

**โปรแกรมการจัดการความดันโลหิตสูงโดยประยุกต์ใช้เซทบอทและผลต่อความรู้ พฤติกรรมสุขภาพ
ความร่วมมือในการใช้ยาความดันโลหิต และตัวบ่งชี้ทางชีวภาพในผู้สูงอายุที่มีความดันโลหิตสูง
ที่อาศัยอยู่ในชุมชน: การพัฒนาโปรแกรม ความเป็นไปได้และผลเบื้องต้นของการใช้โปรแกรม***

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บทคัดย่อ

โรคความดันโลหิตสูงเป็นโรคไม่ติดต่อเรื้อรังที่พบได้บ่อยในผู้สูงอายุที่อาศัยอยู่ในชุมชน ที่จำเป็นต้องมีการจัดการเพื่อควบคุมความดันโลหิตอย่างต่อเนื่อง โดยพบผู้สูงอายุที่เข้ารับบริการแผนกผู้ป่วยนอก โรงพยาบาลศรีนครินทร์ มีจำนวนเพิ่มขึ้นทุกปี ซึ่งช่วงปี พ.ศ. 2566-2567 มีผู้ป่วยสูงอายุ คิดเป็นร้อยละ 38-40 ของผู้ป่วยทั้งหมด ถึงแม้ว่าผู้ป่วยกลุ่มดังกล่าว จะสามารถเข้าถึงการรักษาได้ แต่ยังคงพบความสามารถในการควบคุมความดันโลหิตยังไม่ดีพอ เนื่องจากรูปแบบการดูแลที่มีการสื่อสารทางเดียวในการให้ความรู้ การให้คำปรึกษาการติดตามผลที่ไม่ต่อเนื่อง และการมีภาระงานสูงของบุคลากรทางการแพทย์ ส่งผลให้การสนับสนุนการจัดการตนเองในระยะยาวยังมีข้อจำกัด

การวิจัยนี้มีวัตถุประสงค์เพื่อพัฒนาประเมินความเป็นไปได้และศึกษาผลเบื้องต้น ของโปรแกรมการจัดการความดันโลหิตสูงโดยใช้เซทบอท โดยเป็นการวิจัยแบบกึ่งทดลองชนิดกลุ่มเดียววัดก่อน - หลัง ในผู้สูงอายุตั้งแต่ 60 ปีขึ้นไป ที่มีความสามารถด้านการรู้คิดและทักษะดิจิทัลเพียงพอ สามารถเข้าถึงสมาร์ตโฟนและใช้ไลน์แอปพลิเคชันได้ จำนวน 15 คน ที่มารับบริการแผนกผู้ป่วยนอก โรงพยาบาลศรีนครินทร์ ซึ่งโปรแกรมใช้ระยะเวลา 12 สัปดาห์ ประกอบด้วย การให้ความรู้ การปรับเปลี่ยนพฤติกรรมสุขภาพ การติดตามต่อเนื่อง และการให้คำปรึกษาผ่านการใช้เซทบอททางไลน์แอปพลิเคชัน ซึ่งรวมถึงการกระตุ้นเตือนและการเสริมแรงเชิงบวกต่อการจัดการความดันโลหิตสูง โดยมีการเก็บข้อมูลก่อนและหลังการทดลอง 12 สัปดาห์

โปรแกรมการจัดการความดันโลหิตสูงโดยประยุกต์ใช้เซทบอทได้ พัฒนาขึ้นโดยมีความตรงเชิงเนื้อหาในระดับดีเยี่ยม (CVI = 0.98; IOC = 0.97) จากการสัมภาษณ์เชิงลึกสะท้อนว่า เซทบอทช่วยให้ผู้ใช้ตระหนักถึงปัจจัยเสี่ยงส่งเสริมการปรับพฤติกรรมสุขภาพ และใช้งานได้ง่าย อย่างไรก็ตาม ผู้ใช้บางรายเสนอให้ปรับเนื้อหาให้กระชับขึ้น ผู้เข้าร่วมทั้ง 15 ราย มีอัตราการคงอยู่ร้อยละ 100 โดยมีการโต้ตอบผ่านเซทบอทรวม 1,413 ครั้ง สามารถตอบโต้ถูกต้องโดยอัตโนมัติ คิดเป็นร้อยละ 87.26 มีฟังก์ชันที่ถูกใช้งานมากที่สุด ได้แก่ วิดีโอให้ความรู้ (ร้อยละ 40.11) คู่มืออิเล็กทรอนิกส์ (ร้อยละ 35.16) และการขอรับคำปรึกษา (ร้อยละ 13.74) ตามลำดับ

ในการศึกษาผลเบื้องต้นของการใช้โปรแกรมพบว่า ผู้เข้าร่วมมีอายุเฉลี่ย 69.07 ± 5.38 ปี มีการเปลี่ยนแปลงอย่างมีนัยสำคัญทางสถิติในด้านความรู้ (15.60 ± 1.05 เป็น 16.53 ± 1.18 ; $p = 0.004$) พฤติกรรมสุขภาพ (23.07 ± 3.86 เป็น 25.33 ± 4.09 ; $p = 0.007$) ความร่วมมือในการใช้ยา (20.70 ± 2.86 เป็น 21.61 ± 2.61 ; $p = 0.008$) และความดันโลหิตซิสโตลิก (133.67 ± 11.89 เป็น 127.07 ± 11.22 มม.ปรอท; $p = 0.014$) อย่างไรก็ตาม ตัวบ่งชี้ทางชีวภาพยังไม่ได้รับการวิเคราะห์ในระยะศึกษาความเป็นไปได้นี้ เนื่องจากข้อจำกัดด้านระยะเวลา

คำสำคัญ: การจัดการความดันโลหิตสูง เซทบอท ผู้สูงอายุที่อาศัยอยู่ในชุมชน

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A chatbot-based hypertension management program and its effects on knowledge, health behaviors, medication adherence, blood pressure, and biomarkers among community-dwelling older adults with hypertension: Program development, feasibility and preliminary effects*

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Abstract

Hypertension is a common non-communicable disease among community-dwelling older adults, requiring continuous blood pressure control. The number of older adults attending the outpatient department at Srinagarind Hospital has been increasing annually. Older patients accounted for 38-40% of all patients during 2023 and 2024. Although this group has access to treatment, their ability to control blood pressure remains suboptimal. This is due to a one-way communication model in education, counseling, discontinuous follow-up, and high nursing workload, which constrain long-term self-management support.

This study aimed to develop, evaluate the feasibility, and examine the preliminary effects of a chatbot-based hypertension management program. A quasi-experimental one-group pretest–posttest design was conducted in 15 older adults aged 60 years or older with adequate cognitive function and digital literacy skills, smartphone access, and LINE application proficiency. Participants were recruited from the outpatient department of Srinagarind Hospital. The 12-week program included health education, lifestyle modification support, continuous follow-up, and consultation through a chatbot embedded in the Line application, incorporating automated reminders and positive reinforcement for hypertension management. Data were collected at baseline and after the 12-week intervention.

The chatbot-based hypertension management program was developed with excellent content validity (CVI = 0.98; IOC = 0.97). In-depth interviews indicated that the chatbot helped users recognize personal risk factors, supported health behavior modification, and was easy to use. However, some participants suggested that the content should be more concise. All 15 participants completed the program, yielding a 100% retention rate, with a total of 1,413 interactions via the chatbot, of which 87.26% were automatically processed correctly. The most frequently used functions were educational videos (40.11%), the electronic manual (35.16%) and text-based consultation (13.74%) respectively.

In the preliminary outcome assessment, participants had a mean age of 69.07 ± 5.38 years. The statistically significant improvements were observed in knowledge (15.60 ± 1.05 to 16.53 ± 1.18 ; $p = 0.004$), health behaviors (23.07 ± 3.86 to 25.33 ± 4.09 ; $p = 0.007$), medication adherence (20.70 ± 2.86 to 21.61 ± 2.61 ; $p = 0.008$), and systolic blood pressure (133.67 ± 11.89 to 127.07 ± 11.22 mmHg; $p = 0.014$). However, biomarker outcomes were not analyzed during this feasibility phase due to time constraints.

keywords: hypertension management; chatbot; community-dwelling older adult

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Introduction

Hypertension is the most prevalent cardiovascular disorder globally and a major contributor to cardiovascular, cerebrovascular, and renal morbidity and mortality if inadequately controlled.¹⁻² Hypertension affects approximately 1.28 billion adults aged 30-79 years worldwide, with prevalence doubling between 1990 and 2019-from 331 million to 626 million women and 317 million to 652 million men-with the majority residing in low- and middle-income countries.²⁻³ Age-related physiological changes, particularly progressive arterial stiffening characterized by elastin loss and collagen accumulation, lead to higher blood pressures, placing older adults at increased risk of complications such as stroke, ischemic heart disease, and chronic kidney disease.⁴⁻⁶

In Thailand, although 13.2 million individuals have been diagnosed and treated for hypertension, more than seven million remain unaware of their condition, with awareness and treatment rates of 55% and 49%, respectively. Blood pressure control is poor at only 30%, far below the 60% target.⁷ Cardiometabolic control is also suboptimal, with limited achievement of LDL cholesterol targets, high prevalence of overweight and obesity, and notable rates of atrial fibrillation, left ventricular hypertrophy, and renal, cardiovascular, and cerebrovascular complications.⁸ Hypertension-related healthcare expenditures reach approximately 80 billion Thai baht annually, highlighting the urgent need for sustained and effective hypertension management strategies.⁷

Uncontrolled hypertension is driven by non-modifiable factors (age, genetics, sex-related hormonal changes, and family history) and modifiable factors, including physical inactivity, unhealthy diet, obesity, alcohol and tobacco use, dyslipidemia, diabetes mellitus, sleep disorders, and psychosocial stress.⁸ In older adults, functional decline and vascular stiffening further complicate management, particularly when sensory and motor impairments limit access to health information.⁹⁻¹⁰ Multicomponent interventions integrating screening, education, counseling, monitoring, and self-recording are most effective, with digital health technologies enhancing adherence and providing timely feedback, resulting in clinically meaningful reductions in blood pressure.¹¹⁻¹⁵ However, the reliance on one-way communication and fragmented follow-up in existing programs highlights the need for interactive, age-appropriate, and scalable digital strategies to support sustained hypertension management in later life.

Prior hypertension management programs for older adults reveal limitations. Many rely on one-way information delivery, limiting sustained engagement and individualized behavior change,¹¹⁻¹² while follow-up is often intermittent or confined to the study period, restricting long-term support.¹⁵ Additionally, inadequate tailoring to age-related sensory, cognitive, and functional limitations reduces participation and adherence,⁹⁻¹⁰ and timely feedback and behavioral reinforcement are frequently lacking despite their importance for sustained change.¹⁴ These gaps highlight the need for interactive, age-appropriate, and continuously accessible interventions. In this context, chatbot-based approaches offer a promising solution by enabling bidirectional communication, ongoing monitoring, and adaptive support for sustained hypertension management among community-dwelling older adults.¹¹⁻¹³

Chatbots are conversational digital tools that support hypertension management through education, monitoring, reminders, and feedback, addressing the limitations of traditional one-way and episodic interventions that hinder sustained engagement among older adults. By enabling continuous bidirectional communication, real-time monitoring, and personalized support via familiar platforms, chatbots enhance daily blood pressure control. In Thailand, this approach is highly feasible due to widespread smartphone use and the popularity of LINE among older adults, making it an optimal delivery channel.¹⁶ Multicomponent digital interventions incorporating chatbots are more effective than single-component approaches,

as they integrate education, self-monitoring, consultation, reminders, and behavioral reinforcement within a single interactive system.¹³⁻¹⁴ Although challenges such as privacy concerns and limited digital literacy remain, these can be mitigated through data protection measures and user-centered, age-appropriate design, supporting the feasibility of chatbot-based hypertension management in community settings.¹⁷⁻¹⁸

LINE is deeply embedded in the daily communication routines of older Thai adults, serving as a primary platform for family, community, and health-related interactions. This familiarity reduces cognitive load, technological anxiety, and onboarding barriers—key determinants of adherence among adults aged ≥ 60 years.¹⁶ LINE's chatbot integration further enables seamless behavioral monitoring and bidirectional nurse–patient communication without requiring navigation of unfamiliar interfaces. In contrast, stand-alone health applications often exhibit poor long-term retention due to their complex usability and limited perceived value beyond health functions.¹⁹ Leveraging a culturally normative, high-penetration platform, therefore, enhances sustained engagement and the likelihood of clinically meaningful blood pressure control.

Health behavior is a key determinant of sustainable hypertension control, as long-term blood pressure management depends on individuals' ability to maintain healthy lifestyles and adhere to treatment recommendations.²⁰ Accordingly, contemporary hypertension management emphasizes self-management approaches grounded in self-regulatory frameworks that promote continuous practice, feedback, and reinforcement. Chatbot-based interventions can operationalize behavior modification strategies derived from Kanfer's self-regulation model²¹ and the adaptive intervention framework proposed by Briesch and Chafouleas.²² Together, these frameworks conceptualize behavior change as an ongoing process of self-monitoring, goal comparison, feedback-driven adjustment, and flexible intervention tailoring, underscoring the importance of continuous monitoring, timely feedback, and responsiveness to individual needs in effective hypertension management programs¹²⁻¹⁴.

At Srinagarind Hospital, older adults constitute a large and increasing proportion of outpatient services, with patients aged ≥ 60 years accounting for 38.38%, 38.76%, 40.06%, and 40.04% of visits from 2021 to 2024, respectively. The most prevalent conditions include chronic kidney disease (CKD) 34,022 (31.99%), hypertension 27,902 (26.25%), diabetes mellitus 23,980 (22.54%), and dyslipidemia 20,409 (19.19%),²³ with CKD frequently coexisting with hypertension and metabolic comorbidities. Hypertension is further associated with complications such as dizziness and falls, particularly among adults aged 60–69 years with poor blood pressure control. High patient volumes and increasing clinical workload limit providers' capacity for continuous monitoring and individualized follow-up, highlighting a gap in long-term hypertension management that scalable chatbot-based care could address by extending interactive monitoring and behavioral support beyond the clinic setting.

Nursing care for older adults with hypertension is constrained by high patient volumes, resulting in brief clinical encounters that limit education, individualized counseling, and continuous follow-up. In high-volume outpatient settings such as Srinagarind Hospital, care remains predominantly biomedical and insufficiently aligned with the ongoing self-management needs of older adults, who often face entrenched lifestyle behaviors, functional decline, and limited social support. Although multicomponent hypertension interventions are effective, their implementation in the real world is limited by fragmented follow-up systems and workforce constraints. Chatbot-based interventions delivered via LINE offer a practical approach to extend nurse-led care beyond clinic visits through accessible, interactive communication and automated support, thereby enhancing continuity of care and reducing routine informational workload. Accordingly, this study aims to develop a chatbot and examine its feasibility, acceptability,

adherence, and preliminary clinical responsiveness to ensure implementation readiness prior to a large-scale effectiveness or randomized controlled trial.

Objective

To develop and examine the feasibility and preliminary effects of a hypertension management program applying a chatbot on knowledge, health behaviors, medication adherence, blood pressure, and biomarkers among community-dwelling older adults with hypertension.

Conceptual framework

The conceptual framework integrates self-management principles adapted from Kanfer²¹ and Briesch et al.²² with a chatbot-based delivery system to support continuous engagement. The framework employs a chatbot to facilitate hypertension self-management among older adults through structured education, monitoring, and ongoing feedback, reducing reliance on face-to-face visits. The program comprises two phases. The preparation phase focuses on establishing rapport with the chatbot, assessing baseline knowledge and behaviors, delivering structured education on hypertension, lifestyle modification, and medication adherence, and supporting goal setting and basic cardiovascular and renal risk screening. The operation phase emphasizes active self-management, in which participants monitor blood pressure, record health behaviors and medication use, and compare progress against individualized goals. Throughout this phase, the chatbot delivers reminders, feedback, and motivational messages, complemented by nurse-led reinforcement. Framework effectiveness is evaluated using multiple outcomes, including feasibility, hypertension-related knowledge, health behaviors, medication adherence, blood pressure control, and laboratory biomarkers (lipid profile, blood glucose, renal function, electrolytes, and uric acid).

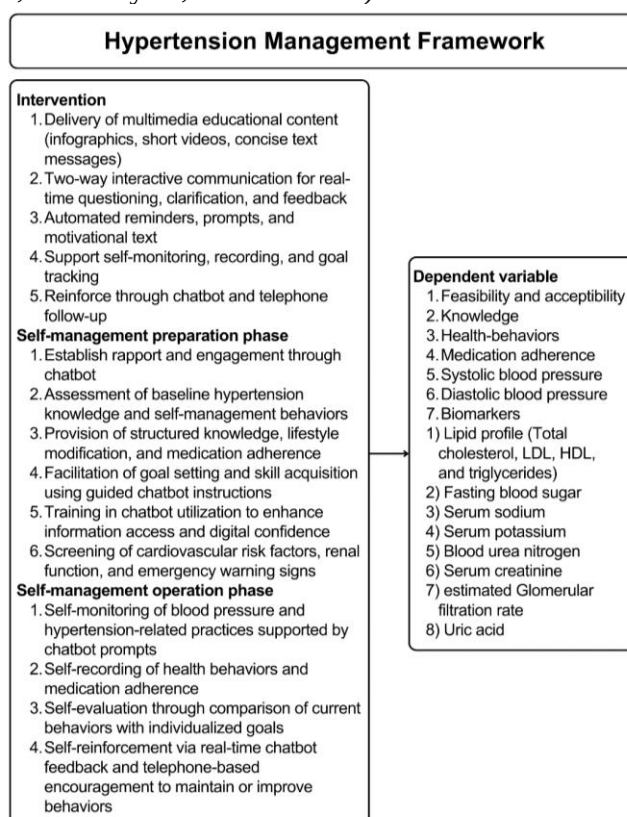


Figure 1 Hypertension management framework

Methodology

This study employed a quasi-experimental one-group pretest–posttest design to develop and evaluate the feasibility and preliminary effects of a chatbot-based intervention for a hypertension management program among community-dwelling older adults at Srinagarind Hospital. This design was selected because the primary aim was mainly to develop and assess the feasibility of outcomes, including acceptability, adherence, and the practicality of implementation, rather than to establish effectiveness. In this feasibility study, the operational workflow, participant engagement, and data completeness were evaluated, and the one-group pretest–posttest design allowed assessment of within-group changes over 12 weeks. This methodological choice serves as a pragmatic and ethically appropriate preparatory step before conducting a larger, controlled, or randomized controlled trial phase.

Research instruments

The experimental intervention, added to standard care, combined brief face-to-face education with 12 weeks of chatbot-based follow-up delivered via LINE at the outpatient clinic of Srinagarind Hospital. Led by a nurse investigator, the program included baseline education and training, daily chatbot engagement with automated support, scheduled reinforcement calls, and outcome assessment (Figure 2). The intervention demonstrated excellent content validity following expert review (CVI = 0.98; IOC = 0.97).

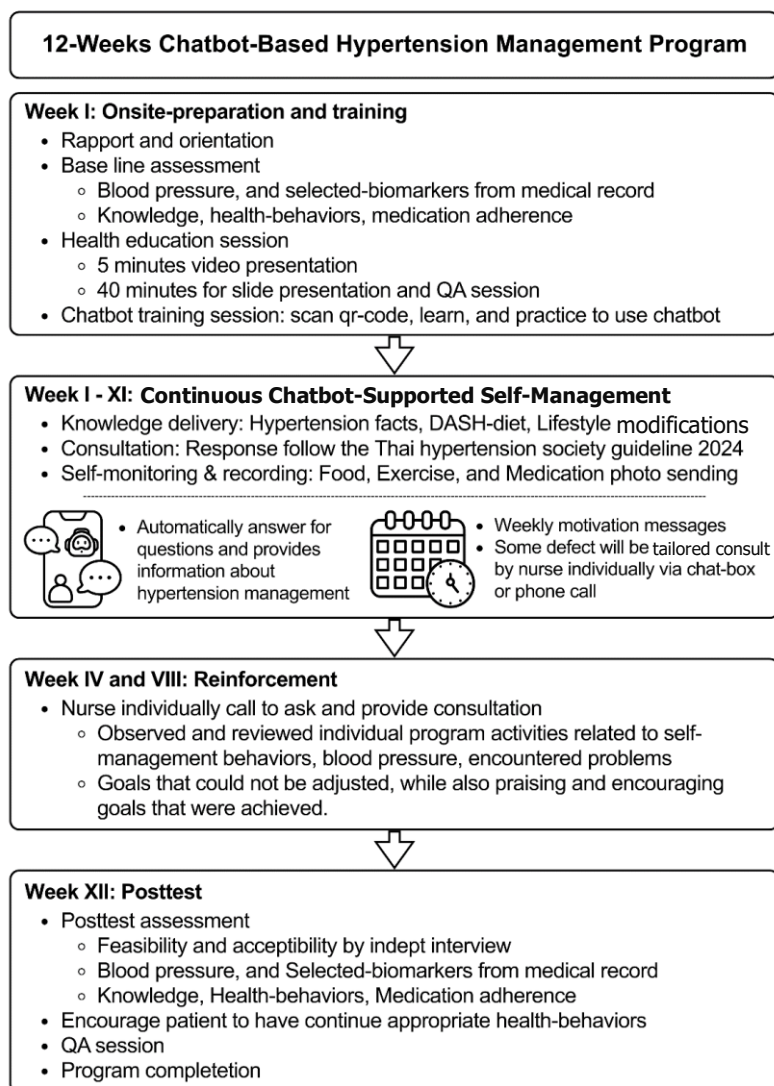


Figure 2 The 12-weeks chatbot-based hypertension management program

Population and sample

Population: The study included community-dwelling older adults aged 60 years or older, both male and female, who routinely received health services at Outpatient Department 9, Srinagarind Hospital.

Sample and group size: A total of 15 voluntary, community-dwelling older adults with hypertension were recruited via consecutive sampling for this feasibility study. The sample size was determined based on a commonly applied rule-of-thumb for pilot and feasibility studies, which recommends enrolling approximately 10-15 participants per group to assess intervention acceptability, implementation processes, and preliminary outcome trends rather than to achieve statistical power for hypothesis testing.²⁴ The eligible participants were adults aged greater than 60 years with physician-diagnosed grade 1-2 hypertension who were receiving antihypertensive treatment and attending routine outpatient care. Participants were required to have adequate functional status, cognitive ability, and digital literacy, as well as access to and ability to use a smartphone with the LINE application. Individuals with unstable or severe medical conditions, or those using other hypertension management or digital health programs, were excluded. Therefore, a total of 15 older adults participated in the study, which followed a consecutive sampling method, and these were explored as primary outcomes, including knowledge, health behaviors, medication adherence, blood pressure, and biomarkers.

Research instruments

1) Screening instruments

1.1 The Barthel-ADL index was used to assess independence in activities of daily living including bowel and bladder control, grooming, toilet use, feeding, transfer, mobility, dressing, stairs, and bathing. This instrument assesses actual performance rather than potential ability, with scores ranging from 0 to 1, 2, or 3 for each activity. Higher scores indicate greater independence, while lower scores reflect increased disability, with a maximum total score of 20 points.²⁵⁻²⁶ It is used to assess the degree of independence a patient has from any help. The content validity index (CVI) of the Barthel ADL assessment tool is 0.95.²⁷

1.2 The Thai Mental State Examination (TMSE) is a cognitive screening tool used to detect cognitive impairment and dementia in the Thai population. It is comparable to the Mini-Mental State Examination (MMSE) and uses a total score ranging from 0 to 30, with scores below 23 indicating possible cognitive impairment. Interpretation of results should consider demographic factors such as age, education, and income, as these can influence performance. The assessment includes orientation, registration, attention and calculation, recall, language, scoring, and result interpretation. The TMSE has demonstrated high content validity with a content validity index (CVI) of 0.97.²⁸

1.3 The eHealth Literacy Scale was developed to assess perceived skills in using information technology for health purposes-Thai version provided by the Department of Health. In addition, this screening instrument was used to assess electronic health literacy and to determine whether participants have a good understanding of and are comfortable with technology, as a potential confounding factor. The scale consists of eight items, each rated on a 5-point Likert scale, and demonstrates high internal consistency (coefficient alpha = 0.88).²⁹

2) Data collection instruments

Part 1: Demographic data

Demographic information was collected using a 15-item questionnaire covering gender, age, weight, height, education, marital status, occupation, duration of diagnosis and treatment, current antihypertensive medication, blood pressure level, underlying diseases, smoking and alcohol consumption, and sleep quality.

Part 2: Hypertension knowledge questionnaire

The hypertension knowledge questionnaire consists of 18 interview-based items adapted from Namrinchuenchitsai on knowledge, attitudes, and behaviors among patients with hypertension. This instrument is an 18-item true–false questionnaire, with total scores ranging from 0 to 18. Higher scores indicate greater knowledge of hypertension. The instrument demonstrated acceptable content validity, with a content validity index of 0.80 based on evaluation by three experts. Reliability testing in a sample of 30 participants yielded satisfactory internal consistency, with a Cronbach’s alpha coefficient of 0.76.³⁰

Part 3: Health-behaviors checklist

The health-behavior checklist for older adults with hypertension was adapted from Prerprao et al., each item is rated on a five-point frequency scale. Scores are summed across all items, yielding a total possible score of 40. Higher total scores indicate more frequent engagement in appropriate hypertension-related health behaviors and reflect better adherence to recommended self-management practices. This instrument included eight domains: healthy diet, DASH diet, sodium restriction, exercise, alcohol use, smoking, stress management, and regular antihypertensive medication. Content validity was reviewed by three experts, with item-objective congruence (IOC) values ranging from 0.67 to 1.00. The instrument showed excellent reliability, with inter-rater reliability of 1.00 and internal consistency (KR-20) greater than 0.80. Each item is rated on a five-level scale based on the number of days the behavior is performed per month.³¹

Part 4: Medication adherence

The Medication Adherence Measure for Oral Medicine (MAM-O), developed by Somprasong et al., was used to assess adherence to antihypertensive medication. The MAM-O comprises eight Likert-type items assessing the frequency of non-adherent medication-taking behaviors during the past month. Each item ranges from 0 to 3 (0 = never, 1 = 1-5 times per month, 2 = 6-10 times per month, 3 = more than 10 times per month), yielding a total raw score of 0-24. To maintain analytical consistency with the study’s definition of medication adherence, scores were reverse coded so that higher total scores reflect greater adherence to prescribed antihypertensive medication regimens. The content validity was evaluated by four experts, yielding a content validity index (CVI) of 0.87, and pilot testing in 15 patients demonstrated acceptable internal consistency (Cronbach’s alpha = 0.71).³²

Part 5: Blood pressure

During the intervention, participants measured their blood pressure at home or primary health center using the same validated automatic blood pressure monitors and reported the values weekly via chatbot prompts. Office blood pressure measurements, obtained using a standardized device and protocol at the health facility, were conducted at pretest and posttest for primary outcome analysis.

3) Blood pressure measurement device

Blood pressure was measured using an OMRON monitor calibrated by the medical departments of Srinagarind Hospital, yielding a test-retest reliability coefficient of 0.95. Measurements were taken on the left arm twice, with a 5-minute rest interval in a seated posture, both at pretest and posttest.

4) Biomarkers

Biomarkers included lipid profile (total cholesterol, LDL, HDL, triglycerides), fasting blood sugar, serum sodium, serum potassium, BUN, creatinine, eGFR, and uric acid. All biomarker data were extracted from participants’ medical records by trained research assistants. These biomarkers were obtained from routine laboratory tests conducted within three months as part of standard clinical care. However, this study could not achieve this outcome due to time constraints and the standard follow-up duration for these biomarkers.

Data collection

Data collection included screening, demographic information, and assessment of knowledge, health behaviors, medication adherence, blood pressure, and biomarkers. Participants then received the intervention, which included education, chatbot training, and a 12-week chatbot-supported phase with weekly engagement, self-recorded behaviors via the LINE application, automated reminders, and brief telephone reinforcement. Posttest data collection repeated the primary outcome assessments and office blood pressure measurements using the same standardized procedures, with biomarker data obtained as available, as shown in Figure 2.

Data analysis

In this feasibility study, outcomes were evaluated using both quantitative and qualitative methods to comprehensively assess acceptability, practicality, and implementation processes. Quantitative feasibility indicators included recruitment rate, adherence to chatbot engagement, and completion rates of outcome measures. These indicators were summarized using descriptive statistics, including frequencies, percentages, means, and ranges, to reflect operational performance and participant engagement over the 12 weeks. The qualitative data were collected through brief semi-structured in-depth interviews with participants at the end of the intervention. These interviews explored perceived usefulness, ease of use, barriers to engagement, and suggestions for improvement. Interview data were analyzed using narrative description. In addition, descriptive statistical summaries and qualitative narrative analysis provided a multidimensional evaluation of feasibility, informing refinement of the intervention and guiding the design of subsequent larger-scale trials. Based on preliminary results, the researcher conducted both nonparametric and parametric statistical tests to examine within-group differences between pretest and posttest scores. The results from both approaches demonstrated consistent trends and statistical conclusions. Given this concordance, the findings were reported by both statistics, as these provide more comprehensive information, including means, mean ranks, standard deviations, confidence intervals, and p-values.

Research ethics

Research ethics were approved by the Center for Ethics in Human Research (CEHR), Khon Kaen University No. HE681006. Participants voluntarily participate and have the right to withdraw at any time without penalty. Participant burden was managed by integrating the program into a structured 12-week schedule with brief telephone follow-ups (5-10 minutes) and using a familiar platform, the Line application, and face-to-face chatbot training sessions that could be extended as needed to ensure understanding. Confidentiality and data protection were supported by collecting structured data through validated instruments and using standardized measurement procedures; the program also minimized unnecessary risk by focusing on education, monitoring, and reinforcement rather than invasive procedures.

Results

The study results are organized into three sections. First, the development of the chatbot-based hypertension management program, drawing on evidence from a systematic review and the Hypertension Society of Thailand guidelines.³³ Second, chatbot training outcomes based on interactions with 15 users are reported, focusing on response accuracy, interaction performance, and qualitative user feedback to reflect system reliability and user acceptability. Finally, findings from a pilot group of 15 participants are presented to demonstrate preliminary outcomes and the feasibility of implementing the program in real-world settings.

1. The development process of the chatbot-based hypertension management program

The development of the chatbot-based hypertension management program was grounded in a rigorous knowledge acquisition process derived from a comprehensive systematic review and an in-depth review of authoritative clinical practice guidelines, with particular emphasis on the Hypertension Society of Thailand Guideline.³³ Evidence synthesis focused on identifying core domains of effective hypertension management among community-dwelling older adults, including blood pressure control principles, medication adherence, lifestyle modification, and risk-factor reduction. Findings from the systematic review informed both the scope and prioritization of content, ensuring alignment with current evidence regarding behavioral change, health education, and technology-assisted hypertension management. Guideline recommendations were translated into concise, structured, and age-appropriate messages, with careful attention to clinical accuracy, cultural relevance, and practical applicability in daily living contexts for older adults.

The chatbot-based hypertension management program was designed with a user-centered, logic-driven architecture to support two-way interaction and consistent information delivery. The chatbot interaction flow incorporated predefined decision rules, intent recognition pathways, and standardized question–answer structures to ensure reliable and accurate responses across repeated use. Language simplicity, short message sequencing, and strategic repetition of essential concepts were deliberately embedded to accommodate age-related cognitive changes and varying levels of digital literacy. Iterative training and testing cycles were conducted to refine response accuracy, intent classification, and system stability, allowing the chatbot to function as both an educational and supportive hypertension management tool rather than a passive information repository.

The finalized content was operationalized through an integrated manual and video-based educational materials that mirrored the chatbot’s instructional framework. Topic coverage included lifestyle modifications such as dietary salt reduction, healthy eating patterns, physical activity promotion, smoking cessation, alcohol cessation, stress management, sleep hygiene, and medication adherence, alongside guidance on blood pressure monitoring and symptom awareness. These materials were developed to reinforce chatbot interactions that promote skill acquisition and facilitate sustained engagement. Expert evaluation demonstrated excellent content validity, with a content validity index of 0.98 and an item-objective congruence index of 0.97.

2. Chatbot training processes and feasibility results

The Chatbot training process and chatbot response were saturated. Following system testing and the chatbot training phase, qualitative feedback was collected to guide iterative refinement of the program. Users also highlighted the chatbot’s role in facilitating reflection on sedentary behaviors and motivating consideration of lifestyle modification indicating interactive format supported self-assessment and learning as follow: “This Chatbot helped me recognize and emphasize that I have risk factors”; “It can provide what I want to know about how to modify my sedentary lifestyle”; “This can help me to consider how severe my blood pressure is. Because I don’t know how to consider myself”; “I want some content in an infographic or E-manual, bigger and shortened the content”; “VDO is good to understand. However, I want a shorter clip for each piece of content”; “Some questions the chatbot did not collectively answer”; “This chatbot is friendly to use; all functions, text, and color are clear to understand.”

A total of 15 participants were recruited, and all completed the 3-month intervention, resulting in a 100% retention rate. Throughout the study, 1,413 chatbot interactions were recorded. The chatbot automatically responded to 1,233 messages (87.26%), while 180

messages (12.74%) required additional handling because they were not automatically processed. The principal investigator refined the chatbot through iterative training, and the research assistant provided individualized responses via text or telephone when necessary.

The three most frequently accessed functions were educational videos (40.11%), the electronic manual (35.16%), and text-based consultation regarding hypertension management and the submission of measured blood pressure values (13.74%), along with other functions, including greetings and chitchat between participants and researchers. The chatbot provided automated responses to standard inquiries, whereas nurse responses were required primarily when participants submitted images rather than text. All scheduled automated messages and weekly educational materials were delivered as programmed with 100% accuracy, and all participants engaged with the content, reflected by a 100% interaction rate with the provided materials.

These insights underscore the importance of optimizing information density and multimedia to align with the attention spans and learning preferences of older adults. In addition, some participants reported instances in which the chatbot did not respond accurately or fully to specific questions, highlighting areas for improvement in intent recognition and response precision. These qualitative findings informed targeted adjustments to chatbot logic, content structure, and multimedia presentation, thereby enhancing usability, response accuracy, and overall system performance prior to pilot implementation.

3. Demographic data of community-dwelling older adult with hypertension

The sample comprised 15 older adults, including eight males (53.3%) and seven females (46.7%), with a mean age of 69.07 ± 5.38 years (range 61-79). The mean body mass index was 27.40 ± 3.78 kg/m² (range 19.78-35.92), indicating that participants were, on average, overweight. Nearly half (46.7%) had completed primary education, followed by those with a bachelor's degree (33.3%), while smaller proportions reported secondary, associate, or postgraduate education. Most participants were married (93.3%). Government service employees represented the largest occupational group (46.7%), followed by farmers (33.3%), unemployed individuals (13.3%), and merchants (6.7%). Regarding health-related behaviors, 73.3% were non-smokers, and 86.7% reported no sleep problems. Overall, the demographic profile indicates a relatively active, socially stable group of older adults with moderate health risks, as shown in Table 1.

Table 1 Demographic data of community-dwelling older adult with hypertension (n = 15)

Demographic data	n	%
Sex		
Male	8	53.3
Female	7	46.7
Body Mass Index (BMI)	Mean = 27.40 SD = 3.78 (Min = 19.78 – Max = 35.92)	
Age	Mean = 69.07 SD = 5.38 (Min = 61.00 – Max = 79.00)	
Education level		
Primary school	7	46.7
Secondary school	1	6.7
Associate degree	1	6.7
Bachelor's degree	5	33.3
Master or Higher	1	6.7
Marital Status		
Marriage	14	93.3
Widowed	1	6.7
Occupation		
Farmer	5	33.3
Merchant	1	6.7
Government service	7	46.7

Table 1 Demographic data of community-dwelling older adult with hypertension (n = 15)
(cont.)

Demographic data	n	%
Unemployed	2	13.3
Smoking consumption		
No	11	73.3
Quit (Used to)	4	26.7
Alcohol consumption		
No	10	66.7
Yes (Current use)	5	33.3
Sleeping problem		
No	13	86.7
Yes	2	13.3

4. Effect of hypertension management program applying chatbot within group before and after intervention (n = 15)

Prior to conducting within-group comparisons of outcomes before and after the chatbot-based hypertension management intervention (n = 15), the assumption of normality was examined using the Shapiro-Wilk test for all study variables, including Knowledge, health behaviors, medication adherence, systolic blood pressure, and diastolic blood pressure. The results indicated that most variables demonstrated normal distributions ($p = 0.112, 0.968, 0.494, 0.097$, respectively), whereas the diastolic blood pressure did not. To address this violation, a study was conducted using both nonparametric and parametric statistical methods to assess the congruence between the two. As the findings from both analytical approaches were consistent, the researcher elected to report the results of the parametric tests for all outcome variables to ensure consistency and comparability of reporting across measures. Therefore, reporting the parametric statistic is stronger and more beneficial for further information comparison.

According to Wilcoxon-Signed Ranks test, the results statistically significant improvements were observed on Knowledge (mean ranks 4.00 $Z = -2.39$ p -value = 0.017), health-behaviors (mean ranks 4.00 $Z = -2.38$ p -value = 0.018), medication adherence (mean ranks 3.50 $Z = -2.23$ p -value = 0.026), systolic blood pressure (mean ranks 7.00 $Z = -2.20$ p -value=0.028); however diastolic blood pressure did not improved (mean ranks 9.00 $Z = -1.65$ p -value = 0.099). Finally, biomarker outcomes were not analyzed in this feasibility phase due to time constraints and incomplete routine laboratory data during the study period. The primary focus of this phase was to assess intervention feasibility rather than definitive clinical effectiveness. These parameters will be systematically collected and analyzed in the subsequent quasi-experimental study to examine the intervention's clinical impact.

In the paired t-test, the results showed statistically significant improvements across all measured outcomes. Participants' knowledge scores increased from a mean of 15.60 ± 1.05 before the intervention to 16.53 ± 1.18 after the intervention ($p = 0.004$). Health behaviors also showed a significant improvement, with mean scores rising from 23.07 ± 3.86 to 25.33 ± 4.09 ($p = 0.007$). Medication adherence significantly increased from a pre-intervention mean of 20.70 ± 2.86 to a post-intervention mean of 21.61 ± 2.61 ($p = 0.008$). In addition, systolic blood pressure decreased significantly from a mean of 133.67 ± 11.89 mmHg before the intervention to 127.07 ± 11.22 mmHg after the intervention ($p = 0.014$); however, diastolic blood pressure, with a mean of 75.40 ± 9.32 mmHg before the intervention to 72.47 ± 7.06 mmHg after the intervention ($p = 0.175$), did not improve. These findings indicate that the chatbot-based hypertension management program was associated with meaningful improvements in cognitive, behavioral, and clinical outcomes.

Table 2 Effect of hypertension management program applying chatbot within group analysis between before and after intervention (n = 15)

Variable	Before		After		t	95%CI		p-value ^t	Mean ranks	Z	p-value ^w
	Mean	SD	Mean	SD		Lower	Upper				
Knowledge	15.60	1.05	16.53	1.18	3.11	-1.58	-0.29	0.004	4.00	-2.39	0.017
Health-behaviors	23.07	3.86	25.33	4.09	2.78	-4.01	-0.52	0.007	4.00	-2.38	0.018
Medication adherence	20.70	2.86	21.61	2.61	2.71	0.19	1.67	0.008	3.50	-2.23	0.026
Systolic blood pressure	133.67	11.89	127.07	11.22	-2.46	0.85	12.35	0.014	7.00	-2.20	0.028
Diastolic blood pressure	75.40	9.32	72.47	7.06	0.968	-3.57	9.43	0.175	9.00	-1.65	0.099

Note: t = paired t-test; W = Wilcoxon signed-rank test

Discussion

The chatbot-based program was practical to implement and showed promising improvements in knowledge, health behaviors, medication adherence, and blood pressure. These results indicate that the intervention may effectively support hypertension self-management among older adults. However, using a single group without a comparison arm increases the risk of selection bias, maturation effects, and other uncontrolled confounding factors that may have influenced the observed changes. Consequently, the current findings provide preliminary evidence of feasibility and potential effectiveness rather than definitive causal effects.³⁴ Future studies employing randomized controlled trials or well-designed comparative group studies are recommended to confirm the effectiveness of the chatbot-based intervention and strengthen the validity of the results.

The chatbot-based hypertension management program was developed in accordance with current clinical guidelines and structured around core self-management domains recommended by the Hypertension Society of Thailand.³³ Beyond content alignment, several interactive features contributed to its potential to enhance blood pressure control. First, the chatbot enabled immediate question-answer responses, allowing participants to obtain timely clarification regarding medication use, blood pressure readings, diet, and symptom concerns. This real-time accessibility reduces uncertainty, prevents misinterpretation of health information, and supports prompt behavioral adjustment.³⁵ Second, structured educational modules were systematically delivered via videos and electronic manuals, reinforcing evidence-based knowledge on lifestyle modification and medication adherence.³⁶ Third, the chatbot used motivational messages and positive feedback to encourage desirable behaviors when participants reported them, thereby strengthening self-efficacy and sustaining engagement.³⁷ Fourth, automated reminders for medication intake and blood pressure monitoring promoted regular adherence to treatment routines.³⁷⁻³⁸ Together, these components immediately provide responsiveness, continuous education, motivational reinforcement, and structured reminders-operationalizing self-regulatory principles and providing ongoing behavioral support beyond clinic visits. The user-centered conversational design, simplified language, and short message sequencing further accommodated age-related cognitive and digital literacy considerations, enhancing usability and sustained participation among older adults.¹⁸

The chatbot training phase demonstrated refinement in optimizing usability and system performance. Qualitative feedback indicated that the chatbot effectively promoted self-reflection and awareness of hypertension risk, consistent with prior studies showing that conversational agents can enhance motivation and learning through interactive dialogue.³⁸ However, the dense content and occasional mismatches in responses highlight persistent challenges in intent

recognition and information delivery, particularly among older populations. Incorporating this feedback into adjustments of chatbot logic and multimedia presentation improved system usability.^{18,39}

The pilot sample consisted of relatively healthy, socially stable, community-dwelling older adults, a demographic profile commonly reported in digital hypertension feasibility studies.^{18,40} Balanced sex distribution, moderate educational attainment, and preserved functional status suggest adequate readiness for chatbot use and likely contributed to high engagement. While this supports feasibility in similar community settings, it also limits generalizability to more vulnerable older populations, underscoring the need for broader testing in future trials.

The preliminary findings demonstrated significant improvements in hypertension knowledge, health behaviors, medication adherence, and systolic blood pressure, reflecting a coherent pattern of early intervention impact. Consistent with prior chatbot and mHealth studies, behavioral and cognitive gains were more pronounced, with blood pressure reduction emerging as a secondary but encouraging outcome.^{18,38,41}

Suggestions and Limitations

This study was limited by its quasi-experimental one-group pretest–posttest design, small sample size, and partial reliance on self-reported outcomes, which constrain causal inference and generalizability. In addition, the intervention was specifically designed for literate older adults with access to and familiarity with smartphones, particularly the LINE application, which limits applicability among individuals with low literacy, limited digital skills, or restricted access to mobile technology. The use of digital innovation may also pose barriers in low-income populations where smartphone ownership and internet connectivity are constrained. Future research should therefore employ adequately powered randomized or two-group designs with more diverse samples to strengthen internal validity, enhance methodological rigor, and refine chatbot accuracy and personalization prior to conducting long-term effectiveness trials.

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