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The Significance of Health Education Technology in the Treatment of Early Stroke in the Community

La Importancia de la Tecnología de Educación para la Salud en el Tratamiento del Ictus Temprano en la Comunidad

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SUMMARY

Introduction: *Stroke remains one of the leading causes of death in Indonesia, with frequent delays in treatment resulting from the public's limited ability to recognize early symptoms. Enhancing community literacy on early stroke detection is therefore crucial for improving response and treatment outcomes.*
Objective: *This study aimed to analyze the effectiveness of technology-based health education, specifically mobile applications, e-learning, social media, and telemedicine, in improving public knowledge and readiness for early stroke management.*
Methods: *A quantitative, cross-sectional research design was employed, involving 100 family members of stroke patients from five referral hospitals in Medan City. Data were collected using a Likert-scale questionnaire and analyzed using Structural Equation Modeling (SEM) with SmartPLS software.*
Results: *Findings indicated that all four health education technology variables significantly enhanced respondents' literacy levels. The model exhibited a high coefficient of determination, and all hypotheses were statistically supported. The application of these technologies was found to accelerate decision-making regarding the timely medical care of stroke symptoms.*
Conclusion: *Technology-based health education is an innovative and effective strategy for strengthening community-level stroke prevention programs. The integration of these tools into public health initiatives is recommended for government agencies and healthcare professionals to reduce treatment delays.*

Keywords: *Health education technology, stroke literacy, early detection, telemedicine, digital health.*

RESUMEN

Introducción: *El accidente cerebrovascular sigue siendo una de las principales causas de muerte en Indonesia, con frecuentes retrasos en el tratamiento debido a la limitada capacidad del público para reconocer los primeros síntomas. Por lo tanto, fortalecer la alfabetización comunitaria sobre la detección temprana de accidentes cerebrovasculares*

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es crucial para optimizar la respuesta y los resultados del tratamiento.
Objetivo: *Analizar la efectividad de la educación para la salud basada en la tecnología, específicamente en las aplicaciones móviles, el aprendizaje electrónico, las redes sociales y la telemedicina, para mejorar el conocimiento público y la preparación para el manejo temprano del accidente cerebrovascular.*
Métodos: *Se empleó un diseño de investigación cuantitativa con un enfoque transversal, en el que participaron 100 encuestados, familiares de pacientes con accidente cerebrovascular, provenientes de cinco hospitales de referencia en Medan City. Los datos se recolectaron mediante un cuestionario en escala Likert y se analizaron mediante el modelado de ecuaciones estructurales (SEM) con el software SmartPLS.*
Resultados: *Los hallazgos indicaron que las cuatro variables tecnológicas de educación para la salud mejoraron significativamente los niveles de alfabetización de los encuestados. El modelo mostró valores elevados del coeficiente de determinación y todas las hipótesis fueron respaldadas estadísticamente. Se encontró que la aplicación de estas tecnologías acelera la toma de decisiones en la búsqueda de atención médica oportuna para los síntomas del accidente cerebrovascular.*
Conclusión: *La educación para la salud basada en la tecnología es una estrategia innovadora y efectiva que puede fortalecer los programas comunitarios de prevención de accidentes cerebrovasculares. Se recomienda la integración de estas herramientas en las iniciativas de salud pública de las agencias gubernamentales y de los profesionales de la salud, a fin de reducir los retrasos en el tratamiento.*

Palabras clave: *Tecnología de educación para la salud, alfabetización sobre accidentes cerebrovasculares, detección temprana, telemedicina, salud digital.*

INTRODUCTION

Stroke is one of the leading causes of death worldwide, including in Indonesia. Based on the Global Burden of Disease (GBD) 2020 report, stroke is the second largest cause of death globally, with 12.2 million new cases every year and around 6.5 million deaths (1). In Indonesia, data from the 2018 Basic Health Research (Riskesdas) show a prevalence of stroke of 10.9 per 1 000 persons aged 15 years and older, with an increasing trend from previous years (2) termed code stroke, is a time-sensitive and high-stakes clinical scenario in the context of the current coronavirus disease 2019 (COVID-19). This condition indicates that stroke not only places a significant burden on the national health system but also has an impact on the quality of life of individuals and families, given that stroke often causes long-term disability (3).

The primary challenge today is the low level of public awareness of the early signs and symptoms of stroke (4). Public awareness of early detection methods, such as FAST (Face, Arm, Speech, Time), remains low (5). Several studies across Indonesia, including West Java and South Sumatra, indicate that only 30 %–40 % of people correctly identify the early signs of stroke (6). This low level of literacy directly delays the community's ability to bring patients to health facilities (7). Facts show that the average stroke patient comes to the hospital 8–12 hours after the first symptoms appear, well past the *golden period* of 3–4.5 hours that greatly determines the success of thrombolytic therapy and the restoration of nerve function. This condition creates a chronological impact in the form of increasing rates of permanent disability, decreased productivity, increasing economic burden on families, and burdening the national health care system.

The low public knowledge also shows that there is a serious gap in public health literacy, especially related to non-communicable diseases such as stroke. This gap is caused by the lack of optimal conventional health communication and education strategies that have been one-way, limited to face-to-face counselling, and do not reach people in remote areas. At the same time, the development of information and communication technologies has created significant opportunities to bridge this gap. With smartphone penetration in Indonesia reaching 77 %, including in rural areas, the use of *health education technology* is a strategically relevant approach.

The concept of completion proposed in this study is the use of digital health education technology as an innovative strategy to enhance public literacy in the early detection and treatment of stroke. This technology includes mobile applications, e-learning, social media, and telemedicine that convey health information in an interactive, engaging, and easily accessible manner at any time. Evidence (8) shows that technology-based educational interventions

have been effective in improving people's knowledge and their rapid response to chronic diseases, including stroke. This approach is not only efficient in terms of cost and time, but also sustainable and capable of overcoming geographical barriers that have been the primary obstacles to health education in Indonesia.

Information and communication technology development offers significant opportunities to address these challenges through health education technology (9). Health education technology uses digital devices, such as smartphone apps, interactive videos, social media, and websites, designed to convey health information effectively and attractively (10). Various international studies have shown that health education technology effectively increases public literacy about chronic diseases such as diabetes, hypertension, and stroke (11) and this might contribute to the increased fall risk after stroke. To improve safe community ambulation, walking adaptability training might be beneficial after stroke. This study is designed to compare the effects of two interventions for improving walking speed and walking adaptability: treadmill-based C-Mill therapy (therapy with augmented reality). For example, a study in South Korea showed a significant increase in people's knowledge of stroke after being intervened with a mobile-based educational app (12). Meanwhile, in India, educational videos in local languages have been shown to increase public awareness of stroke symptoms by up to 65 % compared to the control group (13).

In Indonesia, the use of health education technology in the context of stroke is still minimal, especially in rural communities with limited access to conventional health information (14). Data from the Central Statistics Agency (BPS) in 2022 indicate that smartphone penetration in Indonesia reached 77 %, including in rural areas, suggesting substantial potential for the use of health education technology (15). However, to date, few studies have examined the effectiveness of health education technology in improving individuals' ability to recognize early signs of stroke (16). Therefore, this research is important for filling knowledge gaps and providing scientific evidence on the extent to which educational technology can contribute to early stroke treatment.

In addition to increasing literacy, health education technology offers advantages in affordability and sustainability (17). Technology-based health education can be accessed anytime, anywhere, minimizing the geographical barriers that people in remote areas often face (18). Educational materials packaged attractively and interactively are also easier for the public to accept and remember than conventional educational methods, which tend to be one-way and less interesting (19). In China, for example, a study using stroke education videos found that the interactive education group experienced a 55 % increase in information retention compared with the group that received only oral education from health workers (20). These data support the assumption that health education technology has the potential to be a strategic innovation for accelerating the response time to stroke symptoms (21).

The high rate of delayed treatment among stroke patients in Indonesia further strengthens the importance of this research. Studies in several hospitals in Jakarta and Surabaya found that the average delay of stroke patients coming to the hospital reached 8-12 hours after the onset of symptoms, well above the golden period (22). This condition results in many patients losing the opportunity to get thrombolytic therapy, which is only effective for a specific period (23). Family or community ignorance about the importance of time in treating stroke is one of the main factors for the delay (24). Therefore, this study is expected to make a real contribution by testing whether health education technology can optimally accelerate decision-making to bring stroke patients to health facilities.

From an academic perspective, this research is important because it can contribute to the body of knowledge in nursing, public health, and health technology, particularly by advancing strategies to increase stroke literacy through innovative approaches. Additionally, it can serve as a reference for future research on educational technology interventions for other diseases that require early detection. From a practical perspective, the results of this research are expected to serve as a basis for developing health education programs by health offices, health centers, and non-governmental organizations engaged in preventing noncommunicable

diseases. The information obtained is also expected to inform health application developers in creating more effective, easier-to-understand educational content on stroke for the wider community.

Overall, the high incidence of stroke, delays in treatment, low public literacy, and the lack of optimal use of health education technology in Indonesia are the fundamental background for the importance of this research being conducted. This research will not only provide an overview of public knowledge following technology-based education but also examine its impact on public knowledge. However, it can also assess the extent to which this intervention affects behavioral changes that accelerate the treatment of early stroke. Thus, it is expected to significantly reduce the burden of stroke in Indonesia through a more modern, inclusive, and technology-based approach.

The primary purpose of this study is to analyze the significance of health education technology in increasing public knowledge and awareness of early stroke management, and to measure its effectiveness in reducing delays to health facilities after the onset of stroke symptoms. In addition, this study aims to identify obstacles to implementing health education technology in the community, thereby providing practical recommendations for the government, health workers, and the private sector seeking to develop similar interventions. Through this research, a technology-based health education model will be created that is applicable and sustainable to the sociocultural characteristics of the Indonesian people.

METHODS

This study employs a quantitative, cross-sectional research design to analyze the relationship between health education technology and community literacy in recognizing early stroke symptoms (25). The cross-sectional approach was chosen because it allows data to be collected at a specific point in time to identify relationships among variables within a population. The focus of this study is to assess how the use of mobile applications, e-learning, social media, and telemedicine affects people's knowledge and preparedness for recognizing and managing early stroke symptoms.

The population comprises the families or companions of stroke patients who have been treated at five referral hospitals in Medan City, namely Haji Adam Malik Hospital, Dr. Pirngadi Medan Hospital, Bunda Thamrin Hospital, Columbia Asia Medan Hospital, and Royal Prima Hospital. The population was selected because family members play an important role in making rapid decisions when stroke symptoms emerge, thereby directly affecting the timeliness of treatment. The research sample comprised 100 respondents, who were proportionally distributed across the five hospitals (about 20 per hospital). This amount is considered sufficient for analysis using Structural Equation Modeling (SEM).

The determination of sample size is based on several methodological considerations. Because the main analysis employs Structural Equation Modeling (SEM), a rule of thumb is to use 10 indicators per latent construct. Assuming the densest construct has 10 items, a minimum of 100 respondents is required. Statistically, the calculation of the sample size for proportional estimation using the Cochran formula ($Z^2 \cdot p(1-p)/d^2$) with $Z = 1.96$, $p = 0.5$, and the margin of error $d = 0.10$ yields $n \approx 96$. To account for non-response and facilitate allocation, the number was rounded to 100 respondents. The sample was then allocated proportionally to five referral hospitals (±20 respondents per hospital). In addition, the initial instrument trials demonstrated sufficient reliability, and a sample size of 100 was considered adequate for assessing parameter stability in SEM analysis.

The sampling technique used is purposive sampling with specific criteria. The inclusion criteria include: (1) respondents aged 18 years and above; (2) have accompanied a family member who has been diagnosed with stroke within the past year; and (3) willing to become a voluntary respondent. The exclusion criteria were respondents who had cognitive impairment or severe communication barriers. Hospital selection is carried out purposively based on the availability of stroke units, patient numbers, and ease of geographic access to ensure data representativeness.

The research instrument is a structured questionnaire prepared in Google Forms and distributed online and offline, coordinated with the hospital. The questionnaire consists of three main parts, namely: (1) the demographic characteristics of the respondents, (2) the level of knowledge and literacy in recognizing the early signs of stroke, and (3) the perception and use of health education technology.

The question format includes Likert, multiple-choice, and open-ended questions to obtain both quantitative and descriptive data. Before being used in the main study, the questionnaire underwent validity and reliability testing. Construct validity was assessed via factor analysis, and reliability using Cronbach's Alpha. The results of the trial with 20 respondents showed that all items were valid (>0.6 loading factor) and reliable ($\alpha = 0.87$), indicating they were suitable for use in the study.

Data collection was conducted from July to December 2024. The researcher coordinates with hospital management to obtain permits and access respondents in inpatient and outpatient areas. Before completing the questionnaire, respondents were informed of the research's purpose, the confidentiality of their data, and their right to refuse or withdraw from the study at any time. The average time to complete the questionnaire is 15-20 minutes. The researcher also assisted respondents with limited digital devices to reduce response bias.

Although this study was non-experimental, the stages of short educational exposure were delivered in digital formats, such as infographics and short videos, on recognizing early signs of stroke. This exposure was provided before respondents answered the knowledge section of the questionnaire, to measure the increase in literacy related to the use of health education technology.

Data Analysis

The collected data were processed and analyzed in SmartPLS using Structural Equation Modeling (SEM). The SEM method was chosen because it can analyze complex causal relationships among latent variables and assess direct and indirect influences simultaneously. Before modelling, a test of data normality, validity, and reliability was conducted. Furthermore, the path coefficient value and regression weight were analyzed to see the strength and significance of the relationship between variables. Descriptive analysis was also undertaken to characterize respondents and describe the distribution of responses. Likert scale scores (1 = strongly disagree, 5 = strongly agree) are converted to numeric values for quantitative interpretation.

Research Ethical Considerations

This research has obtained ethical approval from the Research Ethics Committee of Sari Mutiara University, Indonesia (No. 3230/F/KEP/USM/I/202). All respondents were informed of the research's purpose, a guarantee of data confidentiality, and the right to refuse or terminate participation without consequences. Each respondent signed an informed consent sheet before participating in the study. The researcher upholds the principles of research ethics, including autonomy, beneficence, non-maleficence, and justice, throughout all stages of the research.

RESULT

Respondent Characteristics

Table 1. Characteristics of Respondent Frequency in Five Hospitals in Medan in 2025.

Characteristics	N	(%)
Age		
20 years -40 years	27	27
>40 years old	73	73
Total	100	100
Gender		
Man	63	63
Woman	37	37
Total	100	100
Education		
Primary school	24	24
Junior high school	29	29
Diploma/Bachelor's	47	47

The characteristics of the respondents in this study are described using three main variables: age, gender, and education level (Table 1). Based on age variables, respondents were grouped into two categories representing the early to advanced adulthood range, which is important for understanding perceptions and knowledge of early stroke management. This distribution reflects the diversity of ages, enabling analysis of the relationship between respondents' maturity levels and their health literacy. In terms of gender, respondents have been proportionally divided between men and women, so the interpretation of the results can consider potential differences in perception and gender roles in decision-making when facing stroke symptoms. This gender diversity also supports the generalizability of research results, especially in Medan City, where certain gender role norms prevail in families.

Meanwhile, the respondents' education levels have been classified as ranging from basic to higher education. This variety of educational backgrounds provides a comprehensive picture of the respondents' ability to receive and understand the health technology-based educational materials provided. Given these diverse characteristics, the data obtained are expected to represent better the family population of stroke patients in Medan City and to support the validity of research findings assessing the effectiveness of health education technology in increasing public literacy on early stroke management.

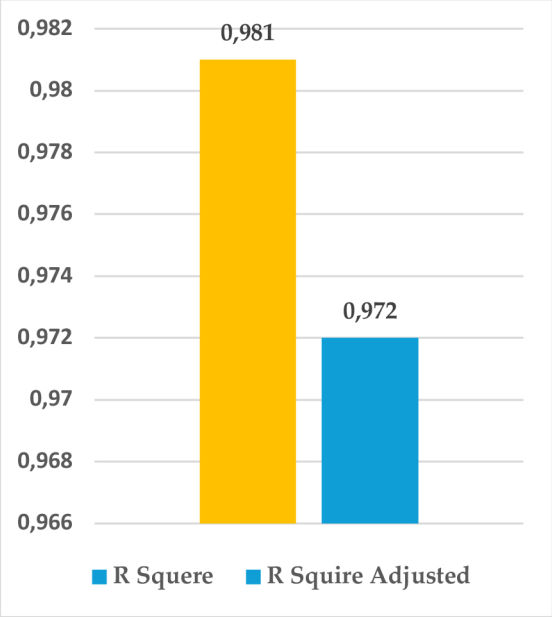
Research Variable Reliability

Table 2. Composite reliability and Cronbach's alpha test results.

Construction	Cronbach's Alpha	Rho_A	Composite Reliability	Average Variance Extracted (AVE
Mobile App	0.758	0.927	0.819	0.667
E-Learning	0.675	0.885	0.752	0.646
Social media	0.613	0.823	0.868	0.751
Telemedicine	0.826	0.721	0.838	0.689
The Significance of Health Education Technology in the Treatment of Early Stroke in the Community	0.876	0.985	0.899	0.967

The instrument reliability test in this study used the Composite Reliability and Cronbach's Alpha tests for each construct of the research variable. The entire construct has demonstrated reliability, as indicated by Cronbach's Alpha and Composite Reliability values exceeding the minimum thresholds suggested in the Partial Least Squares (PLS) analysis: 0.6 for Cronbach's Alpha and 0.7 for Composite Reliability (Table 2). These results indicate that the research instruments exhibit good internal consistency for measuring each construct, including the variables of mobile applications, e-learning, social media, and telemedicine, as well as the overall construct of the significance of health education technology in the treatment of early stroke in the community. In addition, the Average Variance Extracted (AVE) value in each construct has also been obtained above the standard value of at least 0.5, which indicates that each indicator in the construct can adequately

explain the variance of the latent variable. This confirms the convergent validity of all constructs, indicating that the research instrument is valid for measuring the influence of health education technology on literacy and people's readiness to recognize early signs of stroke. Thus, the results of these reliability and validity tests support the reliability of the collected data and increase confidence in the accuracy of the analysis to be conducted in the research.



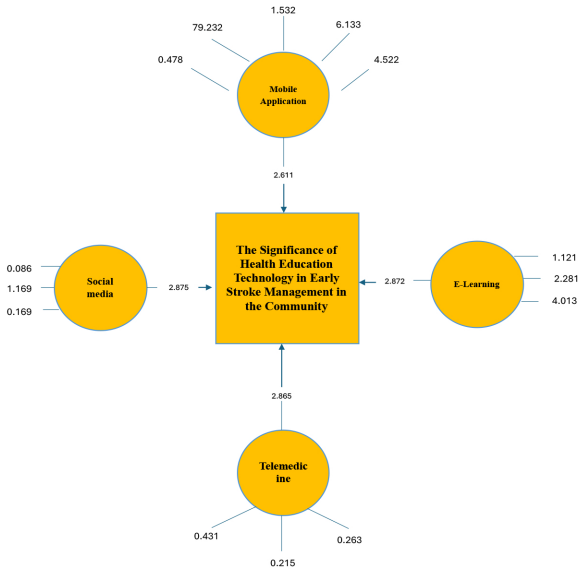
Graph 1. The Significance of Health Education Technology in the Treatment of Early Stroke in the Community.

The coefficient of determination results in this study indicate that the model accounts for variability in the dependent variable, namely, the significance of health education technology in treating early stroke in the community (Graph 1). The coefficient of determination obtained exceeds the generally accepted threshold for quantitative research, indicating that the independent variables in this model account for most of the variation in the dependent variable. In addition, the adjusted determination coefficient values are close to the maximum value, confirming that the model has an excellent fit and minimal bias given the number of predictors. These findings support the conclusion that health education technology significantly increases people's literacy and readiness to detect early signs of stroke. Hence, the technology has the potential to be implemented more widely as a community-based preventive health education strategy.

Hypothesis tests

Hypothesis tests were conducted on independent and dependent variables using the bootstrapping method in SE Mpls to assess the validity and reliability of the research data. In this test, T-statistics and P-values are used, and the results will later be presented in a t-table to assess the validity of the research data. The T-statistic is > 1.96, and the P-value is < 0.05.

The results of hypothesis testing in this study have shown that the four independent variables, namely mobile applications, e-learning, social media, and telemedicine, have been proven to have a significant influence on increasing the significance of health education technology in the treatment of early stroke in the community (Graph 2). All variables have yielded significance values below the set threshold, so the entire research hypothesis is accepted. The t-test results



Variable	*Original Sample (O)*	*Sample Mean (M)*	*STDEV*	*T-Statistics (|O/STDEV|)*	*P- value*	*Hypothesis*
Mobile App	0.252	0.251	0.093	2.611	**0.037**	**Accepted**
E-Learning	0.341	0.192	0.101	2.872	**0.031**	**Accepted**
Social media	0.269	0.248	0.078	2.875	**0.038**	**Accepted**
Telemedicine	0.437	0.471	0.154	2.865	**0.002**	**Accepted**

Graph 2. Results of hypothesis testing.

also support this conclusion, with t-statistics exceeding the critical value, confirming that each independent variable contributes to the research model in a statistically significant manner. These findings indicate that implementing various forms of educational technology, such as mobile applications, online learning platforms, social media, and telemedicine services, is important for increasing public awareness and readiness to recognize the early symptoms of stroke. Thus, health education technology has been proven to be an effective intervention strategy to accelerate stroke management in the community.

DISCUSSION

This study shows that health education technology—including mobile applications, e-learning, social media, and telemedicine—has a significant effect on increasing public literacy about the early signs of stroke. The results of the Structural Equation Modeling (SEM) analysis showed a high value of determination coefficient, indicating that the four independent variables were able to explain most of the variation in people's readiness to face a stroke. All constructs in the research instrument had Cronbach's Alpha and Composite Reliability values above the minimum threshold, and Average Variance Extracted (AVE) values indicating good convergent validity. This means that the instruments used are reliable and valid. The respondents' characteristics indicated that most were over 40 years old and that men comprised a larger proportion. In addition, the respondents' educational backgrounds span from elementary school through college. This fact illustrates that the productive adult age group, especially men as the main decision-makers in

the family, has a strategic role in bringing family members who experience stroke symptoms to health facilities quickly.

These findings support the Technology Acceptance Model (TAM), which explains that the perception of benefits and ease of use influences acceptance of technology (26). Respondents in this study demonstrated an understanding of the real benefits of health education technology, particularly in accelerating decision-making regarding stroke symptoms. This is also consistent with the Health Belief Model (HBM), which emphasizes that a person will engage in preventive behavior if they are aware of their disease susceptibility and believe that the preventive measures are beneficial (27). Thus, the use of health apps and social media not only increases perceived susceptibility to stroke risk but also strengthens perceived benefits of encouraging prompt action (28). This theory explains why more educated respondents tend to have a higher level of understanding and readiness in using digital educational media.

The results of this study demonstrate significant potential for applying health education technology to enhance people's readiness to face stroke. Still, its effectiveness is strongly influenced by demographic factors and respondents' social situations. Based on the analysis of characteristics, the age group over 40 years showed a relatively higher level of health literacy than the younger age group, as they had first-hand experience with family health decision-making. Meanwhile, the dominance of male respondents may reflect cultural norms in which men are still considered the primary decision-makers in family medical matters. This explains why technology-based interventions must address gender dynamics so that health education can also reach women, who are the primary caregivers of patients.

In terms of education, respondents with secondary and higher education are better able to use technology optimally because they have stronger digital literacy skills. However, it was also identified possible confounding factors, such as prior experience assisting stroke patients, exposure to health information through mass media, and social support, that may affect respondents' health literacy beyond the effects of technological interventions. Therefore, control for this confounding factor is achieved by selecting homogeneous samples based on past-year experience accompanying stroke patients.

In social contexts, it was argued that geographical conditions and the ease of access to health facilities also determine the effectiveness of educational technology. Respondents living in areas with better digital infrastructure tend to show a larger increase in knowledge than those with limited internet access. This reinforces the importance of local government support in expanding access to telemedicine and digital education in the suburbs.

CONCLUSION

The use of health education technologies, including mobile applications, e-learning, social media, and telemedicine, has been shown to significantly improve individuals' ability to recognize the early signs of stroke. All variables were positively associated with increased knowledge and the patient's family's readiness to take prompt action when stroke symptoms appeared. These results confirm that the use of health education technology plays an important role in accelerating the treatment of early stroke, reducing delays to health facilities, and potentially reducing the number of disability and deaths due to stroke. Health education technology can be an innovative and effective strategy in supporting stroke prevention programs, especially in areas with limited access to conventional education. Therefore, local governments and health workers are advised to integrate this technology into promotive and preventive programs through interactive applications, e-learning modules, social media campaigns, and telemedicine services adapted to local culture. It is recommended that health workers receive training to optimize the use of educational technology and increase public awareness. For further research, it is recommended to expand the scope to include additional regions and to conduct long-term studies to assess the sustainable impact of educational technology on behavior change related to stroke prevention.

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