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Research Article

Developing a Chain Mediation Model of Recurrence Risk Perception and Health Behavior Among Patients With Stroke: A Cross-sectional Study

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SUMMARY

Purpose: To understand the recurrence risk perception of stroke patients and develop a chain mediation model of recurrence risk perception and health behavior.
Methods: A cross-sectional study and convenience sampling were used. Stroke survivors were recruited from the neurology departments of three tertiary hospitals. Their recurrence risk perception, behavioral decision-making, social support, self-efficacy, recurrence worry, and health behavior were measured by relevant tools. Data was analyzed through one-way analysis and regression analysis, and the AMOS 21.0 software was used to explore the mediating relationships between variables.
Results: Of the 419 participants, 74.7% were aware of stroke recurrence risk. However, only 28.2% could accurately estimate their own recurrence risk. Recurrence risk perception was significantly correlated with behavioral decision-making, social support, self-efficacy, and health behavior ($r = .19 \sim .50$, $p < .05$). Social support and recurrence risk perception could affect health behavior indirectly through self-efficacy, behavioral decision-making, and worry. Behavioral decision-making acted as a main mediator between recurrence risk perception and health behavior, while the path coefficient was .47 and .37, respectively. The chain mediation effect between recurrence risk perception and health behavior was established with a total effect value of .19 ($p < .01$).
Conclusion: Most stroke survivors could be aware of recurrence risk but failed to accurately estimate their individual risk. In the mediation model of recurrence risk perception and health behavior, social support seemed to be an important external factor, while self-efficacy, behavioral decision-making, and worry seemed to act as key internal factors.
Registration: The research project was registered on 29 June 2020 (CTR2000034244).

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Introduction

Globally, advancements in the clinical management of acute stroke over the last decade have resulted in a higher survival rate among individuals following a stroke compared to previous periods [1,2]. There are over 101 million survivors of stroke worldwide, and 12.2 million new strokes occur each year [3]. Compared to the general population, stroke survivors face a 15-fold higher risk of experiencing recurrent strokes [4]. The cumulative rates of stroke recurrence at six months, one year, and two years are aggregated at 9.5%, 10.4%, and 16.1%, respectively [5]. Notably, the potential fatality associated with recurrent stroke, with a mortality rate of 25.0% within 28 days [6]. It remains notably challenging in preventing stroke recurrence, particularly in low-to-middle-income countries (LMICs) [7]. Health behavior has been a well-established determinant of stroke recurrence and is the most cost-effective prevention strategy [8]. More than 80 percent of strokes can be prevented by modifying risk factors, such as adherence to taking medications [9], and adopting healthy lifestyles [10,11]. Encouraging stroke survivors to adopt and maintain health behavior remains challenging [12–14]. A prospective study revealed that 22.4% of stroke survivors continued smoking after recovery [2]. Additionally, some stroke survivors developed multiple new risk factors; for instance, 16.4% became obese, and some patients engaged in heavy drinking [2]. Even so, more than half of these stroke survivors were satisfied with their lifestyle and felt no urgency to change [15].

Motivation has been approved to be an essential trigger that could influence the internalization and maintenance of health behavior [16]. Past evidence showed that risk awareness could affect peoples' intrinsic motivation for health behavior [17]. The influence of risk perception in the motivation and volition process has also been emphasized in relevant theory [18]. Risk perception is defined as patients' understanding of risk exposure level, relevant risk factors, and consequences of recurrence [19]. Studies have shown that inaccuracy in perceived stroke risk hinders the formation and change of health behavior in daily life [20]. Patients who are aware of symptoms and risk factors intend to modify unhealthy lifestyles after recovering from a stroke [21]. However, studies also illustrated that the role of risk perception as a prevention strategy might be overestimated. Even though an accurate perception of recurrence risk might motivate patients to change their behavior [22,23], patients might be more prone to worry, affecting their intention to behave when they perceive risk [24]. Overestimating the risk may lead to chronic stress, while underestimation can lead to ignoring the risk and affecting coping motivation and adherence [25]. Furthermore, recurrent events may affect stroke patients' perceived benefits of behavior change and reduce their confidence in changing health outcomes accordingly [17]. Therefore, further exploration of the relationship between recurrence risk perception and health behavior among stroke survivors is needed.

Additionally, decision-making has been approved to be a critical process of health behavior change [26]. The importance of healthy decision-making was identified, but the relevant influential factors are also complex [27–29]. It has always been difficult to change habitual behavior, especially for adults, so behavioral change is closely related to trade-offs in decision-making [30]. According to the Behavioral Decision Theory [31], health behavior is fraught with complexity when people may face certain or uncertain situations [32]. For example, self-efficacy, as a person's belief in their ability to accomplish a specific task, can influence one's decision in intention and actual change behavior [33]. Social support, as an external factor, might also affect the motivation and volition phase of health behavior change. Nevertheless, evidence of the link between social support, recurrence risk perception, and behavioral decision-making among stroke survivors is still limited.

The Situation-Specific Theory Model (SST) is a theoretical framework that centers on a particular nursing phenomenon, is confined to a specific demographic or clinical context, and potentially provides a novel viewpoint for tackling the behavioral management challenges encountered in the care of a specific cohort of stroke patients [34]. Given the significance of health behavior promotion in the secondary prevention of stroke, and the growing international scholarly interest and anticipation for the development of situational theories, this study aims to understand the perception of recurrence risk among stroke patients, explore the relationship and the mechanism of recurrence risk perception and health behavior with stroke patients. This may provide a new practice framework for clinical and community health behavior promotion and secondary prevention of stroke. At the same time, it can also provide new research evidence for the theory of health behavior.

Hypothesized model

A hypothetical model is derived from our previous study [35]. We have integrated methods such as literature review, qualitative research, and theoretical analysis to preliminarily construct a theoretical model for the perception of stroke recurrence risk and the context of behavioral decision-making. This model further verifies the close relationship between perception and behavior, emphasizing that behavioral decision-making is an inevitable process in the generation and dynamic change of behavior. There exists a complex pathway of influencing factors between risk perception and health behavior. Therefore, in this study, the inputs encompass personal factors and external factors, including social support, risk perception, self-efficacy, and concerns about recurrence. The core variable is the behavioral decision, and the outcome is health behavior. We hypothesize that these personal and external factors influence the health behavior of stroke patients by directly or indirectly affecting the behavioral decision-making process (Figure 1).

Methods

Study design and participants

This cross-sectional study was conducted from November 2020 to February 2021. Participants were recruited from the neurology departments of three tertiary hospitals in three cities in Henan Province, China. The inclusion criteria comprised survivors of stroke [36] with specified communication ability (Token test $\geq$17 points) and self-care capability (Activities of Daily Living $\geq$40); [37] without obvious cognitive dysfunction (Mini-Mental State Examination $\geq$17 points).

Data collection

Three trained investigators conducted the investigation. The investigation tools consisted of the following two sections: (1) The demographic and disease-related questionnaire, which was designed by the research team to collect the characteristics of study participants, including demographic and disease-related information related to age, gender, educational background, marital status, stroke type, and combined disease. (2) Structural questionnaires or scales for outcome variables about recurrence worry, recurrent risk, and recurrence risk perception, et al. All stroke patients who met the inclusion criteria were informed of the detailed information (e.g., survey aims, research significance, expected time of investigation).

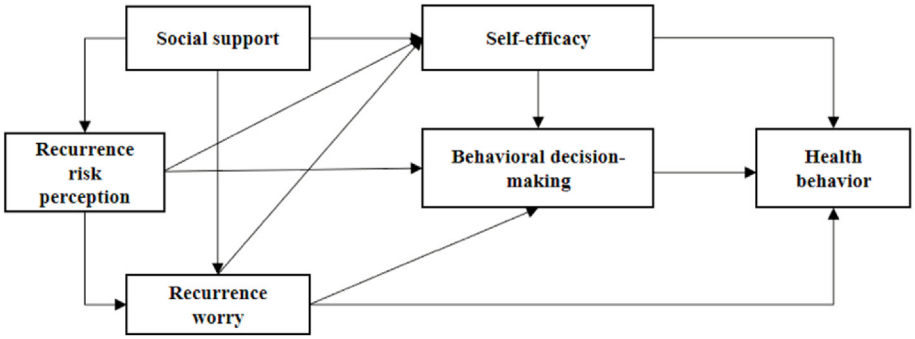

Figure 1. Hypothesized model.

In preparation for administering questionnaires, we collaborated with ward nurses to explain the purpose and significance of this study to the participants, disclosing the required number of questionnaires and estimated duration upfront, and secured written consent from each individual. To reduce the cognitive burden on hospitalized patients, we solicited feedback after piloting the questionnaire, refining it iteratively, and providing clear instructions for its completion. Participants filled out the survey in a quiet hospital room, with the option to pause as needed to manage their workload. If they had any questions about the manual, the investigators showed great patience to provide help. Upon finishing, the researcher ensured the questionnaire's completeness. As a gesture of gratitude, participants were given manuals as a gift, regardless of their questionnaire completion status. It is important to note that no financial compensation was offered to the study participants.

Outcome variables

Recurrence risk of stroke patients

The objective risk of recurrent stroke was measured using the Essen Stroke Risk Scale (ESRS). The ESRS is a globally recognized tool for predicting ischemic stroke recurrence [38], and it is effective in predicting the risk of recurrent stroke in Chinese patients [39]. The total score of a combination of eight criteria was used to assess the risk of recurrent stroke: age, hypertension, diabetes, previous myocardial infarction, other cardiovascular diseases, peripheral arterial disease, smoking, and previous ischemic stroke or TIA history, which is under 65 years old (0 point), 65 to 75 years old (1 point), and over 75 years old (2 points). The total score of ESRS is 0 ~ 9, while the low-risk, moderate-risk, and high-risk group scores were 0 ~ 2, 3 ~ 6, and 7 ~ 9 points, respectively.

Recurrence worry

The Recurrence Worry Questionnaire was a single-item questionnaire, and it was designed based on literature [40,41]. The patient's worry level was measured by a question: “To what degree do you worry about your recurrence risk?” The responses include “strongly worry, worry, neutrality, not worry, strongly not worry”, and scored as 5, 4, 3, 2, and 1, respectively.

Recurrence risk perception

The Stroke Recurrence Risk Perception Scale [42,43] is a self-report scale, and it was developed based on a rigorous literature review procedure, qualitative interviews, and expert consultation. It contains two parts: the first part is a self-assessment of recurrence risk with the question, “Compared with most people your age and gender, what would you say your chances are for developing another stroke?” The response was classified as unknown, no, low, moderate, and high. The second part comprises three dimensions with 17 items: “recurrence severity perception,” “disease risk factor perception,” and “behavioral risk factor perception.” The Cronbach's α and content validity index (CVI) of the total scale are .85 and .95.

Self-efficacy

The 13-item Stroke Self-Efficacy Questionnaire was designed by Jones [44], and it has been translated by native researchers [45]. It is an 11-point Likert scale, which is a psychometric scale commonly used in questionnaire-based research, with scores ranging from 0 (“not confident at all”) to 10 (“completely confident”). The scores reflect the self-efficacy level of the respondent, with higher scores indicating greater confidence. The Cronbach's α index of the scale is .97.

Health behavioral decision-making

The Health Behavioral Decision-Making Scale (HBDMS) was designed mainly for patients with or at high risk of stroke [46]. It is a self-reporting scale containing 30 items with four dimensions: “motivation of behavioral change,” “intention of behavioral change,” “decision-making relevant factors,” and “decision balance.” The HBDMS is a five-point Likert scale, assigning a score of 1, 2, 3, 4, and 5 points according to the responses from "strongly disagree" to "strongly agree." Each dimension can be scored separately, with higher scores indicating that an individual is more inclined to adopt health behavior. The Cronbach's α and CVI of the scale are .93 and .98.

Social support

The Social Support Rating Scale was developed by Xiao and has been widely used [47]. It consists of 10 items measuring three dimensions: subjective support (four items), objective support (three items), and support-seeking behavior (three items). The SSRS scale can be used in two ways. First, raw scores within each of the three domains are summed, giving a subjective (range: 8 ~ 32) and objective (range: 1 ~ 22) support score and a support-seeking behavior score (range: 3 ~ 12). Second, item scores are added, generating a total support score ranging from 12 ~ 66. The Cronbach's α of the scale is .92.

Health behavior

The Health Behavior Scale for Stroke Patients was designed by Wan and has been widely used among stroke patients [48,49]. The scale is a self-reporting scale with six subcategories (i.e., exercise, medication adherence, guideline adherence, nutrition, health responsibility, smoking, and alcohol abstinence). The HBS-SP comprises 25 items, and it is a 4-point Likert scale, on which a rating of 1, 2, 3, and 4 points indicate “never,” “sometimes,” “often,” and

"usually," respectively. The "medication adherence" and "smoking and alcohol abstinence" subcategories are reverse-scored. A higher total score indicates better health behavior. The average score of the scale is calculated. The Cronbach's α and CVI of this scale are .89 and .85.

Data analysis

We investigated the participants' demographic characteristics and conducted statistical analysis using IBM SPSS (version 21.0). The descriptive statistics (means, standard deviations, and percentages) were calculated to represent the demographic characteristics. The mean scores of two unrelated groups were compared using a two-independent-sample t-test. Differences among three or more groups' scores were tested using a one-way analysis of variance (ANOVA). The relationships between the predictive factors and health behavior were analyzed using Pearson correlation coefficients. Stepwise linear regression was performed to identify the predictors of health behavior. Multicollinearity was checked using the tolerance test and variance inflation factors (VIF), VIFs between 1 and 5 suggest a moderate correlation. However, it was not severe enough to warrant corrective measures, while VIFs greater than 5 represented critical levels of multicollinearity where the coefficients were poorly estimated [50]. The results were checked for accuracy, and two-tailed p-values <.05 were considered significant.

In addition, mediation analysis, widely used in medical research [51], was used to understand the mechanism between variables [52]. The hypothesized model was tested using AMOS 21.0 software. The mediation analysis involved modelling indirect and direct effects and hypothesizing the effects' parameters [53]. The direct effect is the pathway from the exogenous variable to the outcome while controlling for the mediator. While the indirect effect describes the pathway from the exogenous variable to the outcome through the mediator [54]. The model's path was shown by squares and arrows, a single-headed arrow pointed from cause to effect. The model predicted the regression weight and the unexplained variance and measurement error were shown using the residual error terms [53]. Then, the goodness-of-fit statistic was calculated to test the consistency of the hypotheses included in the model. Given the sensitivity of these criteria, alternative incremental fit indices are considered, including a root-mean-square error approximation (RMSEA) < .05, goodness-of-fit index (GIF) > .90, comparative fit index (CFI) and adjusted goodness of fit index (ACFI) > .90 [55].

Ethical considerations

This study was approved by the Institutional Review Board of the Zhengzhou University in August 2020 (Approval No. ZZURIB2020-08), and participants gave informed consent at the beginning of the survey.

Results

Characteristics of the Participants

A total of 450 patients were recruited, and 419 completed the questionnaires (effective response rate: 93.1%). The average health behavior was at a medium level. Among the 419 stroke survivors, the average age was 65 years old, and 65.2% were men (Table 1). More than 60.0% of participants completed education up to junior school or below, and 84.1% claimed to worry about recurrence (Table 1).

Accuracy of recurrence risk perception

Out of 419 participants, 313 (74.7%) demonstrated awareness of their potential stroke recurrence risk. Among these individuals, 4.4%, 21.2%, 23.4%, and 25.3% estimated their risk levels respectively as no risk, low, moderate, and high. For the patients with ischemic stroke, the actual risk of recurrent stroke calculated from ESRS showed that 50.9% had a moderate risk, 48.3% had a low risk, and 0.8% were classified as having high risk. Among the 387 patients with ischemic stroke, 25.6% claimed that they had no idea about recurrence risk at all, and only 28.2% could estimate their risk accurately. Nearly half of the participants (46.3%) inaccurately perceived their risk of recurrent stroke. Within this subgroup, 12.1% underestimated their stroke risk, while 34.1% overestimated it.

The correlation between variables and health behavior

Patients with less recurrence worry had relatively higher health behavior scores (Strongly not worry: 2.93 ± 0.81, Not worry: 2.65 ± 0.32, Neutrality: 2.66 ± 0.32, Worry: 2.51 ± 0.35, Strongly worry group: 2.63 ± 0.48, $F = 3.60$, $p = .007$). In addition, the Pearson correlation analysis demonstrated that recurrence risk perception was positively correlated with self-efficacy, behavioral decision-making, social support, and health behavior. Self-efficacy was negatively correlated with the recurrence worry and positively correlated with behavioral decision-making, social support, and health behavior. Recurrence worry was positively correlated with behavioral decision-making. behavioral decision-making was positively correlated with social support and health behavior. Social support was positively correlated with health behavior (Table 2).

The regression model of health behavior and relevant influential factors

The linear regression model was developed to explore the possible influential factors of health behavior. Results showed that the constant term was 6.39, but there was no statistical significance. The recurrent stroke had a significant direct predictive effect on health behavior ($\beta = 3.55$, $p = .003$). The recurrence worry positively predicted perceived social support ($\beta = 2.19$, $p = .004$). The self-efficacy positively predicted perceived social support ($\beta = 0.07$, $p < .001$). The social support positively predicted perceived social support ($\beta = 0.25$, $p = .014$). The behavioral decision-making positively predicted perceived social support ($\beta = 0.42$, $p < .001$). The adjusted R^2 of the regression model was 0.334 ($F = 14.99$, $p < .001$), which means that the eight factors in Table 3 could explain a 33.4% variance in health behavior.

The mediator model of recurrence risk perception and health behavior

The mediating model and relevant path coefficients are the regression weights analyzed by Amos 21.0 software; the model indexes are well ($X^2/df = 1.24$; RMSEA = .02; GFI = .97; AGFI = .98). As shown in Figure 2, the arrows indicate the potential direct effect of a causal variable on an effect variable; e1 to e5 are residuals (error terms) that are uncorrelated with the variables in the model and with each other. The numbers represent path coefficients, which are standardized versions of the linear regression weights used to examine the possible causal linkages between the statistical variables. Social support was an indirect factor that affected behavioral decision-making and health behavior via the direct effect of recurrence risk perception ($\beta = 0.22$, $p < .01$). Recurrence risk perception was an indirect factor that affected behavioral decision-making via the mediating effect of self-efficacy ($\beta = 0.15$, $p < .01$)

Table 1 *The Health Behavior of Stroke Patients with Different Characteristics (N = 419).*

Characteristics/n/%			$\bar{x}\pm s$	t/F	p	Characteristics/n/%			$\bar{x}\pm s$	t/F	p
Region	Rural	144 (34.4)	2.58 ± .36	0.46[b]	.645	Gender	Men	273(65.2)	2.53 ± .40	−2.91[b]	.004**
	Urban	275 (65.6)	2.56 ± .39				Women	146 (34.8)	2.64 ± .35		
Education background	Primary school and below	107 (25.5)	3.86 ± .32	3.58[c]	.014*	Age group	<45	24 (5.7)	4.05 ± .52	2.60[c]	.076
	Junior school	147 (35.1)	3.98 ± .41				45~	176 (42.0)	3.98 ± .39		
	High school or equal	97 (23.2)	3.93 ± .38				65~	219 (52.3)	3.91 ± .36		
	College and above	68 (16.2)	4.04 ± .44			Marital status	Married	364 (86.9)	3.95 ± .38	.69[c]	.560
Income (monthly/RMB)	<1000	27 (6.4)	3.84 ± .44	4.90[c]	.002**		Single	4 (01.0)	3.77 ± .72		
	1000~	60 (14.3)	3.82 ± .41				Divorced	11 (2.6)	3.83 ± .34		
	2000~	122 (29.1)	3.93 ± .35				Widowed	40 (9.6)	3.92 ± .45		
	3000~	210 (50.1)	4.01 ± .39			Main caregivers	Spouse (S)	200 (47.7)	3.98 ± .38	2.31[c]	.057
Stroke type	Ischemic	366 (87.4)	4.01 ± .53	1.00[c]	.369		Children (C)	81 (19.33)	3.95 ± .42		
	Hemorrhagic	32 (7.6)	3.94 ± .38				S and C	80 (19.1)	3.93 ± .31		
	Mixed	21 (5.0)	3.86 ± .40				Self	39 (9.3)	3.78 ± .47		
BMI	Lean	13 (3.1)	2.93 ± .37	0.16[c]	.926		Other	19 (4.5)	3.95 ± .39		
	Normal	181 (43.2)	3.96 ± .41			Complication number	One	273 (65.2)	3.94 ± .37	.67[c]	.515
	Overweight	172 (41.1)	3.93 ± .36				Two	94 (22.4)	3.94 ± .40		
	Obesity	53 (12.7)	0.43 ± .06				Three or more	52 (12.4)	4.00 ± .47		
Accuracy of recurrence risk perception[a]	Didn't know	106 (25.3)	2.55 ± .32	4.93[c]	.002**	Activity of daily life	Mostly dependent	81 (19.3)	3.99 ± .52	1.31[c]	.272
	Underestimate	50 (11.9)	2.72 ± .43				Partially dependent	67 (16.0)	3.95 ± .35		
	Accurate	120 (28.6)	2.60 ± .35				Partially dependent	109 (26.0)	3.89 ± .34		
	Overestimate	143 (34.1)	2.49 ± .42				Independent	162 (38.7)	3.95 ± .37		
Recurrence time	First-ever stroke	242 (57.8)	2.92 ± .38	0.95[c]	.389	Hypertension	No	131 (31.3)	2.60 ± .36	1.33[b]	.184
	Recurrent stroke	103 (24.6)	3.97 ± .43				Yes	288 (68.7)	2.55 ± .39		
	Multiple-recurrent stroke	74 (17.7)	3.98 ± .35			Diabetes	No	297 (70.9)	2.56 ± .37	−0.32[b]	.746
Recurrence worry	Strongly worry	79 (18.9)	2.63 ± .48	3.60[c]	.007**		Yes	122 (29.1)	2.57 ± .41		
	Worry	273 (65.2)	2.51 ± .35			Myocardial infarction	No	401 (95.7)	2.56 ± .38	−2.09[b]	.037*
	Neutrality	34 (8.1)	2.66 ± .32				Yes	18 (4.3)	2.74 ± .39		
	Not worry	29 (6.9)	2.65 ± .32			Other cardiovascular diseases	No	361 (86.2)	2.53 ± .38	−4.64[b]	<.001**
	Strongly not worry	4 (1.0)	2.93 ± .81				Yes	58 (13.8)	2.78 ± .35		
Hospital follow-up	No	255 (60.9)	2.54 ± .42	−0.92[b]	.359	Smoking history	No	301 (71.8)	2.64 ± .35	6.88[b]	.001**
	Yes	164 (39.1)	2.57 ± .36				Yes	118 (28.2)	2.37 ± .39		
Hemiplegia	No	322 (76.8)	2.54 ± .37	−2.31[b]	.021*	Community follow-up	No	306 (73.0)	2.52 ± .43	−1.53[b]	.126
	Yes	97 (23.2)	2.64 ± .41				Yes	113 (27.0)	2.58 ± .37		

Note: BMI = Body Mass Index; *$p < .05$; **$p < .01$.

[a] Bonferroni corrections tests showed significant differences between the overrated and underrated groups ($p < .05$).

[b] t-test.

[c] Analysis of variance.

Table 2 *The Correlation Between Variables and Health Behavior of Stroke Patients (N = 419).*

Variables	RRP	SE	RW	BDM	SS
Recurrence risk perception/RRP	1.00				
Self-efficacy/SE	.19*	1.00			
Recurrence worry/RW	.08	−.18**	1.00		
Behavioral decision-making/BDM	.50**	.151**	.20**	1.00	
Social support/SS	.23**	.14**	−.06	.12*	1.00
Health behavior/HB	.19**	.17**	−.05	.36**	.15**

Note: *$p < .05$; **$p < .01$.

Table 3 *The Linear Regression of Factors Influencing Stroke Patients' Health Behavior (N = 419).*

Variables	*B*	SD	*t*	*p*	95.0%CI (L,U)
Constant	6.39	7.14	.90	.371	−7.64, 20.42
Smoking history	−7.28	1.28	−5.71	<.001	−9.79, −4.77
Recurrent stroke	3.55	1.19	2.98	.003	1.21, 5.88
Income[a]	0.05	0.02	2.78	.006	0.02, 0.09
Hemiplegia	0.15	0.04	3.73	<.001	0.07, 0.23
Recurrence worry	2.19	0.76	2.88	.004	0.69, 3.68
Self-efficacy	0.07	0.02	3.85	<.001	0.03, 0.10
Social support	0.25	0.10	2.46	.014	0.05, 0.44
Behavioral decision-making	0.42	0.05	8.58	<.001	0.33, 0.52

[a] Be analyzed as grade data; SD = standard deviation; CI = confidence interval; L = lower; U = upper.

and recurrence worry (β = 0.10, $p < .05$). Self-efficacy and recurrence worry can indirectly affect health behavior via the direct effect of behavioral decision-making (β = 0.11, 0.18, $p < .01$), and recurrence worry was an indirect factor of health behavior by the mediating effect of self-efficacy as well (β = −0.19, $p < .01$). The direct effects among the variables were confirmed as well, including social support to recurrence risk perception (β = 0.22, $p < .05$), recurrence risk perception to behavioral decision-making (β = 0.47, $p < .01$), behavioral decision-making to health behavior (β = 0.37, $p < .01$), recurrence worry to health behavior (β = −0.11, $p < .01$), and all relevant results were presented in Table 4 and Figure 2.

Discussion

This study's most meaningful and encouraging finding is that patients with stroke demonstrated awareness of recurrence risk, which is not precisely consistent with previous qualitative study [17]. The majority of stroke patients (74.7%) in this quantitative study claimed that they knew the risk of recurrence. However, the remaining 25.3% said they did not know the recurrent risk, which differs from the studies from Boden-Albala et al [56] and Saengsuwan J [23]. Those two studies did not report the percentage of stroke patients who "did not know risk". It may be explained by the reason that they assumed all the participants knew stroke recurrent risk and directly compared patients' perceived risk with the actual risk of further stroke. However, based on the previous qualitative study [17], not all first-ever strokes were aware of the risk of stroke recurrence, so providing a 'do not know' option is necessary in future surveys. In terms of recurrence risk perception accuracy, only the results of patients diagnosed with ischemic stroke were analyzed in this study. However, the consistency between subjective and objective assessments of the recurrence risk is less than satisfactory, which means a small number of stroke patients' subjective self-rated risk was consistent with the objective risk level. Only 28.2% could accurately perceive their recurrence risk, 34.1% of the patients were overestimated, and 12.1% were underestimated, this will lead to individuals not being able to objectively and accurately assess the risk, affecting the right behavior decisions. Our findings are similar to the results of rural stroke patients [57], but quite different from the results in other countries. The American scholar Boden-Albala et al interviewed patients with different ethnic backgrounds after their first stroke or TIA in acute care settings [56]. Their findings revealed that 70.0% of patients overestimated their risk, and 10.0% underestimated it. At the same time, another study conducted by Saengsuwan J in Thailand found that over 40.0% of patients underestimated and nearly one-fifth (17.1%) overestimated their risk [23]. To some extent, these differences could support the existing evidence that risk perception is a contextual topic. Further multi-center studies are needed to explore the necessity of employing standardized measurements and to analyze the complex influencing factors.

The results of this study showed that health behavior is positively associated with recurrence risk perception. However, no direct relationship was detected between health behavior and recurrence risk perception, and the relationship was found to be relatively weak (r = .19, $p < .01$). On the one hand, our findings are consistent with many health behavior change theories that state that disease risk perceptions are a critical determinant of health behavior [58]. Conversely, our findings suggest that risk perception's role in promoting health behavior change has been overestimated. However, this finding did not extend to the correlation

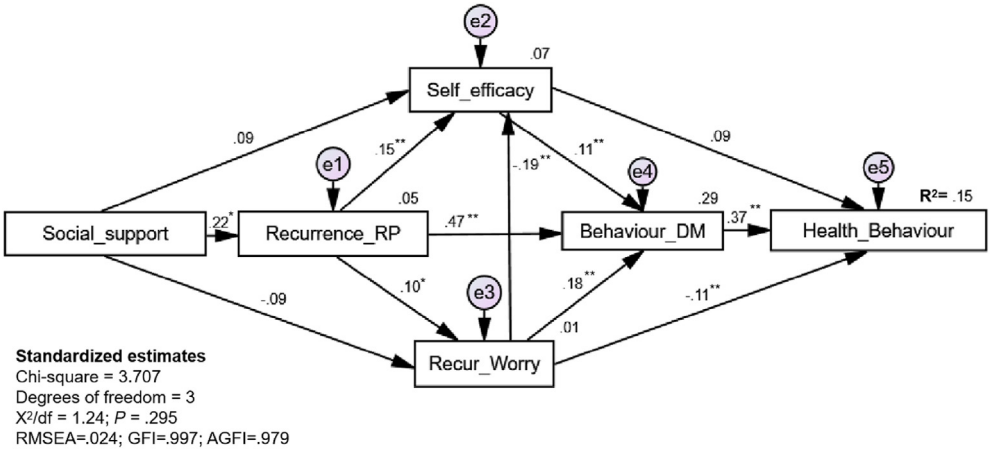

Figure 2. The mediator model of recurrence risk perception and health behavior of stroke patients. *Note:* RP = risk perception; Recur = recurrence; DM = decision-making; *$p < .05$; **$p < .01$.

Table 4 *The Direct and Indirect Effect Between Variables of Stroke Patients (N = 419).*

Pathways	EV	Boot SE	Boot CI LCI	Boot CI UCI	*p*
SS → RRP	.23	.05	.13	.32	.001**
SS → RRP → RW	.02	.00	.00	.01	.035*
SS → multiple factors → BDM	.11	.03	.05	.17	.001**
SS → multiple factors → HB	.06	.02	.03	.10	.001**
RRP → BDM	.47	.04	.38	.54	.001**
RRP → RW → SE	−.02	.01	−.04	−.00	.041*
RRP → multiple factors → BDM	.03	.01	.01	.06	.010*
RRP → multiple factors → HB	.17	.03	.13	.25	.001**
SE → BDM → HB	.04	.18	.01	.08	.020*
SE → HB	.09	.05	−.01	.19	.077
RW → SE	−.19	.04	−.26	−.10	.001**
RW → SE → BDM	−.02	.01	−.04	−.00	.016*
RW → multiple factors → HB	.04	.02	.00	.08	.036*
RW → HB	−.11	.05	−.21	−.01	.036*
BDM → HB	.37	.05	.26	.46	.001**

Note: EV = effective value; SE = standard error; LCI = lower confidence interval; UCI = upper confidence interval; SS = social support; RRP = recurrence risk perception; RW = recurrence worry; BDM = behavioral decision-making; SE = self-efficacy; HB = health behavior; multiple factors = more than one factor work in one path; *$p < .05$; **$p < .01$.

between recurrence risk perception and health behavior. We think the outcome might be linked to the model's design. In our model, health behavior is not only affected by recurrence risk perception, but also by recurrence worry, self-efficacy, behavioral decision-making, etc. These factors may potentially mask the link between recurrence risk perception and health behavior, leaving a seemingly negligible correlation. The results indicated that patients who can accurately estimate their recurrence risk showed better health behavior (Mean (SD):2.60 ± 0.35) than someone who overestimated risk (Mean (SD): 2.49 ± 0.42). Surprisingly, the result revealed that patients who underestimated their recurrence risk had the best health behavior (Mean (SD): 2.72 ± 0.43) compared to those who accurately estimated or overestimated their recurrence risks. Meanwhile, for the patients who claimed “did not know”, their health behavior score was moderate (Mean (SD): 2.55 ± 0.32). Whatever these findings provide new evidence to uncover the relationship between recurrence risk perception and health behavior. Therefore, future study is still needed to understand the possible causal mechanism of risk perception and health behavior.

Mediation analysis could provide convincing information on understanding the mechanism and developing theory, then facilitate nursing research [52]. The mediation analysis of this study confirmed a chain mediating effect between social support, recurrence risk perception, behavioral decision-making, and health behavior. It indicated that social support could positively affect stroke patients' awareness of recurrence risk, promote individuals to make health behavior decisions, and help them modify unhealthy habits or maintain health behavior. Regarding self-efficacy, this study found that it was mediated by behavioral decision-making and indirectly influenced health behavior, while the direct effect did not exist. This result is consistent with previous studies that self-efficacy was a determinant of health behavior [59]. However, it also illustrates a new finding that even when patients have the confidence to act, they must go through the decision-making process. Recurrence worry, defined as fear, was also approved to be an important influencing factor of health behavior; its indirect effect through self-efficacy and behavioral decision-making was first confirmed in this study. Based on the relationship between recurrence risk perception and recurrence worry found in this study, the role of emotional response factors should be fully considered when carrying out recurrence risk education-related interventions in the future. After all, it has been confirmed that risk information can stimulate intrinsic motivation and cause worry and fear, which might reduce self-confidence [60].

Overall, the direct impact of relapse risk perception on health behavior may be overestimated, and there exists a complex mechanism between the two. Establishing a specific situational theoretical model is necessary. This study enriches the existing theoretical framework by introducing mediating variables such as social support, self-efficacy, relapse concerns, and behavioral decision-making, thereby opening new avenues and methods for subsequent research. Future studies could employ a combination of quantitative and qualitative approaches to explore the mechanisms underlying health behavior in different cultural and social contexts, providing a basis for developing more targeted intervention strategies.

Limitations

This study innovatively explored the correlation between recurrence risk perception and health behavior in stroke patients, and the intrinsic and extrinsic factors were analyzed using mediation analysis. There are still some limitations. Firstly, the low correlation between recurrence risk perception and health behavior might not provide strong evidence for targeting risk perception, but did arouse the importance to explore the relationship between various variables, which emphasizes the necessity of developing health behavior theory, and provide evidence for developing multi-aspects interventions. Secondly, stroke severity was not fully considered while it could be a possible confounding variable, even if we reported the activity of daily life or hemiplegia as alternatives, some other index (i.e., NIHSS) should be collected as well. Finally, a cross-sectional survey can infer correlation but is not always sufficient to determine a direct cause, this had potential implications for the robustness of our findings. The mediation analysis was used, but more data are still needed to prove the causal relationship.

Conclusions

Most stroke patients are aware of recurrence risk, but are unable to accurately perceive their personal risk. There exists a complex chain mediation pathway between risk perception of recurrence and health behavior, where social support serves as an important external factor, behavioral decision-making is a key internal influencing variable, and self-efficacy and concerns about recurrence are significant factors influencing health behavior as well. The establishment of this model can enrich the content of health behavior-related theories from a contextual perspective and provide a new framework for the development of intervention measures for specific populations.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author LBL.

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Ethics approval statement

This study was approved by the Institutional Review Board of the Zhengzhou University in August 2020 (Approval no. ZZURIB2020-08), and participants gave informed consent at the beginning of the survey.

Clinical trial registration

The study project has been registered in the Clinical Trials Registry (Reg. No: ChiCTR2000034244)

Statement conferring

As the author of this manuscript, I hereby confirm and agree that if my article is accepted by ANR, I will grant the copyright of this work to ANR. I declare that this manuscript is my original creation and does not infringe on the copyrights or any other rights of third parties.

Conflict of interest

None.

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