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Predictive Model of Blood Pressure Control Behavior in Efforts to Prevent Complications Using the Health Belief Model (HBM) Approach Among Hypertensive Patients

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ABSTRACT

Background: In Denpasar City, the prevalence of hypertension and its complications has increased from year to year. The occurrence of complications among hypertensive patients is largely due to poor blood pressure control behavior. To improve patients' blood pressure control behavior, it is necessary to develop a predictive model that considers social support from healthcare providers, as well as patients' perceptions and beliefs. Objectives: To develop a predictive model of blood pressure control behavior using the Health Belief Model (HBM) approach. Methods: This study consisted of two phases: a quantitative phase using a cross-sectional design and a quasi-experimental phase employing a nonequivalent (pretest and posttest) control group design. The study was conducted over a two-month period in Denpasar City. The study population included hypertensive patients who were actively registered in the primary healthcare center's medical records. Data were collected through questionnaires and analyzed using Structural Equation Modeling (SEM) and cross-tabulation. Results: Of the 192 respondents, 59.8% were found to have poor blood pressure control behavior. The SEM analysis showed a good model fit, with behavioral factors such as self-efficacy (coefficient = 0.370; p = 0.001), healthcare provider support (coefficient = 0.244; p = 0.004), and perceived susceptibility (coefficient = -0.084; p = 0.000) significantly influencing blood pressure control behavior. The predictive behavior model was successfully developed based on the findings of the previous research stages. The intervention using the predictive behavior model effectively improved blood pressure control behavior (PR = 5.6; p = 0.022). Conclusion: The predictive behavior model based on the Health Belief Model (HBM) was successfully developed and demonstrated the ability to enhance blood pressure control behavior. Therefore, its application should be expanded to prevent complications among hypertensive patients in Denpasar City.

INTRODUCTION

Blood pressure control among patients with hypertension to prevent complications is achieved through two primary approaches: pharmacological and non-pharmacological (1). The pharmacological approach consists of routine medication, whereas the non-pharmacological approach involves adopting a healthy lifestyle, including regular physical activity, maintaining a balanced diet, abstaining from smoking, and avoiding alcohol consumption (2). According to 2018 Riskesdas data, 52% of hypertensive patients who adhered to pharmacological treatment achieved controlled blood pressure, compared to those who did not adhere (3). Adherence to non-pharmacological strategies, such as physical activity, dietary management, smoking cessation, and abstaining from alcohol, also represents a significant alternative for blood pressure control. Patients with hypertension are expected to regulate their diet and participate in regular physical activity. Additionally, blood pressure can be managed by avoiding smoking and alcohol consumption (4). The 2018 Riskesdas data further indicate that 58% of hypertensive patients adhering to a healthy lifestyle achieved controlled blood pressure, compared with those who did not (5).

The effectiveness of blood pressure control behaviors in preventing complications among hypertensive patients, through both pharmacological and non-pharmacological means, is influenced by multiple factors. Previous research has identified age, occupation, gender, education, income level, and self-efficacy as determinants of blood pressure control behaviors (6–10). Furthermore, a 2021 study conducted in China reported that social support from healthcare providers and patients' perceptions of recovery significantly influence these behaviors (11). Hypertensive patients who receive support from healthcare workers are 2.3 times more likely to engage in blood pressure control compared to those without such support. Similarly, patients with a positive perception of recovery are 4.2 times more likely to perform blood pressure control behaviors (12).

In summary, complications among hypertensive patients are primarily associated with low adherence to both pharmacological and non-pharmacological blood pressure control behaviors. Enhancing these behaviors depends on several factors, including patient characteristics, self-efficacy, patient perceptions, and social support from healthcare providers. This study aims to develop a behavioral model that integrates these influencing factors to improve blood pressure control behaviors among hypertensive patients in Denpasar City and reduce the risk of complications.

METHODS

StudyDesign and Setting

This study consists of 2 stages. The two stages of the study were conducted from September to October 2025. The first stage, which used quantitative research with a cross-sectional design, was conducted to analyze factors in blood pressure control behavior, including the health belief model, social support, and self-efficacy theory, among selected hypertension patients in Denpasar City

Participants and Sampling

Participants were hypertensive patients registered at Public Health Centers (Puskesmas) in Denpasar City, aged ≥35 years, who provided informed consent and could communicate effectively. Patients with severe complications (e.g., stroke or heart failure), cognitive impairment, severe illness, or those unavailable during the data collection period were excluded.

Data Collection Procedures

Data collection was carried out by survey using a questionnaire , then analyzed using structural equation modeling analysis and logistic regression. The questionnaire used in this study was developed based on the Health Belief Model (HBM) and self-efficacy theory, with adaptations to the local context. Prior to data collection, the instrument was tested for validity and reliability. Item validity was assessed using Pearson correlation, with all items demonstrating correlation coefficients exceeding the r-table value, indicating acceptable validity. Reliability was evaluated using Cronbach's alpha, with all variables showing values ≥0.70, confirming good internal consistency.

Data Analysis

The second stage used a quasi-experimental research method with a nonequivalent (pretest and posttest) control group design which was carried out to prove that the predictive model intervention could improve the blood pressure control behavior of hypertensive patients located in Public Health Centers throughout West Denpasar District (intervention group) and in Public Health Centers throughout East Denpasar District (control group). Data collection was carried out using a survey questionnaire twice before and after the intervention, and the data were analyzed using cross-tabulation in STATA (13) (2).

Ethical Considerations

This research was conducted in accordance with research ethics standards and has obtained ethical clearance from the authorized ethics committee. Evidence of the ethical approval is available at the following link https://drive.google.com/file/d/1o9KOzib0ySg6glYfaoSAixmZrBFLDK8B/view?usp=sharingand the number of ethics was 005067/KEP Universitas Dhyana Pura/2025.

RESULT AND DISCUSSION

RESULT

Stage 1 Results

The quantitative study successfully interviewed all 192 participants. Based on age, most respondents were ≥ 60 years old (70.83%), with an average age of 64.2 years. Regarding gender, the majority of respondents were female (65.1%). Regarding educational level, a large proportion had an elementary school education (primary education), totaling 86 individuals (44.8%); the rest had junior and senior high school education (secondary education), totaling 81 individuals (42.2%), and only a small number had a diploma or bachelor's degree (higher education), amounting to 25 individuals (13.0%). The detailed characteristics of the study respondents are presented in Table 1 below.

Tabel 1. Characteristic of Respondent Data

Characteristic of respondent (n=192)	f (%)
Age (years), mean ± SD (min–max)	64,2±9,5 (35-88)
Non-elderly (< 60 years)	56 (29,17%)
Elderly (≥ 60 years)	136 (70,83%)
Gender	
Female	125 (65,1%)
Male	67 (34,9%)
Occupation	
Housewife / Unemployed	105 (54,7%)
Farm laborer	2 (1,0%)
Private employee	15 (7,8%)
Entrepreneur / Trader	28 (14,6%)
Civil servant / Police / Retired	42 (21,9%)
Income level	
Low (≤ IDR 2,700,000)	162 (84,4%)
High (> IDR 2,700,000)	30 (15,6%)
Education level	
Primary education (≤ Elementary school)	86 (44,8%)
Secondary education (Junior and Senior high school)	81 (42,2%)
Higher education (≥ Diploma)	25 (13,0%)
Marital status	
Single	5 (2,6%)
Divorced	40 (20,8%)
Married	147 (76,6%)

The description of blood pressure control behaviors was measured based on treatment adherence and adherence to a healthy lifestyle.

Tabel 2. Description of Blood Pressure Control Behaviors Among Hypertensive Patients

Variable (n=192)	f (%)
Blood Pressure Control Behaviors of Respondent	
Poor	115 (59,8%)
Good	77 (40,2%)
Respondent Treatment Adherence	
Non-Adherence	76 (39,6%)
Adherence	116 (60,4%)
Respondent Healthy Lifestyle Adherence	
Non-Adherence	61 (31,8%)
Adherencece	131 (68,2%)

Blood pressure control behavior is considered good if respondents adhere to treatment and maintain a healthy lifestyle. Conversely, blood pressure control behavior is considered poor if respondents do not adhere to

treatment and a healthy lifestyle, or if they are non-adherent to either component. The analysis showed that 115 respondents (59.8%) had poor blood pressure control, while 77 (40.2%) had good blood pressure control.

The factors influencing blood pressure control behavior among hypertensive patients across all Public Health Centers (Puskesmas) in Denpasar City were analyzed using SEM in STATA. The patient characteristic variables, which include age, gender, occupation, income level, education level, and marital status, were not included in the analysis because they were categorical in scale. Additionally, the variable related to perceived benefits was excluded from the model because it was considered to compromise model fit. The initial SEM analysis focused on behavioral factors without incorporating the Health Belief Model. The initial goodness-of-fit results showed RMSEA and SRMR values of 0.108 and 0.096, respectively (>0.08), and a CFI value of 0.852 (<0.90). Modification index procedures were then applied, yielding an RMSEA of 0.092 (>0.08), an SRMR of 0.069 (<0.08), and a CFI of 0.901 (>0.90). These results indicate that the model was not yet fully fit, as the RMSEA remained >0.08, although the other criteria (SRMR and CFI) met the required thresholds.

Tabel 3. Results of the SEM Analysis of Blood Pressure Control Behavior Factors Among Hypertensive Respondent Using the Health Belief Model Approach

No	Factors Influencing Blood Pressure Control Behavior	Direct Effect		Indirect Effect		Total Effect	
		Coef*	p value	Coef*	p value	Coef*	p value
1.	Self-efficacy	0,370	0,001	-	-	0,370	0,001
2.	Health provider support	-	-	0,244	0,004	0,244	0,004
3.	Perceived susceptibility	-	-	-0,084	0,000	-0,084	0,000
4.	Perceived barriers	0,017	0,764	0,030	0,111	0,047	0,387
5.	Perceived severity	-0,057	0,090	-	-	-0,057	0,090

Coef* = Standardized coefficients; RMSEA = 0,076 ; SRMR = 0,069 ; CFI = 0,920

The initial goodness-of-fit test results showed an RMSEA value of 0.112 (>0.08), an SRMR value of 0.079 (<0.08), and a CFI value of 0.823 (<0.90). After applying modification indices procedures, the final model produced RMSEA and SRMR values of 0.076 and 0.069 (<0.08), respectively, and a CFI value of 0.920 (>0.90). These results indicate that the model is considered fit. Respondent characteristics were not included in the SEM analysis because they used categorical data scales. Therefore, the patient characteristic variables were analyzed separately using logistic regression. The logistic regression analysis of patient characteristics is described below, with the results presented in the following table:

Tabel 4. Results of the Logistic Regression Analysis of Respondent Characteristics on Blood Pressure Control Behavior Among Hypertensive Patients

Respondent Characteristic	OR	SE	p value	95% CI
Age	1,231	0,441	0,561	0,6097836 – 2,488739
Gender	0,839	0,295	0,618	0,42123 – 1,671843
Occupation	0,976	0,107	0,831	0,7869655 – 1,212214
Income level	1,069	0,551	0,897	0,3888956 – 2,938852
Education level	1,473	0,381	0,135	0,8864283 – 2,448644
Marital status	1,347	0,450	0,372	0,699748 – 2,59408

SE = Standard error; Pseudo R^2 = 0.0164; Prob > chi^2 = 0.6295

Based on Table 4 above, the respondent characteristic variables, across their categories, did not influence blood pressure control behavior (all p-values > 0.05). These results confirm that patient characteristics do not affect blood pressure control behavior, as both regression analyses conducted produced consistent findings (p-values > 0.05).

Stage 2 Results

With the implementation of the predictive model intervention developed based on the SEM analysis results from stage 1 of the study, it is expected that poor blood pressure control behaviors can be improved to good behaviors. The descriptive pre-intervention analysis showed that blood pressure control behaviors among hypertensive patients in both the control group and the intervention group did not vary significantly. The results of the model intervention evaluation can be seen in Table 5 below:

Tabel 5. Results of the Analysis of Blood Pressure Control Behavior by Study Group

No	Study Group	Blood Pressure Control Behavior							
		Pre (n=16)				Post (n=16)			
		Poor n (%)	Good n (%)	RR	p value	Poor n (%)	Good n (%)	RR	p value
1.	Control (Kec. Dentim)	9 (56,3%)	7 (43,7%)	*ref*	1,000	10 (62,5%)	6 (37,5%)	*ref*	0,022
2.	Intervension (Kec. Denbar)	9 (56,3%)	7 (43,7%)	0,0		4 (25,0%)	12 (75,0%)	5,6	

The post-intervention analysis of respondents' blood pressure control behavior, conducted after one month of intervention, showed a statistically significant difference between the control and intervention groups, with an RR value of 5,6 and a p-value of 0.022. This indicates that the likelihood of improved blood pressure control behavior among respondents in the intervention group was 5,6 times higher compared to the control group.

DISCUSSION

Self-efficacy had a direct effect on blood pressure control behavior, with a standardized coefficient value of 0.370 and a p-value of 0.001. This means that the more confident hypertensive patients are in adhering to medication and adopting a healthy lifestyle, the better their blood pressure control behavior will be. According to self-efficacy theory, the forms of self-efficacy measured in this study included confidence in consuming vegetable-based meals without added salt or seasonings, confidence in exercising regularly, confidence in not smoking or consuming alcohol, and confidence in taking medication regularly. The findings of this study are consistent with Abdillah's research, which found that self-efficacy influences blood pressure control efforts among hypertensive patients at community health centers (Puskesmas). Higher self-efficacy enables hypertensive patients to control their blood pressure through medication adherence, reduced salt intake, dietary modification, weight loss, and regular exercise. Hypertensive patients with high self-efficacy can better control their blood pressure by minimizing risk factors for complications. Individuals with high self-efficacy can manage their blood pressure effectively and overcome challenges, whereas those with low self-efficacy tend to feel incapable of controlling it (14). This study also aligns with Rikmasari's findings, which reported that self-efficacy influences self-management of blood pressure in patients (p = 0.046). Higher e among hypertensive patients (clp = 0.046), management, thereby helping prevent complications. Self-management refers to the ability of hypertensive patients to regulate their diet, exercise routinely, maintain medication adherence by always carrying their medication or setting reminder alarms, consume adequate fruits and vegetables, lower cholesterol or saturated fat levels, avoid or reduce alcohol and smoking, limit excessive salt intake, and engage in at least 20 minutes of physical activity daily. Hypertensive patients with strong self-efficacy are more likely to initiate behaviors that help them maintain their health when facing health threats and demonstrate greater persistence in continuing these behaviors, which positively impacts their overall well-being(16). Individuals with high self-efficacy also tend to persist and are less easily influenced to engage in risky behaviors because they are firm and resilient in maintaining health-supportive behaviors. Without adequate self-efficacy, hypertensive patients are reluctant to engage in behaviors that support their health(17).

In this study, the factor of health worker social support—emotional, instrumental, informational, and appraisal support—was also analyzed. The results showed an effect on blood pressure control behavior, with a standardized coefficient of 0.244 and a p-value of 0.004. These findings are consistent with research by Sakinah (2021), which reported that port from health workers influences blood pressure control behavior by increasing hypertensive patients' self-efficacy to adhere to a healthy lifestyle. The role of health workers is strongly associated with treatment adherence among hypertensive patients. Professional interaction between health workers and patients can provide feedback after patients receive information about their diagnosis, the risks associated with the disease, treatment procedures, and potential barriers they may experience. The better the quality of services provided, the more frequently patients will visit health facilities. Good communication enhances the relationship between health workers and hypertensive patients, enabling patients to feel satisfied and confident about continuing their treatment, which is reflected in consistent visits to health services. Social support from health workers strengthens the influence of self-efficacy on blood pressure control behavior. This occurs because health workers provide quality services to hypertensive patients, contributing to better blood pressure control behaviors. Friendly health workers who communicate well with patients, deliver treatment without long waiting times, encourage

recovery, assist patients in making treatment-related decisions, and clearly explain the treatment being provided represent forms of social support, including emotional, instrumental, informational, and appraisal support (18).

In this study, the analysis of patient perceptions, an important construct within the Health Belief Model (HBM), was also conducted. Perceived susceptibility, perceived severity, and perceived barriers are key variables in the HBM framework. The results showed that perceived susceptibility had an indirect negative effect on blood pressure control behavior (standardized coefficient = –0.084; p = 0.000). This variable influenced behavior only through self-efficacy as a mediating factor. This indicates that the more frequently hypertensive patients *agree* that they feel susceptible (high perceived vulnerability), the lower their self-efficacy becomes, leading to poorer blood pressure control behaviors. Conversely, patients who *rarely* feel susceptible or perceive susceptibility as positive tend to have higher self-efficacy and therefore demonstrate better blood pressure control behavior. Forms of perceived susceptibility include feeling at risk for complications and other diseases, perceiving hypertension as an unclear or unpredictable illness, and believing that having hypertension is a sign to rest more frequently. These findings are inconsistent with those of 20), who found that most patients had a *positive* perception of susceptibility (n = 52; 54.2%). Skepticism was considered a trigger that encouraged patients to take preventive actions and properly control their blood pressure (19). Similarly, Aulia Rachman reported that patients who consistently perceived susceptibility tended to engage more actively in disease control efforts(20). Honey (2018) also reported a positive association between perceived susceptibility and blood pressure control behavior, with a standardized coefficient of 0.21 and a p-value of 0.034, indicating that stronger perceptions of susceptibility lead to a greater likelihood of adopting health behaviors(21). According to the current researcher, the differences in findings are due to the *indirect* influence of perceived susceptibility on behavior, which is mediated by self-efficacy. Hypertensive patients with higher self-efficacy tend to perceive a lower risk of complications, whereas those with low self-efficacy tend to perceive themselves as more vulnerable to complications. This interpretation is supported by Naryati, who found that perceived susceptibility negatively affects patient self-efficacy. Patients who believe they are highly vulnerable or at greater risk of complications tend to be more pessimistic about their ability to manage their condition effectively(22).

Overall, the findings indicate that after one month of intervention, the intervention group demonstrated greater improvements in medication adherence, healthy lifestyle adherence, and blood pressure control behaviors. This suggests that the behavioral model intervention, combined with the implementation of the Minimum Service Standards (SPM) for hypertensive patients in Denpasar City, was more effective at improving blood pressure control behavior. In contrast, the decrease observed in the control group related to medication adherence, healthy lifestyle adherence, and blood pressure control behavior before and after the study was likely influenced by the fact that not all respondent characteristics between the intervention and control groups were comparable. Differences were found in age, occupation, and educational level, with p-values < 0.05, suggesting that these characteristics may have contributed to the behavioral changes observed in the control group. The ultimate goal of the predictive model intervention is to develop an effective self-management mechanism among patients. Individuals tend to maintain a behavior over a long period of time when they can regulate the newly adopted behavior and have effective strategies to overcome barriers to performing it. A study conducted by Sonia reported that patients with good self-management demonstrate higher adherence to antihypertensive medication, better blood pressure management, and greater consistency in maintaining a healthy lifestyle(23). In contrast, patients with moderate self-management have not fully integrated hypertension control behaviors into their daily routines. They still exhibit unhealthy behaviors such as smoking, consuming high-fat foods, failing to monitor blood pressure regularly, consuming alcohol, and engaging in insufficient physical activity. Meanwhile, patients with poor self-management reported that they do not understand the reasons or methods for managing their hypertension. Self-management is an essential personal strategy for maintaining health. Individuals who are able to perform effective self-management through proper self-care can reduce the impact of the disease and prevent progression to more severe stages of hypertension. Therefore, through the behavioral model intervention applied in this study, it is expected that hypertensive patients will develop a strong self-management mechanism that improves medication adherence, promotes healthier lifestyle patterns, helps maintain controlled blood pressure, and ultimately prevents complications(24, 25).

CONCLUSION

Self-efficacy and support from healthcare providers directly influence blood pressure control behavior among hypertensive patients, whereas patients' perceived vulnerability indirectly negatively affects blood pressure

control behavior through self-efficacy. The predictive model using the Health Belief Model approach has been developed and proven to improve blood pressure control behavior by significantly increasing medication and healthy lifestyle adherence among hypertensive patients in Denpasar City.

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AUTHOR'S CONTRIBUTION STATEMENT

Author: research topic, analysis data, writing original draft preparation, writing-review and editing, reviewed empirical studies, discussion and conclusion and project administration. Co-Author: concept, method, analysis data, research topic, designed the methodology, reviewed empirical studies, discussion and conclusion and editing the paper

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

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