The Influential factors of Adherence to Physical Activity and Exercise among Community-Dwelling Stroke Survivors: A Path Analysis

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Abstract

Background: Regular physical activity and exercise (PAE) after stroke is essential, but the adherence to PAE and its influential factors is rarely studied and unclear in developed countries. The aim of this study was to investigate the status of PAE adherence, and to identify its influential factors among Chinese community-dwelling stroke survivors.

Methods: A cross-sectional study was conducted, 208 stroke survivors were randomly selected from three communities (60.10% men, mean age 70.25 ± 9.08 years). Physical Activity and Exercise Adherence Scale (PAEAS) was used as a measure of compliance, knowledge, attitude, self-efficacy and social support were measured using relevant scales. Influential factors of PAE adherence and associations between those variables were explored using multiple linear regression and path analysis.

Results: The mean adherence rate was moderate (62.0%), stroke survivors tended to be more adherent to do PAE than monitoring and seeking advices ($70.30\% > 53.50\% > 48.30\%$). Regression results revealed that seven factors significantly associated with PAE adherence, including knowledge, attitude, self-efficacy, social support, self-care ability, community rehabilitation experience, and times since stroke ($R^2 = 75.10\%$, $F = 45.593$, $p < 0.05$). Furthermore, path analysis showed that knowledge had a significant indirect positive influence with self-efficacy as a mediator on adherence ($\beta = 0.16$, $p < 0.05$); while attitude and social support impacted both directly and indirectly on adherence with self-efficacy as the mediator; what's more, self-efficacy was an important predictor that performed the strongest direct effect on community-dwelling stroke survivors' PAE adherence ($\beta = 0.44$, $p < 0.01$). These four variables accounted for a total of 67.00% of the variance of PAE adherence among community-dwelling stroke survivors.

Conclusions: Physical activity and exercise adherence of community stroke survivors is needed to be improved. Attitude and social support presented both direct and indirect impacts on PAE adherence through self-efficacy, while knowledge only exhibited an indirect influencing effect on adherence. Health care professionals should administer a more comprehensive and systematic assessment to seek to improve self-efficacy through the development of effective interventions for promoting adherence to PAE in this population.

Background

Globally, stroke is a leading cause of death and disability, particularly in low- and middle-income countries (1), and this burden is increasing (2-4). Persistent physical activity and exercise is important for maintaining motor function across all life stages after stroke (5). Regular physical activity and exercise not only has positive effects on stroke survivors' physical improvement but also has benefits for cognitive function rehabilitation (6), psychological domains, and quality of life (7). Systematic reviews have confirmed the benefits of physical activity and exercise in stroke survivors (8, 9). According to *Physical Activity and Exercise Recommendations for Stroke Survivors* from the American Heart Association (AHA), the recommended frequency and duration of continuous aerobic exercise range from 20-60 min/d and

from 3-5 days per week, the intensity and frequency of muscular strength exercise are 1-3 sets of 10-15 repetitions of 8-10 exercises, 2-3 days/week, depending on a patient's fitness status (5, 10).

However, stroke survivors may cease physical activity or reduce the frequency and duration, studies have shown that low adherence to recommended physical activity and exercise is a major problem among stroke survivors(5, 11, 12). Even continuous monitoring during an exercise intervention with stroke survivors living in a community resulted in a mean exercise class attendance of only 60%, and after one year's follow-up, only 44% of participants completed the recommended exercise of walking 10,000 steps per day (13). In a study conducted by Gunnes (12) in Norway, the rate of adherence to long-term physical activity and exercise was 51.2% at the beginning and increased by 2.6% per month with individualized monthly coaching by a physical therapist. Another investigation conducted in USA also revealed that only 65.3% of stroke patients who completed 6 months of rehabilitation with a professional organization reported adhering to at least part of the home exercise program (11). Stroke survivors who discharged from hospital spent only 13% to 45% (14) of their days engaging in therapeutic activities. Research from China also demonstrated that 70.6% of the stroke survivors spent less than 8.5 hours per week on moderate activity (15). So, it is very important to explore the reasons for adherence or non-adherence in order to design more effective and long-lasting interventions.

Social Cognitive Theory (SCT) has been widely used to explore and explain physical activity and exercise behavior, evidences recommend that researchers should report direct, indirect, and total effects from all constructs to behavior (16). According to SCT, stroke survivors' adherence behavior may be determined by personal, social factors, and environmental factors (17, 18). Personal correlates, demographic and health variables, have been related to exercise (19). Among social factors, social support has been shown to correlate with physical activity in general populations (20) and older patients (21). Environmental factors of physical activity have recently received attention (22), while rehabilitation service in community have not been rigorously studied. The SCT postulates that psychosocial, physical and behavioral factors potentially influence each other both theoretically and structurally, and there are several studies that have examined and identified the pathways used by various psychosocial factors to influence physical activity and exercise (23, 24). However, none have examined these interrelationships with respect to physical activity and exercise adherence behavior in a cohort of community-dwelling stroke survivors.

In this study, we aimed to investigate the physical activity and exercise adherence of community-dwellers after stroke, explore its association with personal, social, and environmental factors in an agentic and systematic perspective, finally to identify the pathways in which factors, such as knowledge, attitude, self-efficacy and social support. The hypothesized model based on a SCT and previous research(19) (20) (21) was evaluated through a path analysis which tested the contributions of various paths in the model; the hypotheses and model are illustrated in Figure 1.

Methods

Participants

A cross-sectional survey study was conducted with 208 community-dwelling stroke survivors. By convenience sampling, three communities (Nan-guan, Qin-ling, and Chang-jiang) with a total of eleven health service stations in Zhengzhou city were selected as the sites of the study. Participants were randomly selected from the health service stations according to their health record number. Of the 468 standard stroke patients in these communities, 50.6% (236) met the study's eligibility criteria: stroke diagnosed by MRI or CT, lucid enough to cooperate with the research interviewers, able to voluntarily sign the information and consent form, able to participate in a face-to-face interview, live in their home rather than any institutional care centers. Among the eligible participants, 16 refused to be interviewed after being informed of the study purpose, and 12 could not be reached via the contact information recorded in their files. Finally, 208 qualified and consenting participants were included.

Data collection

Three trained investigators conducted the investigation, and informed consent was obtained from all participants. Participants were interviewed face-to-face by the three investigators at the patient's home or the community center. To guarantee the accuracy of the data, all participants were asked to carefully review and confirm their answers to the questionnaires immediately after completing them. A copy of the *Manuals of Daily Life for Stroke Patients* designed by our research group was given to each participant as a gift at the end of the investigation.

Independent variables

The demographic and disease-specific data questionnaire was designed and used to collect the information of age, gender, education level, marital status, time since stroke, number of complications and experience of community rehabilitation, etc.

Stroke Attitudes and Knowledge Questionnaire (SAKQ): The SAKQ was developed based on the literature (25). It contains 27 yes-or-no questions for knowledge assessment and 16 to-what-extent questions for attitude assessment. The knowledge subscale includes four sections: stroke accident knowledge (5 items), risk factors knowledge (8 items), physical activity knowledge (9 items), and prevent recurrence knowledge (5 items). Scale options are either 'no (score of 0)' or 'yes (score of 1)', higher scores indicate better knowledge. The attitude section contains 16 items: attitude toward controlling risk factors (8 items), attitude toward regular physical activity (3 items), and attitude toward health responsibility (5 items). Responses are divided into three levels: "important", "not sure", and "not important", scored as 3 points, 2 points, and 1 point, respectively. The sum of the points reflects the respondent's overall attitude toward physical activity and exercise. The Cronbach's α and Content Validity Index (CVI) of the knowledge section are 0.85 and 0.92, respectively, the Cronbach's α and CVI of the attitude section are 0.88 and 0.87, respectively. Overall, the Cronbach's α and CVI for the reliability-validity of all questionnaire items are 0.90 and 0.95, respectively(26).

Perceived Social Support Scale (PSSS): The PSSS was described by McDowell and Zimet et al. (27, 28). It measures the perceived support that patients receive from their family, friends or communities. This scale

contains 10 items divided into three sections: objective support (OS), with 3 items; subjective support (SS), with 4 items; and utilization of social support (USS), with 3 items. The final score is the sum of each of the 10 item scores. The Cronbach's alpha for PSSS in present study is 0.92, and the item-total correlations range from 0.89 to 0.94.

Self-Efficacy for Managing Chronic Disease 6-Item Scale (SES6C): The SES6C was designed by Lorig K et al. (29) and is widely used to measure the confidence of chronic disease patients in doing certain activities(30, 31). The measure consists of six items. It uses a 10-point Likert scale a psychometric scale commonly used in questionnaire-based research, with scores ranging from 1 ("not confident at all") to 10 ("completely confident"). The scale is interpreted by calculating a mean score over at least four of the six items thus allowing a maximum of two missing item responses. The scores reflect the self-efficacy level of the respondent, with higher scores indicating greater confidence. Cronbach's alpha for the SES6C is 0.88 and the split-half is 0.80(32).

Dependent variable

Physical Activity Adherence and Exercise Scale (PAAES): The PAAES was previously tested (33) and widely used(34) to determine the adherence to the recommended rehabilitation physical activity and exercise regimen of community-dwelling stroke survivors (10). PAAES contains 14 items organized into three sections: adherence to PAE participation (PAEP), with 8 items; adherence to PAE monitoring (PAEM), with 3 items; and adherence to PAE advice-seeking (PAEA), with 3 items. The scores for each question range from 1 ("never") to 4 ("always"), and higher scores indicate better adherence. Adherence rate M can be calculated using the formula " $M = \text{actual score} / \text{max}$ ", max is obtained by multiplying the number of entries by 4. The adherence rate is defined as high at $\geq 75\%$, moderate at $50\% - 75\%$ and low at $\leq 50\%$ (35, 36). Cronbach's alpha value of PAAS is 0.900, in relation to each domain are 0.705 – 0.897, the Scale Content Validity Index (S-CVI) is computed as 0.950 (37).

Statistical analysis

We investigated participants' demographic characteristics and path analysis assumptions using IBM SPSS (version 21). Descriptive statistics (means, standard deviations and percentages) were calculated to represent the demographic characteristics, along with the scores of PAAES, SKAQ, SES6C and PSSS. Two unrelated groups' mean scores were compared using a two-independent-sample t-test, differences of three or more groups' scores were tested by means of one-way analysis of variance (ANOVA). Multiple two-group comparisons were conducted using a least significant difference (LSD) t-test. The relationships between predictive factors and adherence were analyzed using Pearson correlation coefficients. Stepwise linear regression was performed to identify the predictors of adherence. The results were checked for accuracy, and two tailed p values which were significant at <0.05 .

The hypothesized model was tested using IBM SPSS AMOS 21.0 software. There were seven hypothesized paths in this study: adherence regressed on knowledge, attitude, social support and self-efficacy; self-efficacy regressed on knowledge, attitude and social support. Path analysis is an extension

of the regression model, a special case of Structural Equation Modeling (SEM) where all variables included in the model are observed (non-latent) variables, it allows for the simultaneous estimation of these equations (24, 38), this path analysis was defined as path analysis with observed variables (PA-OV) (39). Additionally, path analysis can involve modeling indirect and direct effects as well as hypothesis tests on the parameters of the effects. The path of the model is shown by squares and arrows. A single-headed arrow points from cause to effect. A double-headed, curved arrow indicates that variables are merely correlated. Regression weight is predicated by the model, and the residual error terms reflect the unexplained variance and measurement error (39). Then the goodness-of-fit statistic is calculated in order to test the consistent with the hypotheses that went into the model. Because these criteria were very sensitive, alternative incremental fit indices were determined such as root-mean-square error approximation (RMSEA) <0.080, goodness of fit index (GIF) >0.900, and comparative fit index (CFI) > 0.900(40).

Results

Characteristics of the Study Sample

Among the 208 stroke survivors, mean age was 70.25 ± 9.08 years (range: 50-90 years); 60.10% of the participants were male, and 75.48% were married. All the data were transformed into categorical variables so that it would be easier to test the differences of physical activity and exercise adherence between groups with different characters (Table 1).

Table 1 Characteristics of participants and physical activity and exercise adherence differences (N=208)

Characters	Groups	n	Adherence rate (%) M(SD)	Group differences	
				F/t value	p value
Age(years)	<60	24	67.04 (17.13)	4.648	0.004**
	60~	64	62.36 (12.84)		
	70~	90	63.25 (15.30)		
	80~	30	53.33 (14.52)		
Gender	Male	125	61.26 (15.07)	-0.853	0.394
	Female	83	63.08 (15.03)		
Previous occupation	Worker	134	62.10 (14.67)	0.563	0.640
	Manager	47	62.16 (17.03)		
	Medical staff	10	65.89 (10.36)		
	Others	17	58.30 (15.39)		
Education level	Illiterate	31	58.35 (16.17)	2.145	0.077
	Preliminary	56	59.85 (14.28)		
	Junior	70	61.94 (13.77)		
	Senior	42	65.77 (16.97)		
	College or above	9	70.44 (12.38)		
Income (¥/month)	<1000	15	55.95 (15.97)	1.364	0.258
	1001~	155	62.26 (15.02)		
	2001~	38	63.25 (14.87)		
Main caregivers	Spouse	91	59.26 (16.42)	3.543	0.008**
	Children	23	56.99 (15.06)		
	Spouse and Children	12	62.80 (13.72)		
	Themselves	76	66.82 (12.38)		
	Others	6	59.52 (15.43)		
Time since stroke (years)	<5	93	61.77 (15.46)	0.418	0.074
	5~	52	60.82 (14.45)		
	10~	37	62.16 (16.55)		
	15~	26	64.84 (13.12)		
Stroke subtype	Hemorrhagic	33	54.38 (12.99)	6.820	0.001**
	Ischemic	168	63.82 (15.04)		
	Uncertain	7	53.83 (12.73)		
Number of Complications	0	29	67.06 (11.04)	3.794	0.011*
	1	80	64.42 (15.90)		
	2	75	58.00 (14.79)		
	3 or more	24	60.19 (14.80)		
Hemiplegia	Yes	114	59.24 (15.62)	2.225	0.027*
	No	94	63.92 (14.45)		
Self-care level (ADL)	needs intensive help	21	43.54 (16.01)	27.167	<0.001**
	needs guidance	33	55.95 (12.09)		
	needs assisting tools	70	61.07 (13.95)		
	completely independent	84	69.73 (11.20)		
Living environment	first floor	69	60.71 (16.70)	0.386	0.858
	second floor	49	63.56 (13.96)		
	third floor	29	64.04 (12.10)		
	fourth floor	24	61.46 (16.39)		
	fifth floor	25	60.21 (16.31)		
	sixth floor or higher	12	62.65 (12.29)		
Inpatient rehabilitation	yes	43	64.45 (14.07)	-1.206	0.229
	no	165	61.34 (15.31)		
Community rehabilitation	yes	19	67.20 (16.88)	-1.587	0.014*
	no	189	61.46 (14.84)		

Note: ** $p < 0.01$; * $p < 0.05$; F/t-value represents the test statistic of one-way ANOVA test or t test; the cut-off value for p -value is 0.05.

Status of adherence

Table 2 illustrates the physical activity and exercise adherence rate, scores of SKAQ, PSSS, SES6C, and relevant proportion or value of conversion. The mean rate of adherence was moderate, at 62.00%, stroke survivors tended to be more adherent to do physical activity than monitoring and seeking advices (70.30%>53.50%>48.30%). The constituent ratio of adherence levels is shown in Figure 2.

Table 2 Descriptive statistics of the variables (N=208)

Variables	Dimensions	Min - Max	Mean (SD)
Adherence (%)	Total adherence rate	25 - 100	62.0 (15.10)
	adherence to PAE participation	25 - 100	70.3(17.20)
	adherence to PAE monitoring	25 - 100	53.5(16.40)
	adherence to PAE advice-seeking	25 - 100	48.3 (17.20)
Knowledge	Total score	3 - 27	14.06 (5.81)
	prevent recurrence knowledge	0 - 5	3.55 (1.42)
	risk factors knowledge	0 - 8	4.75 (2.39)
	stroke accident knowledge	0 - 5	2.17 (1.58)
	physical activity knowledge	0 - 9	3.60 (2.29)
Attitude	Total score	16 - 48	32.46 (7.39)
	attitude toward controlling risk factors	8 - 24	17.11(3.72)
	attitude toward regular physical activity	3 - 9	6.37 (1.66)
	attitude toward health responsibility	5 - 15	8.98 (3.07)
Social support	Total score	12 - 62	29.67(6.65)
	objective support	1 - 18	6.87(1.83)
	subjective support	8 - 32	17.20(4.15)
	utilization of social support	3 - 12	5.60(2.33)
Self-efficacy		0 - 6	3.46(1.71)

Regression results

Pearson correlation coefficients demonstrated that the physical activity and exercise adherence rates had significant statistical correlations with scores of knowledge, attitude, social support and self-efficacy; these were presented in Table 3. The regression analysis was constructed using the factors with a statistically significant contribution shown in Tables 1 and 3. Finally, after analysis, seven independent variables entered into the regression model, with a R^2 of 75.1%, the F -value was 45.593 and p -value was 0.001(Table 4).

Table 3 Pearson correlation coefficients between possible influential variables and adherence (N=208)

Variables	Dimensions	PAEP	PAEM	PAEA	TAR
Knowledge about stroke		0.432	0.511	0.311	0.477
	stroke accident knowledge	0.233	0.311	0.109▲	0.251
	risk factors knowledge	0.317	0.442	0.298	0.382
	physical activity knowledge	0.358	0.350	0.188	0.360
	risk factors knowledge	0.394	0.436	0.345	0.443
Attitude toward stroke		0.572	0.701	0.544	0.669
	attitude toward controlling risk factors	0.498	0.649	0.455	0.587
	attitude toward regular physical activity	0.598	0.550	0.424	0.622
	attitude toward health responsibility	0.449	0.603	0.526	0.562
Social Support		0.498	0.512	0.513	0.569
	subjective support	0.424	0.445	0.421	0.483
	objective support	0.192	0.284	0.209	0.242
	utilization of social support	0.514	0.444	0.550	0.573
Self-efficacy		0.690	0.514	0.528	0.699

Note: ▲ $p > 0.05$, all the rest variables are statistically significant ($p < 0.05$).

Table 4 Influencing factors of physical activity and exercise adherence (N=208)

Variables/Associations	$\beta(SB)$	SE	$t\text{-value}$	$p\text{-value}$
Content	3.417	2.046	1.379	0.170
Self-efficacy	0.374	0.023	7.957	<0.001
Social support	0.222	0.146	5.502	<0.001
Community rehabilitation experience	0.199	1.185	4.918	<0.001
Attitude	0.194	0.104	4.234	<0.001
Self-care ability	0.178	0.387	3.940	<0.001
Knowledge	0.108	0.151	2.630	0.009
Times since stroke	0.099	0.298	2.647	0.009

Path analysis results

The path coefficients are regression weights obtained from the regression analysis. As shown in Figure 3, one-way arrows indicate the direct effect of a cause variable on an effect variable. Two-way arrows indicate correlated variables, e1 and e2 were residuals (error terms) that were uncorrelated with the variables in the model and with each other. All relations were linear and additive. The numbers are path coefficients, which are standardized versions of the linear regression weights used to examine the possible causal linkages between statistical variables. First, knowledge was an indirect influential factor that affected adherence via the meditating effect of self-efficacy ($\beta = 0.16$, $p < 0.05$). Second, social support and attitude presented direct effects on adherence, with coefficients of 0.20 and 0.30, respectively. Third, knowledge, attitude, and social support were exogenous variables, while self-efficacy meditates the relationship between them and adherence with coefficients of 0.16, 0.23, 0.38, respectively. Finally, the strongest direct effect of self-efficacy, for adherence was significant ($\beta = 0.44$, $p < 0.01$). In summary, the variables accounted for a total of 67.00% of the variance of physical activity and exercise adherence among community-dwelling stroke survivors.

Fitness of the hypothetical path model

The results of this model test analysis showed that the chi-square value of this model was 2.201 ($p = 0.138 > 0.05$), Goodness-of-fit index (CFI) value was 0.997 and compare fix index (GFI) was 0.996, RMSEA value was 0.076, CN, critical N was 362 > 200. These criteria indicated that the data fit our hypothetical path model adequately(39-41).

Discussion

Although previous studies had confirmed, adherence to physical activity and exercise is very important for stroke survivors' long-term outcomes (12, 36, 42), it is a worldwide concern as well. The results of the present study showed that the mean adherence rate was moderate (62.00%), only 20.19% of the participants had a high level of adherence rate. The results were similar to but slightly lower than those in Duncan's study (36); in that study, the average adherence rate was 68.2% in the acute phase and 69.5% in the post-acute phase. Another study by Ovbiagele et al. (43) found that nearly 70% of 144 stroke survivors maintained regular exercise upon being discharged from hospital, which was similar to but slightly higher

than our findings. Despite differences in research design, cultural background, and economical level, lack of conventional management(44), not ideal health care seeking behavior(45) have been main barriers for adherence behavior, and it is likely to present an even greater influence on Chinese community-dwelling stroke survivors' long-term outcomes over the next few decades.

To further understand the physical activity and exercise adherence status, we analyzed the adherence rate of each subdimension. Results showed that the rate of adherence to participation was the highest, approximately 70.30%, while the rate of adherence to monitoring was 53.49% and that of adherence to advice-seeking was only 48.32%. This illustrates that most of the stroke survivors preferred to do regular physical activity and exercise but did not pay much attention to self-monitoring when performing exercise, and only approximately 15.38% of them had ratings consistent with a high level of adherence, as shown in Figure 1. Moreover, the results also indicated that community-dwelling stroke survivors rarely received positive advices when they ran into barriers because only 14.42% were rated as having high adherence to PAE advice seeking. Possible explanations are that consciousness, language, movement, and other disabilities may affect stroke patients' intention to communicate with others(46). In addition, according to the National norms for basic public health services in China(47), no regular home visits or phone communication service will be provided to community-dwelling stroke survivors, and there is no routine mandatory follow-up service from hospital as well. Therefore, this may be helpful in explain the reason that why most of stroke survivors are unaware of the importance of asking for advice, for they do not know how to get help.

Regarding to the possible influential factors. The hemiplegic patients with lower self-care ability performed worse physical activity and exercise adherence, however it was revealed that hemiplegia was not a significant predictor in the multivariate linear regression analysis. All in all, the more dependent patients were, the lower their adherence rates were, and these results are reasonably similar to other investigations (48). In addition, patients are willing to receive assistance from caregivers (49), however, the inconsistent perceived needs between stroke survivors and their caregivers should be considered (50). What's more, the interpersonal relationship challenges among stroke survivors and family caregivers should be considered as well (51). Regarding the correlation between marital status and adherence, there was no significant difference in adherence rates between stroke survivors who had a spouse as a caregiver and those who did not (0.624 vs. 0.607, $p > 0.05$). We were surprised to find that the adherence rates of the patients who had caregivers were lower than those of the patients who looked after themselves. Perhaps it is necessary to conduct a systematic review regarding the association of marital status with adherence for further understanding.

Our findings demonstrated that patients with better knowledge and positive attitudes tended to have higher adherence levels. Knowledge is known as an influencing factor that triggers motivation for adherence behavior among all kinds of patients (52, 53). Stroke survivors who are more knowledgeable can more positively accept the importance of physical activity as they are more aware of the benefits of physical activity and exercise adherence. However, path analysis results showed that knowledge only exerts an indirect positive effect on adherence through its direct effects on self-efficacy. This could be

have been caused by individuals who has disability, the positive effect of better knowledge on healthy behavior may be eliminated by the fear or restriction of participation(13). Studies highlighted that patients often feel unprepared do deal with long-term disabilities, self-efficacy has been proposed as important determinant of adaptation process in individuals after stroke(24, 42, 54). Researches also demonstrated that patients who proactively and willingly participated in exercise had high adherence, even without any supervision (55, 56).

In this study, social support as a protective factor in the adherence pathway demonstrated a direct, positive, and significant association with adherence and indirectly associated with adherence through self-efficacy. This finding is supported by the results reported in Zhao's study (57). Our findings thus suggested that social support was more important than other external factors like environmental factors for adherence among community-dwelling stroke survivors. This matches the results of Damush et al., who reported that social support was a facilitator of exercise after stroke (19). Effective social support could come from physicians, family members, friends, other patients or volunteers, etc. However, from the viewpoints of health care professionals, many barriers exist that interfere with their ability to provide help or support to stroke survivors (58), among them time constraints was the main barrier (59). Especially in China, with limited health care service in community and lack of effective social support system, it's a big challenge using social factors to improve stroke survivors' physical activity and exercise adherence at home.

Finally, but most importantly, self-efficacy presented as a key and predictive factor that can both directly affect physical activity and exercise adherence and mediate other variables. In our study, the results showed that self-efficacy is not only an influencing factor but is also an important determinant of physical activity and exercise adherence for stroke survivors. Our results were consistent with those of two previous studies by Ivey et al. (60) and Frederick et al. (61), who suggested that patients with higher self-efficacy tend to have better adherence. However, other researchers have reported conflicting results, such as in a study of sports prescription lead by Jones et al. (48). They found that patients with high self-efficacy do not necessarily comply better than others because they may have higher expectations of recovery; when these patients were not satisfied with their results, they retreated, and their levels of persistence, enthusiasm and adherence changed. Therefore, we propose that the synergies and mechanism of knowledge, attitude, social support and self-efficacy in PAE adherence behavior should be clarified and applied in future practice.

This project has several limitations. First, a relatively small group of Chinese stroke survivors participated in the study, so the results cannot be directly extrapolated to all stroke survivors. Second, we conducted the investigation at one time point, but it will be superioris to conduct a longitudinal study of first-ever stroke survivors to identify the trajectory of physical activity adherence. In addition, other barriers and facilitators should be considered in study, or a qualitative study is needed to explore how variables like self-efficacy, et al. influences adherence among stroke survivors. Such a study would provide more detailed guidance for further intervention development if the sample size was larger or the study design was more comprehensive.

Conclusions

In summary, we explored factors that might associate with the adherence to physical activities and exercise among community-dwelling stroke survivors in China. The results showed that overall adherence was moderate and that adherence to seeking advice was the lowest-scoring aspect. The most significant discovery was that stroke survivors' adherence could be influenced by personal, social and environmental factors, including self-efficacy, attitude, social support, self-care level, time since initial diagnosis, community rehabilitation experience, and knowledge. Among these, attitude and self-efficacy are the most important. In particular, self-efficacy is a major determinant for community-dwelling stroke survivors because of its direct effect on adherence and its mediating effect on other variables. Specific interventions should be performed to encourage stroke patients' internal motivation and thus improve their adherence to prescribed physical activity and exercise, including frequent health interviews in the community, proper monitoring, reminders about scheduled exercise and other tactics.

Abbreviations

PAE: Physical Activity and Exercise; AHA: American Heart Association; SCT: Social Cognitive Theory SCT; SAKQ: Stroke Attitudes and Knowledge Questionnaire; CVI: Content Validity Index; PSSS: Perceived Social Support Scale; SES6C: Self-Efficacy for Managing Chronic Disease 6-Item Scale; PAAES: Physical Activity Adherence and Exercise Scale; PAEP: PAE participation; PAEM: PAE monitoring; PAEA: PAE advice-seeking; ANOVA: one-way analysis of variance; LSD: least significant difference; SEM: Structural Equation Modeling; PA-OV: path analysis with observed variables; RMSEA: root-mean-square error approximation; GIF: goodness of fit index; CFI: comparative fit index;

Declarations

Ethics approval and consent to participate

The protocol was evaluated and approved by the Research and Health Ethics Committee of Zhengzhou University.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

BLL designed the study design, analyzed and interpreted the data and wrote the article. YXM analyzed and interpreted the data. ZXZ provided critical review for important intellectual content, and approved the final version of the article. LML and HX provided review for the result and discussion sections. BLL, YXM and WWN acquired information. All authors read and approved the final manuscript.

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Figures

Figure 1

Hypothesized model of physical activity and exercise adherence

Figure 2

The constitute ratio of three levels of (a) Total, (b) PAEP, (c) PAEM, and (d) PAEA.

Figure 3

Path analysis results.