International Journal of Biology and Life Sciences
ISSN: 2957-9511 | Vol. 9, No. 3, 2025

The Influence of Theoretical Integration Strategy on Self-Management Behavior in Middle-Aged and Young Stroke Patients

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Abstract: Objective To explore the impact of empowerment interventions based on cross-theory models on self-management behavior, self-efficacy, and daily living abilities in middle-aged and young stroke patients. Methods A single-blind randomized controlled trial design was adopted, selecting 10 4 middle-aged and young stroke patients hospitalized in four neurology departments at a tertiary hospital in Xian from April to October 2023 as the study subjects. The patients were randomly divided into an intervention group of 52 cases and a control group of 52 cases. The control group received routine care, while the intervention group received empowerment interventions based on cross-theory models in addition to routine care. Changes in self-management behavior, self-efficacy, and daily living abilities were assessed at baseline, 1-month post-intervention, 3 months post-intervention, and 6 months post-intervention. Results A total of 101 middle-aged and young stroke patients participated in the study. At 1 month, 3 months, and 6 months post-intervention, there were statistically significant differences in self-management behavior between the two groups ($F=77.048$, $P<0.001$), with a significant interaction effect between intervention methods and timing factors ($F=19.714$, $P<0.001$). At 3 months and 6 months post-intervention, there were statistically significant differences in each stage of self-management behavior between the two groups ($P<0.05$). At 1 month, 3 months, and 6 months post-intervention, there were no statistically significant differences in self-efficacy or daily living abilities between the two groups ($P>0.05$) Compared with the baseline, all differences were statistically significant ($P<0.001$). The self-efficacy and daily living ability scores at each time point before and after intervention within different groups were also statistically significant ($P<0.05$). Conclusion: Empowerment interventions based on cross-theory models can improve self-management behaviors in middle-aged and young stroke patients, enhancing their self-efficacy and daily activity capabilities. These findings can provide a reference for developing personalized intervention strategies and improving care plans for stroke patients.

Keywords: Self-management; Patient Empowerment; Cross-theory Model; Stroke.

1. Introduction

Stroke is a common cerebrovascular disease, and its high incidence and recurrence rate pose a serious threat to patients rehabilitation and quality of life[1-2]There are 13.7 million new cases of stroke worldwide each year, with China accounting for about 40 percent[3]In recent years, the proportion of stroke patients aged 40-64 in China has risen to 52.65%, showing a trend of high incidence among middle-aged and young people[4]Effective treatment, self-management support and regular follow-up are considered to be key to stroke recovery, with self-management being particularly important[5] However, most patients have limited self-management skills, and more than half of them do not know how to manage themselves effectively[6]Health empowerment theory is a widely used method of self-management education for stroke patients[7-8]The theory emphasizes patient-centered care and promotes patient recovery through personalized advice and professional support[9-10]Trans-Theoretical Model (TTM) is a commonly used individual behavior change theory model that can be used to develop personalized interventions at different stages of behavior [11-14]This study aims to explore the effects of TTM-based health empowerment intervention on self-management ability, self-efficacy and daily living ability of middle-aged and young stroke patients, and verify the effectiveness of this intervention measure, so as to provide more effective support and guidance for the rehabilitation of middle-aged and young stroke patients.

2. Data and Methods

2.1. General Data

A total of 104 middle-aged and young stroke patients were selected from four neurology departments at a tertiary hospital in Xian, from April to October 2023. Inclusion Criteria: (1) Met the diagnostic criteria for stroke, confirmed by head CT or MRI; (2) Age 18-59 years, willing to participate, and owned a smartphone with WeChat. Exclusion Criteria: (1) History of mental illness; (2) Presence of other major diseases or systemic infections; (3) Severe limb pain or spasticity, or recent uncontrolled seizures; aphasia, deafness, or impaired consciousness that prevented cooperation; (4) Expected survival less than 3 months. The primary outcome measure was self-management score, with $\alpha=0.05$, $\beta=0.1$, $\mu1=1.96$, $\mu2=1.28$, referring to previous literature[15], $\sigma=14.96$, $\delta=14.75$, substituting into the sample size calculation formula, each group has 22 cases, assuming a 20% dropout rate, each group has 27 cases, totaling 10 4 patients recruited, with 52 in the control group and 52 in the intervention group. Non-study participants use computer-generated random numbers to sequentially number and seal envelopes, which are opened after signing informed consent forms and completing baseline surveys to determine the group

assignments.

Table 1. Comparison of general data between the two groups of patients [n, %]

	project	Control group (n=50)	Intervention group (n = 51)	Statistical values	*P*
Age (years, x±s)		52.4±6.93	53.08±5.11	-0.561[a]	0.576
sex	man	36(72)	41 (80.4)	0.982[b]	0.322
	woman	14(28)	10(19.6)		
degree of education	Primary school and below	3(6)	6(12)	3.271[c]	0.363
	junior middle school	15(30)	21(41)		
	High school and secondary vocational school	23(46)	16(31)		
	University degree or above	9(18)	8(16)		
marital status	Has a spouse	49(98)	49(96)	/	0.508
	mateless	1(2)	2(4)		
Per capita monthly income of the family (yuan)	<3000	5(10)	10(20)	5.027[b]	0.170
	3 000-5 000	21(42)	17(33)		
	5 000-1 0000	16(32)	21(41)		
	>10000	8(16)	3(6)		
Primary caregiver	father and mother	1(2)	1(2)	0.381[c]	1.000
	Wife or husband	35(70)	35(69)		
	sons and daughters	11(22)	12(24)		
	Hire staff	3(6)	3(6)		
Number of chronic diseases (number)	0	8(16)	7(14)	6.659[c]	0.082
	1	37(74)	30(59)		
	2	1(2)	8(16)		
	≥ 3	4(8)	6(12)		
animal force	Level 0-1	1(2)	1(2)	2.102[c]	0.393
	Level 2-3	11(22)	6(12)		
	Level 4-5	38(76)	44(86)		
Medical expense payment method	medical insurance	49(98)	48(94)	/	0.316
	at ones own expense	1(2)	3(6)		

Note: All data are expressed as frequency (%). Age variables are indicated by mean ± standard deviation; inter-group comparisons are marked with "a" using the t-test. Categorical variable comparisons between groups are marked with "b" using the Pearsons chi-square test. Categorical variable comparisons are marked with "c" using the Fisher precision test.

Note: The data is expressed in frequency (%). Age variables are expressed as means ±standard deviation; The inter-group comparison is marked as "a" using t-test. The comparison of categorical variables between two groups was conducted using Pearson chi square test, labeled as "b". The comparison of categorical variables was conducted using Fishers exact test, labeled as "c"

The data collection is conducted by four non-study members using a single-blind method, with training provided

before data collection, ensuring consistency among assessors ranging from 0.84 to 0.96. During the study, one case was lost to follow-up in the intervention group, and two cases were lost in the control group, resulting in 51 cases in the intervention group and 50 cases in the control group. There were no statistically significant differences in general patient characteristics between the two groups (P>0.05), indicating comparability, as shown in Table 1. This study is a double-arm single-blind randomized clinical trial (Clinical Trial Registration Number: ChiCTR2300070976) and has been approved by the hospital's ethics committee.

2.2. Intervention Methods

2.2.1. Control Group the Control Group Patients Received Routine Inpatient Health Education

After admission, the ward environment and admission procedures were introduced to the patients. Inpatient assessments were conducted, and knowledge about stroke was explained along with the distribution of the "Stroke Self-Management Handbook." During hospitalization, patients were educated on bed rest, diet, medication use, toileting, limb positioning, and swallowing function training. On the day before discharge, they received health education on diet, medication, regular lifestyle, and follow-up visits. After discharge, a follow-up file was established for them, and telephone follow-ups were conducted to provide guidance on nursing issues during home care and to ensure regular outpatient visits.

2.2.2. Intervention Group

1) Establish the Intervention Team The research team consists of 8 members. One chief nurse is responsible for forming the research team, advancing the research work, and quality control; one nursing graduate student and one associate chief physician participate in the development of the research plan and provide relevant clinical technical support to ensure patient safety; four neurology nurses are responsible for collecting, supervising, organizing, and reviewing clinical data from each ward; one postdoctoral fellow in nursing is responsible for statistical analysis of the data.

2) Intervention Plan Formulation and Implementation The initial draft of expert questionnaire was formed through literature review and qualitative interview, and the specific intervention strategy was determined after two rounds of Delphi questionnaire, as shown in Table 2.

2.3. Observation Indicators and Evaluation Methods

1) General data questionnaire Based on extensive reading of relevant literature, a general data questionnaire was designed by oneself, including age, gender, education level, marital status, per capita monthly income of the family, main caregiver, number of chronic diseases combined, muscle strength, and payment method of medical expenses.

2) The self-management behavior of stroke patients was assessed using the Self-Management Behavior Scale before the start of intervention, one month after intervention, three months after intervention, and six months after intervention. This scale was designed by Wang Yanjiao et al. in their study on the construction of self-management projects for patients during the recovery period of stroke [16] It consists of 51 items in 7 dimensions, and each item is rated by a 5-point scale with a total score of 50-255 points. The higher the score, the better the patients self-management behavior. Cronbach sα was 0.835.

3) Self-efficacy was assessed using the Stroke Rehabilitation Self-Efficacy Scale before the start of intervention, one month after intervention, three months after intervention, and six months after intervention to evaluate self-efficacy scores in both groups of patients. The scale was developed by Jones and translated by Li Hongyan et al., evaluating patients subjective rehabilitation efficacy status. It consists of 13 items with a total score ranging from 0 to 130, where higher scores indicate better self-efficacy. The Cronbach α was 0.97 [17]

4) Self-Management Behavior Stage Assessment Questionnaire The self-management behavior stage assessment questionnaire was used to evaluate the stages of self-management behavior in two groups of patients before the start of intervention, one month after the first month, three months, and six months after the intervention. This study's behavioral stage assessment questionnaire is based on the framework of the TTM theoretical model, combined with the behavioral stage assessment questionnaire developed by the American Cancer Prevention Research Center [18] The Chinese version of the questionnaire underwent localization modifications and adjustments in terms of subject concepts, forming a six-month self-management behavior assessment questionnaire for stroke patients. A pre-survey was conducted with 50 randomly selected patients, yielding a retest reliability of 0.83. The questionnaire consists of five options, which define the stage of self-management behavior based on patient responses, as shown in Table 2.

5) The Daily Living Activities (Barthel Index, BI) scale was used to assess the daily living activities of patients in two groups before the start of intervention, one month after intervention, three months after intervention, and six months after intervention. This scale primarily evaluates the patients ability to perform daily activities. It consists of 10 items with a total score ranging from 0 to 100. Higher scores indicate better independence. The Chinese version of the Barthel index has been widely used [19] It has good internal consistency, inter-evaluator reliability and concurrent validity [20-21]

2.4. Statistical Methods Were Performed by IBM SPSS 26.0 for Statistical Analysis

The data were expressed as number of cases and percentage, and the comparison between groups was performed by chi-square test; the measurement data were normal distribution after normality test, and the mean ± standard deviation. ($\bar{x} \pm s$) indicates; the comparison between time points in two groups uses a t-test for independent samples; the overall analysis of repeated measurement data in two groups uses repeated measures ANOVA; after Mauchlys sphericity test, the data do not meet the sphericity condition, and Green Lhouse-Geisse correction is used, with P<0.05 indicating statistically significant differences.

3. Results

3.1. Comparison of Self-Management Behavior Scores Before and After Interventions in Two Groups

The overall self-management behavior scores of the two groups before and after interventions showed no statistically significant differences (F=0.608, P=0.438). However, there were statistically significant differences in self-management behavior scores within the two groups at different

intervention time points (F=77.048, P<0.001), indicating an interaction effect between intervention methods and timing (F=19.714, P<0.001).

Table 2. Specific Content of Empowerment Intervention Plan Based on TTM

operational definition	No intention to change behavior in the last 6 months, and no motivation or behavior change during this period	Pre-intention phase
Identify the problem and express your feelings	At this stage, patients do not understand the significance of self-management, nor do they have the intention to self-manage. Therefore, the focus of this stage is to arouse the awareness of stroke patients to engage in self-management behaviors and promote their active participation in self-management behaviors.	
Set goals and make plans	Members of the intervention group conducted one-on-one interviews and group knowledge lectures with patients to understand the reasons for their lack of self-management and jointly find appropriate solutions. Inform patients about the knowledge related to self-management behaviors for stroke, and help them understand the risks of stroke and its impact on their future quality of life. Teach them the importance of disease management, dietary control, regular medication, and regular exercise for the prognosis of stroke. Explain the harm of maintaining poor long-term behaviors to foster good health awareness in patients, stimulating their intrinsic motivation to change self-management behaviors. Gradually guide the transformation of patient mindset; instruct patients to obtain knowledge on self-rehabilitation and management of stroke through healthcare providers, fellow patients, and online resources.	
Effect evaluation	Evaluate the patients knowledge of self-management and willingness to participate in self-management, and move on to the next stage of intervention if the intervention is effective	
operational definition	At this stage, patients have potential motivation and willingness to change behavior, but no clear plan, commitment and change behavior	The intention stage
Identify the problem and express your feelings	At this stage, patients subconsciously recognize the importance of self-management. However, due to concerns about their inability to consistently adhere to self-management behaviors, they often fail to clearly initiate a self-management plan. Therefore, it is essential to patiently guide patients in expressing the difficulties they face in engaging in self-management activities and help them analyze the reasons. This will assist in finding management strategies that suit their individual needs, thereby strengthening their resolve to participate in self-management.	
Set goals and make plans	Make positive and favorable evaluations of the patients correct health beliefs and attitudes, and reiterate that self-management behaviors such as disease management, dietary control, regular medication use, and periodic exercise must be implemented to achieve the expected goals. Interventionists need to pay attention to the patients psychological state, enhance humanistic care, and help them learn to appreciate themselves. They can also utilize external resources like family members or close friends for support. Guide patients to reflect on how self-management impacts their recovery and future quality of life, play a liaison role, and encourage well-managed patients to share their experiences and insights, setting examples to boost the patients confidence.	
Effectiveness assessment	The understanding of patients beliefs about self-health management and their psychological preparation and knowledge reserve for the implementation of self-management behavior change were evaluated, and patients who achieved the expected goals were encouraged to participate in the formulation of the next stage of self-management plan together.	
operational definition	At this stage, patients have the motivation to change their self-management behavior and make some changes or do some preparatory work.	preparatory phase
Identify the problem and express your feelings	At this stage, patients feel ready to cooperate with self-management behaviors, so planning and implementation on schedule are critical. For patients who fail to enter the next stage on time, researchers should actively listen to negative emotions during the process of changing their actions, help find solutions together, and develop personalized improvement measures.	
Set goals and make plans	Encourage the involvement of the patients primary caregiver. Researchers work with patients and their primary caregivers to develop practical self-management behavior plans, encouraging the caregiver to provide active assistance and guidance when the patient encounters self-management barriers. At the same time, patients are encouraged to overcome challenging tasks and take on a supervisory role. Through explanations and demonstrations by professionals, scanning codes to watch stroke health education videos in the ward, patients are taught specific methods for active and passive exercise, dietary choices, and weight index calculations. When patients have questions, multidisciplinary team members should answer them and encourage each patient to actively participate in consultations on stroke self-management behaviors.	
Effectiveness assessment	The understanding of the specific content of patient self-management, especially the ability to set goals and implement plans, should be assessed to reach the next stage for those who achieve the expected goals.	
operational definition	At this stage, the patients behavior has changed, but the time is short, so it is easy to rebound.	Action phase
Identify the problem and express your feelings	At this stage, patients can experience the benefits of self-management, but the implementation of good self-management behavior is not regular, and the number and time of continuous implementation have not reached the requirements. Therefore, it is necessary to actively consolidate the results, help patients correctly implement self-management behaviors and motivate patients to adhere to them regularly in the long term.	
Set goals and make plans	Researchers tailor personalized goals and plans based on the patients individual circumstances, requiring them to record daily exercise, adhere to prescribed medication, control their diet, and other good behaviors. They also need to document the frequency of these positive actions and write down the reasons for any inability to maintain good behavior. Patients can be encouraged to check in within a WeChat group, with researchers providing supervision and feedback. Those who perform well may receive small gifts as rewards. Patients are encouraged to present their exercise methods, blood pressure, and blood glucose monitoring through face-to-face meetings or video recordings, ensuring accuracy. Incorrect self-management behaviors are guided and corrected. Patients are also encouraged to overcome the difficulties of implementing self-management at this stage, mobilizing family members and friends to offer external support, promptly affirming the patient, and encouraging them to persist in correct self-management practices.	
Effect evaluation	The effectiveness of patients self-management plan according to the pre-set target should be evaluated, such as moving to the next stage when the expected target is achieved. For patients with difficulties or rebound phenomena in the implementation of behavioral plan, intervention measures should be implemented cyclically according to the development stage of behavior.	
operational definition	At this stage, the patient has mature beliefs and abilities to change behavior.	maintenance stage
Identify the problem and express your feelings	At this stage, patients have developed good self-management habits, so the key to emphasize the persistence of long-term regular implementation of self-management behaviors should be emphasized to avoid the regression of healthy behaviors.	
Set goals and make plans	The test values of blood pressure, blood sugar and body mass index before and after the implementation of self-management behavior were compared to stimulate the enthusiasm of patients to adhere to self-management behavior. By regularly checking the patients exercise methods and intensity, blood pressure monitoring, dietary choices, etc., to understand how well the patient is implementing these measures. Team members conduct timely phone follow-ups to inquire about the patients self-management execution and any current issues. They promptly encourage patients who maintain good self-management behavior and analyze the reasons for those showing signs of disengagement, offering appropriate advice to help resolve their concerns and boost their motivation.	
Effectiveness assessment	Evaluate the effect of patient self-management	

Table 3. Comparison of self-management behavior scores at different time points within two groups of patients before and after intervention (score, $\overline{x \pm s}$)

Self-management behavior	Intervention group					control group				
	T0 (preintervention) (n = 52)	T1 (after 1 month of intervention) (n = 52)	T2 (after 3 months of intervention) (n=51)	T3 (after 6 months of intervention) (n = 51)	*F* price	T0 (preintervention) (n = 52)	T1 (after 1 month of intervention) (n=51)	T2 (3 months after intervention) (n = 51)	T3 (after 6 months of intervention) (n = 50)	*F price*
disease control	22.63± 8.21	30.55±7.79[a]	38.22±6.601[ab]	38.31± 6.635[abc]	56.535**	25.48± 9.31	27.72±9.29	23.7±7.84[b]	40.88±5.36[abc]	90.912**
Safe drug management	13.92± 4.783	16.78±3.43[a]	18.53±2.49[ab]	18.53± 2.49[abc]	26.469**	15.24± 5.09	16.72±3.94	16.34±4.84	20.48±2.62[abc]	42.95**
Dietary management	24.51± 4.305	27.18±3.439[a]	29.78±2.63[ab]	29.78± 0.369[abc]	41.308**	26.2±4.16	26.86±3.36	26.68±3.80	26.94±2.65[a]	30.16**
emotion management	15.43± 4.60	19.59±4.26[a]	20.86±2.95[ab]	21.06± 2.79[ab]	17.472**	17.48± 5.54	18.44±5.27	19.54±4.5[a]	19.78±3.51[a]	14.274**
Interpersonal management	20.49± 5.07	22.33±4.23	23.12±2.85[a]	23.27± 2.65[ab]	6.758**	22.7± 4.56	24.28±4.48	22.82±4.89	22.16±4.37	1.316**
Rehabilitation exercise management	24.43± 7.43	27.45±6.54	27.45±5.70[ab]	27.98± 5.12[ab]	6.808**	23.44± 8.43	24.58±8.04	24.64±8.15	25.86±5.89[a]	13.01**
Self-management behavior total score	146.41± 27.70	169.94±22.63[a]	188.10± 15.96[ab]	189.29± 14.63[abc]	62.301**	157.82± 24.58	169.64±22.32[a]	161.68±22.45[b]	196.22± 17.52[abc]	78.399**

Note: * indicates P <0.05, ** indicates P <0.001; a indicates P <0.05 compared with pre-intervention; b indicates P <0.05 compared with one month after intervention; c indicates P <0.05 compared with three months after intervention.

Note: * indicates P<0.05, * * indicates P<0.001. A represents P<0.05 compared to before intervention; B represents P<0.05 compared to one month after intervention; C represents P<0.05 compared to 3 months after intervention.

Simple effect analysis revealed that the total self-management scores and their dimensions in the intervention group at each time point showed statistically significant differences (P<0.05); except for interpersonal relationship management, the total self-management scores and their dimensions in the control group at each time point also showed statistically significant differences (P<0.05), as shown in Table 3.

3.2. Comparison of Self-management Behavior Stages before and after Intervention in Two Groups of Patients

Before and one month after the intervention, no statistically significant differences were found in any behavioral stages between the two groups (P>0.05). Three months and six months after the intervention, statistically significant differences were observed in all behavioral stages of both groups (P<0.05), indicating that health education based on TTM combined with empowerment can promote changes in the behavioral stages of patients in the intervention group, with better intervention effects compared to the control group, as shown in Table 4.

3.3. Comparison of Self-Management Efficacy Scores at Each Time Point Before and After Intervention in Two Groups of Patients

There was no statistically significant difference in the total self-efficacy score between the two groups before and after intervention (P>0.05); there was an interaction effect between the intervention method and time factor (P<0.001); simple effect analysis showed that compared with before intervention, the self-efficacy scores at each time point in both groups were statistically significant (P<0.05), see Table 5.

3.4. Comparison of Barthel Index Scores at Each Time Point before and after Intervention in Two Groups of Patients

The repeated measurement ANOVA of the total Barthel index scores before and after intervention showed that different intervention methods did not have statistical

significance on the Barthel index scores of patients in both groups after intervention (P>0.05); over time, the daily living abilities of patients in both groups gradually improved, with significant differences in Barthel index scores at various time points within each group before and after intervention (P<0.05); there was an interaction effect between the intervention method and time factors (P<0.001); simple effect analysis showed that there were statistical differences in Barthel scores at each time point within both groups before and after intervention (P<0.001), see Table 6.

Table 4. Comparison of self-management behavior stages at each time point before and after intervention in two groups of patients (n, %)

behavioral phase	T0 (pre-intervention)		T1 (1 month after intervention)		T2 (3 months after intervention)		T3 (6 months after intervention)	
	Control group (n = 52)	Intervention group (n = 52)	Control group (n = 51)	Intervention group (n = 52)	Control group (n = 51)	Intervention group (n = 51)	Control group (n = 50)	Intervention group (n = 51)
The unintentional phase	4(7.7)	5(9.6)	4(7.8)	1(1.9)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Intention phase	24(46.2)	19(36.5)	15(29.5)	15(28.9)	12(23.5)	0(0.0)	12(24.0)	0(0.0)
preparatory phase	15(28.8)	16(30.8)	18(35.3)	22(42.3)	24(47.1)	2(3.9)	23(46.0)	0(0.0)
Action phase	5(9.6)	4(7.7)	10(19.6)	4(7.7)	8(15.7)	41(80.4)	10(20.0)	13(25.5)
maintenance stage	4(7.7)	8(15.4)	4(7.8)	10(19.2)	7(13.7)	8(15.7)	5(10.0)	38(74.5)
Fisher Exact probability	2.323		7.469		58.485		70.223	
P	0.69		0.109		0.001		0.001	

Table 5. Comparison of self-efficacy scores at different time points before and after intervention between two groups of patients

	Control group (n = 50)	Intervention group (n = 51)	T	G	T*G
T0 (pre-intervention)	117.32±16.60	101.45±25.87	*F=6.*919 *P<0.001*	*F=0.006 P=0.938*	*F=8.178 P<0.*001
T1 (1 month after intervention)	112.98±32.11	113.65±21.46[a]			
T2 (3 months after intervention)	110.84±25.26	121.45±9.83[a]			
T3 (after 6 months of intervention)	119.76±16.61[c]	123.61±8.30[abc]			
F	4.96	17.762			
P	0.003	<0.001			

Note: a compared with pre-intervention P <0.05; b compared with one month after intervention P <0.05; c compared with three months after intervention P <0.05; T represents the effect within group, G represents the effect between groups, and T * G represents the effect within group * between groups.

Note: Compared with before intervention, P<0.05; Compared with one month after intervention, P<0.05; P<0.05 compared to 3 months after intervention; T represents intragroup effect, G represents inter group effect, and T * G represents intragroup * inter group effect.

4. Discussion

This study found significant time-effect differences in self-management behavior between the two groups of patients. Compared to before the intervention, there were statistical differences in both the total scores and each dimension of self-management behavior for both the intervention group and the control group (P<0.001). One month after the intervention, patients in the intervention group showed significant differences across multiple dimensions, while only a significant difference was observed in the total score of self-management behavior for the control group. Three months after the intervention, all dimensions of the intervention group except interpersonal management were better than before and one month after the intervention, whereas the control group showed improvement only in some dimensions. Six months after the intervention, all dimensions of the intervention group were significantly better than before and one month after the intervention, and some dimensions were better than three months after the intervention (P<0.05), while the control group showed improvement only in some dimensions compared to before the intervention. This finding is similar to previous studies [22], It indicates that over time, the self-management behaviors of both groups of patients have improved. However, traditional inpatient health education

falls short in interpersonal relationship management, and the intervention effect has not shown significant decline in the early stages. In contrast, empowerment interventions based on TTM offer advantages for full-cycle management. The reason may be that self-management behaviors are largely part of individual lifestyles, but traditional health education methods are relatively monolithic and have weak constraints on patients, leading to poor educational outcomes. By comparison, empowerment interventions can stimulate patients health responsibility and beliefs early on, allowing healthcare providers to continuously motivate patients to maintain behavioral momentum based on TTM theory.

Table 6. Comparison of Barthel index scores at different time points before and after intervention between two groups of patients

	Control group (n = 50)	Intervention group (n = 51)	T	G	T*G
T0 (pre-intervention)	3.94±0.42	2.67±0.74	*F=3.223 P<0.023*	*F=0.005 P=0.945*	*F=48.446 P<0.001*
T1 (1 month after intervention)	3.24±0.92[a]	3.75±0.44[a]			
T2 (3 months after intervention)	3.18±0.92[a]	3.75±0.44[a]			
T3 (after 6 months of intervention)	3.4±0.81[ab]	3.75±0.44[abc]			
F	14.844	33.187			
P	<0.001	<0.001			

Note: A P <0.05 compared with pre-intervention; b P <0.05 compared with one month after intervention; c p <0.05 compared with three months after intervention. T represents the effect within group, G represents the effect between groups, and T * G represents the effect within group * between groups.

Note: Compared with before intervention, P<0.05; Compared with one month after intervention, P<0.05; P<0.05 compared to 3 months after intervention. T represents intragroup effect, G represents inter group effect, and T * G represents intragroup * inter group effect.

The results of this study show that the TTM-based combined empowerment intervention demonstrates superior effects in promoting behavioral changes among middle-aged and young stroke patients compared to conventional health education (P<0.05), especially in converting intention into action and maintaining healthy behaviors. As shown in Table 4, before the intervention and one month after the intervention, most patients were at the intention and preparation stage, with no significant difference in the behavioral stage between the two groups (P>0.05). This indicates that most patients have recognized the importance of self-management but have not yet put it into practice. However, after six months of intervention, most patients in the intervention group entered the action and maintenance stage, while most patients in the control group remained at the intention and preparation stage. The comparison of behavioral stages between the two groups shows a significant statistical difference (P<0.05). This is consistent with Huang Ruixiu[23]And Han Hailing[15]The research findings are consistent. This may be related to the fact that the subjects included in this study were mainly middle-aged and young adults, mostly urban residents, thus their grasp of health knowledge is more comprehensive and their ability to accept and absorb information is stronger. Therefore, as the intervention period extended, the number of patients in the intervention group who changed and maintained healthy behaviors was significantly higher than those in the control group.

According to Banduras social cognitive model, self-efficacy is defined as a psychological structure that describes peoples beliefs about their performance and success in specific situations[24]This study found that the TTM-based empowerment intervention for middle-aged and young stroke patients showed significant time-effect differences in self-efficacy. Compared to before the intervention, both the intervention group and the control group experienced a significant increase in self-efficacy (P<0.001). However, the control group did not show a significant difference early in the intervention; it was only after six months that their self-efficacy surpassed that of the three-month intervention group (P<0.05). In contrast, the intervention group demonstrated significantly better self-efficacy at one month, three months, and six months post-intervention compared to before (P<0.05), with the highest self-efficacy observed six months post-intervention (P<0.001). This indicates that compared to traditional inpatient health education, TTM-based empowerment interventions have sustained advantages in enhancing self-efficacy for middle-aged and young stroke patients. This finding aligns with those of Huang Jinfeng et al., Liu Xia et al [25, 26] The research findings are largely consistent. Analysis suggests that traditional inpatient health education merely stimulates patients' potential for self-management through the form of responsibility nurses or group health education, failing to comprehensively consider the obstacles in the process of patient behavior change. In contrast, empowerment interventions based on TTM are more conducive to promoting positive behavioral changes in patients, making them feel greater perceptual benefits, thereby enhancing their sense of efficacy. Therefore, future behavioral interventions for middle-aged and young stroke patients should take individual differences into account and develop personalized intervention measures.

This study found that there were significant time-effect differences in Barthel index scores between the two groups of patients (P=0.023). Compared to before the intervention, both the intervention group and the control group showed improvements in their Barthel index scores (P<0.001). However, only the self-efficacy of the control group slightly improved at 6 months after the intervention compared to

earlier stages (P<0.05). In contrast, the self-efficacy of the intervention group was significantly better than pre-intervention levels at 1, 3, and 6 months (P<0.05). This indicates that the intervention group played a more positive role in enhancing patients daily living abilities. This may be attributed to the empowerment process based on TTM, which enables patients to set personal goals and action plans, develop problem-solving skills, and make full use of resources. This finding is consistent with previous studies showing that self-management programs for stroke patients have a positive impact on functional outcomes [25, 27, 28] Therefore, it is suggested that patients and their families should be actively invited to participate in the development of self-care activity plan to ensure that the goals and behavioral plans are more in line with the patients living habits, so as to improve their compliance.

In summary, this study investigated the effectiveness of a health intervention model that combines TTM with empowerment education in middle-aged and young stroke patients. The results showed that TTM-based empowerment interventions can promote and maintain positive self-management behaviors in middle-aged and young stroke patients, as well as improve their self-efficacy and daily living abilities. However, since the intervention measures in this study were comprehensive, it is not easy to determine the specific components of TTM-based empowerment interventions that are effective. Furthermore, the behavioral stage distribution assessment scale based on TTM theory lacks specific quantitative evaluation criteria, which may affect the reliability of the assessment results. It is recommended that future research explore objective and effective behavioral stage assessment scales.

Acknowledgments

Fund Project: Shaanxi Provincial Basic Research Program of Natural Science (No.: 2024 JC-YBMS-603).

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