Development and usability evaluation of a culturally adapted stroke prevention educational programme on WeChat apps

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Abstract

Background: The persistently high incidence of stroke in many nations is suggestive of an area for further improvement on existing strategies of primary stroke prevention. Although the era of digitalisation has led to the increasing use of mobile applications (apps) in healthcare, more studies are needed to determine the efficacy of apps in producing the desired health outcomes across different nations and cultures.

Objective: To describe the development and evaluate the usability of a mobile app in delivering a culturally adapted stroke prevention educational programme for middle-aged adults in the Republic of China.

Methods: The educational programme was developed in three phases. In Phase 1, the process involved analysing requirements and designing structured modules. Phase 2 concentrated on expert consultation and technical development to deliver the educational programme. Phase 3 included a usability trial and refinement of the educational program based on trial results.

Results: Educational content was derived from the Chinese Guidelines for the Prevention and Treatment of Stroke and the Dietary Guidelines for Residents. The WeChat platform was used to deliver the educational programme. Participants expressed satisfaction with the content, interface, and functions of the apps, indicating that the apps have good usability.

Conclusions: The development process of the Educational Programme was designed to maximise the culturally appropriate, and impact of lifestyle changes and stroke prevention. An app-based educational programme that has demonstrated good usability is a vital factor prior to deploying it in an intervention to evaluate its effects on health outcomes.

Introduction

Background

Stroke remains one of the leading causes of mortality and morbidity worldwide;[1] it is critical to emphasise the significance of timely intervention in reducing mortality and disability rates associated with a stroke. According to the 2024 Heart Disease and Stroke Statistics report by the American Heart Association,[2] there has been a concerning trend in

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stroke-related mortality in the United States. From 2011 to 2021, the age-adjusted stroke death rate increased by 8.4%, rising from 37.9 per 100,000 to 41.1 per 100,000. Concurrently, the actual number of stroke-related deaths surged by 26.3%, escalating from 128,932 to 162,890 deaths. Based on a 2020 study involving a large and representative sample of adults aged 40 years or older, the estimated prevalence, incidence, and mortality rate of stroke in China were 2.6%, 505.2 per 100,000 person-years, and 343.4 per 100,000 person-years, respectively.[3] Meanwhile, China also has a large population of chronic disease patients,[4–6] including those with hypertension, hyperlipidaemia, diabetes, obesity, and heart disease which are high-risk groups and potential sources of stroke. These findings[7] emphasise the urgency to enhance stroke primary prevention strategies within the broader Chinese population. Lifestyle behaviours[8] are a crucial factor in the development of stroke risk factors, highlighting the importance of promoting healthy habits to reduce the incidence of stroke.[9]

Mobile technology such as smartphones offers a potential solution for measuring a healthy lifestyle.[10] Applications (apps) are being used to prevent and manage risk factors, increase physical activity (PA),[11] improve dietary habits,[12] quit smoking,[13] and reduce stress,[14] depression and obesity.[15] However, at present, apps related to stroke prevention primarily focus on risk screening,[16] with a lack of comprehensive guidance on personalised dietary and healthy lifestyle choices. Furthermore, most dietary apps predominantly address utilising app functionalities for weight loss[17] and modifying intake of specific nutrients to meet the needs of certain diseases,[18,19] while neglecting attention to stroke prevention knowledge among the population at risk of stroke. In addition, there is also a lack of intervention programmes that are tailored to the dietary habits of the Chinese population and culture.

WeChat, among the world's most popular social media communication platforms, boasts over 1.2 billion active users. Originating as a messaging service, it has evolved into a comprehensive social media platform.[20] As of Q2 2023, WeChat boasts a global user base of 1.671 billion monthly active users, with 4 million users in the United States. WeChat provides versatile features,[21] including WeChat Official Accounts and WeChat Mini Programs, enabling the efficient delivery of healthcare services. Tencent's (A Chinese conglomerate founded in 1998 that launched the WeChat mobile app, now China's leading social network and communications platform) revenue data indicates a remarkable year-on-year growth of 13.91%, adding 75 million users to WeChat Mini Programs, totalling 614 million users in 2023. The daily active users of WeChat Mini Programs have surged by 284% from 2017 to 2023.[22] With the increasing popularity of mobile health (mHealth) services, WeChat is positioned to play a crucial role in the mHealth landscape.

Given the increasing internet access and mobile phone ownership in China and the growing popularity of the WeChat platform,[23] a mobile phone educational programme that has been culturally adapted could be effective in strengthening health awareness of stroke for middle-aged adults who are increasingly at risk of the condition. Our programme combined WeChat Mini Programs and Official Accounts and aimed to enhance the prevention of stroke by drawing on established theories, knowledge of the disease, and evidence related to diet and exercise. To ensure the user-friendliness of the mobile phone programme, it was necessary to conduct usability testing with users.

Objective

This study aimed to develop and evaluate the usability of a WeChat app to deliver a healthcare programme to gain a deep understanding of the app's usability in practice and provide valuable insights and recommendations for the development of mHealth management apps.

Methods

Overall study design

This study employs a multi-phase, mixed-methods design. Figure 1 shows the overview of the Stroke-Preventive Diet and Lifestyle Educational Programme development process.

1. Collecting requirements from education guidelines, a review of lifestyle changes education apps already available, and theory that could most benefit from the development.
2. Revising the prototype features with experts concerning content and establishing a software development team.
3. Usability test the educational programme in a formative evaluation study with target participants for further refinement.

Phase 1: collection requirements materials of the stroke-preventive diet and lifestyle educational programme

Content and theory: The content of this app combines the Chinese Dietary Guidelines for Residents (2022),[24] the Guidelines for the Prevention and Treatment of Stroke in China,[25] and the Health Belief Model (HBM).[26] The Chinese Dietary Guidelines for Residents[27] is an important manual for guiding the Chinese people's diet, providing basic principles and methods for dietary intake, including content related to moderate diversity and balanced nutrition. The HBM[28] is a theoretical framework that attempts
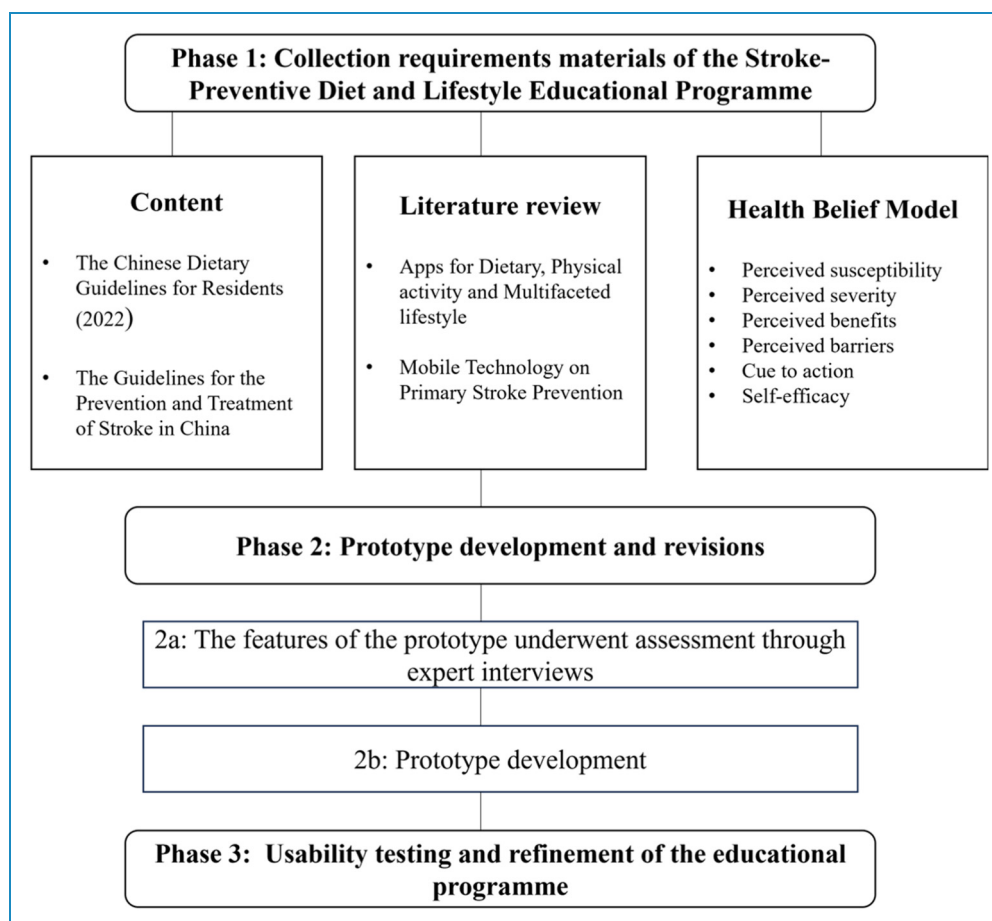
Figure 1. Overview of the stroke-preventive diet and lifestyle educational programme development process.

to explain and predict health-related behaviours and has since been widely used in health promotion, disease prevention, and interventions on making behaviour change, making it one of the most widely utilised models in understanding health-related actions. Within this model, key factors influencing health behaviours include an individual's perceived susceptibility to sickness or disease, their perception of potential consequences, recognition of the positive outcomes of acting, awareness of barriers to action, exposure to factors that motivate action, and their confidence in their ability to succeed.

Platform: The Stroke-Preventive Diet and Lifestyle Educational Programme, including dietary guidance, was developed in WeChat for smartphone and tablet devices. It combines the different functionalities of WeChat Mini Programs and Official Accounts. A WeChat Official Account,[29] commonly referred to as a WeChat public account, is akin to a Facebook Page. It is a publicly accessible profile enabling individuals or entities to share content, amass followers, and market their offerings. Articles from Official Accounts can be easily shared on WeChat Moments or promoted through article push notifications, attracting more user attention and traffic. They are advantageous for content dissemination, easy operation and maintenance, better interactivity, and a stable user base.

The WeChat Mini Program[30] is a lightweight app that requires no installation, downloading, or uninstallation built within the WeChat platform with endless functionalities.[31] It offers a user-friendly interface and features a low entry barrier, wide audience reach, strong social interaction, and versatile app scenarios, which provide a native app experience, enabling richer and more intricate interactive experiences. It can make up for the limitations of Official Accounts in terms of interactive apps.

Phase 2: prototype development and revisions

Phase 2a: the features of the prototype underwent assessment through expert interviews. Expert consultation can be defined as an inquiry of information from one or more individuals.[32] Face-to-face interview is one of the most typical consultation methods.[33] Two interviewers, both holding PhDs in Nursing and possessing extensive training in qualitative research interview techniques, facilitated the

sessions. They commenced by expressing gratitude to the experts for their time and interest, while succinctly restating the interview's objectives and aims. The interviews began with the presentation of the concept, utilising an initial draft prepared by one of the interviewers (LC). Questions were then posed, with a flexible approach employed to adapt to the natural flow of conversation. Throughout the dialogue, emphasis was placed on active listening and respectful engagement, with a commitment to avoiding interruptions, arguments, or dominating the discourse. Additionally, prior permission was obtained for recording or note-taking, ensuring strict adherence to the expert's confidentiality and preferences. The following four topics were discussed: (1) the main content (2) the adherence among the target population, (3) the suggestions for the format of modules, and (4) feasibility. After the interviews, researchers (LC and ZJH) undertook data analysis using semi-structured qualitative content analysis. They meticulously reviewed notes or recordings, summarising key points, insights, and feedback offered by the experts. Comparison and contrast of results were then conducted to identify patterns, gaps, or contradictions. Subsequently, the findings were applied to the research project, facilitating the resolution of questions, and issues, and the enhancement of the study. Throughout the study, the researchers critically scrutinised their roles and interrogated data interpretations to mitigate potential biases. It's noteworthy that all interviews with experts were conducted at their respective workplaces.

Phase 2b: prototype development. Establishing a software development team consisting of four members, including two senior software engineers (responsible for app module design, development, and ongoing maintenance), 1 professional graphic designer (responsible for page design), and a researcher (LC, responsible for formulating the app development plan and proposing system requirements for the app, maintained real-time communication with team members). The software development team, after optimising the initial draft of the app content based on preliminary research and expert consultations, proceeded to design the app. They also modified and wrote the frontend and backend code for the app and completed the development of the mobile app.

Phase 3: usability testing and refinement of the educational programme

Study design: The evaluation study of the programme encompassed a combination of quantitative and qualitative

Table 1. The interview outline.

No	Questions
1	Overall, how do you feel about using this mobile phone programme? • What are your thoughts on obtaining information through WeChat? • What beneficial experiences has this programme provided to you? • Do you find this application easy to use?
2	How do you feel about the combination of the Mini Program and the Official Account? • What content within the Mini Program encourages you to continue using it? • What are your thoughts on the real-time updates provided by the Official Account? • Which features do you find most convenient to use?
3	Any thoughts on the layout and distribution?
4	What are your thoughts on the content of the articles? • Content distribution • Images • Colours • Text
5	What additional information would you like this programme to provide? What specific information are you more interested in? • Diet • Physical activity • Disease
6	Are there any shortcomings of this programme? How would you suggest improving them?
7	Would you be willing to continue using this programme to assist with your self-management? What is your reason for this?

Table 2. Module content.

Modules	First-level indicator	Second-level indicator
Disease prevention	Risk assessment	Outcomes: • Low risk • Medium risk • High risk
	Stroke prevention	Understanding stroke
		Risk factors for stroke: • Uncontrollable risk factors • Controllable risk factors
		Clinical manifestations of stroke
		Early recognition and first aid of stroke
	Physical activity	Relationship between physical activity and health
		Common knowledge about physical fitness and health
	Widgets or tools	Goal setting
		Logging and tracking
		'FAST' stroke recognition
Chronic disease management	Popularization of chronic diseases	Knowledge including diabetes, hypertension, heart disease, dyslipidaemia, and obesity) • Causes of various chronic diseases • Clinical manifestations • Complications and hazards • Prevention and treatment
	Chronic disease diet	Diet recommendations for diabetes, high blood pressure, heart disease, obesity, etc. • Recommendation for low-salt diet • Recommendation for a low-sugar diet • Recommendation for a low-fat diet
Dietary recommendations	Nutrition education	Chinese dietary guidelines
		Knowledge of balanced nutrition
		Introduction to the Chinese food collection 'Three Meals a Day'
	Dietary tips or techniques	
	Recipe instructions	Simple daily healthy diet recommendations suitable for Chinese middle-aged and elderly people and in line with local characteristics
	Seasonal dishes	Recommendations for some seasonal dishes
Real-time updates	Real-time educational updates on official accounts	Primary content updates include: • Latest dietary evidence • Balanced diet recipes

(continued)

Modules	First-level indicator	Second-level indicator
		• Seasonal dish recommendations • Exercise-related information
	Reminders	Design goals for timely prompts according to requirements (Eating fruit, drinking water, exercising)

data collection methods. Studies have found that 98% of usability issues could be identified through feedback from 10 users.[34] Based on this, we recruited a total of 23 users to use the mobile programme for 2 weeks and then gathered through the System Usability Scale (SUS) to assess the usability of the quantitative data from the educational mobile programme. Initially, 25 participants were approached for involvement in the study. However, two declined participations due to work commitments. Remarkably, there were no dropouts among the remaining participants throughout the study period. Following the quantitative evaluation, 15 out of the 25 participants were invited to participate in semi-structured interviews aimed at delving deeper into their user experience.

Study setting and sampling: Eligible individuals from four local communities in Henan Province, China, were purposively sampled. We used purposive sampling to attempt to reach maximum variation regarding gender and cultural background for the participants.

Recruitment ceased upon reaching data saturation. Study inclusion criteria were (1) the presence of one or more 'modifiable' stroke risk factors including cardiovascular disease (CVD), hypertension, dyslipidaemia, atrial fibrillation, diabetes, being overweight or obese, being physically inactive, smoking, consuming excess alcohol; (2) owned a mobile phone with an iOS or Android operating system and had been using it for not less than 3 months. All participants provided written informed consent before taking part in the study and received a reimbursement of RMB 20 (approximately US $3) for their time involved.

Data collection procedures. **Quantitative collaboration:** Prior to introducing the programme, participants received a briefing on the study's purpose and were thanked for their cooperation. They were assured that their personal information would be protected and used exclusively for research purposes. Participants were given the option to withdraw at their discretion and were required to sign an informed consent form. Subsequently, detailed instructions were provided on how to use the programme, including accessing the Mini program, following the Official Account, and receiving updates for a smooth initiation. The 2-week trial period commenced, during which participants independently accessed the program using their

smartphones. Throughout the trial, participants were encouraged to promptly contact researchers via their mobile phones for assistance or guidance as needed.

At the conclusion of the 2-week period, participants were instructed to independently complete the validated 10-question SUS. The SUS score was interpreted using the adjective rating scale developed by Bangor[35] to ensure participants grasped the questions' intent and could furnish accurate responses. Participants were allotted ample time to thoughtfully consider the questions and were provided with sufficient opportunity to furnish precise answers. Paper-based questionnaires were collected by researchers at the participants' workplace, ensuring confidentiality. All data were anonymized and accessible solely to the researchers. The quantitative findings would be complemented by subsequent qualitative interviews to bolster the reliability and accuracy of the data.

Qualitative interviews: Following 2 weeks of using the programme, we conducted user interviews to collect data related to participants' experiences in using the mobile app. Inductive thematic analysis with semi-structured interviews was conducted. The interviews took place at the participants' workplace, with no additional personnel present in the room throughout the sessions. The interviews were conducted by two researchers, LC and ZJH, both of whom had previous training and experience in qualitative research, with the aim of minimising interviewer bias on participant responses. During the interviews, LC took the field notes. Each interview lasted around 20 to 30 minutes, following the interview guide. Afterward, the researchers, LC and ZJH, reviewed the recordings of the FGDs, ensuring accuracy, and then transcribed them verbatim. The interview outline is presented in Table 1.

Data analysis. **Quantitative analysis:** The data were entered and evaluated using SPSS Statistics Version 27. The data were summarised as categorical data, as well as mean and SD for numerical data. To calculate the SUS score,[36] users would first rank each of the 10 template questions on a scale of 1 to 5 based on their level of agreement. For odd-numbered questions, 1 is subtracted from the score, and for even-numbered questions, the score is subtracted from 5. The resulting scores are added up and multiplied by 2.5 to obtain the final SUS score.

Table 3. Summary of expert opinions.

	Expert suggestions	Prototyping
Modules	Most of the content in this module focuses on stroke and stroke prevention knowledge in the context of disease prevention. It is recommended to change the module name to 'Stroke Prevention.	Change the module 'Disease Prevention' to 'Stroke Prevention'.
	Placing the exercise module within the stroke prevention module may affect the effectiveness of exercise intervention. It is recommended to list it separately.	List relevant knowledge about exercise separately.
	Preventing stroke is particularly important, and it is crucial to make the research subjects aware of the early warning signs as a key aspect of prevention.	Consider placing 'Early Identification' prominently so that everyone can quickly recognise it.
Contents	How can we make the intervention content more understandable for participants? Only through understanding can they make judgments and act.	The content design should be straightforward to understand, avoiding the use of excessive technical jargon.
	The principles are quite simple, but after explaining them, the patient still doesn't know anything.	Consider adding visuals, audio, and video content appropriately.
	It's essential to understand the specific areas of interest for everyone.	Thoroughly integrating the content of qualitative interviews conducted in the early stages with the research population to gain in-depth insights and understanding of the research population's concerns and preferences.
	Different populations require tailored dietary plans based on their physiological characteristics.	For example, in the case of obese patients, with three meals a day, each meal should consist of roughly one-third of the total intake. The dietary plan should prioritise vegetables, with an emphasis on dark-coloured vegetables comprising half of the meal, while carbohydrates can be more flexible.
	The content needs to be authentic, reliable, and evidence-based.	According to the disease prevention and control guidelines, provide categorised and relevant introductions.
Feasibility	The concept of a diabetes diet is very comprehensive, with knowledge of overall quantity control and combinations, but lacking specifics on how to implement it.	A weekly meal plan must be presented in a very specific manner. Patients receive educational content in the form of everyday explanations, handouts, and food estimations, which enable them to better understand.
	Although an Eastern healthy diet is preferable, it might be challenging for individuals in the Northern regions to adhere to. Therefore, a recommendation would be to consume fish or seafood at least twice a week.	Tailoring intervention content to local habits and customs of the study population to make it easier to achieve the intervention goals.
Adherence	How to improve patient dietary and physical activity compliance? How to make it more purposeful and increase participant engagement?	Ways to promote compliance: Tailor the plan to align with their existing lifestyle habits. Provide options for free choice, similar to food exchange options. Offer professional, regular follow-up. Conduct risk self-assessment, which is crucial for increasing motivation and purpose.

Table 3. Continued.

Expert suggestions	Prototyping
	Introduce topics of interest to individuals with chronic conditions, such as providing an overview and explanation of chronic diseases, to make them more attentive to their health, including dietary and other healthy lifestyle choices. Emphasise the risks by detailing the severity of the consequences of the disease, ideally with visual representations.

Qualitative analysis: For the qualitative interviews, the analysis was performed after completing all data collection. Thematic analysis was performed using the NVivo 12 Plus software. Three researchers (LC, LWL, and CMC) possessed prior training and expertise in qualitative research. LC, a nursing health researcher, received formal training in qualitative research methods and has conducted qualitative interviews in previous studies. LWL, a lecturer, is an experienced qualitative researcher with a substantial publication record in the field. CMC, a nursing science professor, leads qualitative research workshops and has authored numerous qualitative research articles. Two researchers, LC and LWL, initially familiarised themselves with the data by thoroughly reviewing the transcripts and field notes. They individually assigned codes to every phrase, sentence, or paragraph in the transcripts, ensuring alignment with the study's objectives. These codes were then amalgamated to formulate broader themes, drawing upon the relationships identified between and within the codes. The analysis underwent further validation by a third researcher, CMC. Subsequently, the three researchers convened meetings to collectively review the analysis, resolving any discrepancies in coding through consensus. All data underwent anonymization and were securely stored in password-protected computers, accessible solely to the researchers. The research team diligently examined and thoroughly scrutinised all identified themes and categories.

Results

Phase 1 study results

Combining the Chinese Dietary Guidelines for Residents with the HBM can lead to the design of a more comprehensive, scientific, and practical health app, helping users to better practice a healthy lifestyle. The American Heart Association[37] has extensively presented and discussed data supporting the benefits of PA and dietary changes in reducing the morbidity and mortality of CVD and stroke in adults. Adopting healthy lifestyles and effective self-management methods can effectively reduce these risk factors, thereby preventing stroke occurrence. According

to Lancet Public Health,[38] methods for preventing stroke incidence may include lowering salt consumption, upping physical exercise, and changing eating habits. Therefore, educational content on healthy lifestyles is of utmost importance. Ensuring that our educational content and information are presented in a direct and easily understandable manner for research subjects is also a key focus for us.

Secondly, adherence holds paramount importance in stroke prevention, denoting patients' active engagement with and adherence to medical advice and treatment regimens, encompassing medication, dietary modifications, exercise routines, and other lifestyle behaviours. Stroke prevention apps offer tailored health suggestions, routine reminders, and tracking capabilities to support users in formulating and executing self-management strategies, ultimately aiding in the attainment of predetermined health objectives. As highlighted by Ruo-Ting Sun et al. (2021),[39] delivering personalised health guidance and reminders via an app can significantly bolster patients' adherence to treatment protocols.

Furthermore, in stroke prevention apps, particular attention to goal setting, action planning, and goal attainment is crucial. Users set specific, measurable, and achievable health goals through the app, such as daily step counts or controlling calorie intake per meal. The app then formulates corresponding action plans based on the user's health status and goals, recommending suitable exercise methods, dietary advice, and so forth. Setting goal[40] is essential to facilitating the successful use of reablement in a variety of situations. More precisely, to make it easier to customise reablement programmes to the needs of users and to create more productive interdisciplinary collaboration by encouraging mutual trust, sharing a common goal, and leveraging one another's skills. Through tracking and monitoring features[41] of the app, users can stay updated on their health status in real time, allowing them to adjust and improve their action plans promptly. This personalised approach to setting health goals, devising action plans, and real-time tracking and monitoring functions help enhance users' health awareness and capacity for behavioural change, effectively preventing the occurrence of stroke.

Through an extensive literature review aimed at elucidating the content and requisites of health management
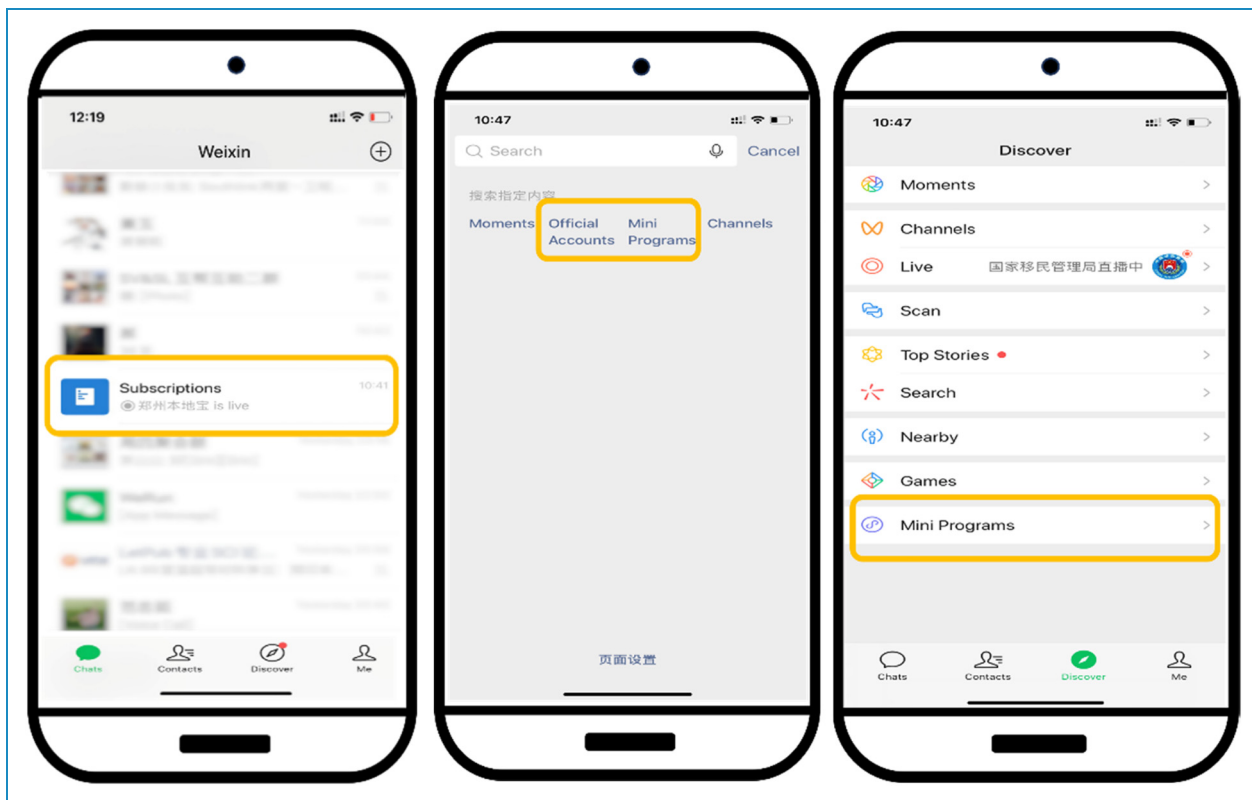
Figure 2. Subscription accounts and Mini Programs appear in the conversion list.
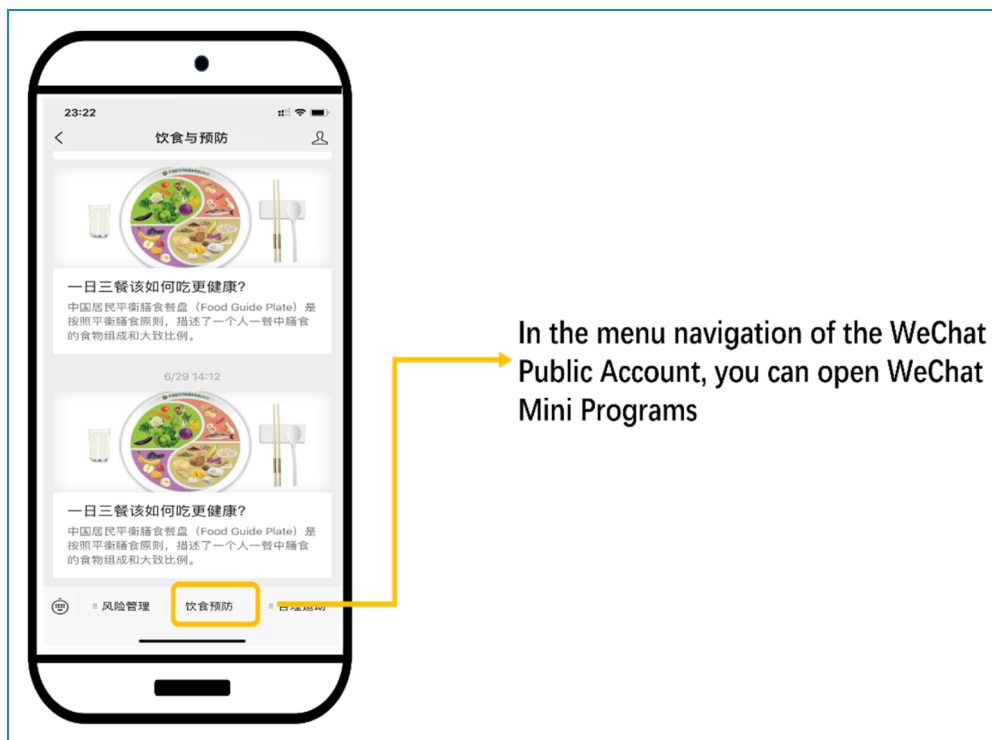

Figure 3. Illustration of the seamless integration of Mini Programs and official accounts.

for individuals at risk of stroke, and a market survey aimed at gaining insights and innovating upon existing diet, PA, or healthy lifestyle management mini-programs and apps available in the market, we proceeded to craft the initial draft of the program. This program, titled 'The Stroke-Preventive Diet and Lifestyle Educational Program' features four primary indicators (disease prevention, chronic disease management, dietary recommendations, and real-time updates) as described in Table 2.

Phase 2 study results

Phase 2a. The outcomes of the expert consultations encompass expert feedback obtained through expert interviews. The experts were deliberately selected so that they would produce diverse ideas from their different specialisations. Our interdisciplinary panel was composed of three nursing education experts, one clinical medicine physician, four clinical nursing experts, and one nutritionist to enhance the exchange of ideas. The experts contributed valuable insights concerning the content of the app modules, contents, feasibility, and adherence. These insights were subjected to discussions within the research team and subsequently integrated into the project (Table 3).

Phase 2b. Before commencing the development process, the research team engaged in multiple discussions with the software development team. In these deliberations,

the researchers initially introduced the background, objectives, and significance of the study. Subsequently, they delineated their envisioned content and desired features for the app. The technical team provided feedback regarding the feasibility of the proposed functionalities, confirming their ability to complete them within the agreed-upon timeframe and methodology. In instances where full implementation was unattainable, alternative suggestions were put forth. Upon the conclusion of the requirements discussion, a comprehensive list of the system's functionalities was compiled. This list specified the included features, sub-features, column attributes, column formats, column content, and other relevant details, which were documented in tables or textual formats. With the support of the software development team, five modules were constructed: risk assessment, diet, PA, identification, and real-time updates area. Figure 2 illustrates the conversion list within WeChat.

Both WeChat Mini Programs and Official Accounts are apps within the WeChat ecosystem. Official Accounts can promote Mini Programs in articles or custom menus, facilitating convenient use for users, and can also set up a Mini Program entrance in the menu bar for easy access. They can complement each other in various scenarios, providing an enhanced user experience (Figure 3).

The Mini Application has taken advantage of the WeChat Official Account's strengths to update the latest information in real time, including disease prevention
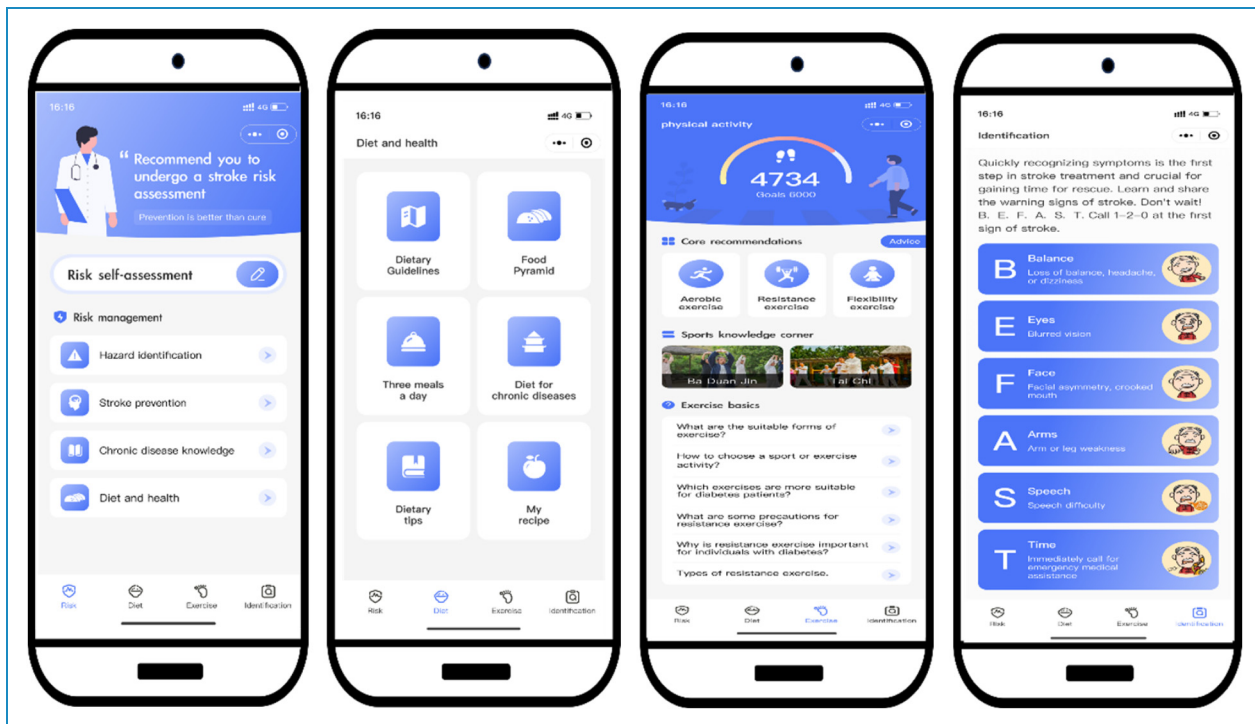

Figure 4. Illustration of the Mini Application with four interfaces.

knowledge, reminders, health interactions, and more. Use of the app begins with the login interface and once the users have logged in, they visualise the home interface, which includes several tabs (e.g. risk management, diet, exercise, and identification) (Figure 4).

The tab of 'Risk' specifically covers certain health issues, including stroke risk assessment and the relationship between chronic diseases and stroke, so that users can perceive whether they face health threats and understand the consequences of the health issue to emphasise its severity. The interface educates users to assess their health risks through risk self-assessment (Recommended by the Stroke Prevention and Control Project Committee of the National Health and Family Planning Commission of China), explaining the risk factors of diseases to users, allowing users to evaluate their vulnerability in terms of health, and further motivating them to act. Prior to starting the assessment, provide clear instructions to participants, outlining its purpose and ensuring anonymity. Encourage honesty, emphasising that truthful responses enhance accuracy and ultimately benefit health.

The interface 'diet' introduces the current dietary situation, the content of balanced dietary guidelines, and the benefits of a healthy diet to make users aware of the benefits of a healthy lifestyle. It provides recommended dietary plans and recipe examples from the Chinese Resident Dietary Guidelines and lists specific steps for healthy eating behaviours. The interface takes into account personal factors such as age, gender, and socioeconomic status, as well as cultural and environmental factors that may affect health-related behaviours and provide solutions to help users at high risk of a stroke overcome barriers to a healthy lifestyle. These include how to develop a healthy eating plan and how to choose healthier foods. Additionally, the app may include other features such as recipe and nutrition value sharing.

The interface about 'exercise' provides suitable exercise plans in line with the guidelines of 'eating and exercise combined for a healthy weight' mentioned in the Chinese Resident Dietary Guidelines. This lists specific steps for healthy exercise behaviours and provides solutions to help users overcome barriers to adopting them.

The last tab of 'identification' is about how to quickly recognise stroke symptoms.

Phase 3 study results

Description of study participants. The study was conducted from December 2022 to February 2023, involving a total of 23 participants who completed the SUS. There were no dropouts among the participants during the study period. The demographic characteristics of the participants are presented in Table 4.

In this study, all 23 participants completed the quantitative evaluation. Table 5 refers to the detailed results. The mean SUS score of 23 users was 81.5 (SD 7.49), with a

Table 4. Demographic information of individuals (n = 23).

Characteristics	n	%
Age range (years), n (%)		
45–50	4	17.4
51–55	9	39.1
56–59	10	43.5
Gender, n (%)		
Males	11	47.8
Females	12	52.2
Work, n (%)		
Full-time work	12	52.2
Part-time work	6	26.1
Retired	5	21.7
Education, n (%)		
Junior high school and below	4	17.4
High school	7	30.4
Junior college or college	8	34.8
Bachelor's degree and above	4	17.4
Marital status, n (%)		
Single	4	17.4
Married/Cohabiting	19	82.6
Residence, n (%)		
Rural area	6	26.1
Urban area	17	73.9
Modifiable risk factors, n (%)[a]		
1	6	26.1
2	12	52.2
≥3	5	21.7

[a]The modifiable risk factors of stroke mainly include (hypertension, diabetes, cardiovascular disease, dyslipidaemia, atrial fibrillation, being overweight or obese (BMI ≥ 25), physically inactive (less than 150 min of moderate-intensity activity per week, or equivalent), smoking, and/or consuming excess alcohol).

minimum score of 72.5 and a maximum score of 95, indicating the good usability of the app used in this study. All participants in the survey indicated that they would like to use this system frequently and discovered that this system's many features were effectively integrated. 95.7% of respondents said they felt very confident utilising the system and that it was convenient to use (Table 5).

Positive and negative feedback in the semi-structured interviews revealed qualitative results. Table 6 displays the demographic attributes of the participants involved in the qualitative interviews. Table 7 lists core themes and relative summary statements derived from the qualitative analysis of participants' interviews.

Discussion

This study aimed to develop and evaluate the usability of a mobile app aimed at providing culturally adapted stroke prevention education to middle-aged adults in mainland China. This research findings indicate that the educational content, sourced from authoritative materials such as the 'Chinese Guidelines for the Prevention and Treatment of

Stroke' and the 'Chinese Resident Dietary Guidelines' was well received by participants. Utilising the WeChat platform as a dissemination mechanism proved effective, with participants expressing satisfaction with the content, interface, and functionality of the app. The reasonable classification system of the app makes the information more organised, improving the efficiency of browsing and searching for information, resulting in positive feedback from users with valuable experiences. These findings suggest that the developed mobile app demonstrates good usability, aligning with the primary objective of assessing its effectiveness in delivering stroke prevention education.

We designed the Stroke-Preventive Diet and Lifestyle Educational Programme which is based on the WeChat ecosystem. Undoubtedly, the successful development and utilisation of mobile apps represent crucial steps in augmenting stroke prevention efforts among middle-aged adults in mainland China. Currently, WeChat has a very high usage rate in China.[42,43] In recent years, there have been some studies on the use of WeChat for mobile education interventions.[44–46] While the mobile age has brought an abundance of information, there remains a lack of reliable

Table 5. The result of the SUS (n = 23).

NO.	SUS questions	Strong disagree	Disagree	No opinion	Agree	Strongly agree	Score mean (SD)
1	I think that I would like to use this system frequently.				16(69.6))	7(30.4)	3.30 (0.470)
2	I found the system unnecessarily complex.	7(30.4)	14(60.9)	2(8.7)			3.22 (0.600)
3	I thought the system was easy to use.			1(4.3)	15(65.2)	7(30.4)	3.26 (0.541)
4	I think that I would need the support of a technical person to be able to use this system.	5(21.7)	17(73.9)	1(4.3)			3.17 (0.491)
5	I found the various functions in this system were well integrated.				18(78.3)	5(21.7)	3.22 (0.422)
6	I thought there was too much inconsistency in this system.	6(26.1)	17(73.9)				3.26 (0.449)
7	I would imagine that most people would learn to use this system very quickly.			1(4.3)	13(56.5)	9(39.1)	3.35 (0.573)
8	I found the system very cumbersome to use.	11(47.8)	10(43.5)	2(8.7)			3.39 (0.656)
9	I felt very confident using the system.			1(4.3)	17(73.9)	5(21.7)	3.17 (0.491)
10	I needed to learn a lot of things before I could get going with this system.	8(34.8)	13(56.5)	2(8.7)			3.26 (0.619)
	The mean SUS Scoring (summation of item scores).						81.5(7.49)

SUS: System Usability Scale.

Table 6. Demographic information involved in the qualitative interviews (n = 15).

No.	Gender	Age	Education level	Residence	Marital status
1	Female	55	Junior college or college	Urban area	Single
2	Male	50	Junior college or college	Urban area	Married
3	Female	48	Junior college or college	Urban area	Single
4	Female	59	Junior high school	Urban area	Married
5	Female	57	Junior high school	Urban area	Married
6	Male	57	High school	Rural area	Married
7	Male	59	Junior college or college	Rural area	Married
8	Male	45	Bachelor's degree	Urban area	Married
9	Male	48	Junior college or college	Rural area	Married
10	Male	58	Junior college or college	Rural area	Married
11	Female	53	Junior college or college	Urban area	Married
12	Female	59	High school	Urban area	Married
13	Male	58	High school	Urban area	Married
14	Male	53	Junior college or college	Urban area	Married
15	Female	50	Junior college or college	Urban area	Married

and targeted channels for learning through smartphones. A dedicated platform is required to facilitate effective learning for everyone. Participants in this study said that such a learning app made sense to them, not only to raise health awareness but also to guide them on how to eat and exercise better as preventive measures. The opening of such a channel through WeChat has been widely accepted, significantly enhancing the accessibility of learning for users.

Through the provision of culturally adapted educational content and harnessing widely utilised digital platforms such as WeChat, the app holds promise in reaching a larger audience and fostering behavioural changes targeted at mitigating the risk of stroke. The advantage of the Official Account is that it is updated in real time and can receive the most cutting-edge knowledge in real time in WeChat.[47] The functions and services of the WeChat Official Account are becoming more and more sophisticated and powerful. By offering more features and services within WeChat Mini Programs, users can become more dependent on the Official Account and Mini Program, increasing user engagement. Through the 2-week test conducted in this study, it was discovered that while Official Accounts possess powerful functions and can achieve full

user push, which is convenient for information dissemination and publicity purposes, they may not meet the demands of complex interaction scenarios and are susceptible to being overshadowed by other subscription accounts. In other intervention studies based on WeChat Official Accounts, the sample size tested is often a large,[48] and the intervention time is relatively long because it takes time to achieve an effect in terms of information dissemination and promotion. Therefore, if we want to maximise the effectiveness of WeChat Official Accounts in the short term, maybe we need to leverage WeChat's communication features, such as WeChat Groups to help achieve this goal.[49]

Furthermore, our research findings are consistent with existing literature on stroke management and risk factor control. Many studies[50,51] emphasise the importance of education and awareness in stroke prevention, highlighting the role of lifestyle changes in reducing the risk of stroke. Kalkonde Y et al.[52] demonstrated the feasibility and acceptability of a mHealth intervention for stroke prevention, offering hope for improving lifestyle and medication compliance. In Sweden, a digitally augmented intervention called 'Make My Day' has been developed within primary healthcare settings to support healthy behaviours

Table 7. List of core themes and relative summary statements derived from the qualitative analysis of participants' interviews (n = 15).

Themes groups	Themes	Summary statements
Positive feedback	Comprehensive	*Overall, the impression is that the content is very comprehensive, written in an easy-to-understand ... (User 5)*
	Relevant	*After reading this, you'll have a better understanding of what to keep in mind... (User 1)*
	Prevention-oriented	*Just like middle-aged and elderly people nowadays, it's time to pay attention to prevention... (User 12)*
	Easy to operate	*Users can easily open the sections they're interested in and access the content they want, making it very convenient. (User 11)*
	Real-time update	*Once you follow the Official Account, it will continuously deliver real-time updates to your subscription feed... (User 2)*
	Seamless integration	*The combination of the two is quite effective and mutually beneficial. In the Mini Program, the content is more comprehensive... (User 7)*
Negative feedback	Emphasis on recipes and local seasonal vegetables	*I feel that I want to learn about some local vegetables commonly available. I believe it's better to eat seasonal produce. (User 10)*
	Focus on individual needs	*I hope there can be more targeted content, for example, if I have blood lipid issues, I will search for information related to blood lipids. (User 14)*
	Healthy interaction through WeChat Groups	*Sometimes, the daily posts on the Official Account can get easily overshadowed by messages from other subscription feeds...（User 6)*
	Reduction of texts	*I prefer content with videos, as it's easier on the eyes. If you are young, reading text might be fine, but as you age, watching videos is more convenient. (User 4)*
Recommendations for improvement	Regular reminders	*Some participants mentioned that when reopening the programme, they were unsure where to find the Official Account. It was difficult to locate it again.*
	Simplification	*The content should be easy to understand and avoid excessive use of medical jargon.*
	Communication	*Engage in effective communication with technical personnel to address and resolve the issue.*

and habits in everyday life for individuals at risk of stroke. To explore experiences with this new intervention, a qualitative study[53] indicated that mHealth apps can support the incorporation of health-promoting behaviours and routines as part of lifestyle-based stroke prevention. However, increased personalisation and tailoring were found to be crucial for user satisfaction. By demonstrating the feasibility and acceptability of delivering stroke prevention education through a mobile app, this study contributes to the literature in this field, further complementing the role of nurse-led interventions. During the usability testing, the participants demonstrated high levels of cooperation and

persisted in using the app until completion without any instances of dropouts. In this study, the quantitative questionnaire analysis results indicated that participants generally acknowledged the good usability of and their satisfaction with the mobile app. The results of the qualitative part are from users who see it as a tool for promoting and enhancing their lifestyles. The findings demonstrate a positive reception towards the mobile app and a willingness to recommend it to others.

In terms of generalizability, although this study primarily focuses on middle-aged adults in mainland China, the foundational principles of mobile app development and

usability can be extrapolated to diverse populations and settings. WeChat has garnered a substantial user base, with the platform being utilised by many individuals aged 16 to 64, constituting roughly 78 percent of this demographic.[54] Additionally, in the United States alone, there are approximately 1.5 million users of this social media network, with about a quarter of individuals aged 18 to 24 actively engaging with the platform. Users typically spend an average of 82 min daily on WeChat, solidifying its position as a formidable competitor among major social media platforms such as Facebook and Instagram. By harnessing digital platforms and culturally sensitive educational content, our research highlights the potential of mobile technology in driving behavioural changes and mitigating the global burden of stroke. Further investigation is warranted to evaluate the app's long-term impact on stroke incidence and outcomes across diverse populations.

Areas for improvement

One limitation of our study design is that calculating completion time was ineffective in evaluating the user's usage pattern as we were unable to accurately measure the time for each task transition. Additionally, since the WeChat Mini Program developed in this study is based on the personal version rather than the enterprise version, we were unable to collect relatively complete data through the background for the 2-week usage. However, qualitative interviews are a further complement to usability testing, delving into users' real feelings and experiences during the usage process and comprehensively evaluating all aspects of the app. The subsequent qualitative interviews provided some in-depth insights, which to some extent enriched our results. Finally, effectively carrying out dietary education and disease prevention requires a significant knowledge reserve for the daily maintenance of the educational programme. Team collaboration is essential for regularly updating and improving the content, ultimately leading to a more expert approach to primary stroke prevention.

Conclusions

This study demonstrated that the educational-based mobile programme offers an intuitive platform that is sufficient for a wide range of people who are at risk of stroke to use. The preferences of participants for mobile apps are also revealed by the study's findings, which can guide future investigations and development initiatives. Once we have further refined the project, we can conduct intervention experiments to validate its positive impact on individuals at risk of stroke and to verify its feasibility.

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