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Developing an Application for Nursing Practice with Hypertension

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Abstract

To address the growing concern of hypertension in Thailand, we developed a mobile health application designed to assist patients in monitoring their blood pressure, adopting healthier behaviors, and improving self-care practices, following recommendations by the World Health Organization (WHO) to reduce modifiable risk factors. This study aims to develop and evaluate a prototype application which integrates data on blood pressure-lowering activities such as exercise routines, dietary changes, and medication adherence, with the effectiveness presented through calculated effect sizes. The application features an assessment form with multiple-choice questions to evaluate users' lifestyle habits, enabling the personalization of recommended activities based on individual needs. Guided by the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), the prototype development involved systematic reviews and meta-analyses of nursing practices in Thailand. A quantitative online survey with four hundred and fifty-six hypertensive participants was conducted; 56.14% were male, and the majority were aged between 30 and 60 years old. Participants were selected based on specific inclusion and exclusion criteria. Satisfaction with the application was measured on a 5-point scale, with an average score of 4.45, indicating high satisfaction. Positive feedback suggests that while the prototype shows promise, further development and evaluation

are needed to assess its effectiveness in reducing blood pressure and promoting healthy behaviors among hypertensive patients.

Keywords: Hypertension, Mobile applications, Nursing practice

What was Known

- Hypertension or high blood pressure is the abnormal condition of blood pressure which could indicate with two numbers for measurement; namely Systolic blood pressure and Diastolic blood pressure.
- Hypertensive patients refer to patients who have been diagnosed with high blood pressure and have blood pressure more than 120/80 mmHg as classified by Thai Hypertension Society's classification of blood pressure level[1].

What's New and Next

- A prototyping application for hypertensive patients in Thailand was developed, offering personalized recommendations based on lifestyle assessments.
- Further evaluation and development are needed to assess the application's effectiveness in reducing blood pressure and promoting healthier behaviors.

Introduction

Hypertension is a serious medical condition that increases the risk of damage to vital organs, including the heart, brain, and kidneys. Persistent high blood pressure, when associated with hypertension, significantly contributes to the development of cardiovascular diseases and other health complications. Most people with hypertension do not notice signs or symptoms until detected by the blood pressure test or getting the severe health event, which can sometimes be fatal[2, 3]. In Thailand, the prevalence of hypertension among individuals aged 15 and above has reached 25.4%[4]. As of 2019, the reported mortality rate from hypertension in Thailand was 14.21 per 100,000 people. Additionally, the number of individuals diagnosed with hypertension was notably high, totaling 1,566,052 cases, which resulted in a morbidity rate of 2,388.83 per 100,000 people[5]. This indicates a concerning prevalence of hypertension. Hypertension stands as the primary risk factor for stroke both from cerebral infarction and intracerebral hemorrhage[6]. Moreover, hypertension is significantly associated with an increased risk of stroke, myocardial infarction and cardiovascular death[7].

There are two (2) categories for the risk factors of hypertension: modifiable and non-modifiable. Modifiable risk factors include unhealthy diets, a body mass index (BMI) above 25.0[8], tobacco and alcohol consumption, and physical inactivity. Non-modifiable risk factors include a family history of hypertension, age over 65 years and co-existing diseases. The best way to prevent and treat hypertension is by reducing modifiable risk factors, as recommended by the WHO[9]. According to Hanucharurnkul and Panpukdee (1991), "the key to successfully controlling blood pressure within the target range lies primarily with the patient's own efforts" (as cited in Tanamai et al.[10]). Similarly, making appropriate lifestyle modifications is a key factor contributing to successfully controlling blood pressure. In Thailand, there are many studies about the practice of nursing care on hypertensive patients which were focusing on reducing modifiable risk. These studies emphasized information sharing, activity interventions, behavior modification, and self-care in hypertension patients. Therefore, promoting healthy behaviors among individuals is essential in reducing various risk factors.

Monitoring blood pressure daily at home is essential for noticing changes and determining appropriate treatments by keeping a consistent record of readings. According to the American Heart Association (AHA), a single blood pressure measurement acts like a snapshot, capturing the value only at that moment. However, regular recording provides a 'time-lapse' view of blood pressure, enabling physicians to make more informed decisions about treatment[11]. It is recommended to measure blood pressure at home twice a day—once in the morning and once in the evening—taking two readings each time with a one-minute interval between them to improve accuracy[12]. With the current innovation in mobile technology, it is widely used to create self-care instruments for chronic patients, including hypertension[13]. Providing hypertensive patients with a tool to record blood pressure values, compile them into a time-lapse view, provide information and guidance, enhances their quality of life.

In this study, researchers aim to explore existing research on nursing practices for hypertensive patients, utilize this knowledge to develop and evaluate a prototype mobile health application guided by the ADDIE model[14]. The ADDIE framework encompasses five stages:, Design, Development, Implementation, and Evaluation[15]. This model is widely applied in healthcare, with numerous studies demonstrating its effectiveness in enhancing nursing knowledge and supporting patient self-care[16, 20] (Figure 1).

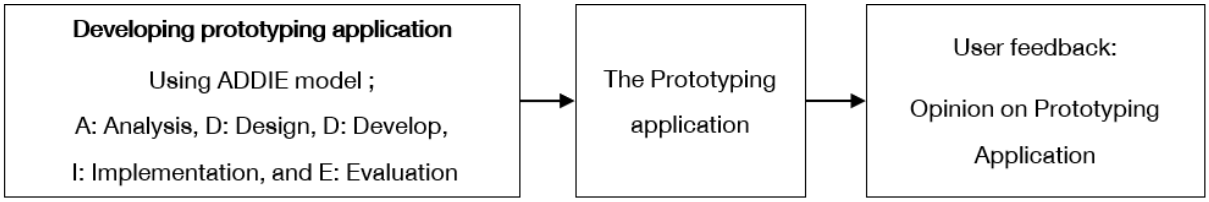

Figure 1 Flowchart throughout the study

Materials and Methods

1. Population and sample

Population was patients with high blood pressure with the sample group was the number of patients with high blood pressure in Thailand. The sample size was calculated using the Krejcie and Morgan formula[21] based on the latest data reported by the Bureau of Non-Communicable Diseases. In 2019, the number of individuals with high blood pressure in Thailand was 1,566,052 cases[5]. With an acceptable margin of error (e^2) 5% and a confidence level ($1-\alpha$) of 95. The proportion of the trait of interest in the population (p) was set at 0.5. The calculated sample size was 385 participants. To account for potential dropout, we increased the sample size by 5%, resulting in a final sample size of 405 participants.

2. Inclusion and exclusion criteria

Inclusion criteria: 1) Patients must have high blood pressure; 2) Patients must be able to read and write; 3) Patients must have access to a device with social media capabilities.

Exclusion criteria: Participants who choose to withdraw from the study or decline participation.

3. Instruments

This research consisted of two instruments: 1) a prototype application of nursing practice for hypertensive patients, and 2) an opinion survey questionnaire. The details were as follows:

3.1 A prototype application of nursing practice for hypertensive patients

The prototype application was developed by the researchers through a review of the literature and application of findings from systematic reviews and meta-analyses (PROSPERO: CRD42024498375). The ADDIE model was used as the framework for developing the application, with the following steps:

(1) Process Analysis: The literature was reviewed, focusing on systematic reviews and meta-analyses of nursing practice for hypertensive patients in Thailand published between

January 1, 2010, and December 31, 2022. Five key activities were identified: 1) knowledge sharing activities, 2) stress management activities, 3) physical activities, 4) dietary activities, and 5) Other activities.

(2) Design Process: Information from the systematic reviews and meta-analyses was used to design the workflow of the application prototype. The workflow included a language selection page (Thai or English), followed by a login page offering three options: login with an existing account, sign up for a new account, or use the application without an account (Figure 2). Users could then navigate to the homepage, which featured seven modules: blood pressure checking, an assessment form for blood pressure-lowering activities, a blood pressure summary dashboard, informational resources, a list of activities to lower blood pressure, a search function, and an AI chatbot. The homepage also provided access to the result page, log page, and settings page (Figures 3-4).

(3) Development Process: The design process involved transferring the workflows to a design page using the Figma program. Icons were sourced from http://www.flaticon.com and properly attributed. Infographics from the Bureau of Non-Communicable Diseases, Thailand,[22] on the information page to help users easily understand the content and created the prototyping application using the Figma program according to the workflows by arranging the pages. This included selecting the background color of the prototype, working on each part of the page, and connecting each page.

(4) Implementation Process: The researchers tested the application for functionality and seamless page transitions. The application was then reviewed by an advisor.

(5) Evaluation Process: A Google Form was created, featuring a video introduction, animated images in .gif format, and an opinion survey questionnaire. The form was published online for the target group to evaluate the prototype.

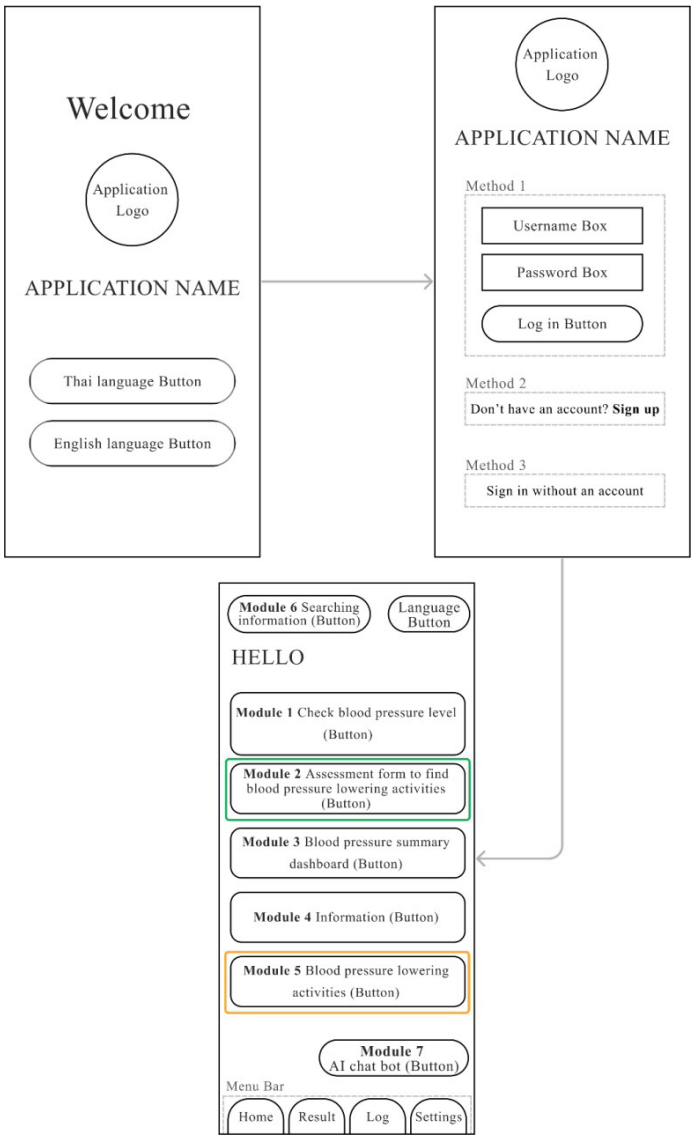

Figure 2 The workflow overview of the prototyping application

Figure 2 illustrates the highlights of two special module's workflow (green line and yellow line), based on a review of literature from systematic reviews and meta-analyses of nursing practice for hypertensive patients in Thailand, published from January 1, 2010, to December 31, 2022.

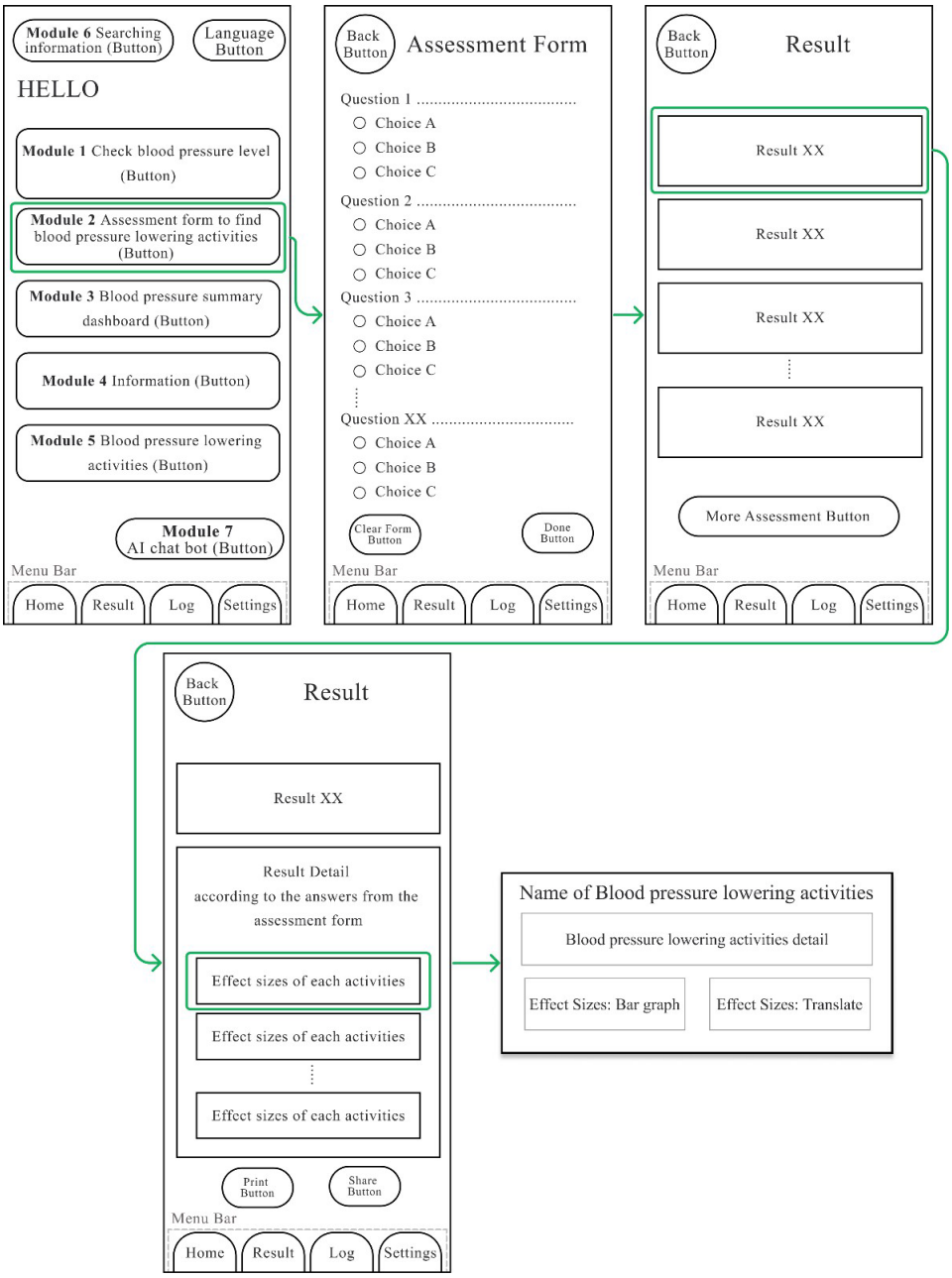

Figure 3 The workflow overview of the prototyping application on Green line

Figure 3 illustrates the highlights of the "Assessment Form" module's workflow. This module featured multiple-choice questions designed to evaluate users' lifestyle habits. Based on the responses, it personalized recommended activities tailored to individual needs. The results were displayed on the results page, where each activity was detailed in effect sizes format, which allowed users to assess the impact of each recommendation.

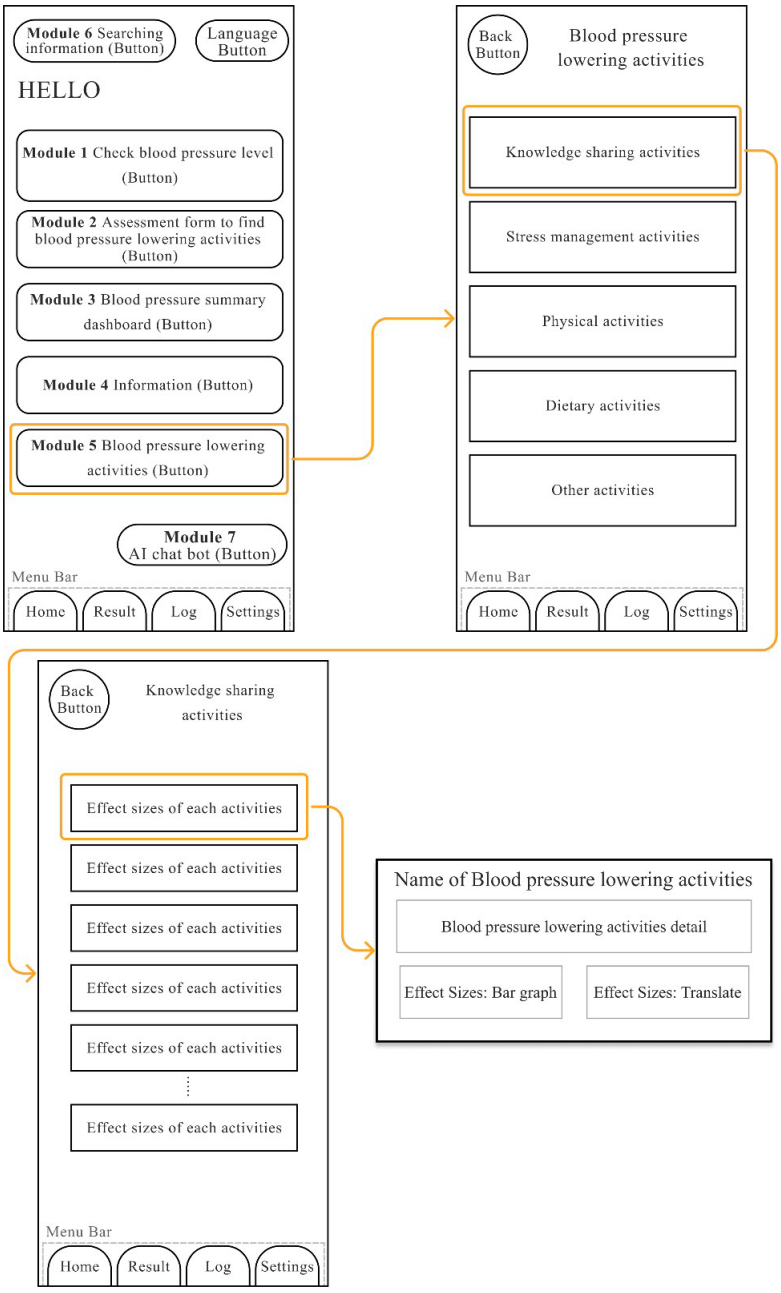

Figure 4 The workflow overview of the prototyping application on Yellow line

Figure 4 illustrates the highlights of the "Blood Pressure Lowering Activities" module's workflow. We categorized nursing practices for hypertensive patients into five activities: 1) knowledge-sharing activities; 2) stress management activities; 3) physical activities; 4) dietary activities; and 5) other activities, all accessible on the homepage. Each activity includes various interventions, with the effect sizes of each intervention displayed.

3.2 An opinion survey questionnaire

The researcher developed the opinion survey questionnaire by reviewing the literature and adapting the Thai Mobile Health Apps Rating Scale by Hongsanun and Insuk (2019)[23]. This scale served as a standard tool for assessing the quality of mobile health apps and has demonstrated good validity, an acceptable level of internal consistency, and an excellent level of reliability. The opinion survey questionnaire was consisted of 13 items divided into 3 parts;

Part 1: General Information (4 items): Gender, age, and whether the participant has high blood pressure

Part 2: Opinion on Using the Application (8 items): 1) The prototyping application is designed to be easy to use and not complicated, 2) The prototyping application uses language that is easy to understand, 3) There is a beautiful, interesting format for presenting information, 4) The menu layout and icons are in appropriate positions and can be seen clearly, 5) The font size used is clear, 6) The prototyping application has sufficient functionality to meet your health needs, 7) Overall, you can understand this prototyping application, and 8) If this prototyping application is developed into an app that can actually be used, are you interested in using this app.

Part 3: Suggestions for improvement: Participants could provide additional feedback on improving the prototype application.

The scoring criteria were based on a 5-level rating scale. The scoring criteria were based on a 5-level rating scale. The scale was defined as follows: 1 represented "Disagree," indicating the lowest score or negative feedback; 2 signified "Somewhat Disagree," suggesting a below-average score; 3 denoted "Neutral," reflecting an acceptable score; 4 corresponded to "Somewhat Agree," indicating a high score; and 5 stood for "Agree," representing the highest score or positive feedback.

Validity and Reliability of Instruments: The opinion survey questionnaire was evaluated by three experts in computer technology, resulting in an Index of Item Objective Congruence (IOC) of 0.86[24] and a Cronbach's alpha of 0.9[25].

4. Data Collection

The data collection was consisted of three (3) process, as follows;

(1) Publishing the Prototyping Application and Opinion Survey Questionnaire: After obtaining approval from the Ethics Committee, the Human Research Ethics Committee of the Faculty of Public Health from Mahidol University, the prototyping application and the opinion

survey questionnaire were released online in Google Forms format. This phase lasted for two months, from-December 2023 to January 2024. The Google Forms were consisted of four parts as follows: Part 1 Provided information on the Personal Data Protection Policy, the Participant Information Sheet, and the Informed Consent Form to ensure ethical compliance and participant understanding. Part 2 introduced the prototyping application through an image gallery featuring a video introduction and animated .gif images illustrating various application components such as the language page, menu bar, homepage, result page, log page, and settings page. Part 3 contained the opinion survey questionnaire for participant feedback, while Part 4 expressed gratitude to participants for their involvement in the study.

(2) Rechecking the Opinion Survey Questionnaire Results: Upon receipt of the completed opinion survey each questionnaire was reviewed to ensure that all fields were filled out completely.

(3) Analyzing the Opinion Survey Questionnaire Results: The collected data were analyzed to summarize the effectiveness of the prototyping application.

5. Human Subjects protection

This research was approved by the Human Research Ethics Committee of the Faculty of Public Health, Mahidol University, under license COA No. 127/2023. Data collection was conducted with strict adherence to protecting respondents' rights and maintaining the confidentiality of all data. Participants were patients who voluntarily chose to take part in the research and had the option to withdraw at any time without impacting their access to health services.

Results

This research results consisted of two (2) parts: 1) Creating a prototyping application for applying nursing practice to hypertensive patients and 2) Surveying opinions on the results of the prototyping application for applying nursing practice to hypertensive patients. The details are as follows:

1. Creating a prototyping application for applying nursing practice to hypertensive patients

The prototyping application was developed using the ADDIE model, which involved reviewing the literature and applying the results of systematic reviews and meta-analyses related to nursing practice for hypertensive patients. The development process was carried out using

the Figma program, a tool for designing websites and applications with interactive features. The final prototyping application was named "My Pleasure," chosen to reflect the researcher's intention to create a helpful tool for hypertensive patients. Additionally, the name serves as a homophone for "(blood) pressure." (Figures 5-11).

2. Survey opinions on the results of the prototyping application for applying nursing practice to hypertensive patients

The results of opinions on the prototyping application for applying of nursing practice to hypertensive patients, which included an introductory video and animated .gif images, was conducted via Google Forms. A total of 456 participants responded to the questionnaire. The details are as follows:

2.1 General information of Participants

From the questionnaire, the majority of respondents were male (56.14%), with all respondents having an average age of 58.36 years. (Table 1).

Table 1 General information of participants (n = 456)

General information	Frequency *n* (%)
Gender	
Male	256 (56.14)
Female	200 (43.86)
Age*	
Less than 30 years	6 (1.32)
30-60 years	250 (54.82)
61-90 years	199 (43.64)
More than 90 years	1 (0.22)
Mean ± SD, years	58.36 ± 10.10
Median (Min-Max), years	59 (19 - 92)

*Unless otherwise stated

Max: maximum; Min: minimum; SD: standard deviation

2.2 Opinion on the prototyping application

Based on the questionnaire, the overall opinion of the prototyping application received positive feedback, with a mean score of 4.45 points. The highest-rated item was “Item

8: If this prototyping application is developed into an app that can actually be used, are you interested in using this app?" which received a score of 4.57 points. This was followed by "Item 3: There is a beautiful, interesting format for presenting information" which received a score of 4.52 points, (Table 2).

Table 2 The opinion on using the prototyping application (PA)

Opinion on using the PA	Mean ± SD
1. The PA is designed to be easy to use and not complicated.	4.39 ± 0.64
2. The PA uses language that is easy to understand.	4.46 ± 0.61
3. There is a beautiful, interesting format for presenting information.	4.52 ± 0.61
4. The menu layout and icons are in appropriate positions and can be seen clearly.	4.43 ± 0.68
5. The font size used is clear.	4.37 ± 0.71
6. The PA has sufficient functionality to meet your health needs.	4.43 ± 0.65
7. Overall, you can understand this PA.	4.46 ± 0.60
8. If this PA is developed into an application that can actually be used, are you interested in using this application?	4.57 ± 0.55
Overall	4.45 ± 0.64

Table 2 presents the scoring criteria based on a 5-level rating scale, where 1 represented "Disagree," indicating the lowest score or negative feedback, and 5 represented "Agree," indicating the highest score or positive feedback. The overall trend in the scores indicated positive feedback, with Item 8 receiving the highest score. This suggested that the prototyping application could be effectively developed into a real application.
SD: standard deviation

2.3 Suggestions on the prototyping application

From the questionnaire, participants provided several suggestions. Overall, they highlighted issues where some text blended with the background color, making it unclear, and recommended increasing the font size for better readability. They also mentioned that technical terms, such as 'dashboard,' were difficult to understand. Additionally, participants suggested providing instructions on how to measure blood pressure and record data at appropriate times. Finally, they recommended adding a function to connect with or receive data from a blood pressure monitor.

Figure 5 Design Pages and Component Details of the Prototyping Application

1. Language Selection Page: Users could choose between Thai and English. After selecting a language, they were directed to the login page.

2. Login Page: Three options were available: logging in with an existing account, signing up for a new account, or accessing the application without an account. Existing users could log in directly to access the homepage. New users could sign up, complete the registration process, and then log in. Users who chose to sign in without an account could use the application temporarily on a single device, though this option did not support data syncing across devices, making account creation preferable for long-term use and tracking blood pressure records.

3. Homepage: The homepage featured seven modules: a blood pressure level checker, an assessment form to identify blood pressure-lowering activities, a blood pressure summary dashboard, informational resources, a list of blood pressure-lowering activities, a search function, and an AI chatbot.

4. Results Page: Users could view a list of assessment results and access blood pressure-lowering activities based on their responses, with options to print or share.

5. Log Page: Accessible through the "Check Blood Pressure Level" module or directly via a button on the menu bar, the log page allowed users to record blood pressure levels and view them in table, bar graph, or line graph formats.

6. Settings Page: This page comprised three modules: language settings, user account management, and additional options, including a customer satisfaction survey, information about the application, and references.

7. Menu Bar: Located on the homepage, the menu bar allowed users to navigate to the results page, log page, and settings page.

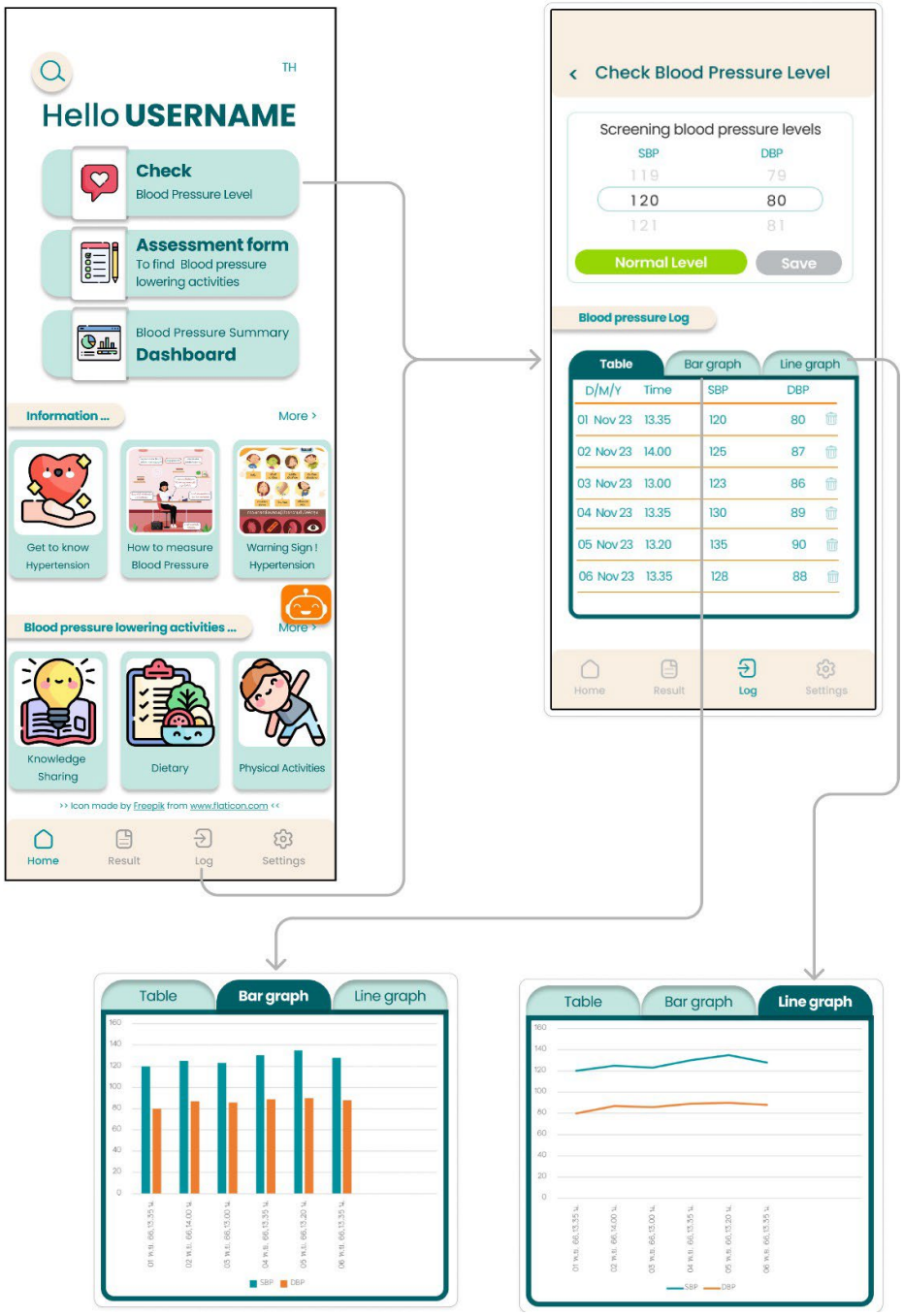

Figure 6 Design Pages of the "Check Blood Pressure Level" Module on the Homepage in the Prototyping Application

The "Check Blood Pressure Level" module, which also functioned as the log page, enabled users to record and save their blood pressure readings. The results were displayed in multiple formats, including a table, bar graph, and line graph.

Figure 7 Design Pages of the " Assessment Form" Module on the Homepage in the Prototyping Application

The "Assessment Form" module included multiple-choice questions to evaluate users' lifestyle habits. This feature enabled the personalization of recommended activities based on individual needs, detailing each activity in effect sizes format, which allowed users to see the impact of each recommendation.

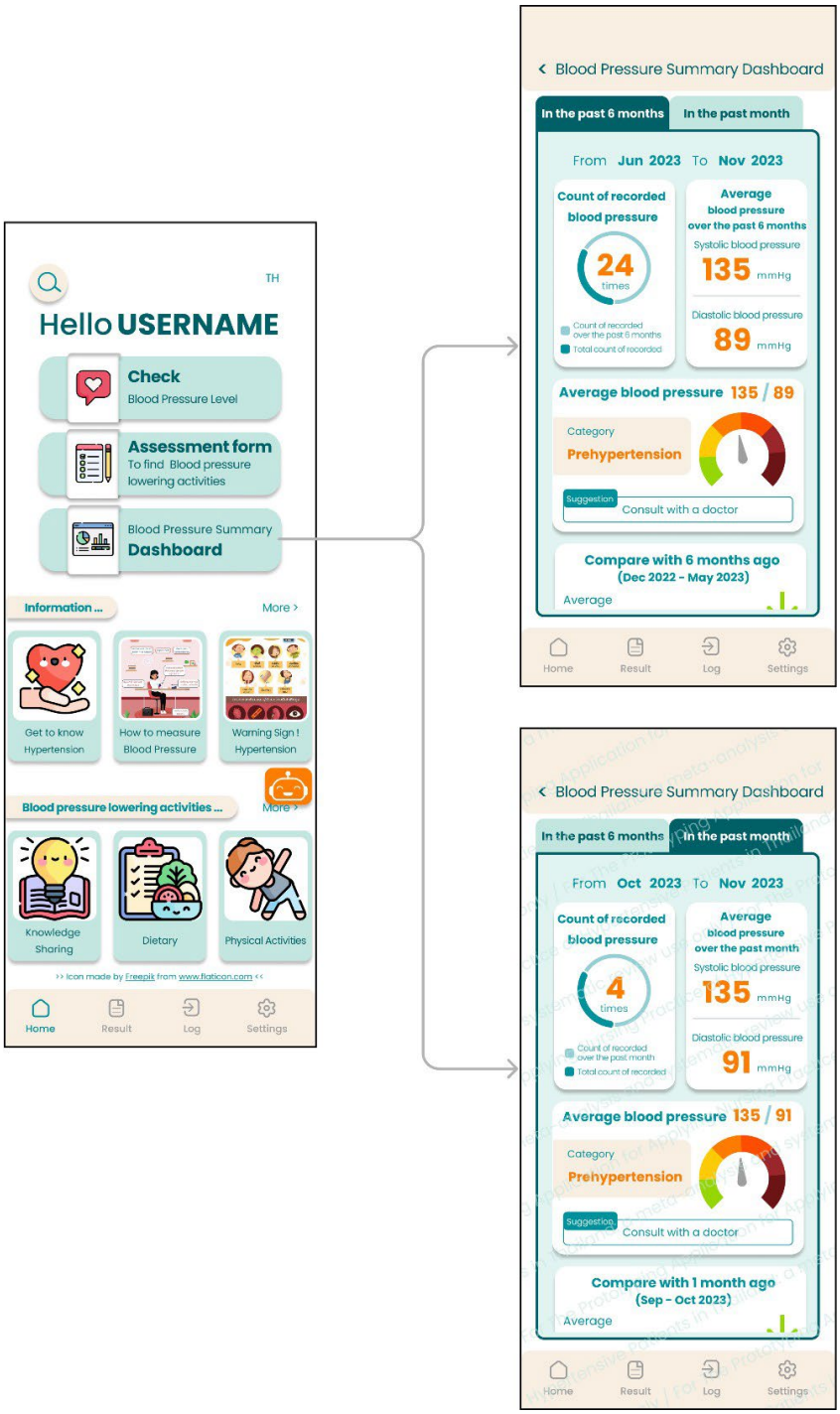

Figure 8 Design Pages of the "Blood Pressure Summary Dashboard" Module on the Homepage in the Prototyping Application

The "Blood Pressure Summary Dashboard" displayed a summary of blood pressure recordings over 6-month and 1-month periods.

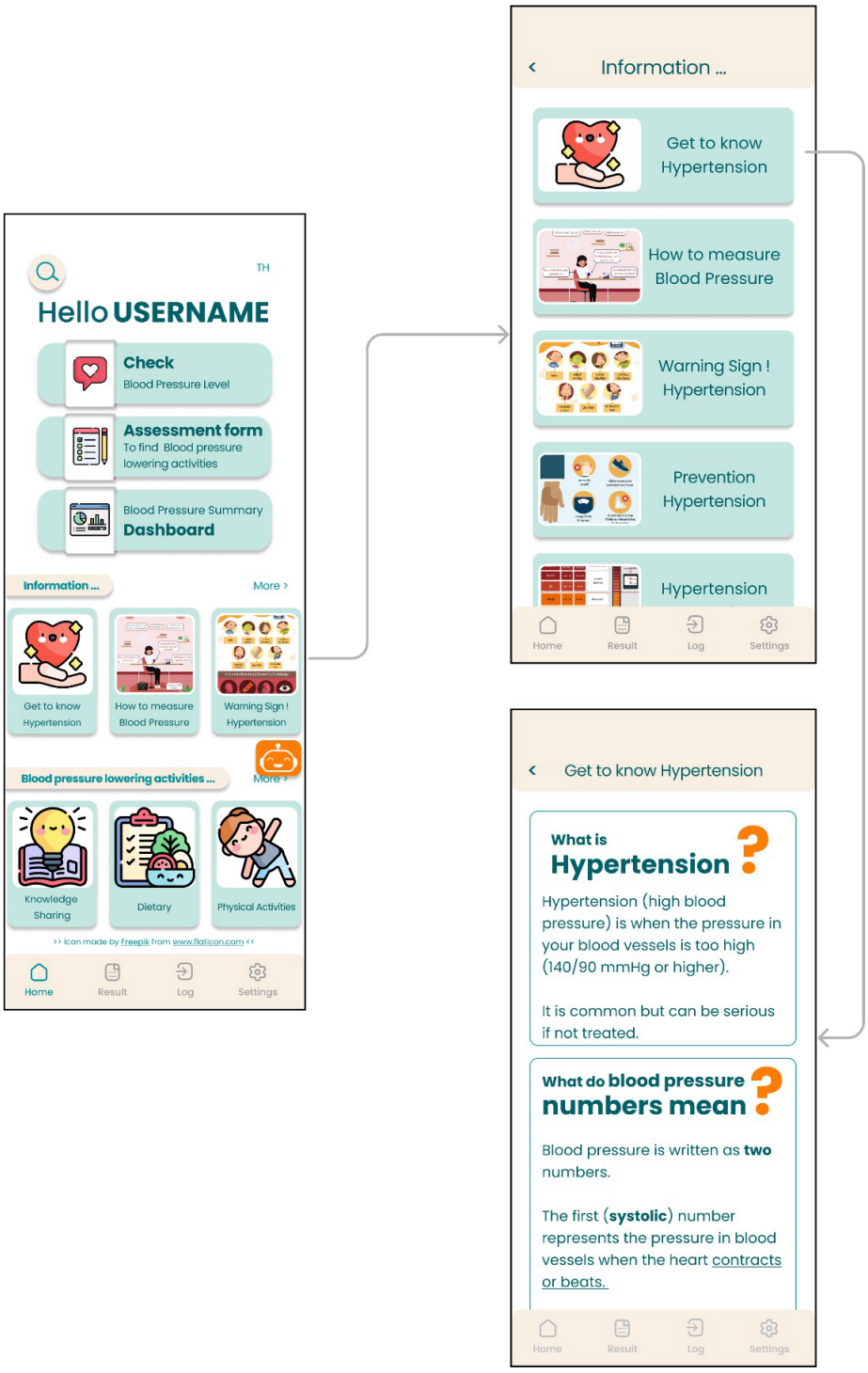

Figure 9 Design Pages of the " Information " Module on the Homepage in the Prototyping Application

The "Information" module provided various topics related to high blood pressure.

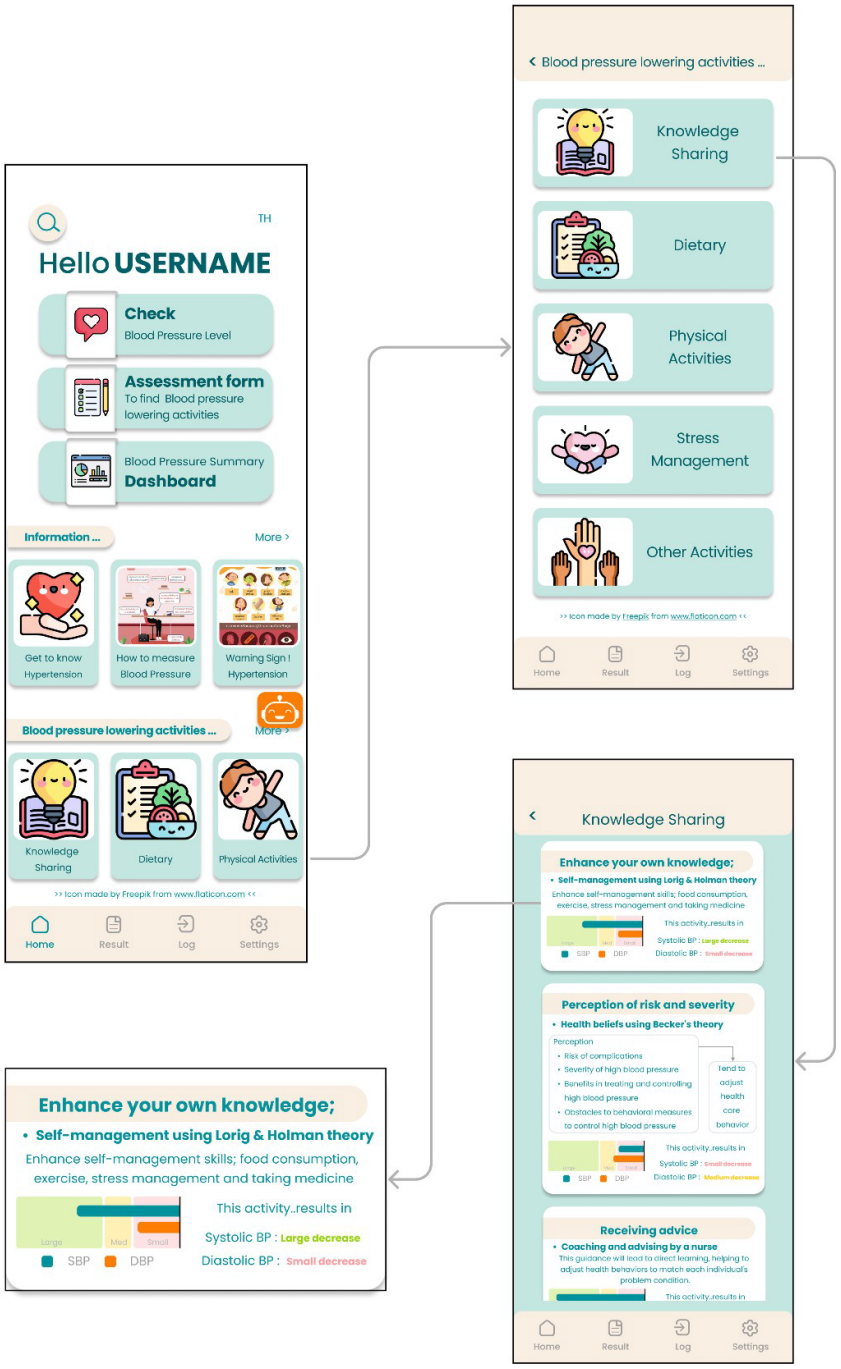

Figure 10 Design Pages of the " Blood Pressure Lowering Activities" Module on the Homepage in the Prototyping Application

The "Blood Pressure Lowering Activities" module listed recommended activities to help manage blood pressure, detailing each activity in effect sizes format. This format allowed users to see the impact of each recommendation.

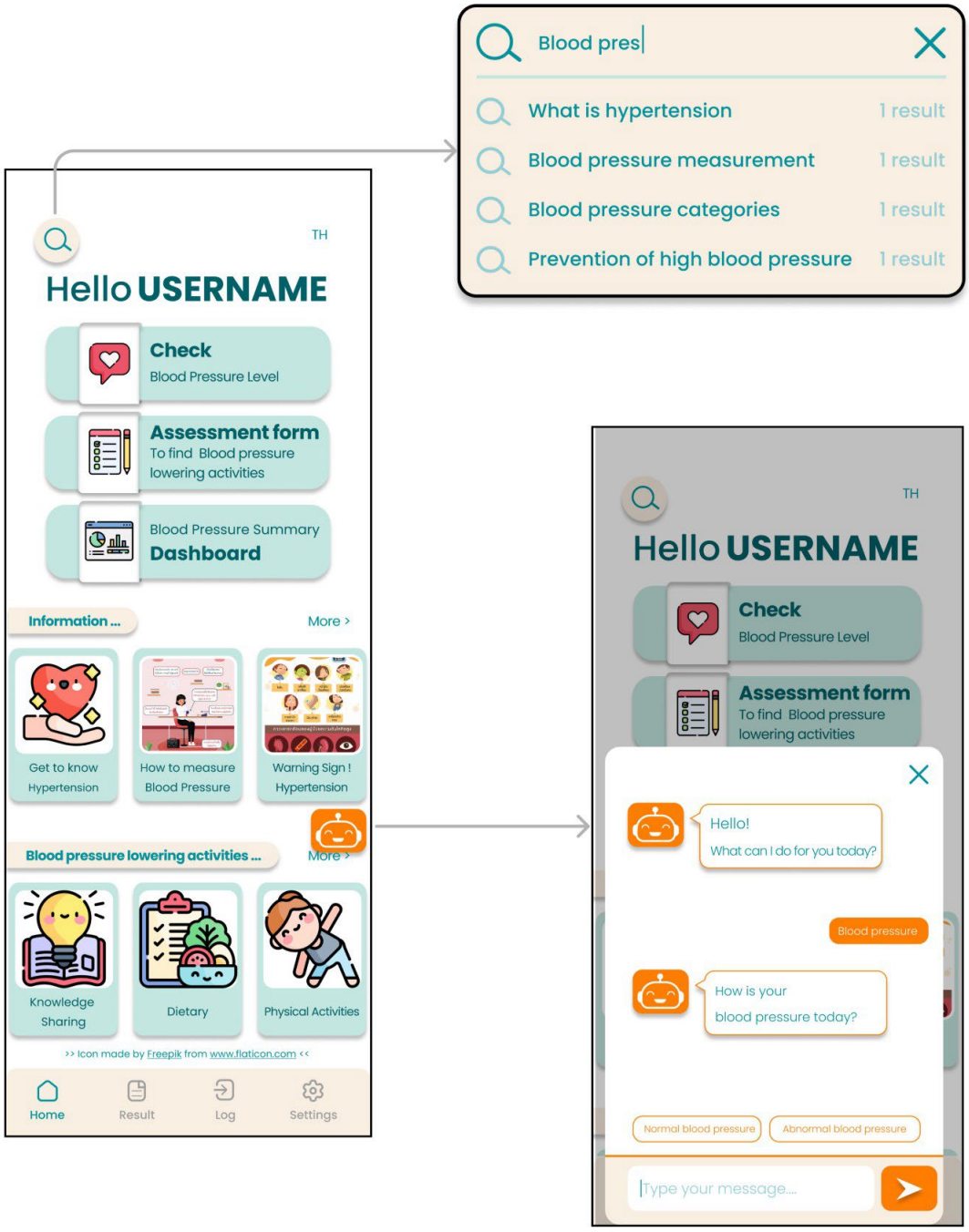

Figure 11 Design Pages of the " Searching Information" Module and the "AI Chat Bot" Module on the Homepage in the Prototyping Application

The "Searching Information" module includes a search bar for retrieving relevant information, while the "AI Chat Bot" module offers an interactive AI assistant to assist users with their inquiries.

Discussion

Through the application of the ADDIE model, a prototype for nursing practice with hypertensive patients was developed following a comprehensive literature review, systematic analysis, and meta-analysis. The ADDIE model, which involves Analysis, Design, Development, Implementation, and Evaluation, guided the development of this prototype. This methodology is commonly used in various fields, including mobile health applications, such as developing discharged instructive application of mild traumatic brain injury in low risk caregiver on mobile devices[17], mobile care app development process to manage symptoms after breast cancer surgery (step 1)[16], and development of a Mobile App for Self-Care Against COVID-19[20].

There were several limitations arose when surveying opinions on the prototyping application were collected via an online platform. Conducting online surveys for hypertensive patients, who are mostly elderly, may present challenges due to potential limitations in technological proficiency. Additionally, the increasing prevalence of cybercrimes has made individuals more cautious and aware of unfamiliar links, which may lead to distrust of our survey link. As a result, collecting opinions from the target group became more challenging.

For further study, further development and evaluation of the prototype application are needed to assess its effectiveness in reducing blood pressure and promoting healthy behaviors among hypertensive patients. It is recommended to expand the application for actual use and consider incorporating features related to other chronic diseases, such as diabetes. Addressing the technological skill levels of elderly users and providing support from family members or caregivers will be crucial for practical use.

Conclusion

This study focused on gathering findings from research on nursing practices for hypertensive patients, synthesizing knowledge from relevant studies, and using this information to develop and evaluate a prototype application based on The ADDIE model. The final prototype was well-received and met the participants' expectations.

Ethical Approval Statement

This research was approved by the Human Research Ethics Committee of the Faculty of Public Health, Mahidol University, under license COA No. 127/2023.

Author Contributions

NS designed the study and formulated the instruments with guidance from HC, PK, FP and AS. NS conducted the study under the supervision of HC, PK, FP, AS and PT. All authors read and approved the manuscript prior to submission for publication.

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Conflicts of Interest

The authors declare no conflict of interest.

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