

Analysis of Structural Equation Modeling on Factors Related to Health Literacy among Elderly Hypertensive Patients in the Community

Peng Huijiao, Huang Wanxia, Zheng Changhua*

Guangzhou Health Science College, Guangzhou, Guangdong, China

*Corresponding author

Abstract: To construct a structural equation model (SEM) of factors related to health literacy among elderly hypertensive patients in the community and analyze the pathways and strengths of these factors' effects on health literacy in the model. Elderly hypertensive patients ($n=140$) registered at a community health center in Guangzhou from December 2023 to March 2024 were selected as the study sample using convenience sampling method. Data collection utilized the General Information Questionnaire, Hypertension Health Knowledge Questionnaire, Short-Form Health Belief Model Scale (SFHBMS), and Health Literacy Management Scale (HeLMS). Pearson correlation and logistic regression analyses examined variable relationships. Amos 26.0 software was used to analyze the path relationships between factors, construct a structural equation model, and fit the data and correct the model via maximum likelihood estimation. The total health literacy score was 107.56 ± 14.30 . Both total health knowledge and health belief scores were positively correlated with the total health literacy score ($P < 0.001$). Health knowledge had a direct effect on health literacy ($\beta = 0.238$, $P = 0.012$), while health beliefs had a direct effect ($\beta = 0.444$, $P < 0.001$). Health knowledge also indirectly influenced health literacy through health beliefs (indirect effect = 0.099). The total effect of health knowledge on health literacy was 0.337, and the mediating effect of health beliefs accounted for 29.38% of the total effect. Health knowledge and health beliefs all have a positive effect on the health literacy of elderly hypertensive patients in the community, and health beliefs play a partial mediating role between health knowledge and health literacy.

Keywords: Hypertension, Health Literacy, Health Belief Model, Structural Equation Modeling

1. Introduction

Hypertension ranks among the top three chronic diseases in Chinese elderly populations, with a prevalence of 58.3% in individuals aged ≥ 60 years^[1]. As a key risk factor for stroke and coronary heart disease, it severely threatens physical health and quality of life^[2]. Challenges in hypertension management include suboptimal awareness, treatment, and control rates^[3]. Active health management of hypertensive patients is integrated into the prevention and treatment system, in which health literacy is a key factor. Health literacy is the ability of individuals to access and understand basic health information and services and to use them to make sound decisions to maintain and promote their health^[4]. Studies show that health literacy directly influences health outcomes^[5]. For example, Nie et al. reported a health literacy rate of 10.10% among hypertensive patients, lower than 16.13% in the general population^[6]. Another study found that health beliefs are one of the factors influencing health literacy, and that health beliefs influence patients' attitudes and behaviors when facing illnesses to a certain extent, which is also in line with the theory of the "Health Belief Model" (HBM)^[7]. Health literacy affects health outcomes in elderly hypertensive patients, and health literacy is influenced by health knowledge and health beliefs.

This study aimed to assess health literacy levels in community-dwelling elderly hypertensive patients, analyze influencing factors, and use SEM to clarify factor relationships, providing a basis for targeted health promotion interventions.

2. Methods

2.1 Study Participants

140 elderly hypertensive patients (≥ 65 years) from a Guangzhou community health service center between December 2023 and March 2024 were selected via convenience sampling. Inclusion criteria: (1) Meets diagnostic criteria for hypertension in the National Guidelines for Hypertension Prevention and Management in Primary Care [8]; (2) Resident in the community, age ≥ 65 years; (3) Capable of effective communication; (4) Volunteer to participate in this project and sign the informed consent form. Exclusion criteria: (1) secondary hypertension; (2) history of stroke; (3) severe complications; (4) people with mental illness or cognitive impairment that prevents them from cooperating. According to the sample size calculation method [9], 140 cases were finally included in the sample of this study.

2.2 Research Instruments

(1) General Information Questionnaire: Developed by the research team, covering sociodemographics information (gender, age, marital status, education, income, etc.) and disease-related data (BMI, disease duration, comorbidities, family history, etc.).

(2) Hypertension Health Knowledge Questionnaire: Adapted from Wan et al.'s Stroke Knowledge Questionnaire (SKQ), including 25 items on exercise, nutrition, etc. Scored as correct (1 point) or incorrect (0 points), converted to a 100-point scale. Higher standardized scores indicate higher levels of stroke health literacy among patients, with 60 being a passing level (Cronbach's $\alpha = 0.87$, CVI = 0.89) [10].

(3) Short Form Health Belief Model Scale (SFHBMS): Modified from Champion's HBM Scale, comprising 20 items across six dimensions (perceived susceptibility, severity, benefits of health behavior, barriers, motivation, self-efficacy). Scored on a 5-point Likert scale (reverse-scored for "barriers"), with higher scores indicating stronger health beliefs (Cronbach's $\alpha = 0.835$, split-half reliability = 0.779, test-retest reliability = 0.811, CVI = 0.85) [11].

(4) Health Literacy Management Scale (HeLMS): Translated by Sun et al. from Jordan's original scale, including 24 items in four dimensions (information acquisition, communication, health improvement motivation, economic support willingness). Scored on a 5-point Likert scale, with total scores 24-120. Higher scores mean better health literacy levels (≥ 96 = adequate health literacy). Cronbach's $\alpha = 0.894$, Cronbach's α for each dimension ranged from 0.857 to 0.947, test-retest reliability = 0.683 [12-13].

2.3 Data Collection

Trained community healthcare workers administered paper questionnaires. Uniform instructions were used in the survey, and the investigator explained in detail how to fill out the questionnaire and the precautions to be taken to the study participants. Participants completed questionnaires independently or with assistance. A total of 150 questionnaires were distributed, yielding an effective response rate of 93.33% (140 valid responses).

2.4 Statistical Analysis

Data were entered and double-checked using Epidata software, and Stata 16.0 software for statistical data processing. Measurement data was described using mean $\pm$ standard deviation and constitutive ratio. Pearson correlation analysis and logistic regression analysis were used to explore the relationships between variables. AMOS 26.0 software was employed to analyze the path relationships among factors, construct a structural equation model, and fit/revise the model using the maximum likelihood method. The significance level was set at $\alpha = 0.05$.

3. Results

3.1 Baseline Characteristics

A total of 140 participants were included in this study, with ages ranging from 56 to 97 years (71.01 ± 8.39 years). There were 54 males (38.57%) and 86 females (61.43%). In terms of educational level, 27 cases (19.29%) had primary school education, 30 cases (21.43%) had junior high school

education, 67 cases (47.86%) had senior high school or technical secondary school education, and 16 cases (11.43%) had college education or above. For marital status, 2 cases (1.43%) were unmarried, 116 cases (82.86%) were married, 3 cases (2.14%) were divorced, and 19 cases (13.57%) were widowed. Regarding occupational status, 5 cases (3.57%) were employed, and 135 cases (96.43%) were retired, including 9 managers in government agencies and enterprises (6.43%), 27 professional and technical personnel (19.29%), 38 clerical and business staff (27.14%), 39 worker operators (27.86%), and 27 sales and service personnel (19.29%). Monthly per capita household income was <3000 CNY in 3 cases (2.14%), 3000-4000 CNY in 9 cases (6.43%), 4000-5000 CNY in 54 cases (38.57%), and ≥5000 CNY in 74 cases (52.86%). Medical expenses were covered by medical insurance in 137 cases (97.86%) and public funding in 3 cases (2.14%). A family history of hypertension was present in 77 cases (55%). Disease duration ranged from 1 to 40 years, with a median of 10 years. Comorbidities included stroke in 10 cases (7.14%), diabetes mellitus in 42 cases (30%), coronary heart disease in 9 cases (6.43%), and hyperlipidemia in 50 cases (35.71%).

3.2 Scores of Health Knowledge, Health Beliefs, and Health Literacy

The results are presented in Table 1.

Table 1 Scores of health knowledge, health beliefs, and health literacy in elderly hypertensive patients (n=140)

Item	Number of items	Total score ($\bar{x} \pm s$)	Mean score of each dimension ($\bar{x} \pm s$)	Rank
Health knowledge	25	76.17±22.78	3.05±0.91	
Health beliefs	20	80.45±8.92	4.02±0.45	
Perceived susceptibility	2	8.07±1.64	4.03±0.82	5
Perceived severity	3	12.65±2.51	4.22±0.84	4
Health motivation	4	18.13±2.78	4.53±0.69	1
Self-efficacy	3	12.81±2.10	4.27±0.70	3
Perceived benefits of health behavior	4	17.95±2.47	4.49±0.62	2
Perceived barriers to health behavior	4	10.84±3.97	2.71±0.99	6
Health literacy	24	107.56±14.30	4.48±0.60	
Information acquisition ability	9	40.55±6.43	4.51±0.71	3
Communication ability	9	39.21±6.24	4.36±0.69	4
Willingness to improve health	4	18.29±2.88	4.57±0.72	2
Willingness for financial support	2	9.51±1.28	4.75±0.64	1

3.3 Correlations and Regression Analysis

Pearson correlation analysis was performed to examine the correlations between health literacy, health knowledge, and health beliefs, with results shown in Table 2. Univariate logistic regression analysis was used to analyze the relationships among health literacy, health knowledge, and health beliefs, and the results are presented in Table 3.

Table 2 Correlation between health literacy and health knowledge/health beliefs in elderly hypertensive patients (n=140)

Health literacy	Total health knowledge score	Total health beliefs score
Total score	0.281***	0.412***
Information acquisition ability	0.267**	0.359***
Communication ability	0.203*	0.383***
Willingness to improve health	0.266**	0.329***
Willingness for financial support	0.212*	0.187*

Note: *, P<0.05; **, P<0.01; ***, P<0.001.

Table 3 Univariate regression analysis of health knowledge and health beliefs influencing health literacy (n=140)

Variable	Health literacy	
	t-value	P-value
Health knowledge		
Exercise	3.52	0.001**
Nutrition	2.31	0.022*
Low-sodium diet	1.41	0.160
Blood pressure monitoring	1.96	0.052
Smoking cessation	1.56	0.120
Alcohol restriction	2.91	0.004**
Medication adherence	1.55	0.123
Stroke risk factors	2.66	0.009**
Stroke premonition	2.53	0.013*
Stroke management	3.39	0.001**
Health beliefs		
Perceived susceptibility	3.36	0.001**
Perceived severity	3.62	<0.001***
Health motivation	4.96	<0.001***
Self-efficacy	5.24	<0.001***
Perceived benefits of health behavior	4.14	<0.001***
Perceived barriers to health behavior	-0.81	0.418

Note: *, P<0.05; **, P<0.01; ***, P<0.001.

3.4 Structural Equation Model

Based on the Health Belief Model^[14] and the results of correlation and regression analyses between health literacy, health knowledge, and health beliefs in this study, a structural equation model (SEM) was employed to further clarify the potential action pathways and causal relationships between variables. The following theoretical path relationships were hypothesized:

- (1) Health knowledge → Health literacy;
- (2) Health beliefs → Health literacy;
- (3) Health knowledge → Health beliefs;
- (4) Health knowledge → Health beliefs → Health literacy.

Accordingly, health literacy was set as the endogenous latent variable, while health knowledge and health beliefs were designated as exogenous latent variables to construct the SEM using AMOS 26.0 software. The model was fitted using maximum likelihood estimation, and the hypothesized model was revised based on modification indices. The fit indices of the revised model are presented in Table 4, and the path coefficient analysis is shown in Table 5. Health knowledge had a direct effect on health literacy ($\beta=0.238$, $P=0.012$), and health beliefs also had a direct effect on health literacy ($\beta=0.444$, $P<0.001$). Additionally, health knowledge indirectly influenced health literacy through health beliefs, with an indirect effect of $0.222 \times 0.444 \approx 0.099$. The total effect of health knowledge on health literacy was $0.238 + 0.099 = 0.337$, and the mediating effect of health beliefs accounted for 29.38% of the total effect. The specific effects between variables are listed in Table 6.

Table 4 Fit indices of the revised hypothetical model (N=140)

Statistical measure	Result	Criteria	Model fit evaluation
Goodness-of-Fit Index(GFI)	0.934	>0.9	Yes
Adjusted Goodness-of-Fit Index(AGFI)	0.897	>0.85(good fit)	Yes
Root Mean Square Error of Approximation(RMSEA)	0.038	<0.05(excellent fit); <0.08(reasonable fit)	Yes
Normed Fit Index(NFI)	0.907	>0.9	Yes
Incremental Fit Index(IFI)	0.983	>0.9	Yes
Comparative Fit Index(CFI)	0.983	>0.9	Yes
Chi-square/df ratio(NC)	1.197	1<NC<3(good fit), <5 (reasonable fit)	Yes
Parsimony Goodness-of-Fit Index(PGFI)	0.595	>0.5	Yes
Parsimony Normed Fit Index(PNFI)	0.674	>0.5	Yes

Table 5 Path coefficient analysis of the model (N=140)

Path	Unstandardized coefficient	Standardized coefficient	S. E.	C. R. (t)	P
Health knowledge→Health beliefs	0.096	0.222	0.046	2.094	0.036
Health knowledge→Health literacy	0.282	0.238	0.112	2.517	0.012
Health beliefs→Health literacy	1.210	0.444	0.272	4.457	***

Note: *, P<0.05; **, P<0.01; ***, P<0.001.

Table 6 Standardized effect sizes of variables on health literacy in the model (N=140)

Variable relationship	Direct effect	Indirect effect	Total effect
Health knowledge→Health beliefs	0.222	0.000	0.222
Health beliefs→Health literacy	0.444	0.000	0.444
Health knowledge→Health literacy	0.238	0.099	0.337

4. Discussion

4.1 Health Literacy Status

The results of this study showed that the total health literacy score among elderly hypertensive patients in the community was (107.56±14.30) points, generally at a good level (≥96 points), outperforming the findings of Wan Qunqun et al. (2015) [15]. This outcome may be attributed to: (1) Active implementation of health policies by government departments, such as "Healthy China 2030" Plan Outline and Healthy China Initiative; (2) Strengthened health education and promotion by various units under policy support.

Among all dimension scores, willingness for financial support scored the highest, followed by willingness to improve health, information acquisition ability, and communication and interaction ability. The high economic level of participants (74 cases, 52.86%, had monthly per capita household income ≥5000 yuan) likely contributed to the top score in financial support willingness. Previous research [13] indicated a strong correlation between the "willingness to improve" dimension and patients' educational level. In this study, most participants (83 cases, 54.97%, with high school education or above) showed high scores in the "willingness to improve health" dimension, possibly due to their profound understanding of the necessity of hypertension self-management. This group tends to actively allocate personal resources (time, energy, and financial support) to maintain health.

With an average age of 71.01±8.39 years, a median disease duration of 10 years, and 111 cases (73.50%) with comorbidities (stroke, diabetes mellitus, coronary heart disease, hyperlipidemia), factors like advanced age, multiple diseases, and mobility/communication difficulties reduced scores in information acquisition and communication interaction abilities. This highlights the need for community healthcare workers to prioritize elderly patients with multiple diseases and mobility issues, who have limited access to modern media (e.g., mobile phones). Tailored health education methods are essential for this group.

4.2 Effects of Health Knowledge and Health Belief on Health Literacy in Community - Dwelling Elderly Hypertensive Patients

The results of this study showed that the total scores of health knowledge and health belief were positively correlated with the total score of health literacy ($P < 0.001$), indicating that the higher the levels of health knowledge and health belief in elderly hypertensive patients, the better their health literacy levels. This is consistent with previous domestic and international research conclusions [7, 16].

Health literacy refers to an individual's ability to obtain health knowledge, understand and handle relevant information and services, and make correct decisions based on such information and services [17]. It can be seen that health knowledge is an important foundation for health literacy. Strengthening health knowledge education for community-dwelling elderly hypertensive patients can improve their health literacy levels. Community healthcare workers can adopt diversified health education methods, such as using popular self-media, short videos, and other communication channels for publicity and education. Meanwhile, for patients with advanced age and low ability to obtain information through modern media such as mobile phones, one-to-one home visits, group salon activities, and other forms can also be adopted to enhance the effectiveness of health education.

The total score of health belief was positively correlated with the total score of health literacy.

Analyzing the reasons, it to some extent indicates that elderly hypertensive patients can perceive the risks (susceptibility) that hypertension will bring to them and other possible serious consequences, such as stroke (severity). They can also perceive the benefits of adopting health behaviors for themselves, and strengthen this perception through health motivation and self - efficacy. Eventually, it can increase their enthusiasm for acquiring and understanding hypertension - related knowledge (information acquisition ability) and maintaining health outcomes (willingness to improve health), and finally improve their health literacy levels to a certain extent.

4.3 Health Belief Plays a Partial Mediating Role between Health Knowledge and Health Literacy in Community - Dwelling Elderly Hypertensive Patients

The structural equation model (SEM) in this study showed that health knowledge not only directly influences the health literacy of community - dwelling elderly hypertensive patients but also indirectly affects health literacy through health belief. The mediating effect value was 0.099, accounting for 29.38% of the total effect. Health belief plays a partial mediating role between patients' health knowledge and health literacy, meaning that a better level of health knowledge can help improve patients' health belief and further promote the enhancement of health literacy.

From the research results, health belief is a key factor for community - dwelling elderly hypertensive patients to perceive risks, perceive benefits, accept persuasion, acquire health knowledge, change bad living habits, have the health motivation to adopt healthy behaviors, and ultimately improve their health literacy levels. Therefore, it is recommended that community healthcare workers, while conducting health knowledge education for patients, should also consider the crucial role of health belief. They should correctly evaluate patients' health belief levels, pay attention to individuals' subjective psychological processes, and formulate personalized health education programs according to patients' specific situations, such as perceived susceptibility, perceived severity, and self - efficacy. This can improve the pertinence and effectiveness of interventions, and further change patients' own health literacy.

5. Conclusion

Current studies on health literacy in hypertensive patients, both domestically and internationally, mostly employ descriptive analysis and multiple regression analysis, which cannot adequately analyze the causal relationships between influencing factors and health literacy. By constructing a structural equation model (SEM) and using the Health Belief Model (HBM) to analyze the correlations among health literacy, health knowledge, and health beliefs in community-dwelling elderly hypertensive patients, this study addressed the limitations of solely using multiple linear regression to evaluate influencing factors of health literacy. It effectively clarified the causal relationships between various components and health literacy, providing a basis for targeted health education.

This study has certain limitations. As a theoretical framework, the Health Belief Model emphasizes the analysis of subjective factors in the cognitive dimension, particularly potential biases in the individualized cognition of health beliefs among the elderly population. It is recommended that future research adopt a trans-theoretical integrated research model, systematically exploring the mechanism of health literacy through constructing a multidimensional analysis model.

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