International Journal of General Medicine

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Knowledge, Attitude, and Practice of Thrombolysis in Family Members of Cerebral Infarction Patients: Structural Equation Modeling Analysis

Fan Huang[1,2], Ling Zhou[1,2], Ping Zhao[1,2], Meiping Guo[1,2], Wujia Chen[1,2]

[1]Intensive Care Unit, Wujin Hospital Affiliated with Jiangsu University, Changzhou, 213000, People's Republic of China; [2]The Wujin Clinical College of Xuzhou Medical University, Changzhou, 213000, People's Republic of China

Correspondence: Wujia Chen, Email 101264101@qq.com

Background: Ischemic stroke, a leading cause of death globally, is often treated with thrombolytic therapy. However, low thrombolysis rates persist due to knowledge gaps among patients and families. This study assessed the knowledge, attitudes, and practices (KAP) of family members of cerebral infarction patients regarding thrombolysis.

Methods: A cross-sectional study was conducted at Wujin People's Hospital (August 2023–July 2024) using an online questionnaire. Demographic data and KAP scores were collected from 505 family members of cerebral infarction patients, including 188 (37.23%) whose relatives underwent thrombolysis.

Results: A total of 505 valid questionnaires were analyzed. Among the participants, 256 (50.69%) were male, and 188 (37.23%) were family members of patients who had undergone thrombolysis during the survey period. The mean scores for knowledge, attitude, and practice were 6.50 ± 2.44 (range: 0 to 10), 21.59 ± 6.33 (range: 6 to 30), and 16.26 ± 5.36 (range: 5 to 25), respectively. Structural equation modeling (SEM) indicated that, within the total population, knowledge had a significant influence on attitude ($\beta = -0.511$, $P < 0.001$) and practice ($\beta = 0.660$, $P < 0.001$), while attitude also significantly affected practice ($\beta = 0.896$, $P < 0.001$). Among participants whose relatives had received thrombolysis, knowledge significantly impacted attitude ($\beta = -0.513$, $P = 0.008$) and practice ($\beta = 0.343$, $P = 0.041$), with attitude further influencing practice ($\beta = 0.856$, $P < 0.001$). For participants whose relatives had not undergone thrombolysis, knowledge significantly affected attitude ($\beta = -0.433$, $P = 0.048$) and practice ($\beta = 0.934$, $P < 0.001$), with attitude continuing to influence practice.

Conclusion: Family members exhibited inadequate thrombolysis knowledge but positive attitudes. Poor practice engagement underscores the need for targeted education to improve decision-making and stroke management participation.

Keywords: cerebral infarction, thrombolysis, knowledge, attitude, and practice, family members, structural equation modeling, stroke management

Introduction

Cerebral infarction is the second leading cause of death globally and the leading cause of death in China.[1] Ischemic stroke is the predominant type, accounting for over 80% of all strokes. It occurs when a major cerebral artery is occluded by a thrombus or embolus, leading to severe consequences.[2,3] Ischemic stroke can cause permanent neuronal necrosis and apoptosis, resulting in impaired neurological function. Cerebral ischemia triggers an inflammatory cascade, further exacerbating the damage.

Thrombolytic therapy has been recognized as the standard treatment for ischemic stroke.[4] Timely administration is critical to minimizing neurological damage, improving survival rates, and enhancing the quality of life for stroke patients.[5] The effectiveness of thrombolytic therapy is highly dependent on rapid intervention, with significantly better outcomes observed when treatment is provided within the optimal time window.

https://doi.org/10.2147/IJGM.S562367
Received: 22 September 2025
Accepted: 20 December 2025
Published: 6 January 2026

The knowledge, attitude, and practice (KAP) survey is a valuable tool for assessing a group's understanding, beliefs, and behaviors regarding a specific topic. It is particularly useful in health literacy research, based on the premise that increased knowledge fosters positive attitudes, which, in turn, influence behavior.[6] Despite the established importance of thrombolytic therapy in acute stroke management, its clinical use remains suboptimal.[7,8] This low application rate can be partly attributed to insufficient or inaccurate knowledge, attitude, and practices among patients and their families regarding thrombolytic therapy. In addition, family members often hesitate because of concerns about bleeding risk, uncertainty about the treatment window, and fear of making an incorrect decision, which may lead to delays in seeking timely care.[9] As family members play a crucial role in decision-making, their understanding and attitude toward thrombolysis can significantly impact the timeliness and effectiveness of treatment decisions.

Therefore, it is essential to understand the current KAP of family members of cerebral infarction patients concerning thrombolytic therapy. In China, thrombolysis remains underutilized despite national efforts to expand its adoption.[8] Structural equation modeling (SEM) was used because it allows simultaneous assessment of the direct and indirect pathways among knowledge, attitude, and practice, which cannot be captured through traditional regression alone. However, little is known about how well family members understand thrombolysis or how their perceptions influence treatment decisions, despite their central role in the decision-making process. This insight can help identify key barriers to early intervention and inform strategies to enhance the clinical application of thrombolysis. This study aims to assess the KAP levels of family members of cerebral infarction patients regarding thrombolytic therapy and to investigate how these factors influence the application of thrombolysis.

Materials and Methods

The Patient and Public Involvement Statement

No patient or public involved in this study.

Study Design and Participants

This cross-sectional study was conducted from August 2023 to July 2024 at Wujin People's Hospital of Changzhou, targeting family members of cerebral infarction patients. In this study, "family members" referred to direct relatives, primary caregivers, and legally recognized direct or collateral relatives such as daughters-in-law, sons-in-law, brothers' wives, or sisters' husbands. Participants were recruited consecutively during the study period when they met the eligibility criteria. The inclusion criteria were: (1) age over 18 years; (2) being a family member of inpatients or outpatients with cerebral infarction; and (3) voluntary agreement to participate, with informed consent. Exclusion criteria included: (1) refusal to participate and (2) inability to complete the questionnaire due to psychological, psychiatric, or severe physical illness. The study was approved by the Ethics Committee of Changzhou Wujin People's Hospital [2023-SR-094], and written informed consent was obtained from all participants.

Questionnaire

A total of 30 questionnaires were collected during the pilot study. The overall Cronbach's α coefficient of 0.786 indicated good internal consistency. This was further validated through expert consultation with three neurologists and two statisticians.

The final version of the questionnaire consisted of four sections: demographic characteristics, knowledge dimension, attitude dimension, and practice dimension. The knowledge section included ten questions, each scored 1 point for correct answers and 0 points for incorrect or unclear responses, with a total score range of 0 to 10. The attitude section consisted of six questions, using a five-point Likert scale ranging from strongly agree (5 points) to strongly disagree (1 point), with a score range of 6 to 30. The practice section included five questions, each scored on a five-point Likert scale ranging from always (5 points) to never (1 point), with a total score range of 5 to 25. Scores above 70% of the maximum in each section were considered indicative of adequate knowledge, a positive attitude, and proactive practice.[10,11]

The online questionnaire was distributed via Questionnaire Star (https://www.wjx.cn/), allowing participants to access and complete it by scanning a QR code through WeChat or following a provided web link. A total of 527 questionnaires

were distributed, and 514 were returned, resulting in a response rate of 97.5%. After excluding invalid questionnaires according to predefined criteria, 505 valid responses were included in the final analysis. The average completion time was 242.4 seconds.

Statistical Methods

Descriptive analysis was conducted to evaluate the participants' demographic data and KAP scores. Continuous data were presented as means and standard deviations (SD), while categorical data were expressed as n (%). Differences in knowledge, attitude, and practice scores across participants with different demographic characteristics were analyzed using t-tests for comparisons between two groups and ANOVA for comparisons among three or more groups with continuous variables. Pearson's correlation analysis and structural equation modeling (SEM) were used to examine the relationships among KAP dimensions. A two-sided P-value of less than 0.05 was considered statistically significant. No blinded data review was used. For the online questionnaire, the system required all items to be completed before submission, resulting in no missing values. In addition, questionnaires with predefined logical inconsistencies were excluded. All statistical analyses were performed using SPSS 27.0 and AMOS 26.0 (IBM, Armonk, NY, USA).

Results

Baseline Characteristics

After excluding two questionnaires due to lack of informed consent and seven cases with logical inconsistencies in trap questions, 505 valid questionnaires were analyzed. Among the participants, 256 (50.69%) were male, with a mean age of 48.83 ± 13.24 years. A total of 249 participants (49.31%) lived in urban areas, 237 (46.93%) had a monthly income of less than 5,000 yuan, 188 (37.23%) were family members of cerebral infarction patients who had undergone thrombolysis at the time of the survey, and 255 (50.50%) reported a general recovery status.

Overall KAP Scores

Overall KAP scores are summarized as follows. The mean scores for knowledge, attitude, and practice were 6.50 ± 2.44, 21.59 ± 6.33, and 16.26 ± 5.36, respectively. Analysis of demographic characteristics revealed significant variations in knowledge and attitude scores across different age groups ($P = 0.004$ and $P < 0.001$, respectively), place of residence ($P < 0.001$ and $P = 0.046$), education levels ($P < 0.001$ and $P = 0.002$), relationship to the patient ($P < 0.001$ and $P < 0.001$), degree of patient recovery ($P = 0.018$ and $P = 0.027$), and types of medical insurance ($P < 0.001$ and $P = 0.009$). Additionally, knowledge scores were significantly associated with the duration since the onset of cerebral infarction ($P < 0.001$). Attitude scores also varied significantly by gender ($P = 0.042$) and whether the patient had undergone thrombolysis ($P = 0.039$) (Table 1).

Item-Level results for Knowledge, Attitude, and Practice

The analysis of the knowledge dimension revealed the three items with the lowest correctness rates were: "Intravenous thrombolysis can be used in patients with intracerebral hemorrhage" (K8) at 56.63%, "Thrombolytic therapy is safe and effective without any side effects" (K5) at 60.79%, and "Thrombolytic therapy has no contraindications and is suitable for all patients with cerebral infarction" (K6) at 65.15%. Regarding attitudes toward thrombolysis, 11.09% strongly disagreed that the suitability of thrombolytic therapy should be determined based on the specific condition of the stroke patient and the doctor's judgment (A1). Additionally, 10.89% strongly disagreed that patients should accept the risk of bleeding complications if intravenous thrombolysis is chosen (A5), and 10.10% strongly disagreed that the dosage of intravenous thrombolytic drugs should be strictly calculated and not adjusted arbitrarily (A6). In terms of practice, 18.42% never actively sought information about intravenous thrombolysis for stroke (P1), 15.05% never consulted a doctor about intravenous thrombolysis for stroke (P2), and 13.86% were never willing to participate in health science lectures on stroke prevention and thrombolysis(P4) (Supplemental Table 1).

https://doi.org/10.2147/IJGM.S562367

Table 1 Demographic Characteristics

	N (%)	Knowledge		Attitude		Practice	
		Mean±SD	P	Mean±SD	P	Mean±SD	P
Total	505	6.50±2.44		21.59±6.33		16.26±5.36	
Gender			0.082		0.042		0.498
Male	256 (50.69)	6.69±2.35		21.03±6.60		16.10±5.51	
Female	249 (49.31)	6.31±2.53		22.17±5.99		16.42±5.21	
Age (years)	48.83±13.24		0.004		<0.001		0.397
≤50	249 (49.31)	6.18±2.76		22.69±5.94		16.05±5.31	
> 50	256 (50.69)	6.81±2.06		20.52±6.52		16.46±5.42	
Place of residence			<0.001		0.046		0.086
Rural areas	144 (28.51)	5.31±2.53		22.69±4.88		16.82±4.86	
Cities	249 (49.31)	6.85±2.40		21.08±6.76		15.72±5.41	
Suburb of town	112 (22.18)	7.26±1.83		21.32±6.83		16.72±5.79	
Education			<0.001		0.002		0.378
Junior high school and below	103 (20.40)	5.49±2.35		22.83±5.08		16.73±4.82	
High school/technical secondary school	155 (30.69)	6.58±2.42		20.81±6.28		16.26±5.54	
Junior college	102 (20.20)	6.95±2.52		20.21±7.24		15.49±5.74	
Bachelor degree or above	145 (28.72)	6.82±2.30		22.53±6.23		16.46±5.25	
Monthly per capita income (yuan)			0.633		0.241		0.800
< 5000	237 (46.93)	6.39±2.35		21.09±6.11		16.26±5.31	
5000-10,000.	163 (32.28)	6.62±2.50		22.08±6.50		16.43±5.51	
> 10,000	105 (20.79)	6.56±2.58		21.97±6.50		15.98±5.28	
The relative relationship between the cerebral infarction patient and you			<0.001		<0.001		0.233
Parents and children	229 (45.35)	6.89±2.24		20.25±6.79		15.85±5.60	
Spouse	88 (17.43)	7.64±1.25		19.63±6.97		16.84±5.62	
Brothers and sisters	20 (3.96)	6.55±1.79		21.45±6.12		17.90±5.26	
Other	168 (33.27)	5.37±2.80		24.46±3.93		16.32±4.86	
Length of time since the onset of cerebral infarction in patients			<0.001		0.153		0.059
Within six months to 1 year	188 (37.23)	6.75±2.35		22.10±6.29		16.98±5.34	
1 to 2 years	112 (22.18)	7.09±2.02		20.64±6.84		15.99±5.73	
More than two years	205 (40.59)	5.95±2.63		21.64±6.04		15.74±5.13	
Whether patients with cerebral infarction were treated with thrombolysis at that time			0.226		0.039		0.340
Yes	188 (37.23)	6.33±2.30		22.35±5.97		16.55±5.09	
No	317 (62.77)	6.60±2.52		21.15±6.50		16.08±5.52	

Degree of recovery for patients to date			0.018		0.027		0.688
Very good	176 (34.85)	6.73±2.39		21.93±6.63		16.54±5.50	
In general	255 (50.50)	6.55±2.33		20.94±6.32		16.11±5.24	
Poor	74 (14.65)	5.78±2.84		23.05±5.27		16.08±5.49	
Types of medical insurance for patients with cerebral infarction			<0.001		0.009		0.996
Only social medical insurance	353 (69.90)	6.18±2.56		22.13±5.95		16.23±5.11	
Only commercial medical insurance	31 (6.14)	6.71±2.36		18.58±7.10		16.32±6.60	
Both social medical insurance and commercial medical insurance	80 (15.84)	7.41±1.56		20.81±6.66		16.28±5.83	
No insurance	41 (8.12)	7.29±2.30		20.73±7.47		16.44±5.75	

https://doi.org/10.2147/IJGM.S562367

Correlations Among KAP Dimensions

Subsequently, correlation analysis was conducted to examine the associations among KAP dimensions. Correlation analysis revealed significant positive associations between knowledge and attitude ($r = -0.098$, $P = 0.027$) and knowledge and practice ($r = 0.167$, $P < 0.001$). A significant correlation was also observed between attitude and practice ($r = 0.685$, $P < 0.001$) (Table 2).

Structural Equation Modeling

Finally, structural equation models were fitted to explore the pathways linking knowledge, attitude, and practice. Three SEMs were fitted: one for the total population, one for participants whose patients had received thrombolysis, and one for those whose patients had not. The fitting indices for all models met or exceeded the respective thresholds, indicating a satisfactory fit (Table 3). For the total population, knowledge influenced attitude ($\beta = -0.511$, $P < 0.001$) and practice ($\beta = 0.660$, $P < 0.001$), and attitude also influenced practice ($\beta = 0.896$, $P < 0.001$). Among participants whose patients had received thrombolysis, knowledge affected attitude ($\beta = -0.513$, $P = 0.008$) and practice ($\beta = 0.343$, $P = 0.041$), and attitude influenced practice ($\beta = 0.856$, $P < 0.001$). Among those whose patients had not received thrombolysis, knowledge impacted attitude ($\beta = -0.433$, $P = 0.048$) and practice ($\beta = 0.934$, $P < 0.001$), while attitude influenced practice ($\beta = 0.890$, $P < 0.001$) (Table 4 and Figure 1).

Table 2 Correlation Analysis

	Knowledge	Attitude	Practice
Knowledge	1		
Attitude	−0.098 (P=0.027)	1	
Practice	0.167 (P<0.001)	0.685 (P<0.001)	1

Table 3 Model Fit

Indicators	Reference	Actual
Total		
CMIN/DF	1-3: Excellent, 3–5: Good	3.535
RMSEA	<0.08: Good	0.071
IFI	>0.8: Good	0.914
TLI	>0.8: Good	0.900
CFI	>0.8: Good	0.914
Had received thrombolytic therapy		
CMIN/DF	1-3: Excellent, 3–5: Good	2.091
RMSEA	<0.08: Good	0.076
IFI	>0.8: Good	0.895
TLI	>0.8: Good	0.877
CFI	>0.8: Good	0.894
Had not received thrombolytic therapy		
CMIN/DF	1-3: Excellent, 3–5: Good	2.726
RMSEA	<0.08: Good	0.074
IFI	>0.8: Good	0.911
TLI	>0.8: Good	0.896
CFI	>0.8: Good	0.910

Table 4 SEM

Total			**β**	**P**
Attitude	←	Knowledge	−0.511	<0.001
Practice	←	Attitude	0.896	<0.001
Practice	←	Knowledge	0.660	<0.001
Had received thrombolytic therapy			**β**	**P**
Attitude	←	Knowledge	−0.513	0.008
Practice	←	Attitude	0.856	<0.001
Practice	←	Knowledge	0.343	0.041
Had not received thrombolytic therapy			**β**	**P**
Attitude	←	Knowledge	−0.433	0.048
Practice	←	Attitude	0.890	<0.001
Practice	←	Knowledge	0.934	<0.001

Discussion

Family members of cerebral infarction patients demonstrated inadequate knowledge, a generally positive attitude, and relatively inactive practice toward thrombolysis. These findings underscore the need for targeted educational interventions to improve knowledge and encourage more proactive behaviors related to thrombolysis, ultimately enhancing patient outcomes in clinical settings.

These results are consistent with previous research highlighting significant knowledge gaps regarding thrombolysis, even among healthcare professionals. For instance, a study among community pharmacists found only a moderate level of knowledge, with just 44% correctly identifying stroke warning signs and only 14% answering questions about thrombolytic therapy delays correctly.[12] Similarly, hospital ward staff showed a good understanding of stroke signs

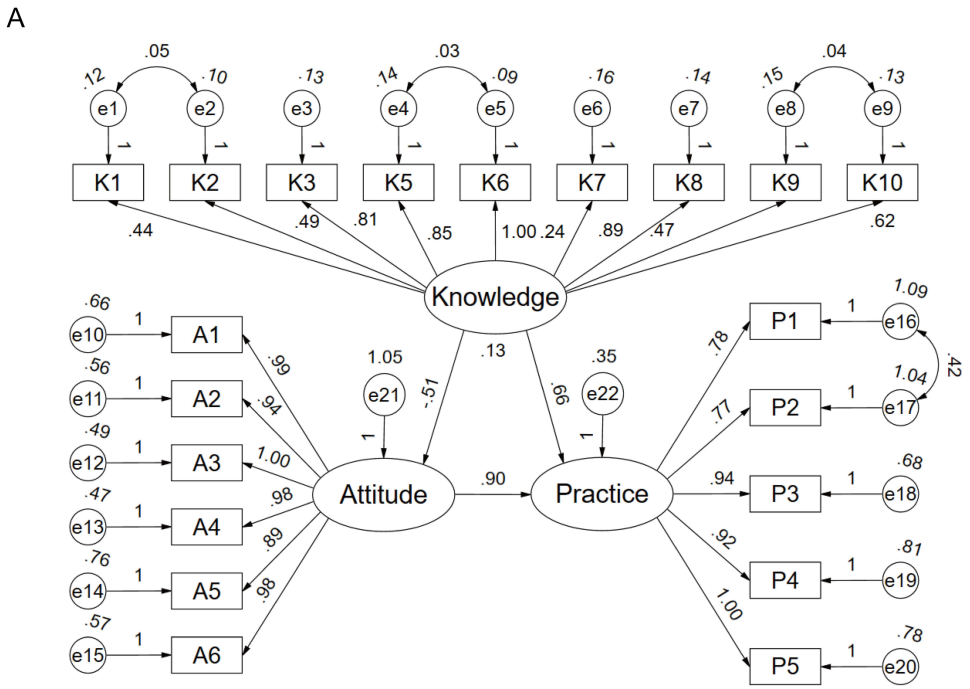

Figure 1 Continued.

https://doi.org/10.2147/IJGM.S562367

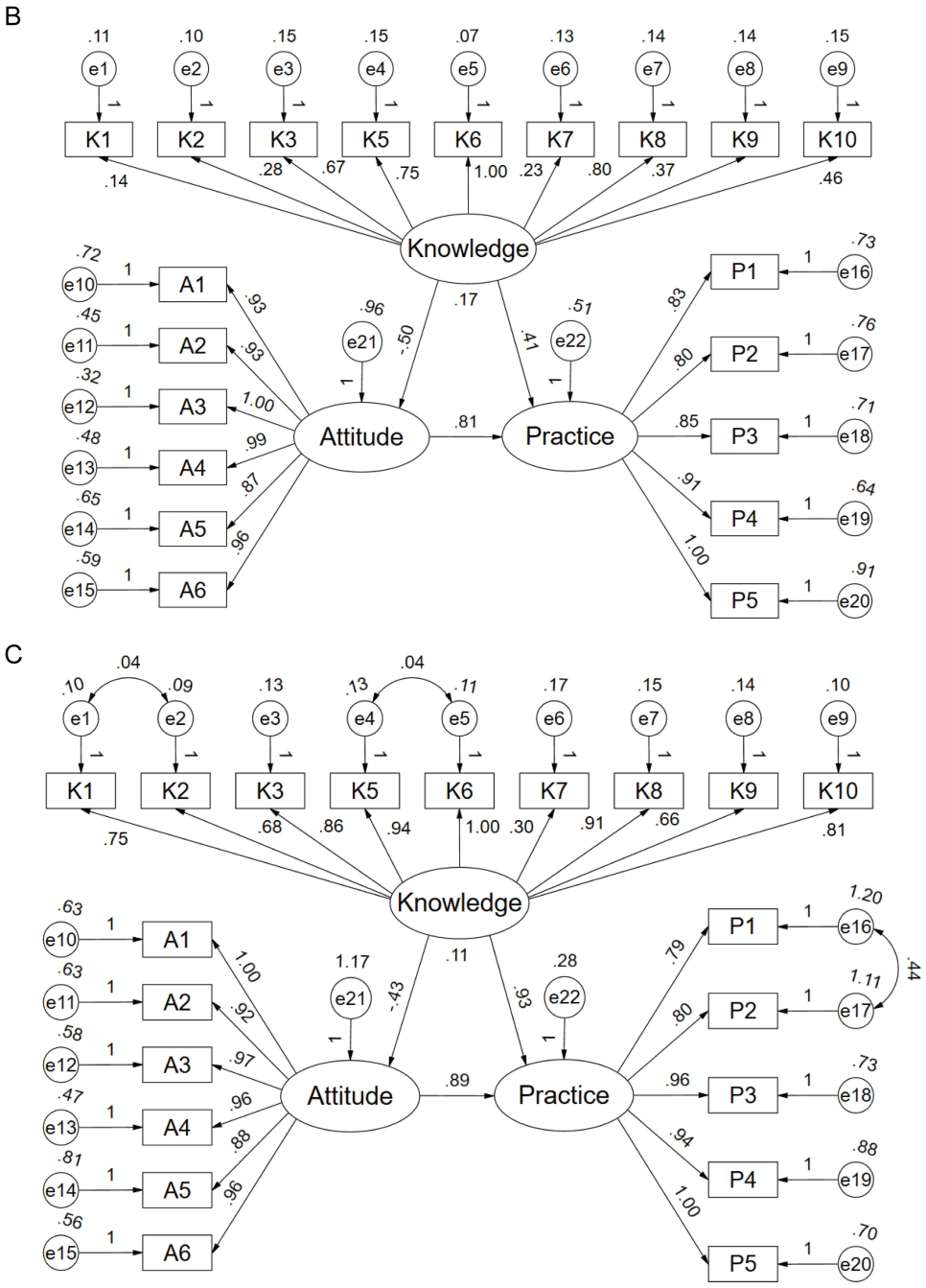

Figure 1 SEM. (**A**) Total population, (**B**) Participants whose patients received thrombolysis, (**C**) Participants whose patients did not receive thrombolysis.

and symptoms but had low awareness of thrombolytic treatment and its optimal time window.[13] Additionally, a study of Chinese neurologists revealed that while most supported intravenous thrombolysis for acute ischemic stroke, they had limited knowledge and confidence, indicating the need for further training.[14] These findings may explain why family members of cerebral infarction patients generally have inadequate knowledge and relatively inactive practice toward thrombolysis.

Interestingly, the presence of a positive attitude despite insufficient knowledge contrasts with other studies where apprehension about thrombolytic therapy was common, likely due to concerns about its risks. A key finding of this study is the negative association between knowledge and attitude. This does not follow the usual KAP pattern. A likely

explanation is that family members with more knowledge may also be more aware of the risks, strict time limits, and uncertainties of thrombolysis, which can lead to more cautious attitudes. In contrast, those with limited knowledge may rely more on general trust in medical care. This suggests that information alone may not improve attitudes, and clear risk communication is also needed.[9] This discrepancy between attitude and practice suggests that a lack of knowledge may be a key barrier to proactive engagement, contributing to ongoing challenges in improving patient outcomes and adherence to treatment protocols in this population. The SEM analysis provided valuable insights into the relationships among KAP across different subgroups. In the total population, knowledge significantly influenced attitude and practice, suggesting that comprehensive educational programs could improve perspectives and behaviors. This aligns with previous research showing that increased knowledge enhances adherence to medical recommendations.[15,16]

In contrast, for family members whose patients had received thrombolysis, the impact of knowledge on attitude and practice was weaker, likely because their direct experience with the treatment balanced their perceptions of its benefits and risks. However, attitude strongly influenced practice in this group, indicating that additional support and positive reinforcement could further enhance their caregiving engagement. For family members whose patients had not undergone thrombolysis, knowledge was the predominant factor influencing practice, while its effect on attitude was minimal. This highlights the need for targeted educational interventions to address specific knowledge gaps and foster more proactive behaviors in stroke care management.

Significant differences in KAP scores were observed across various demographic factors. Gender differences were noted in attitude, with females demonstrating a more positive attitude toward thrombolysis. This could be related to higher health literacy and caregiving roles typically associated with women, as suggested by previous research.[17,18] However, the absence of gender differences in knowledge and practice indicates that, despite a positive attitude, women may still face barriers in translating these attitudes into active practice, such as a lack of confidence or access to resources.

Age differences were evident in both knowledge and attitude, with younger family members having lower knowledge but a more favorable attitude compared to older participants. This may reflect generational differences in access to information and risk perceptions. Differences based on place of residence were also significant, with rural residents exhibiting lower knowledge but a more positive attitude. This might be due to limited exposure to healthcare services and lower expectations of treatment outcomes in rural areas.[19]

Educational background influenced both knowledge and attitude, with higher education levels correlating with better knowledge, though not necessarily a more favorable attitude. This suggests that education alone may not be sufficient to change attitudes toward thrombolysis, and additional interventions, such as counseling, may be needed. The relationship between the family member and the patient also played a significant role, with spouses demonstrating higher levels of knowledge and a more critical attitude, likely due to their closer involvement in caregiving and decision-making.[20,21] Interestingly, these variables did not significantly affect practice scores, indicating that improving knowledge and attitude may not be enough to change behavior without addressing practical barriers such as time constraints and lack of support.

The study highlighted critical gaps in knowledge distribution, particularly regarding the safety, contraindications, and appropriate use of thrombolytic therapy. Many respondents held misconceptions about the safety and applicability of thrombolysis, which is consistent with previous findings that identified similar barriers to the utilization of this therapy.[22,23] To address these issues, it is recommended to implement targeted educational programs focused on dispelling common myths and providing clear, evidence-based information. These programs could include interactive workshops, informational sessions, and educational materials tailored to the needs of family members. Additionally, involving healthcare professionals in direct communication with families, using simple and accessible language, could help bridge these knowledge gaps. Establishing community outreach programs to provide education on stroke management and thrombolysis, particularly in underserved areas, could further enhance understanding and acceptance of this treatment.[24–26] Although attitudes were generally positive, a considerable number of participants were hesitant to fully trust medical recommendations or accept the risks associated with thrombolytic therapy. This contrasts with other studies where a positive attitude was more strongly associated with trust in healthcare providers.[27,28] To improve attitudes, fostering a supportive environment in which family members feel comfortable discussing their concerns with healthcare providers is crucial. Encouraging shared decision-making and providing opportunities for families to participate in treatment

discussions can help build trust and increase their willingness to support thrombolysis. Support groups or peer networks where family members can share experiences and gain insights from others in similar situations may also boost their confidence in thrombolytic therapy.[29,30]

The inactive practice observed among participants, such as limited information-seeking behavior and low participation in health education activities, underscores the need for strategies that actively engage family members. Healthcare providers could schedule regular follow-up sessions that include educational components tailored to the specific needs of family members. Utilizing digital tools, such as mobile apps or online platforms, could provide accessible information and reminders, making it easier for family members to stay informed and involved. Additionally, organizing community-based workshops on stroke management and the benefits of thrombolysis, particularly in areas with limited healthcare access, could increase participation and engagement. Offering webinars or interactive online resources may be an effective alternative for those less inclined to attend in-person sessions. Collaborating with local organizations to distribute educational materials and hosting information sessions at community centers could also help reach a wider audience.[31,32]

This study has several limitations. First, as a single-center study, the findings may not be generalizable to other regions or healthcare settings. Second, the use of self-reported online questionnaires may introduce response bias, as participants might provide socially desirable answers rather than reflecting their true knowledge, attitudes, and practices. Third, the cross-sectional design limits the ability to establish causal relationships between knowledge, attitude, and practice, necessitating further longitudinal studies to better understand these dynamics over time.

Conclusion

In conclusion, family members of cerebral infarction patients demonstrated inadequate knowledge, a positive attitude, and inactive practice regarding thrombolysis. Targeted educational interventions are needed to improve family members' knowledge and engagement in the management and decision-making process for thrombolytic therapy in cerebral infarction patients.

Data Sharing Statement

All data generated or analysed during this study are included in this published article.

Ethics Declaration and Consent to Participate

The study was approved by the Ethics Committee of Changzhou Wujin People's Hospital [2023-SR-094], and written informed consent was obtained from all participants. All methods were performed in accordance with the relevant guidelines and regulations All methods were performed in accordance with the relevant guidelines and regulations, and the study complied with the principles of the Declaration of Helsinki.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors declare that they have no competing interests.

References

1. Wu S, Wu B, Liu M, et al. Stroke in China: advances and challenges in epidemiology, prevention, and management. *Lancet Neurol*. 2019;18(4):394–405. doi:10.1016/S1474-4422(18)30500-3
2. Durukan A, Tatlisumak T. Acute ischemic stroke: overview of major experimental rodent models, pathophysiology, and therapy of focal cerebral ischemia. *Pharmacol Biochem Behav*. 2007;87(1):179–197. doi:10.1016/j.pbb.2007.04.015

3. Stubblefield JJ, Lechleiter JD. Time to target stroke: examining the circadian system in stroke. *Yale J Biol Med*. 2019;92(2):349–357.
4. Feske SK. Ischemic Stroke. *Am J Med*. 2021;134(12):1457–1464. doi:10.1016/j.amjmed.2021.07.027
5. Wardlaw JM, Murray V, Berge E, Del Zoppo GJ. Thrombolysis for acute ischaemic stroke. *Cochrane Database Syst Rev*. 2014;2014(7):Cd000213. doi:10.1002/14651858.CD000213.pub3
6. Chen Z, Zhou X, Jiang L, et al. Knowledge, attitudes, and practices of family caregivers for patients with cerebral infarction toward home-based care. *Front Public Health*. 2024;12:1436423. doi:10.3389/fpubh.2024.1436423
7. Scherf S, Limburg M, Wimmers R, Middelkoop I, Lingsma H. Increase in national intravenous thrombolysis rates for ischaemic stroke between 2005 and 2012: is bigger better? *BMC Neurol*. 2016;16:53. doi:10.1186/s12883-016-0574-7
8. Wang Y, Liao X, Zhao X, et al. Using recombinant tissue plasminogen activator to treat acute ischemic stroke in China: analysis of the results from the Chinese National Stroke Registry (CNSR). *Stroke*. 2011;42(6):1658–1664. doi:10.1161/STROKEAHA.110.604249
9. Li D, Guo Y, Ma K, et al. A study on factors influencing decision - making conflicts of proxies of thrombolytic patients with acute ischemic stroke: a network analysis. *BMC Med Inform Decis Mak*. 2025;25(1):346. doi:10.1186/s12911-025-03187-1
10. Hebo HJ, Gemeda DH, Abdusemed KA. Hepatitis B and C viral infection: prevalence, knowledge, attitude, practice, and occupational exposure among healthcare workers of Jimma University Medical Center, Southwest Ethiopia. *ScientificWorldJournal*. 2019;2019:9482607. doi:10.1155/2019/9482607
11. Lee F, Suryohusodo AA. Knowledge, attitude, and practice assessment toward COVID-19 among communities in East Nusa Tenggara, Indonesia: a cross-sectional study. *Front Public Health*. 2022;10:957630. doi:10.3389/fpubh.2022.957630
12. Khettar S, Viprey M, Haesebaert J, et al. Stroke patients' support: evaluation of knowledge, practices and training needs of French community pharmacists. *Int J Clin Pharm*. 2021;43(4):980–989. doi:10.1007/s11096-020-01204-z
13. Mellon L, Hasan H, Lee S, Williams D, Hickey A. Knowledge of thrombolytic therapy amongst hospital staff: preliminary results and treatment implications. *Stroke*. 2015;46(12):3551–3553. doi:10.1161/STROKEAHA.115.010327
14. Wang MD, Yin XX, Yang TT, et al. Chinese neurologists' perspective on intravenous thrombolysis for acute ischemic stroke. *Brain Behav*. 2018;8(1):e00882. doi:10.1002/brb3.882
15. Png D, Yeoh E, Tan C, Lim SC. A pair of siblings with Wolfram syndrome: a review of the literature and treatment options. *J Investig Med High Impact Case Rep*. 2023;11:23247096221150631. doi:10.1177/23247096221150631
16. Wang RH, Hong YW, Li CC, et al. Using social media data in diabetes care: bridging the conceptual gap between health providers and the network population. *BMC Prim Care*. 2022;23(1):241. doi:10.1186/s12875-022-01846-0
17. Agner J, Meyer M, Kaukau TM, et al. Health literacy, social networks, and health outcomes among mental health clubhouse members in Hawaii. *Int J Environ Res Public Health*. 2023;20(1):837. doi:10.3390/ijerph20010837
18. Aung PL, Soe MT, Oo TL, et al. Spatiotemporal dynamics of malaria in Banmauk Township, Sagaing region of Northern Myanmar: characteristics, trends, and risk factors. *BMC Infect Dis*. 2022;22(1):653. doi:10.1186/s12879-022-07634-6
19. Du R, Wang P, Ma L, Larcher LM, Wang T, Chen C. Health-related quality of life and associated factors in patients with myocardial infarction after returning to work: a cross-sectional study. *Health Qual Life Outcomes*. 2020;18(1):190. doi:10.1186/s12955-020-01447-4
20. Lu SJ, Kao HO, Chang BL, et al. Identification of quality gaps in healthcare services using the SERVQUAL instrument and importance-performance analysis in medical intensive care: a prospective study at a medical center in Taiwan. *BMC Health Serv Res*. 2020;20(1):908. doi:10.1186/s12913-020-05764-8
21. Zang Y, Liu S, Chen Y. Qualitative study of willingness and demand for participation in decision-making regarding anticoagulation therapy in patient undergoing heart valve replacement. *BMC Med Inform Decis Mak*. 2022;22(1):45. doi:10.1186/s12911-022-01780-2
22. Bae MJ, Ha SY. Subsequent subarachnoid hemorrhage from clinically unrelated vertebral artery dissection after thrombolytic therapy. *Neurointervention*. 2022;17(1):54–57. doi:10.5469/neuroint.2021.00458
23. Kunz WG, Sporns PB, Psychogios MN, et al. Cost-effectiveness of endovascular thrombectomy in childhood stroke: an analysis of the Save ChildS Study. *J Stroke*. 2022;24(1):138–147. doi:10.5853/jos.2021.01606
24. Aggrohia A, Bhatia V, Saroch A, Pannu AK. Predicting cerebral infarction in tuberculous meningitis and its prognostic significance. *Biomark Med*. 2024;18(8):407–417. doi:10.1080/17520363.2024.2347194
25. Kivimäki M, Batty GD, Pentti J, et al. Association between socioeconomic status and the development of mental and physical health conditions in adulthood: a multi-cohort study. *Lancet Public Health*. 2020;5(3):e140–e149. doi:10.1016/S2468-2667(19)30248-8
26. Tagawa N, Fujinami A, Natsume S, Mizuno S, Kato I. Relationship between adiponectin multimer levels and subtypes of cerebral infarction. *PLoS One*. 2022;17(1):e0262542. doi:10.1371/journal.pone.0262542
27. Ameh PO, Uti OG, Daramola OO. Study motivations, specialty preferences, and empathy of dental students in a Nigerian university. *Pan Afr Med J*. 2022;41:328. doi:10.11604/pamj.2022.41.328.33123
28. Chen G, Li C. restoring doctor-patient trust to curb violence against doctors. *j multidiscip healthc*. 2022;15:2091–2095. doi:10.2147/JMDH.S383094
29. Ng TP, Wong C, Leong ELE, et al. Simultaneous cardio-cerebral infarction: a meta-analysis. *Qjm*. 2022;115(6):374–380. doi:10.1093/qjmed/hcab158
30. Zhao Y, Zhang X, Chen X, Wei Y. Neuronal injuries in cerebral infarction and ischemic stroke: from mechanisms to treatment (Review). *Int J Mol Med*. 2022;49(2).
31. Anai M, Saruwatari K, Ikeda T, et al. Clinical impact of cerebral infarction in patients with non-small cell lung cancer. *Int J Clin Oncol*. 2022;27(5):863–870. doi:10.1007/s10147-022-02132-w
32. Kong Y, Feng YQ, Lu YT, et al. Predictive serum biomarkers of patients with cerebral infarction. *Neurol Res*. 2022;44(4):331–341. doi:10.1080/01616412.2021.1987055