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Face Detection-Enabled FAST Mobile Application for Stroke Risk Self-Screening in Hypertensive Patients

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Abstract

Delayed pre-hospital recognition of stroke symptoms sustains high mortality and disability, especially where awareness and rapid access are limited. Objective: To evaluate a smartphone FAST application integrating face detection for self-screening among individuals with hypertension. Methods: This study was conducted from July to August 2025. Two expert raters assessed usability with the MAUQ; inter-rater reliability was assessed using Cohen's kappa. A pre–post study (n=80) tested change in combined knowledge/behavior; normality was confirmed, and paired t-tests were applied. Post-intervention semi-structured interviews underwent thematic analysis. Results: Expert agreement was statistically significant (kappa=0.400; p=0.018), indicating fair-to-moderate reliability. Knowledge/behavior improved significantly from pre to post (t (79) = -21,334; p <0.001; mean difference −4.538; 95% CI -4,961 to -4,114). Themes included helpfulness (practical recognition, relevant education), internet dependence (limitations in low-coverage areas), perceived complexity (photo-capture burden), portability (use across settings), and targeted education (content aligned with needs). Conclusion: A smartphone-based FAST app with face detection is feasible and associated with significant gains in knowledge/behavior for early stroke recognition. Priorities include improving rater consistency, validating module accuracy against clinical standards, reducing dependence on connectivity, and streamlining image capture to enhance pre-hospital impact.

Introduction

Stroke is a neurological disorder caused by the interruption or rupture of blood flow in the cerebral arteries (Chen *et al*., 2022). It is a leading cause of death and ranks third as a cause of disability worldwide(Kaur *et al*., 2023; Prasetyo *et al*., 2021). According to the World Stroke Organization (WSO), there were 12.2 million new stroke cases in 2022, with 6.5 million deaths annually(Prasetyo *et al*., 2021). WSO also reports that one in four individuals will experience a stroke in their lifetime, particularly after the age of 25 (WSO, 2022). In Indonesia, the Ministry of Health (2018) identifies stroke as the leading cause of mortality, accounting for 21.1% of deaths, higher than other diseases(Kementrian Kesehatan, 2019; Nurani *et al*., 2019; Wantonoro *et al*., 2025).

Hypertension is a major risk factor for stroke, with approximately 60% of individuals with hypertension ultimately experiencing stroke (Anita *et al*., 2023; Li *et al*., 2019; Nissa & Sari, 2022; Tursina *et al*., 2024). The 2018 Basic Health Research (Riskesdas) estimated 63,309,620 Indonesians living with hypertension, with 427,218 deaths attributable to hypertension. A major barrier in stroke care is delayed treatment due to late detection (Dekker *et al*., 2024; Patil *et al*., 2022; Saefurrohim *et al*., 2022). Stroke has a "golden hour"; the earlier

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appropriate therapy is provided, the better the patient's prognosis. Treatment delays can result in permanent cerebral damage and even death(Nurani *et al*., 2019; Zuliani, 2021).

Limited public and family knowledge of stroke symptoms contributes to delays in seeking medical help. Therefore, early detection education in prehospital settings and highrisk communities is crucial to improving therapeutic success and clinical outcomes in stroke (Hickey *et al*., 2018; Tazin *et al*., 2021). Early detection is a key component of the stroke chain of survival. One widely used tool is the FAST method (Face, Arm, Speech, Time) (Chen *et al*., 2022; Pickham *et al*., 2019; Zuliani, 2021). FAST enables rapid identification of early signs—Face (facial asymmetry), Arm (arm weakness), Speech (speech disturbance), and Time (urgency to seek medical assistance). Implementing FAST has been associated with reduced brain injury and improved chances of recovery (Hickey *et al*., 2018). Despite its effectiveness, communitylevel implementation of FAST is often hampered by limited access to healthcare services, especially in prehospital phases and resourcelimited areas. In Indonesia, gaps in rapid stroke detection remain, underscoring the need for technologybased solutions to expand early detection coverage.

Indonesia is among the largest markets for internet and smartphone users, making digital health applications increasingly relevant for selfmonitoring(BPS, 2018). In this context, a smartphone application integrating Face Detection with the FAST framework presents an innovative solution for rapid, standardized symptom screening. Early detection is essential because stroke can affect individuals across age groups, and its signs are often difficult for laypersons to recognize (Dewi & Mahyuni, 2024; Lees *et al*., 2016; Wei *et al*., 2024). This study introduces an innovation for earlier identification of stroke signs to support families in recognizing symptoms more quickly and accurately, to raise awareness, expedite referrals, and ultimately reduce strokerelated mortality and disability. The objectives are: 1) to develop a FAST application leveraging Face Detection technology to detect stroke symptoms in patients with hypertension; and 2) to analyze the effect of using the FAST application on improving patients' knowledge and ability to perform early detection of stroke attacks.

Method

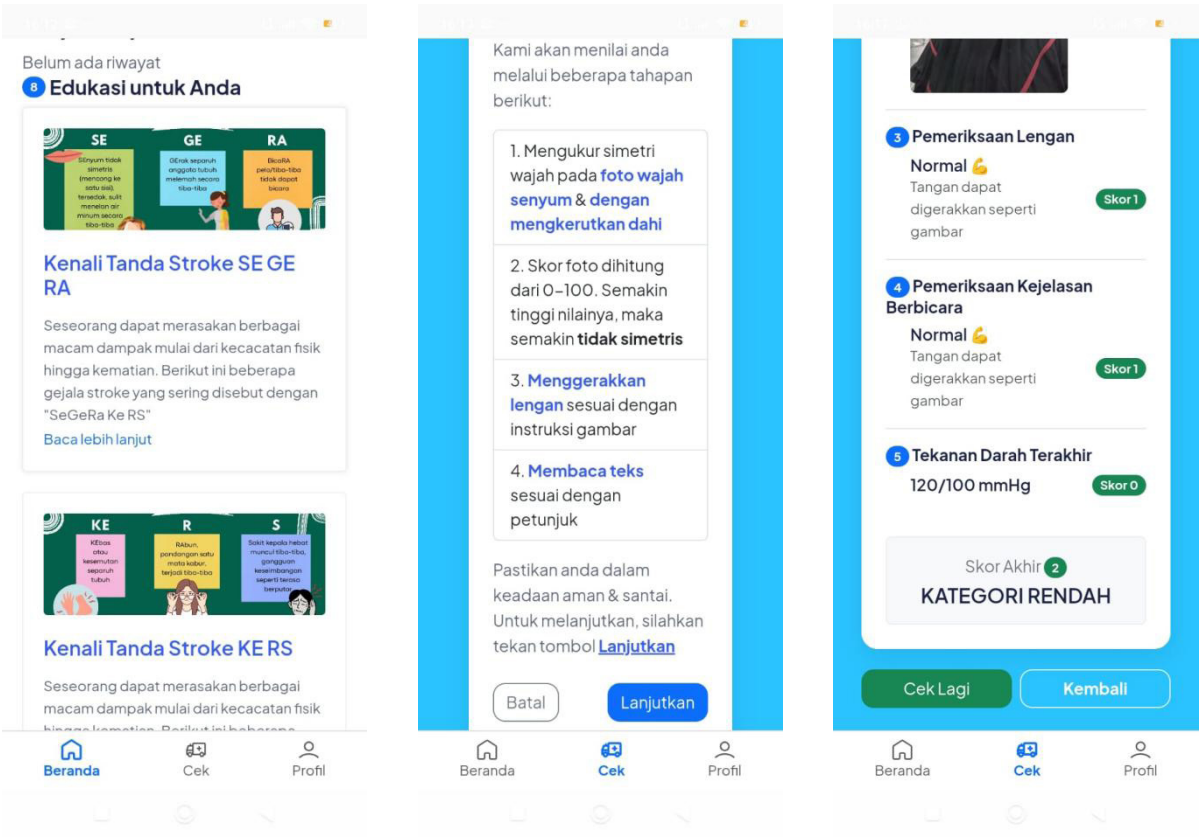
This study employed a mixed-methods sequential explanatory design, comprising a quantitative pre-post intervention assessment followed by qualitative interviews to make sure quantitative findings. The quantitative phase evaluated changes in knowledge and early detection behavior using the FAST mobile application, while the qualitative phase explored user experiences and implementation barriers among patients with hypertension. Qualitative data collection utilized semi-structured interviews (n=15, post-intervention) to explore user responses and feedback. The study was conducted at Citra Husada Hospital in Jember, Indonesia, from July to August 2025. Participants were recruited via non-probability consecutive sampling, enrolling all eligible hypertensive patients sequentially until the target sample size (n=80) was achieved. Inclusion criteria : (1) Patients with a hypertension diagnosis; (2) have a smartphone; (3) cohabitation with family; (4) willingness to complete the full intervention. Exclusion criteria included the inability to operate smartphones or illiteracy, ensuring technological competency for app utilization. Sample size determination utilized power analysis based on a standard deviation of 0.8 from prior stroke screening studies, targeting α=0.05 and power=80%.

Participants received a 1-week FAST mobile application intervention. The FAST app integrated: (1) face detection module for facial asymmetry analysis; (2) arm movement detection; (3) speech recognition for impairment assessment; (4) automated time-stamping; (5) tailored educational modules on stroke symptoms and hypertension risks; (6) post-screening recommendations with emergency referral guidance. Instruments: a) Usability Assessment: Mobile Application Rating Scale (MAUQ) rated by two independent expert raters (Cohen's κ for inter-rater reliability); b) Knowledge-Behavior Questionnaire: 17-item validated scale (Cronbach's α=0.82) measuring stroke recognition knowledge and behavioral response, administered pre- and post-intervention; c) Qualitative Component: Semi-

structured interviews (n=15, 20-30 minutes) exploring app acceptability, usability barriers, and perceived utility. Quantitative data underwent normality testing (Kolmogorov-Smirnov and Shapiro-Wilk), followed by paired t-test for pre-post comparisons (SPSS v.26). Qualitative transcripts were analyzed via Braun and Clarke thematic analysis, with researcher triangulation for credibility. Significance was set at $p<0.05$. Ethical approval was obtained from Universitas dr. Soebandi with Number 1343/KEPK/UDS/VIII/2025.

Result and Discussion

The majority of participants were in the middle adult age group (41-60 years; 66%), representing a productive age phase with elevated stroke risk due to chronic hypertension. Most participants were female (72.5%), consistent with higher hypertension prevalence among middle-aged women in Indonesia. Thirty-five percent of participants had a stroke history (n=28), with the majority experiencing stroke duration >6 months (90%; n=72), indicating a population with chronic stroke experience relevant for secondary screening evaluation.



a b c

FIGURE 1. FAST App Interface on a Smartphone (a). Education; (b) Indicator Screening; (c) Results and Interpretation

Table 1. Distribution of Demographic and Clinical Characteristics of Participants(n-80)

Variable	Category	Respondents n (%)	Total
Age	Early Adult (18 - 40)	1 (1,3)	
	Middle-aged adult (41 - 60)	53 (66,3)	80 (100)
	Elderly (>60)	26 (32,5)	
Hypertension Duration	<6 Months	8 (10)	80 (100)
	>6 Months	72 (90)	
Gender	Male	23 (27,5)	80 (100)
	Female	57 (72,5)	
History of Stroke Attack	Yes	28 (35)	80 (100)
	No	52 (65)	
Systolic	Elevated 120-129	9 (11)	80 (100)
	Stage1 130-139	9 (11)	
	Stage 2 >140	57 (73)	
	Severe >180	5 (6)	
Diastolic	Elevated <80	8(10)	80 (100)
	Stage 1 80-89	11 (24)	
	Stage 2 >90	53 (66)	

Source: Primary Data, 2025

Blood pressure characteristics were prominent with stage 2 hypertension dominance, both diastolic (66.3%; n=53) and systolic (71.3%; n=57), signifying a very high-risk group (4-6 times stroke risk) appropriate for the FAST app intervention target.

The expert validation in this study involved two teams of specialists in medical-surgical nursing. Inter-rater reliability assessment utilized the mHealth App Usability Questionnaire (MAUQ). Cohen's kappa test yielded a significance value of p=0.018 (κ=0.400), indicating statistically significant agreement between the two reviewers and fair-to-moderate reliability in usability evaluation. The significant p-value (0.018<0.05) confirms consistent evaluation between expert raters, supporting the FAST application's usability validity for patients. Kappa=0.400 reflects acceptable reliability for mHealth tools in clinical settings, though refinement of rating guidelines could enhance consistency toward substantial agreement (κ>0.60).

The results of the normality test data analysis showed that all Kolmogorov-Smirnov results were > 0.05. This indicates that all data are normally distributed, so the test used was parametric (paired t-test).

Based on the paired t-test results (Table 4), a significant difference was observed between patients' knowledge and behavior before and after the FAST application intervention with p-value=0.000 (<0.05). The pre-post mean difference was -4.538, indicating meaningful improvement in stroke

Table 2. Results of the Test of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Before	,118	80	,078	,972	80	,075
After	,098	80	,054	,978	80	,186

a. Lilliefors Significance Correction

Source: Primary Data, 2025

Table 3. Differences in Knowledge and Behavior Pre-Post Intervention

Variable	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pre-Post Knowledge & Behavior	-4,538	1,902	,213	-4,961	-4,114	-21,334	79	,000

Source: Primary Data, 2025

Early detection capabilities. Qualitative data collection utilized semi-structured interviews (n=15, post-intervention) to explore user responses and feedback. Thematic analysis (Braun & Clarke) yielded 4 main themes with 9 subthemes.

Qualitative interviews with 15 participants were conducted to explain users' experiences after using the FAST mobile application. Thematic analysis identified four main themes: perceived benefits and satisfaction, barriers to application use, privacy and data security concerns, and technical challenges. Overall, participants perceived the application as useful because it helped them recognize early stroke symptoms, understand the relationship between hypertension and stroke, and perform simple self-screening at home. The education and screening features were considered practical and relevant to family-based early detection.

"The application helps us recognize stroke symptoms earlier, especially for family members with hypertension." (P1), "The information about stroke and hypertension is easy to understand." (P3).

However, several participants reported barriers related to limited digital literacy, particularly among elderly users. Some users needed assistance from family members to operate the application, complete the screening steps, and interpret the results. This

Table 4. Qualitative Data

Main Themes	Categories	Sub-Categories	Relational Explanations
Perceptions of Benefits and Satisfaction with the Application	Benefits and satisfaction	Early stroke risk detection in the family Relevant stroke and hypertension education Practical use anytime	The application increases family awareness, supports early detection, and improves satisfaction through practical access.
Barriers to Application Use	User limitations	Minimal technology skills Less user-friendly for elderly users Requires family assistance	Limited digital literacy and age-related barriers reduce independent use, especially among older adults.
Privacy and Data Security Concerns	Data protection	Concern about facial photos and personal data being recorded	Privacy concerns may influence trust and willingness to use the application.
Technical Challenges in Application Use	Application and infra structure problems	Application features are not yet optimal Internet connection issues in rural areas	Technical limitations and unstable internet access may affect usability and continuity of application use.

Source: Primary Data, 2025

finding indicates that although the application improved knowledge and early detection behavior, its use among older adults may still require family support.

"For older people, it is difficult to use the application alone." (P7).

Participants also expressed privacy concerns, especially regarding facial photos and personal data entered into the application. In addition, technical problems such as unstable internet connections and application features that were not yet fully optimal were identified as challenges, particularly in rural areas.

"When the internet signal is weak, the application takes longer to open." (P13).

These qualitative findings support the quantitative results by explaining why participants' knowledge and behavior improved after the intervention. The application provided accessible education and practical screening guidance, which strengthened users' awareness of early stroke detection. At the same time, the qualitative data also highlight several aspects that need improvement, including simplifying the interface for elderly users, strengthening data privacy information, and optimizing the application for areas with limited internet access. This study demonstrated that the FAST mobile application with face detection was associated with a significant improvement in knowledge and early stroke detection behavior among hypertensive patients. The increase in post-intervention scores indicates that smartphone-based education and screening may support patients and families in recognizing early stroke symptoms. This finding is important because hypertension is a major risk factor for stroke, and early recognition of stroke warning signs in the pre-hospital phase remains a critical component in reducing treatment delays and improving patient outcomes(Dekker *et al*., 2024; Patil *et al*., 2022; Zuliani, 2021).

The improvement in knowledge and behavior may be explained by the integrated features of the FAST mobile application. The application combines stroke and hypertension education, facial asymmetry screening, arm movement assessment, speech screening, time-stamping, and follow-up recommendations in one structured workflow. This integration allows users not only to receive health information but also to practice the steps of early stroke recognition. Therefore, the application may provide a more practical learning experience compared with conventional education that only delivers information without interactive screening features. The qualitative findings strengthened and explained the quantitative results. Participants perceived the application as useful, practical, and relevant for family-based early stroke detection. They reported that the application helped them recognize stroke symptoms earlier, understand the relationship between hypertension and stroke, and perform simple self-screening at home. These findings indicate that the improvement in knowledge and behavior was not only a statistical result but also reflected meaningful user experiences after using the application. In the context of a sequential explanatory mixed-methods design, the qualitative data provide an explanation of how the intervention influenced users' awareness, confidence, and readiness to respond to stroke warning signs.

The findings of this study are consistent with previous evidence that FAST-based education can improve public awareness of stroke symptoms and appropriate emergency response (Chen *et al*., 2022; El Ammar *et al*., 2020; Nogueira *et al*., 2017; O'Brien *et al*., 2012). FAST is a simple and widely recognized method for identifying stroke warning signs, including facial drooping, arm weakness, speech disturbance, and the urgency of time(Aroor *et al*., 2017; Pickham *et al*., 2019). However, community implementation of FAST is often limited by inadequate knowledge, low exposure to stroke education, and uncertainty in recognizing symptoms(Nogueira *et al*., 2017). This study extends previous findings by integrating FAST education into a mobile-based screening application, making the FAST concept more accessible and applicable for hypertensive patients and their families.

From a public health perspective, the FAST mobile application has the potential to support early stroke recognition in the community and pre-hospital setting(El Ammar *et al*., 2020; Nogueira *et al*., 2017). Many stroke events are first identified at home by patients, spouses, children, or other family members. Therefore, family readiness plays an important

role in deciding whether and when to seek emergency care. The application may serve as a complementary tool in hypertension education, outpatient counseling, community-based non-communicable disease programs, and family health promotion(Bonura *et al*., 2022; Dekker *et al*., 2024; Lees *et al*., 2016). Nurses, health workers, and community cadres may use this application to strengthen education about stroke warning signs and encourage timely referral when symptoms occur.

However, the qualitative findings also identified several barriers that should be considered before wider implementation. Limited digital literacy, particularly among elderly users, may reduce the ability to use the application independently. Some participants required assistance from family members to operate the application, complete the screening process, and interpret the results. This finding suggests that the FAST mobile application should not be positioned only as an individual self-screening tool, but also as a family-assisted screening tool. For older adults and users with limited technology skills, family involvement may improve application use and strengthen the role of the household in early stroke detection.

Technical challenges, particularly unstable internet connection, may also limit implementation in rural or low-connectivity areas. Participants reported that a weak internet signal made the application slower and less convenient to use. This issue is relevant in Indonesia, where digital health implementation may face unequal access to internet infrastructure across regions. Future versions of the application should consider low-bandwidth operation, offline educational content, simplified image-capture procedures, and a more user-friendly interface. These improvements are needed to ensure that the application can be used not only in urban settings but also in rural communities where stroke education and rapid access to health services may be more limited.

The novelty of this study lies in the integration of face detection into a FAST-aligned mobile self-screening process for hypertensive patients. Unlike digital tools that mainly provide passive health information or reminders, this application combines screening, education, and post-screening recommendations in one workflow. By integrating facial asymmetry detection, arm movement assessment, speech screening, and time-stamping, the application offers a more comprehensive approach to supporting early stroke recognition. This integrated design may improve preparedness among high-risk families and support faster decision-making in the pre-hospital phase.

Despite these promising findings, this study has several limitations. First, the pre-post design without a control group limits causal interpretation of the intervention effect. Second, the study was conducted among hypertensive patients from one hospital and only included participants who owned smartphones, which may limit generalizability to populations with lower digital access. Third, the qualitative interviews involved 15 participants and may not represent all user experiences, particularly among elderly users or those with very low digital literacy. Future studies should use controlled designs, larger and more diverse samples, diagnostic accuracy testing, and implementation evaluation in rural or low-connectivity settings. Overall, this study suggests that a smartphone-based FAST application with face detection is feasible and acceptable as an educational and self-screening tool for hypertensive patients. The quantitative findings showed significant improvement in knowledge and behavior, while the qualitative findings provided contextual understanding of the benefits, barriers, privacy concerns, and technical challenges experienced by users. These integrated findings support the potential use of the application as a complementary strategy for improving family-based early stroke recognition and strengthening pre-hospital stroke response.

Conclusion

This study indicates that the smartphone-based FAST application with face detection is feasible and useful for supporting early stroke recognition among individuals with hypertension. The intervention significantly improved participants' knowledge and early detection behavior, while qualitative findings showed that the application was perceived as practical, relevant, and helpful for family-

based stroke awareness. The application offers a promising digital health tool by combining facial asymmetry detection, FAST-based screening, education, and referral recommendations. However, further improvements are needed to simplify its use for elderly users, reduce internet dependency, improve image-capture procedures, and strengthen data privacy information. Future studies should test the application in larger populations and validate its screening accuracy against clinical standards.

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