, and behavioral control is influenced by how confident an individual is that s/he can execute a given behavior. According to TPB, behavioral attitudes to medication adherence are influenced by perceived outcomes, and behavioral control is influenced by how confident an individual is that s/he can execute a given behavior. The HBM assumes that behavioral intentions depend on an individual's own beliefs.[18] When considering medication adherence behavior, perceived susceptibility and perceived severity describe an individual's subjective perception of the risk and potential threat of a disease and influence the individual's attitudes and intentions to adopt medication adherence behavior. Perceived benefits and perceived barriers describe the benefits that an individual obtains or barriers that may be encountered, reflecting an individual's willingness and likelihood to adopt medication adherence behavior. Cues-to-action and self-efficacy refer to an individual's subjective judgment of whether s/he will be able to successfully adopt medication adherence behavior.[19] This study combined the strongest components from each theory to create a complete integrated model to elicit change in health-related behavior (Figure 1).
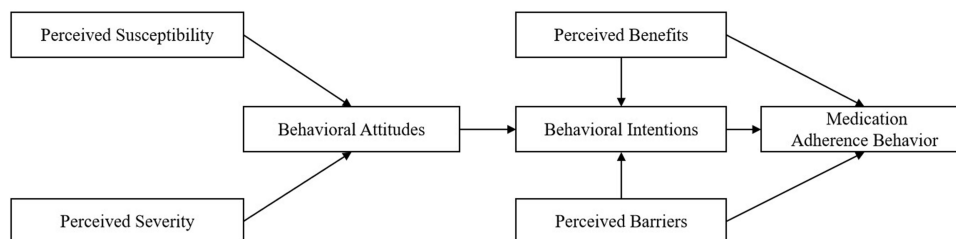

Figure 1 Theoretical model of factors influencing medication adherence behavior. The conceptual model combined the strongest components of the Theory of Planned Behavior (TPB) and the Health Belief Model (HBM).

Participants

This study was approved by the ethics committee of North Sichuan Medical College (#NSMC lunlishencha 202201). Data were analyzed using structural equation modeling (SEM). Sample size was calculated as n=400, assuming a confidence interval of 1.96, a margin of error of 5%, a population proportion of 0.5, and that an SEM requires 10–15 observations per estimated parameter.[20]

A convenience sample of patients aged >60 years with confirmed hypertension attending various community health service centers in Nanchong City, China, between October and December 2020 were eligible for his study. Inclusion criteria were 1) history of hypertension; 2) aged > 60 years; 3) currently or previously prescribed antihypertensive medication; 4) attending a community health service center in Nanchong, China; 5) provided written informed consent to participate in the study; and 6) ability to communicate and willing to work with the researchers. Exclusion criteria were patients with 1) severe complications including cancer, severe cardiopathy, and liver and kidney diseases; 2) secondary hypertension; 3) cognitive impairment; or 4) psychiatric abnormalities.

Instruments

In this study, a total of five trained investigators administered a structured self-administered questionnaire to the patients enrolled in the study. Most patients were able to complete the questionnaire independently. For patients with dyslexia, investigators could directly communicate with these patients, but were unable to provide responses to the questions. In these circumstances, a specifically trained investigator completed the questionnaire based on patient response.

The questionnaire consisted of three parts. Part 1 described the concepts of medication adherence behavior. Part 2 collected demographic data, including patient gender, age, education level, marital status, occupation, per capita monthly income, and health insurance. Part 3 comprised components derived from the TPB and HBM, included as seven subscales with 3 items each: behavioral intentions, behavioral attitudes, perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and medication adherence behavior. Behavioral intentions referred to the motivating factors that influenced the patient to perform a health-related behavior. Behavioral attitudes referred to the degree to which the patient had a positive or negative evaluation of a health-related behavior, following consideration of the outcomes of the behavior. Perceived susceptibility referred to the patient's subjective perception of the risk of acquiring a disease or health problem. Perceived severity referred to the patient's subjective perception of the consequences of a disease. Perceived benefits/barriers referred to the patient's subjective perception of the benefits and barriers related to a health-related behavior. Medication adherence behavior referred to the extent to which a patient correctly followed medical advice (Table 1).

Items were developed based on a literature review, expert consultation and factor analysis. Items were scored on a 5-point Likert scale. Psychometric assessment of Part 3 of the questionnaire showed the Cronbach's α of the total

Table 1 Psychometric Assessment of Part 3 of the Questionnaire (N=400)

Variable	Choice	Factor	KMO	Cronbach's α
Perceived Susceptibility	If I do not comply with my medication, my blood pressure cannot be effectively controlled.	0.871	0.738	0.867
	Not complying with my medication will increase the risk of hypertension and its complications such as stroke, coronary heart disease and kidney disease.	0.857		
	There are people who have suffered from hypertension and its complications due to nonadherence with medication.	0.867		
Perceived Severity	I only take medication when I am not feeling well.	0.872	0.734	0.870
	I decide whether to stop taking my medication or not.	0.856		
	Whether I take my medication depends on my blood pressure. I do not have to follow my doctor's recommendations	0.870		

(*Continued*)

Table 1 (Continued).

Variable	Choice	Factor	KMO	Cronbach's α
Perceived Barriers	I have a poor memory. Sometimes I forget to take my medication.	0.884	0.748	0.892
	I am sometimes too busy to take medication.	0.908		
	Sometimes my blood pressure is well controlled and I stop taking medication to save on medical expenses.	0.885		
Perceived Benefits	Blood pressure is well controlled as long as I take medication every day.	0.876	0.742	0.876
	The risk of hypertension and its complications such as stroke, coronary heart disease and kidney disease can be effectively reduced as long as medication is taken daily in adherence with my doctor.	0.881		
	As long as my medication is taken daily, it can significantly improve quality of life for my family.	0.834		
Behavioral Attitudes	If my blood pressure is not controlled properly, it has adverse effects on health.	0.901	0.759	0.914
	If my blood pressure is not under control, it will affect normal work and daily life.	0.894		
	If my blood pressure is not under control, it will increase the risk of complications such as stroke, coronary heart disease and kidney disease, and increase the burden on the family.	0.869		
Behavioral Intention	What is your overall willingness to take medication?	0.901	0.759	0.925
	Do you take your medication in order to promote health?	0.894		
	Will you actively take medication in the future?	0.869		
Medication Adherence Behavior	I have been taking medication in the exact dosage and frequency recommended by the doctor in the past 6 months.	0.916	0.770	0.938
	I do not stop taking medication on my own even when I feel that my condition is under control.	0.915		
	I do not change the dosage and frequency of medication when I feel that my condition has worsened.	0.909		
Overall			0.822	0.849

questionnaire and each subscale were > 0.8, which indicates good internal consistency. Kaiser-Meyer-Olkin (KMO) testing confirmed that the variables were suitable for a factor analysis (Table 1).

Statistical Methods

Data were collected in Excel. Exploratory factor analysis was conducted using SPSS software to assess the reliability and validity of Part 3 of the questionnaire. Confirmatory factor analysis and SEM were conducted using AMOS software, including calculating factor loadings and standardized path coefficients, and fitting the SEM. P < 0.05 was considered a statistically significant difference.

Results
Characteristics of the Study Subjects

A total of 400 patients with hypertension were enrolled in this study. Table 2 summarizes the baseline characteristics of these patients. Mean (SD) age was 64.81±12.05 years, and 49.0% of the patients were male. 13.2% of patients had higher education, and approximately 50% of patients were educated below high school. 54.5% of patients were farmers. Most

Table 2 Patient Demographic Characteristics (N=400)

Characteristic	Categories	n	%
Gender			
	Male	196	49.00%
	Female	204	51.00%
Age			
	60~65	163	40.75%
	66~70	159	39.75%
	71~75	56	14.00%
	76~80	19	4.75%
	>80	3	0.75%
Education			
	Below high school	192	48.00%
	High school	125	31.25%
	Higher education	53	13.25%
	Other	30	7.50%
Marital status			
	Married	183	45.75%
	Single	9	2.25%
	Divorced/widowed	208	52.00%
Occupation			
	Farmer	218	54.50%
	Public officials	68	17.00%
	Enterprise personnel	45	11.25%
	Self-employed person	18	4.50%
	Other	51	12.75%
Monthly income			
	<1500 Yuan	69	17.25%
	1500–3000 Yuan	136	34.00%
	3001–4500 Yuan	121	30.25%
	>4500 Yuan	74	18.50%
Social security			
	Employee medical insurance	109	27.25%
	Resident medical insurance	72	18.00%
	Other	219	54.75%

(*Continued*)

Table 2 (Continued).

Characteristic	Categories	n	%
Course of disease			
	≤5 years	36	9.00%
	6–10 years	217	54.25%
	11–15 years	89	22.25%
	>15 years	58	14.50%

patients had experienced hypertension for more than 5 years, with 36.7% of patients experiencing hypertension for more than 10 years.

Main Results

AMOS software was used to estimate the SEM. Fit indices ($\chi2$=265.959, $\chi2$/DF = 1.469 [< 2], root mean square error of approximation [RMSEA] = 0.034 [<0.05], and Comparative Fit Index [CFI]; Normed Fit Index [NFI], Tucker Lewis index [TLI] and Incremental Fit Index [IFI], all ≥ 0.9), implied good fit between the conceptual model and the survey data in this study.

Final path coefficients representing the strength of connections between the variables are shown in Figure 2. Behavioral intentions had a direct positive effect on antihypertensive medication adherence behavior at the 0.001 level (path coefficient =0.353; p<0.001), and was the main predictor of antihypertensive medication adherence behavior. Behavioral attitudes had a direct positive effect on behavioral intentions (path coefficient =0.298; p<0.001) and an indirect positive effect on antihypertensive medication adherence behavior (path coefficient =0.105; p<0.001). Perceived benefits had a direct positive effect on behavioral intentions (path coefficient = 0.335; p<0.001) and antihypertensive medication adherence behavior (path coefficient = 0.201; p<0.001), and an indirect positive effect on antihypertensive medication adherence behavior (path coefficient = 0.118; p<0.001). Perceived barriers had a direct negative effect on behavioral intentions (path coefficient = −0.169; p<0.001) and antihypertensive medication adherence behavior (path coefficient =−0.150, p<0.01), and an indirect negative effect on antihypertensive medication adherence behavior (path coefficient =−0.060; p<0.001). Perceived susceptibility and perceived severity were predictors of behavioral attitudes. Perceived susceptibility (path coefficient =0.390, p<0.001, and perceived severity (path coefficient =0.408; p<0.001) had direct positive effects on behavioral attitudes.

Discussion
Adaptability of the Model
The most important contribution of this study is that a conceptual model based on TPB and HBM is innovatively developed and empirically tested using survey data from Nanchong city in western China. Empirical study has proved
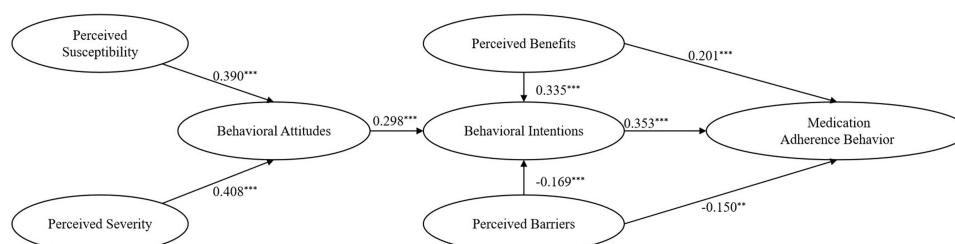

Figure 2 Path analysis medication adherence behavior. In structural equation modeling, the p-value is used to determine the significance of the assumed path. Model output results indicate that the independent variable is significantly correlated with the dependent variable at the 0.01 or 0.001 level.
Notes: **P value <0.01; ***P value <0.001.

that the model has a high explanatory and predictive ability for the antihypertensive drug compliance behavior of elderly patients in western China.

This new conceptual model integrates the influence of behavioral intentions, behavioral attitudes, perceived benefits, perceived barriers, perceived susceptibility, and perceived severity on antihypertensive medication adherence.

Fully consider that the patient is a social being, and his/her behavior will be affected by various sources. These complicated factors will affect whether the patient will comply with the medication. Only by clarifying these factors can we better help the patient.

The Effect of Behavioral Intentions

In the present study, behavioral intentions (path coefficient =0.353; p<0.001) were the main predictor of antihypertensive medication adherence behavior. These findings are consistent with previous research, which has demonstrated the close association between behavioral intentions and medication adherence.[21,22]

Within the context of medication adherence behavior, behavioral intentions determine whether patients take their medication in accordance with medical advice. Treatment for hypertension requires chronic therapy and maintenance of certain lifestyle habits and dietary restrictions, such as taking medication on time and avoiding foods or beverages that interact with medications. Only patients with strong behavioral intentions can adhere to medication and change their lifestyle, increasing treatment efficacy. These findings imply that enhancing behavioral intentions may improve medication adherence and treatment outcomes in patients with hypertension.[23–25]

The Effect of Behavioral Attitudes

In this study, behavioral attitudes indirectly influenced medication adherence behavior through behavioral intentions (path coefficient = 0.105). Previous research shows a close correlation between behavioral attitudes, behavioral intentions, medication adherence, and blood pressure control.[26–28] Patients with a positive attitude towards medication and the intention to adhere to the prescribed medication regimen are more likely to exhibit positive medication adherence behavior, which should improve clinical outcomes. To the authors' knowledge, previous reports have examined the effects of behavioral attitudes and behavioral intentions on medication adherence behavior. The present study verified the accuracy of these previous studies and further explored the mediating role of behavioral intentions in medication adherence behavior in patients with hypertension.

The Effect of Perceived Benefits and Perceived Barriers

Perceived benefits (direct: path coefficient = 0.201; indirect: path coefficient = 0.118) and perceived barriers (direct: path coefficient = −0.150; indirect: path coefficient = −0.060) directly, and indirectly through behavioral intentions, influenced antihypertensive medication adherence behavior. When patients perceive the benefits of medication, such as reducing blood pressure and complications, they are more likely to adhere to the prescribed medication.[29] Perceived barriers, such as lack of efficacy, side effects, and costs may reduce patients' confidence in treatment and decrease their adherence behavior.[30,31] Consistent with this, other studies have demonstrated the direct impact of perceived benefits and barriers on patients' decisions to manage hypertension.[32]

Perceived benefits and perceived barriers have an indirect influence on medication adherence through behavioral intentions. When patients perceive the benefits of medication, such as reducing blood pressure and complications, lowering medical costs, and improving health outcomes, their willingness to continue using medication increases.[33] Conversely, perceived barriers can diminish individuals' recognition of the effectiveness and importance of medication therapy, creating doubts and resistance to medication adherence,[33] highlighting the importance of reducing perceived barriers to medication adherence.[34]

The Effect of Perceived Susceptibility and Perceived Severity

Perceived susceptibility and perceived severity were predictors of behavioral attitudes, with standardized path coefficients of 0.390 and 0.408, respectively (p<0.001). Patients' perception of the severity and susceptibility of their condition can motivate them to adhere to antihypertensive medication.[35] When patients perceive hypertension as a more severe

condition (perceived high severity) and themselves as more susceptible to hypertension (perceived high susceptibility), they are more likely to exhibit improved medication adherence behavior.[36]

Perceived severity and susceptibility can indirectly affect patients' medication adherence behavior by influencing their behavioral attitudes and behavioral intentions towards hypertension. When individuals have a high perception of severity and susceptibility, they tend to pay more attention to their illness and personal feelings, take their condition seriously, and are more likely to adopt positive attitudes and behaviors to control hypertension. Conversely, if they have a low perception of severity and susceptibility, they may not take their illness seriously and may not adhere to medication as prescribed.

Recommendations

The findings from the present study may inform the implementation of public health programs to improve blood pressure control, education and medication adherence in patients with hypertension in western China. Based on the factors influencing medication adherence behavior identified in this study and in conjunction with the development of targeted interventions led by primary healthcare providers, appropriate measures can be taken to improve medication adherence behavior in patients with hypertension.

Collaborative decision-making between clinicians and patients may enhance disease awareness, promote a high level of awareness of the severity and susceptibility of the disease, assist elderly patients and their families in managing chronic diseases, and induce changes in attitudes and behaviors. Emphasis should be placed on the burden of chronic disease and the provision of community resources, and family members should be provided health education so they can offer appropriate support to elderly patients.

Limitations

This study was limited by its cross-sectional design. Data were collected from patients with hypertension in Nanchong City, Sichuan Province, China; therefore, the sample size was small and may not be generalizable to other regions. Also, our study based on the data from a single center, which may have some selection bias and thus distort the conclusions.

Conclusion

A novel conceptual model integrating key components from TPB and HBM was developed and empirically tested using survey data collected in Nanchong city, western China. The model's high explanatory and predictive power for antihypertensive drug compliance behavior among elderly patients was demonstrated by empirical studies.

The model suggested the development of interventions that improve medication adherence behavior in elderly patients with hypertension in western China. Managing elderly patients with chronic diseases may facilitate the adoption and maintenance of long-term changes in medication adherence behavior, with potential to prevent progression of disease and improve quality of life.

Ethics Approval and Informed Consent

The study was conducted in accordance with the Declaration of Helsinki, and approved by the the ethics committee of North Sichuan Medical College (#NSMC lunlishencha 202201). Informed consent was obtained from all study subjects.

Disclosure

The authors report no conflicts of interest in this work.

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