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Role of Cardio-Vascular Risk Assessment in Educational Intervention Based on Health Belief Model for Medical Adherence in Patients with Hypertension

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ABSTRACT

Aims Hypertension is a critical health condition requiring consistent medical adherence to prevent complications. This study aimed to evaluate the effects of a cardiovascular risk assessment and an educational intervention grounded in the Health Belief Model (HBM) on medication adherence among patients with hypertension.

Materials & Methods A semi-experimental study was conducted with three groups: a combined risk assessment and education group, a risk assessment-only group, and a control group, each consisting of 40 patients. Cardiovascular risk was individually assessed in both intervention groups using the Framingham model, with risk categories (low, moderate, high) explained to personalize the intervention and enhance perceived susceptibility. Additionally, patients in the combined intervention group received an educational booklet structured around HBM components. All participants completed questionnaires measuring knowledge, HBM constructs, the Morisky Medication Adherence Questionnaire, and treatment compliance (measured by the ratio of consumed to prescribed medications) at baseline and after three months. Data analysis was performed using SPSS software version 26.

Findings The three groups were demographically comparable. Over time, the combined intervention group showed significant improvements in all HBM constructs. The risk assessment-only group demonstrated improvements in perceived barriers, perceived benefits, self-efficacy, and awareness. Both intervention groups exhibited enhanced treatment compliance and medication adherence compared to the control group.

Conclusion The combined educational and risk assessment intervention proved more effective in improving awareness and strengthening HBM constructs than risk assessment alone.

Keywords High Blood Pressure; Cardiovascular Diseases; Risk Assessment; Health Belief Model

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Introduction

Hypertension is a non-communicable disease affecting millions worldwide [1]. Approximately 1.28 billion adults aged 30-79 years suffer from hypertension, with two-thirds living in low- and middle-income countries [2, 3]. Alarmingly, around 700 million people with high blood pressure are not receiving any treatment [4]. In Iran, around 6.6 million people individuals aged 25 to 64 have hypertension [5]. This condition is a leading cause of heart attacks and stroke deaths, estimated to cause 9.5 million deaths annually. It is predicted to account for a quarter of all deaths by 2030 [2].

With the increasing prevalence of cardiovascular diseases [6, 7], preventing complications and effectively treating these conditions is crucial. This necessitates proactive measures, such as ensuring patients adhere to prescribed medications [8]. However, maintaining medical adherence poses a significant challenge. The World Health Organization recognizes non-compliance as a critical issue that can increase mortality [9]. Medical adherence refers to a person's conformity with recommendations provided by healthcare providers [10]. Non-compliance with hypertension treatments can lead to a heightened risk of cardiovascular diseases, heart attacks, and stroke. It can also diminish the quality of life, contributing to depression and escalating treatment costs due to frequent doctor visits and side effects [11].

An essential aspect of medical adherence is patients' understanding of their disease and its treatment, alongside their beliefs about their health conditions [12]. Educating patients is crucial in enhancing awareness and changing these beliefs [13]. Health education experts employ behavior change theories and models to promote awareness, modify health beliefs, and encourage appropriate health behaviors [14]. One such model is the Health Belief Model (HBM), which posits that individuals are more likely to respond positively to health messages when they perceive themselves at risk (perceived sensitivity), and believe the threat is serious (perceived severity). Additionally, they must perceive that behavior change offers significant benefits (perceived benefits), and they can overcome barriers to these changes (perceived barriers). In this context, educational programs are likely effective [15, 16].

One of the reasons that people continue to practice unhealthy behaviors is due to inaccurate perceptions of risk and susceptibility, called unrealistic optimism. People show a selective focus on health behavior. In selective focus, individuals ignore their own risk-increasing behavior and focus on their own risk-reducing behavior. Instead, individuals ignore others' risk-decreasing behavior and focus on others' risk-increasing behavior. Accordingly, individuals perceive others as susceptible to disease, not themselves [17]. Perceived susceptibility and severity, as indicators of perceived threat, are vital factors in health behavior [17, 18]. When individuals believe that they are at a high risk of experiencing adverse health consequences, they are more likely to take preventive measures. One manipulation method of perceived susceptibility for increasing behavior is risk personalized based on a person's characteristics or behavior [19, 20]. Cardiovascular risk assessment by Framingham risk score considering several factors, including age, sex, smoking status, total cholesterol levels, HDL cholesterol levels, and blood pressure, estimates an individual's risk of developing cardiovascular disease within the next ten years [21]. Therefore, it seems that risk assessment increases medical adherence in two ways. First, according to the theory of unrealistic optimism, risk assessment can increase individuals' perception of their disease susceptibility and directly lead to medical adherence, and second, by considering demographic factors such as age, gender, smoking status, etc. (as a set of modifying factors), it can have an indirect effect on treatment adherence.

Various studies based on the HBM show that appropriate interventions rooted in the model can improve medical adherence [22, 23]. Conversely, previous studies have emphasized the importance of risk assessment in planning preventive strategies [24], and enhancing risk perception [18]. However, in none of the interventions based on the HBM, the intervention method on the perceived susceptibility construct was based on personalizing risk (reducing unrealistic optimism), and the role of risk assessment as a factor that may affect other beliefs and medical adherence behavior was not identified. Therefore, the research aims for this study were as follows:

This study aims to determine whether risk assessment combined with Health Belief Model (HBM)-based education is as effective as risk assessment alone in improving knowledge and beliefs about medical adherence and treatment compatibility.

Materials and Methods

Study design and participants

This semi-experimental research was conducted with hypertensive participants from October 2023 to June 2024 in Bushehr city. The study population consisted of individuals diagnosed with hypertension for over one year, characterized by a systolic blood pressure exceeding 140mmHg or diastolic blood pressure above 90mmHg.

The inclusion criteria were as follows: Participants must be receiving treatment with antihypertensive medication, must not regularly adhere to their prescribed treatment (as reported by themselves), must have a ratio of prescribed to consumed medications of less than 80% over a week, and must express a willingness to participate. The exclusion criteria included a history of heart surgery or angioplasty, a previous heart attack, unwillingness to continue participation, failure to read the training booklet after three follow-ups, and incomplete questionnaire responses.

Sample size

Drawing from the findings of the Zamani *et al.* study [25], and with a significance level (α) of 0.05 and the test's power of 90%, the minimum sample size required for each group was calculated to be 33. Considering a potential attrition rate of 20%, the final sample size for each group was set at 40 patients, for a total of 120 patients in three groups.

Six comprehensive health service centers in Bushehr were selected randomly through a lottery process. Two centers were assigned to each group. In these centers, a list of all people with high blood pressure who met the inclusion criteria was compiled. From this list, participants were randomly selected using EXCEL software based on the number of covered patients and the desired group sizes. Selected participants were then contacted, and the study's objectives and inclusion criteria (including medication usage patterns) were confirmed. In total, 40 patients were included in the risk assessment and education (based on the HBM) group, 40 in the risk assessment group, and 40 in the control group.

Intervention

Before starting the study, the patient's total cholesterol and HDL cholesterol levels were measured. After preparing the blood test results, the patients completed the questionnaires. For patients in the risk assessment group with education based on the HBM (risk assessment and education group), risk assessment was initially performed using the Framingham model (detailed explanations are provided in the educational content section). The results indicated each patient's probability of developing cardiovascular diseases within the next 10 years compared to similar individuals based on age and the type of risk a person (low risk, moderate risk, or high risk) was interpreted.

Subsequently, a booklet based on the HBM's constructs was provided, and they were asked to read it and follow their doctor's recommendations regarding medication.

One week after receiving the booklet, a follow-up phone call was made to check whether they had read it. In cases where they had not, an additional week was provided to complete the reading.

This follow-up process was repeated three times, and those who did not read the booklet by the end of this period were excluded from the study.

In the risk assessment group, the Framingham Model was also used to determine patients' probabilities of developing cardiovascular diseases over the next 10 years, with categorizations as low, moderate, or high risk. Participants were asked to adhere to their doctor's medication recommendations. Two text messages were sent each month to monitor the treatment plans for both intervention groups (risk assessment and education, as well as the risk assessment group).

The control group did not receive any training until the end of the study period. Their 10-year risk levels were assessed and explained to them after the study to maintain ethical consideration. After three months, participants were invited to complete a follow-up questionnaire.

Educational content

Risk assessment is calculated based on several factors, including age, sex, smoking status, total cholesterol levels, HDL cholesterol levels, untreated systolic blood pressure, and treated systolic blood pressure. The scoring related to these parameters differs by gender. For instance, in women, scores for age range from -7 for 20- to 34-year-olds to 16 for 75- to 79-year-olds; in men, scores range from -9 to 13 for the same age brackets.

The risk percentage was determined based on the calculated scores. Patients with a risk assessment of 10% or less fall into the low-risk group, those with a risk of 10% to 20% were categorized as medium risk, and patients with a score over 20% are considered high risk for cardiovascular diseases. For further information about the scoring system, please refer to the provided reference [26].

The booklet contained information about the prevalence of cardiovascular diseases (perceived sensitivity), the severity of complications and consequences of cardiovascular diseases (perceived severity), the benefits of adhering to treatment (perceived benefits), and the barriers to following through with treatment (perceived barriers). Additionally, the booklet recommended strategies to improve medical adherence, such as saving reminders on mobile phones and using daily and weekly medication reminder boxes, to enhance patients' confidence in their ability to comply with treatment (perceived self-efficacy).

Data collection

In this study, a questionnaire served as the data collection tool, consisting of four parts: Demographic information, knowledge, constructs of the Health Belief Model (HBM), including perceived self-efficacy, barriers, benefits, susceptibility, and severity. The final section assessed medical adherence and treatment compatibility to measure participant behavior.

1. Demographic information questionnaire: This questionnaire comprised 15 questions, covering aspects such as age, gender, education level, occupation, marital status, family income, health insurance, duration of hypertension, duration of drug use, history of chronic diseases, and family history of hypertension.

2. Knowledge questionnaire: A portion of the HK-LS standard questionnaire comprising 12 questions assessed participants' knowledge about hypertension definitions, lifestyle factors, treatment considerations, drug therapy, dietary practices, and potential complications of hypertension. Each question contained a true or false statement, rated on a three-point scale: True, false, and I don't know. Correct answers received a score of 1, while incorrect answers and 'I don't know' received a score of 0, yielding a total score range from 0 to 12. In Erkoc *et al.*'s study, the reliability of this instrument was reported at 0.82 [27], while this study found the reliability for this section to be 0.80.

3. HBM constructs questionnaire

- Self-efficacy: This construct was measured using the standard HIV medical adherence self-efficacy questionnaire. It included 12 questions rated on an 11-point scale from 0 (I can't do it at all) to 10 (I can do it completely). One question, "I will continue to take my medication even if the CD4 cells decrease significantly in the next 3 months", was excluded due to its specificity to HIV [28].

Scores ranged from 0 to 100, and higher scores indicate a greater belief in the ability to adhere to treatment. This tool's content validity, construct validity, and internal consistency have been confirmed [28]. In this study, Cronbach's coefficient was estimated at 0.87.

- Perceived barriers: The PMAQ (Patient Medication Adherence Questionnaire), designed by Lingran, included 61 questions, of which 20 were utilized in this study. Responses were measured using a 5-level Likert scale from strongly agree (score 5) to strongly disagree (score 1), with higher scores indicating more perceived barriers [29]. The total score range was from 20 to 100, with a Cronbach's coefficient of 0.79.

- Perceived benefits, sensitivity, and severity: These constructs included five questions about perceived benefits, four about perceived sensitivity, and six about perceived severity, using a tool developed by the researcher based on HBM principles. Each was rated using a 5-point Likert scale. Scores ranged from 0 to 25 for perceived benefits, 0 to 20 for perceived sensitivity, and 0 to 30 for perceived severity. Higher scores reflect a better understanding of each construct, with Cronbach's alpha coefficients of 0.92, 0.88, and 0.79, respectively, for these constructs.

4. Medical adherence questionnaire: To assess medical adherence, the researcher employed Morisky's standard medical adherence questionnaire, which consists of 8 questions [30].

This questionnaire included seven binary (yes/no) questions and one rated on a 5-point Likert scale. Scoring ranged from 0 to 8, with a score of 1 for a "yes" answer and a score of 0 for a "no". In the 8th question, scoring was based on these classifications: Never (1), rarely (0.75), sometimes (0.5), usually (0.25), and always (0).

A lower score indicates higher medical adherence. In Morisky *et al.*'s study, Cronbach's alpha coefficient was reported at 0.83 [30], while this study's coefficient was 0.79.

5. Treatment compliance: To evaluate treatment compatibility, the number of drugs prescribed and taken during the current week was assessed, and the ratio of consumed to prescribed drugs was calculated. A compliance rate of 80% or higher was considered adequate.

Ten health education experts reviewed the prepared questionnaires. To assess the experts' agreement on the questions, the content validity ratio (CVR) was measured, and scores of 0.62 or higher indicated good content validity [31]. In this study, the CVR for each question was higher than 0.67.

Before data collection, the questionnaire reliability was tested in 30 hypertensive patients. The Cronbach's alpha coefficients were 0.82, 0.90, 0.71, 0.82, 0.78, 0.71, and 0.83 for knowledge, perceived self-efficacy, severity, benefits, barriers, susceptibility, and medical adherence, respectively. All the questionnaires were reliable.

Statistical analysis

During the study, one patient from the risk assessment and education group was excluded due to not reading the booklet. During the follow-up, two patients from the risk assessment group and 2 patients from the control group were excluded from the study due to their unwillingness to continue participation.

Therefore, out of 106 participants, 35 were included in the risk assessment and education group, 34 in the risk assessment group, and 37 in the control group. Data analysis was conducted using SPSS software, version 23.0. Descriptive statistics, Chi-square test, ANOVA, paired t-tests, and repeated measurement ANOVA were employed to analyze the data.

Ethical considerations

All patients provided written informed consent. To uphold ethical standards in research, patients could withdraw from the study anytime. The collected data were managed confidentially.

Findings

In this research, an analysis of demographic data indicated that the three groups were homogeneous in terms of demographic information, except for education level. Ages were 50.81±10.17 years in the risk assessment and education group, 51.14±9.41 years in the risk assessment group, and 50.08±10.54 years in the control group (p=0.896; Table 1).

Before the study, most participants in both intervention groups were at a low-risk level for cardiovascular disease (17 of our results suggest that, or 47.2%, in the risk assessment and education group, and 18 patients, or 50%, in the risk assessment group; p=0.965).

Significant differences were observed between the risk assessment and education group and the risk group for perceived sensitivity (p=0.001), perceived severity (p<0.001), perceived barriers (p=0.007), and perceived self-efficacy (p=0.001), indicating that risk assessment with education was more effective in changing beliefs. Both groups showed similar effects for perceived benefits (p=0.405; Table 2). The average change in the risk and education group's knowledge score was significantly higher than in the risk group (p=0.024; Table 2).

There was no statistically significant difference in medical adherence among the three groups at the beginning of the study (p=0.318). However, after the intervention, both the risk and education group and risk group demonstrated increased medical adherence scores, with the risk and education group showing a significantly higher medical adherence rate than the risk group (p=0.001; Table 2). Additionally, at the beginning of the study, patients in all three groups had less than 80% treatment compliance. After the intervention, 24 participants (68.6%) in the risk assessment and education group, 17 participants in the risk assessment group (50%), and one patient (2.7%) in the control group were compatible with the treatment. A significant difference in treatment compliance was noted among the three groups (p<0.001). However, no significant difference was found in compliance between the risk assessment and education group and the risk assessment group (p=0.116).

Table 1. Comparison of demographic factors between risk assessment and education group (*n*=35), risk assessment group (n=34), and control groups (n=37) among patients with hypertension

Parameter			Risk assessment & education	Risk assessment	Control	χ^2	p-value
Sex		Male	15 (41.7)	21 (58.3)	19 (48.7)	2.02	0.365
		Female	21 (58.3)	15 (41.7)	20 (51.3)		
Marital status		Married	29 (50.6)	29 (80.6)	25 (64.1)	5.79	0.215
		Single	3 (8.3)	6 (16.7)	9 (23.1)		
		Divorced/widowed	4 (11.1)	1 (2.8)	5 (12.8)		
Income status		Sufficient	15 (41.7)	18 (50)	20 (51.3)	0.80	0.670
		Insufficient	21 (58.3)	18 (50)	19 (48.7)		
Education level		Under diploma	11 (30.6)	10 27.8)	5 (12.8)	11.71	0.020
		Diploma	12 (33.3)	6 (16.7)	20 (51.3)		
		Bachelor or master	13 (36.1)	20 (55.6)	14 (35.9)		
Insurance		Yes	35 (97.2)	35 (97.2)	38 (97.4)	0.004	0.998
		No	1 (2.8)	1 (2.8)	1 (26)		
Job	Female	Housekeeper	12 (57.1)	6 (40)	7 (35)	2.21	0.331
		Employed	9 (42.9)	9 (60)	13 (65)		
	Male	Unemployed or pensionary	2 (13.3)	2 (9.5)	2 (10.5)	2.99	0.559
		Employee	7 (46.7)	5 (23.8)	5 (26.3)		
		Manual worker	6 (40)	14 (66.7)	12 (63.2)		
Diseases history		Yes	19 (52.8)	15 (41.7)	21 (53.8)	1.33	0.514
		No	17 (47.2)	21 (58.3)	18 (46.2)		
Family BP history		Yes	14 (38.9)	21 (58.3)	25 (64.1)	5.18	0.075
		No	22 (61.1)	15 (41.7)	14 (35.9)		
Hypertension duration		<5 year	9 (25.0)	12 (33.3)	12 (30.8)	1.16	0.884
		5-10 year	13 (36.1)	14 (38.9)	14 (35.9)		
		10< year	14 (38.9)	10 (27.8)	13 (33.3)		
Drug use duration		<5 year	13 (36.1)	18 (50)	18 (46.2)	2.38	0.667
		5-10 year	12 (33.3)	12 (33.3)	12 (30.8)		
		10< year	11 (30.6)	6 (17.7)	9 (23.1)		

Table 2. Comparing the mean of HBM's constructs and medical adherence during the intervention in risk assessment and education (n=35), risk assessment (n=34), and control (n=37) groups among patients with hypertension (p<0.001)

Parameter	Time	Risk assessment & education	Risk assessment	Control	F
Knowledge	Before education	8.14±2.87	9.00±1.91	8.15±2.33	8.56
	3 months later	10.50±2.24	9.97±2.87	8.00±2.75	
	p-value	<0.001	0.029	0.78	
Perceived sensitivity	Before education	12.63±3.03	14.00±3.08	11.81±3.10	16.28
	3 months later	15.43±1.87	14.70±2.74	11.30±2.77	
	p-value	<0.001	0.097	0.033	
Perceived severity	Before education	18.37±3.56	21.62±3.63	19.03±3.37	29.15
	3 months later	22.91±1.72	22.44±3.19	18.84±2.71	
	p-value	<0.001	0.112	0.494	
Perceived benefit	Before education	18.11±2.10	18.41±1.71	16.68±3.02	10.29
	3 months later	20.14±2.28	19.97±2.42	16.35±2.43	
	p-value	<0.001	0.001	0.183	
Perceived barriers	Before education	60.43±6.90	58.23±6.71	58.40±8.36	33.99
	3 months later	46.23±6.99	49.12±7.64	58.73±7.53	
	p-value	<0.001	<0.001	0.703	
Perceived self-efficacy	Before education	61.46±21.20	64.38±13.25	62.51±15.93	69.3
	3 months later	84.46±9.26	76.50±15.16	50.13±9.16	
	p-value	<0.001	<0.001	<0.001	
Medical adherence	Before education	3.23±1.69	3.77±1.59	3.75±1.45	28.22
	3 months later	6.51±1.31	5.42±2.17	3.55±1.56	
	p-value	<0.001	0.001	0.297	

Discussion

This research confirmed the effectiveness of educational content based on the HBM and risk assessment of cardiovascular diseases in enhancing medical adherence among patients with high blood pressure. Risk assessment combined with education increased knowledge and positively modified patients' beliefs regarding all constructs of the HBM, thereby improving medical adherence. In the risk assessment group, patients' knowledge and beliefs about perceived benefits and self-efficacy increased while the perceived barriers decreased. Consequently, the risk assessment led to a significant enhancement in treatment compliance and medical adherence.

Importantly, risk assessment coupled with education proved to be more effective than risk assessment alone in transforming patients' beliefs and knowledge, except regarding their understanding of the benefits of medical adherence.

Regarding medical adherence, risk assessment with HBM constructs' education had a greater effect than risk assessment alone. Still, risk assessment with and without education had the same effect on compliance with treatment.

Regarding knowledge, the educational intervention significantly raised the awareness scores in both groups, corroborating earlier findings [32, 33]. Chukwuemeka *et al.* similarly have found that individuals with more information about cardiovascular risk factors exhibit higher knowledge levels [34].

Perceived sensitivity, a critical factor influencing treatment compliance among hypertensive patients, notably improved in the group receiving risk assessment with education. This aligns with previous research by Khorsandi *et al.*, which reported a 15% increase in perceived susceptibility following HBM-based educational interventions [35].

Additionally, studies by Hossein Alipour *et al.* [36] and Karimi *et al.* [37] report improvements in perceived sensitivity among patients. However, no significant changes were noted in the risk assessment and education group. However, in the risk assessment group, no significant change was observed in perceived sensitivity after the intervention. This gap in literature underscores the need for further investigation into this aspect. However, the risk assessment and education approach increased perceived severity. Research by Federman and colleagues emphasizes that patients' understanding of the dangers posed by their condition is a crucial determinant of medical adherence [38]. The findings of several other studies reinforce these results [22, 33, 39].

Overall, conducting cardiovascular risk assessments in hypertensive patients could enhance perceived threats (sensitivity and severity) and thus promote medical adherence, consistent with Kreuter & Strecher's conclusions [40].

Perceived obstacles also significantly impact medical adherence. Our results indicated a decrease in perceived barrier scores among patients in both intervention groups, supporting findings from prior studies [23].

Moreover, we observed increased perceived benefit scores among patients in the 347-348 intervention groups, aligning with research conducted by Hossein Alipour *et al.* [36] and Khorsandi *et al.* [35]. Additionally, Pletcher & Moran have demonstrated that cardiovascular risk assessments bolster patients' perceived benefits of preventive interventions, which is consistent with our findings [24].

Perceived self-efficacy, a key determinant of health behaviors, is vital in medical adherence, particularly for hypertensive individuals. Enhancing patients' self-efficacy makes them more likely to feel capable of adhering to treatment regimens. Our study successfully elevated perceived self-efficacy scores in both intervention groups, aligning with previous research [41].

Recognizing that medical adherence is essential for hypertension management, our study aimed to improve treatment compliance and medical adherence through HBM's constructs and assess cardiovascular disease risk. Our findings showed a significant increase in patients' compliance and treatment compatibility scores for both groups. These findings align with studies conducted by Radhakrishnan *et al.* [32], Yazdanpanah *et al.* [42], and Jones *et al.* [43].

Conclusion

Risk assessment effectively increases patient's knowledge and comprehension of the benefits, barriers, and self-efficacy concerning their treatment. However, risk assessment combined with HBM-based education improves patients' beliefs and knowledge more than risk assessment alone. Both interventions significantly enhance treatment compliance and medical adherence in hypertensive patients.

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Conflicts of Interests: The authors of this study have no conflicts of interest to declare.

Authors' Contribution: Malekzadeh F (First Author), Introduction Writer/Assistant Researcher/Discussion Writer (30%); Tahmasebi R (Second Author), Methodologist/Assistant Researcher/Statistical Analyst (30%); Noroozi A (Third Author), Introduction Writer/Methodologist/Original Researcher/Discussion Writer (40%)

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