Enhancing Health Literacy Through "I Watch Sodium" Application among Prehypertension University Staff: A Quasi-experimental Study

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Abstract: Excessive sodium intake adversely affects health outcomes and leads to premature death among adults. This quasi-experimental study was conducted with a two-group pretest-posttest design to examine the effects of enhancing health literacy using the "I Watch Sodium" application. Participants were aged between 30 and 59 years, had prehypertension and consumed a high-sodium diet at least twice a day. The study sample consisted of 80 university staff members in a province in lower northern Thailand. They were equally assigned to an experimental and a comparison group. The experimental group participated in the intervention program, while the comparison group did not. Data were collected between February and April 2023. The primary outcome measures consisted of the Sodium Consumption Health Literacy, Sodium Consumption Behavior, Dietary Approaches to Stop Hypertension Diet Consumption Behavior, the Amount of Sodium Consumed Questionnaires and blood pressure were measured at pretest and posttest eight weeks after the completion of the program. The descriptive statistics, the chi-square test, an independent t-test, and the paired t-test were used to analyze the data.

The results showed that after the intervention, the experimental group had significantly increased mean health literacy scores about sodium consumption and Dietary Approaches to Stop Hypertension (DASH) diet consumption behavior. In addition, the mean scores of sodium consumption behavior, the amount of sodium consumed, systolic blood pressure, and diastolic blood pressure decreased significantly compared to the comparison group eight weeks after the study ended. Nurses and health professionals can apply the "I Watch Sodium" App to people with prehypertension. However, randomized controlled trials and 24-hour sodium excretion measurements are required for future studies.

Keywords: Applications, DASH diet, Health literacy, Prehypertension, Sodium consumption, Technology and health software, University staff

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Introduction

High sodium intake is one of the global burdens of an unhealthy diet that is a major public health challenge worldwide. An estimated 1.89 million diet-related deaths each year are associated with excessive sodium intake.[1] The global average sodium intake is 4,310 mg per person per day, which is higher than the World Health Organization (WHO) recommendation of less than 2,000 mg per day for adults.[1] To prevent and

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reduce non-communicable diseases (NCDs) associated with excess sodium consumption, the WHO adopted a policy to encourage people to reduce sodium intake by setting guidelines and various means of public communication.[2] The WHO regards sodium as one of the most harmful items of diet and aims to prevent over two million deaths by 2025 by reducing sodium intake. It is predicted that over seven million deaths could be prevented by 2030.[2] Excessive sodium consumption is associated with many health problems, including increased blood pressure and the risk of kidney disease.[3]

The WHO has launched several policies for sodium reduction, including national policy commitment, reformulation to reduce sodium content across the food supply, front-of-pack labeling systems, mass media campaigns, marketing restrictions, fiscal policies, and lastly, the sodium country scorecard for monitoring a country's progress in making national commitments and implementing policy to reduce sodium intake.[2] In the Southeast Asia Region, Thailand has reached a score of 3 out of 4 for implementing mandatory policies for sodium reduction and declaration of sodium in pre-packaged food.[2] However, the estimated sodium consumption among Thai adults was still higher than the amount recommended by WHO, as a previous study showed that the average sodium consumption was 3,636 mg per day.[4] Also, the prevalence of raised blood pressure in those over 15 years significantly increased from 21.4% in 2009 to 25.4% in 2021.[5] Based on this evidence, Thailand has been working to reduce several risk factors and risk behaviors, including excessive sodium intake[5] by setting a goal of reducing sodium by 30% or equivalent to the amount of sodium mean 3,046 mg per day by the year 2025 through SALTS strategies consisted of "S (Stakeholder network), A (Awareness), L (Legislation and environment reform), T (Technology and innovation), and S (Surveillance, monitoring and evaluation)"[6(p.11)] at both of the national and the provincial levels.[6]

The workplace is considered a priority-setting for the promotion of the health and well-being of workers,[7] especially as approximately 1.28 billion working adults over 30 years have hypertension and are faced with premature death.[8] High blood pressure increases as people age, as shown in the Thai National Health Examination Survey VI (NHES VI) 2019-2020. This survey revealed that the prevalence rate of hypertension in people aged 30-44 years was 13.1%, continually increasing with the highest in those over 80 years (76.8%), while the age group of 15-29 years was the lowest (3.3%).[9] In the four regions in Thailand, the north had the highest prevalence of hypertension (29.2%), especially in urban areas.[9] The annual report of NCDs in 2022 in Thailand found that for those over 35 years, approximately 4.6% were at risk of hypertension.[10] In addition, a health literacy study regarding NCDs found that 7.12 % of people had a moderate level.[10] Therefore, this study was concerned with implementing an application for promoting health literacy about sodium consumption and modifying behavior in university staff at risk of increased blood pressure, especially in prehypertension, which tends to develop into hypertension.

Literature Review and Conceptual Framework

The conceptual framework for this study was based on an integrated model of health literacy (HL) by Sorensen et al. [11] HL is defined as "the ability to access, understand, appraise, and apply health-related information to improve health."[11(p.10)] and is considered one of the important determinants of health. A systematic review found that people with higher HL had better blood pressure and knowledge about hypertension.[12] Low HL is a major influencing factor affecting the quality of life of people with hypertension.[13] HL intervention was found to be an effective program for promoting disease knowledge, influencing attitudes,

and positive behavior among adults with NCDs,[14] which is vital for improving positive health outcomes in chronic conditions.[15]

Teach-back is a recommended HL-based approach to communication as it has effective strategies for training and education in clinical and general practice for positive and learning-related outcomes such as improving knowledge recall and retention, promoting accurate skills, self-care ability, and better health outcomes.[16] The ″Ask Me Three″ technique is an educational method designed by health literacy experts to help patients in their care by developing communication skills. The method consists of three questions: "1) What is my main problem? 2) What do I need to do? and 3) Why is it important for me to do this?"[17(p.202)] The ″Ask Me Three″ is low cost but easy to access, which increases satisfaction and improves health outcomes.[17]

A successful intervention to reduce sodium consumption involves redesigning "food ingredients, food labeling, taxes, subsidies, and communication campaigns."[18(p.486)] Intervention in education and a combination of short-duration strategies are valuable in decreasing sodium intake.[18] However, few studies have been undertaken on the value of such applications in reducing sodium consumption in adults,[18-20] especially applications for promoting health literacy regarding sodium consumption.

Therefore, increasing HL skills will strengthen motivation to improve understanding, accessing, appraising, and applying sodium information to support individuals in making judgments and decisions on sodium consumption behaviors, DASH diet behavior, and prevention of high blood pressure in the future.

Study Aim

This study aimed to examine the effects of enhancing health literacy through the "I Watch Sodium" application on HL about sodium consumption, sodium consumption behavior, and dietary approaches to stop hypertension (DASH), diet consumption behavior, the amount of sodium consumed, and blood pressure among university staff in a province in lower northern Thailand.

Methods

Design: This study used a quasi-experimental design with two groups and a pretest-posttest design. This report is written following the TREND Statement Checklist on Transparent Reporting of Evaluation Non-Randomized Controlled Study.

Sample and Setting: The setting was two different faculties (Affiliation A and Affiliation B) of the same public university in a province of lower northern Thailand. Participants were recruited from two affiliations in different locations. The sample size was calculated from n4Studies application[21] with the formula for testing of two independent means.[22-23] The calculated sample size was 25 people per group. Considering participant loss during implementation, the researchers added 20% more using the sample size-adjusted formula.[24] Thus, the final number of participants was 40 per group. The inclusion criteria were 1) male and female university staff aged 30 to 59 years; 2) having blood pressure at prehypertension level [systolic blood pressure (SBP) 120-139 mmHg, diastolic blood pressure (DBP) 80-89 mmHg], which was measured from health checkups during a previous 1-3 month period; or 3) consumed high sodium dietary at least two meals per day, which was measured through self-assessment regarding high sodium consumption behavior, such as added fish sauce, ate processed food or snacks, ate ready-to-eat food from street food vendors, canteen, or restaurant; and 4) willingness to participate in this study. Those excluded from the study were those with an illness condition such as kidney disease and those without devices, such as a computer, laptop, or mobile phone, to connect the application. For discontinuation, the criteria was to leave the study. The intervention period was from February to April 2023.

Ethical Considerations: This study was approved by the Ethics Committee in Human Research at Naresuan University, Thailand, Project Number: COA No. 206/2022, IRB No. P2-0378/2564. Participants who met the criteria were provided information regarding the research objective and the study's processes and signed the forms saying they gave informed consent. Code names were used to protect their privacy, and all data was kept private.

Instruments: The authors developed five self-administered questionnaires to collect data. These questionnaires were reviewed by three experts in the fields of public health and nutrition. The item objective congruence index (IOC) in Parts 2 to 5 of the questionnaires was 0.67-1.00.

Part 1: *The General Information* (12 items) included demographic characteristics such as sex, age, weight and height, blood pressure value, marital status, income, education level, and family history of hypertension. Blood pressure was measured with an automated oscillometer device (OMRON, HEM 7156A).

Part 2: *The Sodium Consumption Health Literacy (SCHL)* was developed based on the HL concept and literature. It comprises 28 items with four subscales: understanding (10 items), accessing (4 items), appraising (5 items), and applying sodium information (9 items). The understanding part asked about the amount of sodium recommendation, reading the Guideline Daily Amount (GDA labels) and the "healthier choice" nutrition logo, the benefit of the DASH diet for hypertension, excessive sodium intake and health outcomes, as well as the meaning of high blood pressure, with the choice of yes, no, or unsure. Correct answers were indicated with 1, and incorrect answers and not sure answers were indicated with 0. The score ranged from 0-10, with higher scores indicating higher understanding; the reliability using The Kuder-Richardson 20 was 0.72. The other three subscales, accessing, appraising, and applying, covered the perceived skills to find, select, evaluate, make decisions, and apply sodium information suitable for their health. A 5-point Likert scale was used for responses ranging from strongly agree = 5 to strongly disagree = 1. The total score of these three subscales (18 items) ranged from 18-90. The total score of the whole instrument with four subscales ranged from 18-100, with a higher score indicating higher SCHL. The Cronbach's alpha coefficients in this study were 0.74, 0.79, and 0.77 for accessing, appraising, and applying sodium information subscales, respectively.

Part 3: *The Sodium Consumption Behavior* was developed based on a previous study.[25] It comprises 22 items of high sodium in food and covers the frequency of high sodium food consumption behavior during the last week. A 5-point Likert scale is used for responses from always = 5 to never = 1. An item example is "I added fish sauce before eating." The score ranges from 22-110, with a higher score indicating higher sodium consumption behavior. The Cronbach's alpha in this study was 0.93.

Part 4: *The Dietary Approaches to Stop Hypertension: DASH Diet Consumption Behavior* comprises ten items covering the frequency of the DASH diet during the last week. A 5-point Likert scale is used for responses from always = 5 to never = 1. An example of one item is "I eat whole grains." The score ranges from 5-50, with a higher score indicating higher DASH diet consumption behavior. The Cronbach's alpha in this study was 0.84.

Part 5: *A 3-day Sodium Record* was used to assess the amount of sodium consumption. Participants recorded the amount of sodium in all foods, snacks, beverages, and fruit for three non-consecutive days (2 weekdays and one weekend day). Participants received a table showing the amount of sodium in foods, which included seasoning, Thai foods menu, processed foods, snacks, bakery, and beverages (milligram: mg. per serving) to help participants estimate the amount of sodium consumed.

The Enhance Health Literacy Through the "I Watch Sodium" Application Program

We developed an application based on four components of health literacy,[11] which consistently, with all the expertise in health education and health

promotion, used responsive web design[26] for creating web applications. The three experts approved this application of health education, nutrition, and a web programmer with the agreement form of each icon, which IOC was 0.67-1.00. The App consisted of eight icons for self-learning, as described in an **Appendix, Table 1, and Figures 1-3**. This App was tested on 30 adult workers, to which the question was applied from a previous study,[27] evaluating the App by five scale ratings (5 = strongly agree, 1 = strongly disagree). It comprises seven items as follows: 1) content that had been corrected, 2) content that was deemed appropriate, 3) content that was taken as understandable, 4) content that has been updated, 5) content that has an appropriate duration, 6) content and media were interesting, and 7) the application must be easy to use. The results showed that 90% strongly agreed for content that was taken as understandable, followed by 86.7% strongly agreed that content and media are interesting and content that had been corrected, 80% strongly agreed for content that has been updated, 76.7% strongly agreed for content that was deemed appropriate, content that has an appropriate duration, and the application must be easy to use. The experimental group would participate by using the application for eight weeks. The activity was designed based on two methods: 1) teach-back, and 2) "Ask Me Three" questions regarding sodium consumption, such as What is sodium? Where does the sodium in food come from? How could we reduce our sodium intake? The App was eight activities from week 1 to week 8 as follows: 1) health status (accessing and understanding), 2) "I Watch Sodium" (accessing and understanding), 3) setting goals for sodium reduction (appraisal and applying), 4) setting goals for increase DASH diet (appraisal and applying), 5) sodium diary (appraisal and applying), 6) sodium in food (accessing and understanding), 7) sodium video (accessing and understanding), and 8) sodium quiz (understanding and appraisal). Teach Back and "Ask Me Three" were used to recheck their understanding, discussion, or feedback via line group. However, the comparison group did not participate in this activity.

Data Collection: Researchers implemented intervention among two affiliations. Registration to the program was conducted through a scanned QR code in the brochure, which provided information regarding objective research and the inclusion criteria. Affiliation A was designated as the experimental group. Affiliation B had similar demographic characteristics and was assigned to the comparison group. However, neither affiliation had provided health literacy regarding sodium education. Participants in each affiliation were asked to complete the questionnaire at the pretest and again at the posttest At the start, the first researcher explained relevant details and methods before distributing the questionnaires to participants in each group. Then, participants were taught how to complete a 3-day sodium diary in the group teaching and measured weight and blood pressure. After one week, the complete questionnaires were collected among both groups. Then, the first researcher taught participants in the experimental group how to use the "I Watch Sodium" application and invited them to the LINE group for discussion for eight weeks. In contrast, the comparison group did not participate in this activity. At the end of the eight weeks posttest the two groups answered the same questionnaires as the pretest.

Statistical Analysis: The data were analyzed using SPSS statistical software. The Shapiro-Wilk test was analyzed for normality. The Chi-square test was used to compare differences in general characteristics between the two groups. In addition, to compare the mean scores of the two groups at the pretest and posttest the independent t-test was selected. Then, a paired t-test was used to compare the mean scores within a group with a 2-sided significance level of 0.05.

Results

Most participants were female. The average age was 38.80 years in the experimental group and 40.68 years in the comparison group. The average body mass index (BMI) of both groups was similar. Most participants in both groups were married and

had similar income levels per month. Both participants were supporting staff, and half of them had a history of hypertension in the family. Around 62.5% of the experimental group did not cook meals daily, whereas 55.0% of the comparison group cooked meals daily. Most participants in both groups had the same amount of drinking water daily. There were no statistical differences in general characteristics at baseline ($p > 0.05$) except for education level ($p = 0.005$) among the two groups (**Table 1**).

Table 1. General characteristics of participants at baseline

General characteristics	Experimental group (n = 40)	Comparison group (n = 40)	*p*-value
	n (%) or Mean (SD)		
Sex			0.066[a]
Male	13 (32.5)	6 (15.0)	
Female	27 (67.5)	34 (85.0)	
Age (years)	38.80 (5.28)	40.68 (7.39)	0.194[b]
Age group (years)			0.663[c]
30-39	18 (45.0)	19 (47.5)	
40-49	21 (52.5)	18 (45.0)	
50-59	1 (2.5)	3 (7.5)	
BMI (kg/m^2)	24.79 (4.38)	24.72 (4.38)	0.937[b]
BMI level			0.795[a]
Underweight (< 18.5 kg/m^2)	2 (5.0)	1 (2.5)	
Normal (18.5-22.9 kg/m^2)	13 (32.5)	15 (37.5)	
Overweight (23-24.9 kg/m^2)	7 (17.5)	9 (22.5)	
Obese (≥ 25 kg/m^2)	18 (45.0)	15 (37.5)	
Marital status			0.939[c]
Single	13 (32.5)	15 (37.5)	
Married	24 (60.0)	22 (55.0)	
Separated/divorced/widowed	3 (7.5)	3 (7.5)	
Income per month (USD)			0.067[c]
< 403	2 (5.0)	6 (15.0)	
403-807	17 (42.5)	24 (60.0)	
808-1345	16 (40.0)	8 (20.0)	
> 1345	5 (12.5)	2 (5.0)	
Education level			0.005[c]
Less than bachelor's degree	3 (7.5)	0 (0.0)	
Bachelor's degree	13 (32.5)	26 (65.0)	
Master's degree or over	24 (60.0)	14 (35.0)	
Employment position			0.060[a]
Academic	9 (22.5)	3 (7.5)	
Supporting	31 (77.5)	37 (92.5)	
History of hypertension in family			0.501[a]
Yes	20 (50.0)	23 (57.5)	
No	20 (50.0)	17 (42.5)	
Cooking meals in daily life			0.116[a]
Yes	15 (37.5)	22 (55.0)	
No	25 (62.5)	18 (45.0)	
Amount of drinking water (milliliter per day)	1,637.50 (548.04)	1,667.50 (625.68)	0.820[b]

[a]chi-square test; [b]Independent t-test; [c]Fisher's exact test; BMI = Body mass index

At pretest, the result showed that the mean score of overall health literacy regarding sodium intake, sodium consumption behavior, DASH diet consumption behavior, the amount of sodium intake, systolic blood pressure, and diastolic blood pressure between the experimental and comparison groups were not significantly different (**Table 2**).

In the posttest the results were significantly changed; the average score of overall health literacy about sodium consumption and DASH diet consumption behavior increased significantly in the experimental group ($p < 0.001$). The mean score of sodium consumption behavior, sodium intake, systolic blood pressure, and diastolic blood pressure decreased significantly in the experimental group ($p < 0.05$). At the same time, the mean scores of all variables were not statistically different from the baseline in the comparison group (**Table 2**).

It was found that the mean score of overall health literacy about sodium significantly increased, in which the experimental group was higher than the comparison group ($p < 0.001$). In line with the DASH diet, consumption behavior significantly increased, and the experimental group was higher than the comparison group ($p < 0.001$). Additionally, the mean score of sodium consumption behavior and the amount of sodium intake significantly decreased, in which the experimental group decreased more than the comparison group ($p < 0.001$ and $p = 0.004$), respectively. The systolic blood pressure of the experimental group decreased significantly compared to the comparison group ($p = 0.047$). However, diastolic blood pressure among the two groups was not significantly different ($p = 0.101$) (**Table 2**).

Table 2. Comparison of the average score of variables between experimental (n = 40) and comparison groups (n = 40) at pretest and posttest

Variables	Experimental group	Comparison group	t[e]	Mean difference [c] (95% CI)	*p*-value[a]
	Mean (SD)				
Overall health literacy about sodium consumption scores					
Pretest	52.30 (10.43)	53.48 (9.20)	-0.53	-1.18 (-5.55, 3.20)	0.595
Posttest	80.50 (5.95)	55.35 (8.42)	15.42	25.15 (21.90, 28.40)	< 0.001
t[f]	-15.50	-1.28			
Mean difference [d]	-28.2	-1.88			
(95% CI)	(-31.88, -24.52)	(-4.84, 1.09)			
p-value [b]	< 0.001	0.208			
Sodium consumption behavior scores					
Pretest	60.35 (16.87)	60.75 (13.50)	-0.12	-0.40 (-7.21, 6.40)	0.907
Posttest	45.23 (7.82)	58.08 (15.03)	-4.80	-12.85 (-18.21, -7.49)	< 0.001
t[f]	5.53	0.96			
Mean difference [d]	15.13	2.66			
(95% CI)	(9.59, 20.66)	(-2.98, 8.33)			
p-value [b]	< 0.001	0.345			
DASH diet consumption behavior scores					
Pretest	24.15 (7.45)	24.45 (5.22)	-0.21	-0.30 (-3.17, 2.57)	0.835
Posttest	30.23 (6.59)	23.80 (5.24)	4.83	6.43 (3.78, 9.07)	< 0.001

Table 2. Comparison of the average score of variables between experimental (n = 40) and comparison groups (n = 40) at Pretest and Posttest (Cont.)

Variables	Experimental group	Comparison group	t[e]	Mean difference [c] (95% CI)	*p*-value[a]
	Mean (SD)				
t[f]	-5.43	0.85			
Mean difference [d]	-6.08	0.65			
(95% CI)	(-8.33, -3.81)	(-0.91, 2.21)			
p-value [b]	< 0.001	0.403			
The amount of sodium intake (mg)					
Pretest	3,317.96 (981.78)	3,221.22 (1,002.86)	0.44	96.74 (-345.03, 538.52)	0.664
Posttest	2,682.84 (610.42)	3,191.28 (879.22)	-3.00	-508.43 (-845.36,-171.51)	0.004
t[f]	4.21	0.22			
Mean difference [d]	635.12	29.94			
(95% CI)	(330.02, 940.22)	(-241.89, 311.78)			
p-value [b]	< 0.001	0.831			
Systolic blood pressure (mmHg)					
Pretest	123.83 (11.38)	121.75 (12.23)	0.79	2.08 (-3.19, 7.34)	0.435
Posttest	117.20 (9.46)	122.13 (12.20)	-2.02	-4.93 (-9.79, -0.07)	0.047
t[f]	4.30	-0.20			
Mean difference [d]	6.63	-0.38			
(95% CI)	(3.51, 9.74)	(-4.12, 3.37)			
p-value [b]	< 0.001	0.840			
Diastolic blood pressure (mmHg)					
Pretest	81.80 (7.95)	80.20 (8.08)	0.89	1.60 (-1.97, 5.17)	0.375
Posttest	78.73 (8.69)	81.53 (6.21)	-1.66	-2.80 (-6.16, 0.56)	0.101
t[f]	2.15	-1.08			
Mean difference [d]	3.08	-1.33			
(95% CI)	(0.18, 5.97)	(-3.82, 1.17)			
p-value [b]	0.038	0.289			

[a] Independent t-test, [b] Paired t-test, [c] = Mean difference (Experimental-Comparison groups), [d] = Mean difference (Pretest-Posttest), t[e] = Independent t-test, t[f] = Paired t-test

Discussion

The Enhance Health Literacy Through "I Watch Sodium" application for eight weeks effectively increased sodium consumption literacy and the DASH diet. In addition, this application was found to help decrease sodium consumption behavior, the amount of sodium intake, and systolic blood pressure. It can be explained that self-study by App seems to improve sodium consumption literacy, consistent with Sorensen et al.[11] These authors explained that HL develops throughout life through formal capacity building and education

as well as informal learning. Promoting individual health literacy should focus on knowledge skills, motivation, and the ability to access, understand, appraise, and apply health information for effective decision-making and appropriate action for their health and health behavior. Also, this App aimed to inform health literacy about sodium consumption by using multiple techniques such as "Ask Me Three" techniques to increase knowledge and provide participants with more communication, using plain language, pictures, videos, and infographics for more understanding and interest, using the teach-back technique for improve participant understanding, goal setting for increasing self-management about sodium consumption. In addition, the Apps provided a diary for recording sodium intake that helped participants to be aware of the amount of sodium intake and suggested that it led to a change in behavior. The sodium quiz provided the question about reading nutrition labeling and helped participants increase their understanding.

Moreover, researchers discuss with the participants through LINE groups to motivate and encourage them to use the App. That is, when the experimental group participated in all functions of the App, their health literacy skill increased. Then, sodium consumption behavior and sodium intake were reduced, which was affected by self-monitoring sodium records through a sodium diary. Therefore, it led to a decrease in systolic blood pressure among the experimental group. Even though diastolic blood pressure did not change significantly, it tended to decline when compared to the comparison group. Our findings were supported by a study by Rahimdel et al.,[28] who found this population group to be more inspired to modify their behavior than healthy people because they were at risk for the development of hypertension.

In addition, the researchers informed about strategies to reduce sodium intake based on nutrition education, such as reading nutrition labels, looking at nutrition healthier logo choices in front of packs, and the main source of sodium in Thai food. Moreover, having a video presented by a health professional who can explain and increase awareness about the impact of sodium on health, the importance of reducing sodium intake, and the suggested DASH diet seems to benefit from reducing the sodium consumption behavior of the experimental group. This strategy is consistent with the "SHAKE technical package for salt reduction"[29(p.11)] recommended by WHO in the K activity, that is, "knowledge, educate and communicate to empower individuals to eat less salt"[29(p.11)] and increasing awareness (A) of sodium and health through using technology and innovation (T) activities of SALTS strategies.[6] The latter is consistent with the study of Sakaguchi et al.[30] The 1-year intervention consisting of a healthy lunch and nutrition education effectively reduced salt intake significantly from 10.7 to 9.3 gm in employees. In addition, previous studies supported our findings that health and nutritional education, combined with other strategies, such as tools for estimating salt consumption, self-monitoring, and a brief education, were successful methods to reduce salt/sodium intake among adults.[31,32] In addition, a similar intervention comprised three measures, which included observing the average sodium consumption and developing an environment to enable and promote behavioral change among people at high risk for hypertension.[33] Interestingly, our study is the first that used the "I Watch Sodium" application to increase health literacy about sodium information and reduce sodium intake among university staff with prehypertension in the lower northern part of Thailand, which used the responsive web design that can access in any device, such as a computer, laptop, or mobile phone and anytime online.

The App-based mobile intervention has shown effectiveness on dietary behavior and nutrition-related health outcomes, especially food consumption behavior, reducing obesity, blood pressure, and blood lipid,[34] thus decreasing salt consumption and the number of systolic blood pressure in adults,[35] but the effects were

not found to be significant in children. For example, the intervention provided only salt awareness posters in the canteen, which did not cover the school meal package. In addition, the children did not access the App all the time, and they did not necessarily understand to access online messages and information as effectively as their parents or other adults.[35]

Furthermore, various studies showed that digital platform implementation, such as WhatsApp and Electronic brochures, especially WhatsApp, successfully reduced salt in adults and could decrease the percentage of sodium reduction in adult participants.[19] However, inconsistent findings were found that a 12-week intervention using the SaltSwitch smartphone App and reduced-sodium salts did not affect sodium intake in adults with high blood pressure. These contrary results may be due to the intervention implemented during the COVID-19 pandemic, which may have affected the results.[36]

Limitations

This study used a quasi-experimental research procedure in assigning participants into groups, which may influence the internal validity of the result. In addition, we did not measure 24-hour sodium excretion. Also, generalizations of the study to other settings and populations other than university staff are limited. Participants added the number by themselves for the "I Watch Sodium" application, which records the amount of sodium consumption. Therefore, some errors could occur.

Conclusion and Implications for Nursing Practice

This study is the first to develop an application to promote health literacy on sodium information for university staff with prehypertension in the lower northern of Thailand. The intervention presented feasible results in promoting sodium-related health literacy in adults at risk of hypertension, and this App is practical and effective in reducing sodium intake and blood pressure levels. Nurses and health care professionals can use this program in their practice. However, further testing using randomized controlled trials with other populations and settings is needed.

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References

1. Pan American Health Organization. Mean salt intake in adults aged 25 years and older in the Americas, 1990-2019. ENLACE Data Portal [Internet]. 2023 [cited 2023 Aug 11]. Available from: https://www.paho.org/en/enlace/salt-intake
2. World Health Organization. WHO global report on sodium intake reduction [Internet]. 2023 Mar 9 [cited 2023 Jan 25]. Available from: https://www.who.int/publications/i/item/9789240069985
3. Malta D, Petersen KS, Johnson C, Trieu K, Rae S, Jefferson K, et al. High sodium intake increases blood pressure and risk of kidney disease. From the science of salt: a regularly updated systematic review of salt and health outcomes (August 2016 to March 2017). J Clin Hypertens (Greenwich). 2018;20(12):1654-65. doi: 10.1111/jch.13408.
4. Chailimpamontree W, Kantachuvesiri S, Aekplakorn W, Lappichetpaiboon R, Thokanit NS, Vathesatogkit P, et al. Estimated dietary sodium intake in Thailand: a nationwide population survey with 24-hour urine collections. J Clin Hypertens (Greenwich). 2021;23(4):744-54. doi: 10.1111/jch.14147.
5. United Nations Thailand. Prevention and control of non-communicable diseases in Thailand: the case for investment [Internet] 2021 Nov 23 [cited 2022 Jan 9]. Available from: https://thailand.un.org/en/159788-prevention-and-control-noncommunicable-diseases-thailand-%E2%80%93-case-investment

6. Bureau of Non-Communicable Diseases, Department of Disease Control, Ministry of Public Health. Implementation guidelines for reducing salt and sodium consumption at the provincial level. Nonthaburi: Bureau of Non-Communicable Diseases, Department of Disease Control; 2023 (in Thai).
7. Andersen LL, Proper KI, Punnett L, Wynne R, Persson R, Wiezer N. Workplace health promotion and Wellbeing. Sci WorldJ. 2015;2015:606875.doi:10.1155/2015/606875.
8. World Health Organization. Hypertension [Internet]. 2023 Mar 16 [cited 2023 May. 12]. Available from: https://www.who.int/news-room/fact-sheets/detail/hypertension
9. Aekplakorn W, Puckcharern H, Satheannoppakao W. Thai National Health Examination Survey VI (NHES VI) 2019-2020 [Internet]. 2021. [cited 2023 October 7]. Available from: https://kb.hsri.or.th/dspace/handle/11228/5425 (in Thai)
10. Bureau of Non-Communicable Disease, Department of Disease Control, Ministry of Public Health. Annual report 2022 [Internet]. 2022. [cited 2023 Oct 7]. Available from: http://www.thaincd.com/document/file/download/paper-manual/Report2565NCDs.pdf
11. Sorensen K, Van den Broucke S, Fullam J, Doyle G, Pelikan J, Slonska Z, et al. Health literacy and public health: a systematic review and integration of definitions and models. BMC Public Health. 2012;12:80. doi: 10.1186/1471-2458-12-80.
12. Mohd Isa D, Shahar S, He FJ, Majid HA. Associations of health literacy with blood pressure and dietary salt intake among adults: a systematic review. Nutrients. 2021; 13(12):4534. doi:10.3390/nu13124534.
13. Zhang Q, Huang F, Zhang L, Li S, Zhang J. The effect of high blood pressure-health literacy, self-management behavior, self-efficacy and social support on the health-related quality of life of Kazakh hypertension patients in a low-income rural area of China: a structural equation model. BMC Public Health. 2021; 21(1): 1114. doi: 10.1186/s12889-021-11129-5.
14. Heine M, Lategan F, Erasmus M, Lombaard CM, Mc Carthy N, Olivier J, et al. Health education interventions to promote health literacy in adults with selected non-communicable diseases living in low-to-middle income countries: a systematic review and meta-analysis. J Eval Clin Pract. 2021;27(6):1417-28. doi: 10.1111/jep.13554.
15. Larsen MH, Mengshoel AM, Andersen MH, Borge CR, Ahlsen B, Dahl KG, et al. "A bit of everything": health literacy interventions in chronic conditions – a systematic review. Patient Educ Couns. 2022;105:2999-3016. doi: 10.1016/j.pec.2022.05.008.
16. Talevski J, Wong Shee A, Rasmussen B, Kemp G, Beauchamp A. Teach-back: a systematic review of implementation and impacts. PLoS One. 2020;15(4):e0231350. doi: 10.1371/journal.pone.0231350.
17. Lord J, Borkowski N, Weech-Maldonado R. Patient engagement in home health: the role of health literacy and "Ask Me Three®" Home Health Care Manag Pract. 2021;33(3): 202-9. doi:10.1177/1084822321996623.
18. Vargas-Meza J, Gonzalez-Rocha A, Campos-Nonato I, et al. Effective and scalable interventions to reduce sodium intake: a systematic review and meta-analysis. Curr Nutr Rep. 2023;12(3):486-94. doi: 10.1007/s13668-023-00477-w.
19. Jarrar AH, Al Dhaheri AS, Lightowler H, Cheikh Ismail L, Al-Meqbaali F, Bataineh MF, et al. Using digital platform approach to reduce salt intake in a sample of UAE population: an intervention study. Front Public Health. 2022 May 24;10:860835. doi: 10.3389/fpubh.2022.860835.
20. Eyles H, Grey J, Jiang Y, Umali E, McLean R, Te Morenga L, et al. Effectiveness of a sodium-reduction smartphone app and reduced-sodium salt to lower sodium intake in adults with hypertension: findings from the salt alternatives randomized controlled trial. JMIR Mhealth Uhealth. 2023; 11: e43675. doi: 10.2196/43675.
21. Ngamjarus C, Chongsuvivatwong V. n4Studies: sample size and power calculations for iOS. The Royal Golden Jubilee Ph.D. Program – The Thailand Research Fund & Prince of Songkla University. 2014.
22. Rosner B. Fundamentals of biostatistics. 5th ed. Pacific Grove, CA: Duxbury; 2000.
23. Sookpool A, Kingmala C, Pangsuk P, Yeanyoun T, Wongmun W. Effectiveness of health literacy and health behavior development program for working people. J Health Sci. 2020;29(3):419-29 (in Thai).
24. Laohasiriwong W. Critical appraisal of public health research articles and developing research proposals. Khonkaen: Klungnana Vitthaya Press; 2017 (in Thai).

25. Youngiam W, Wattanaburanon A, Keeratisiroj O, Songthap A, Phetphum C, Wangwonsin A. Factors influencing sodium consumption behaviors among university employees in Phitsanulok Province, Thailand: a cross-sectional study. J Health Res. 2024;38(1):46-56. https://doi.org/10.56808/2586-940X.1059
26. Bader WI, Hammouri AI. Responsive web design techniques. Int J Comput Appl. 2016;150(2):18-27.
27. Thongnopakun S, Manwong M, Rodjarkpai Y et al. The effects of the "Our Love, Our Control" online program on sexual health literacy (SHL) and behaviors in preventing unintended pregnancy and sexually transmitted diseases (STDs) among adolescents in agricultural areas during COVID-19 outbreak in Thailand. F1000Res. 2022; 11:929 doi: 10.12688/f1000research.121767.1.
28. Rahimdel T, Morowatisharifabad MA, Salehi-Abargouei A, Mirzaei M, Fallahzadeh H. Evaluation of an education program based on the theory of planned behavior for salt intake in individuals at risk of hypertension. Health Educ Res. 2019; 34(3): 268-78. doi: 10.1093/her/cyz007.
29. World Health Organization. SHAKE the salt habit: technical package for salt reduction. [Internet]. 2017 Mar 21 [cited 2023 May 5]. Available from: https://www.who.int/publications/i/item/WHO-NMH-PND-16.4
30. Sakaguchi K, Takemi Y, Hayashi F, Koiwai K, Nakamura M. Effect of workplace dietaryintervention on salt intake and sodium to potassium ratio of Japanese employees: a quasi-experimental study. J Occup Health. 2021;63(1): e12288. doi: 10.1002/1348-9585.12288.
31. Silva-Santos T, Moreira P, Rodrigues M, Padrão P, Pinho O, Norton P, et al. Interventions that successfully reduced adults' salt intake: a systematic review. Nutrients. 2021;14(1):6. doi: 10.3390/nu14010006.
32. Spiteri G, Monaco MG, Carta A, Torroni L, Taus F, Verlato G, et al. Reduction of excessive dietary sodium consumption: effectiveness of a prevention intervention among health workers in a large Italian hospital. Int J Environ Res Public Health. 2023;20(8):5478. doi: 10.3390/ijerph20085478.
33. Prompunjai P, Thammakun T, Singthong T. Model development for reducing sodium consumption at the district level using a district health board mechanism. OSIR. 2023;16(1): 22-30. doi: 10.59096/osir.v16i1.262035.
34. Villinger K, Wahl DR, Boeing H, Schupp HT, Renner B. The effectiveness of app-based mobile interventions on nutrition behaviours and nutrition-related health outcomes: a systematic review and meta-analysis. Obes Rev. 2019; 20(10):1465-84. doi: 10.1111/obr.12903.
35. He FJ, Zhang P, Luo R, Li Y, Sun Y, Chen F, et al. App based education programme to reduce salt intake (AppSalt) in school children and their families in China: parallel, cluster randomised controlled trial. BMJ. 2022;376:e066982. doi: 10.1136/bmj-2021-066982.
36. Eyles H, Grey J, Jiang Y, et al. Effectiveness of a sodium-reduction smartphone app and reduced-sodium salt to lower sodium intake in adults with hypertension: findings from the salt alternatives randomized controlled trial. JMIR Mhealth Uhealth. 2023;11: e43675. doi:10.2196/43675.

Appendix

Table 1. Activities of the application "I Watch Sodium" for experimental group

Icon / Item	Objective	Activity
 1. Login	To increase accessing and understanding skills regarding sodium information	**Week 1: Accessing and understanding (40 minutes)** - Researchers explain how to use the application by registering to login. - The participants' weight and blood pressure were measured, and they filled out the "I Watch Sodium" application. - An application will interpret the health status, body mass index, and blood pressure and give recommendations. - This function helps promote attitude and inform of health status, which summarizes the blood pressure levels that participants should be aware of their status.
 2. Handout of "I Watch Sodium"	To increase access and understanding skills regarding sodium information	**Week 2: Accessing and understanding (40 minutes)** - This function, participants will learn by reading the handout "I Watch Sodium" consisting of ten infographics on information regarding sodium and health presented through plain language and pictures with the "Ask Me Three" technique, including 1) What is sodium? 2) Where does the sodium in food come from? 3) How could we reduce our sodium intake? 4) How to reduce sodium: ABCD, 5) Traffic lights labeling the amount of sodium, 6) Health effect of high sodium intake, 7) Knowing blood pressure value, 8) Latent sodium, 9) Thais sodium intake, and 10) DASH Diet. - "Ask Me Three" techniques were applied to ask and discuss the following questions with participants via line group: 1) What is sodium? 2) Where does the sodium in food come from? 3) How could we reduce our sodium intake?
 3. Goal for sodium reduction	To increase appraisal and applying sodium information skills by goal setting method	**Week 3: Appraisal and applying (40 minutes)** In this function, participants will set their goal for reducing sodium intake once a week, for example, 1) I will read the nutrition label or healthier choice logo, 2) I will choose low sodium food, 3) I will taste it before adding, 4) I will reducing added seasoning sauces, and 5) I will reduce processed food, etc. - Participants were stimulated to discuss and asked to set their goals by using the application once a week via LINE group.
 4. Goal for increasing DASH diet	To increase appraisal and applying sodium information skills by goal setting method	**Week 4: Appraisal and applying (40 minutes)** - In this function, participants will plan and set their goal to increase their DASH diet in daily life once a week, for example, 1) I will eat grain, brown rice, or tofu, 2) I will eat various vegetables and fruit, 3) I will drink soy milk or milk, 4) I will use rice bran oil for cooking, 5) I will eat lean meat, etc. - Researchers encourage and discuss the foods that should be consumed with the participant to set their goal through a LINE group.

Table 1. Activities of the application "I Watch Sodium" for experimental group (Cont.)

Icon / Item	Objective	Activity
 5. Sodium diary	- To increase appraisal and applying skills regarding sodium information - To support self-monitoring sodium intake	**Week 5: Appraisal and applying (40 minutes)** - This function is provided to self-record sodium intake at least three days per week. - All participants recorded their food and the amount of sodium intake on the sodium calendar. After recording, the program will calculate and inform the amount of sodium consumed, which is presented in the graph and suggested messages. For example, "You did a great job today. Your sodium intake is less than 2,000 mg." - The teach-back technique was applied to check their understanding of sodium recordings by asking via LINE group and explaining more if they do not understand.
 6. Sodium in foods	To increase access and understanding skills about sodium information	**Week 6: Accessing and understanding (40 minutes)** - This function presents the amount of sodium in food, such as seasoning, processed food, Thai food menu, fast food, snacks, bakery, fruit, and beverages. A teach-back technique was applied to check participants' comprehension by asking questions and using this information to estimate how much sodium they received to record on the application via line group.
 7. Sodium video	To increase access and understanding skills about sodium information	**Week 7: Accessing and understanding (40 minutes)** In this function, participants will learn from video-related sodium, presented by specialist doctors such as nephrologists and internists. The media was created by the Thai Health Promotion Foundation, Mahidol University, and the RAMA channel, which consisted of nine items, each video around 10-25 minutes. The content focuses on salt, sodium intake and health, the danger of high sodium intake, and how to reduce sodium intake.
 8. Sodium quiz	To increase understanding and appraisal skills regarding sodium information	**Week 8: Understanding and Appraisal (30 minutes)** - The participant will take a quiz with true or false choices and short answers in this function. For example, 1) Sodium intake recommendation for healthy people is less than 2,000 mg daily, 2) What does the information on the Healthier Choice nutrition logo mean? 3) What is the amount of sodium in the nutrition label of this instant noodle? 4) What is the DASH diet focusing on?; etc. - Participants with the highest scores will receive a reward and share their opinions and experiences using the application "I Watch Sodium" via LINE Group.

Figure 1. The "I Watch Sodium" application (Health status)

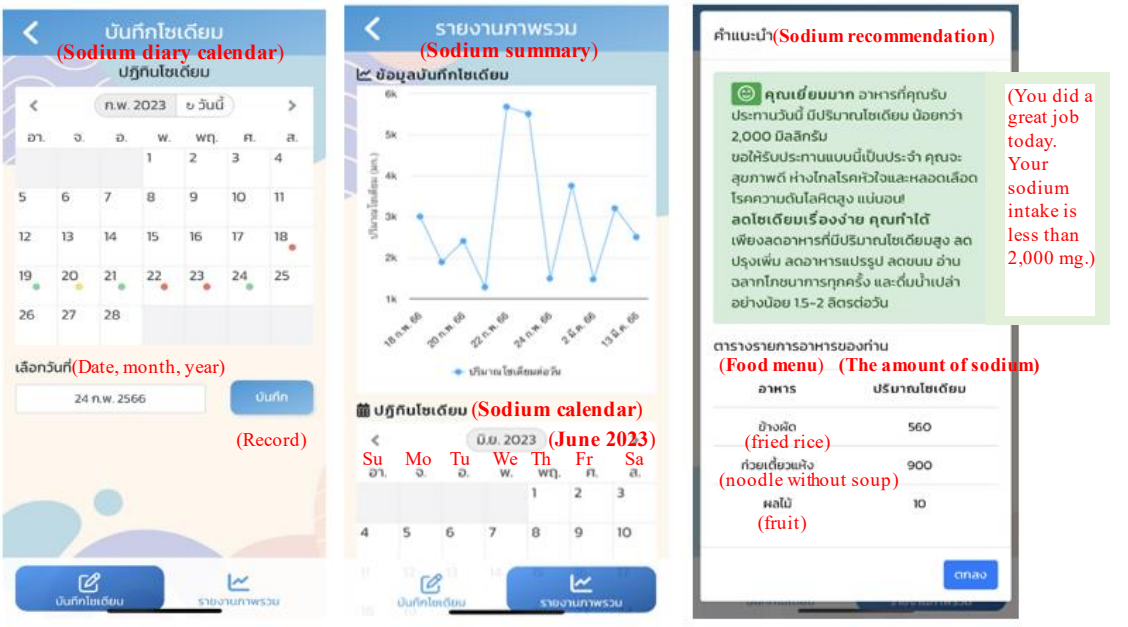

Figure 2. The "I Watch Sodium" application (Sodium diary).

Figure 3. The "I Watch Sodium" application (Setting goals for sodium reduction)

การส่งเสริมความรอบรู้ด้านสุขภาพ โดยแอปพลิเคชัน "รู้ทันโซเดียม" ในบุคลากรมหาวิทยาลัยที่มีภาวะก่อนความดันโลหิตสูง: การวิจัยกึ่งทดลอง

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บทคัดย่อ: การบริโภคโซเดียมสูงส่งผลเสียต่อสุขภาพ และนำมาสู่การเสียชีวิตก่อนวัยอันควรในผู้ใหญ่ การวิจัยแบบกึ่งทดลอง 2 กลุ่ม วัดผลก่อนและหลังทดลอง เพื่อศึกษาผลของการส่งเสริมความรอบรู้ด้านสุขภาพ โดยแอปพลิเคชัน "รู้ทันโซเดียม" ของบุคลากรมหาวิทยาลัยในจังหวัดหนึ่งของภาคเหนือตอนล่าง ประเทศไทย ที่มีอายุ 30-59 ปี เป็นผู้ที่มีความดันโลหิตอยู่ในระดับก่อนเป็นความดันโลหิตสูง และมีพฤติกรรมการบริโภคอาหารที่มีโซเดียมสูง อย่างน้อย 2 มื้อต่อวัน กลุ่มตัวอย่าง จำนวน 80 คน ได้รับการแบ่งจำนวนเท่ากันให้เข้าร่วมในกลุ่มทดลองและกลุ่มเปรียบเทียบ โดยกลุ่มทดลองได้เข้าร่วมโปรแกรม ส่วนกลุ่มเปรียบเทียบไม่ได้เข้าร่วมโปรแกรม เก็บรวบรวมข้อมูลระหว่างเดือนกุมภาพันธ์ ถึง เดือนเมษายน พ.ศ. 2566 วัดผลลัพธ์หลักของการศึกษา ประกอบด้วย ความรอบรู้ด้านสุขภาพในการบริโภคโซเดียม พฤติกรรมการบริโภคโซเดียม พฤติกรรมการบริโภคอาหารต้านโรคความดันโลหิตสูง ปริมาณโซเดียมที่บริโภค และระดับความดันโลหิต วัดผลก่อนและหลังทดลองภายหลังเสร็จสิ้น 8 สัปดาห์ วิเคราะห์ข้อมูลโดยใช้สถิติเชิงพรรณนา การทดสอบไคสแควร์ การเปรียบเทียบค่าเฉลี่ยระหว่างกลุ่มตัวอย่างสองกลุ่มที่เป็นอิสระจากกัน และไม่เป็นอิสระจากกัน

ผลการศึกษา พบว่า ภายหลังการเข้าร่วมโปรแกรม กลุ่มทดลองมีคะแนนเฉลี่ยความรอบรู้ด้านสุขภาพในการบริโภคโซเดียม และพฤติกรรมการบริโภคอาหารต้านโรคความดันโลหิตสูง เพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ นอกจากนี้ คะแนนเฉลี่ยพฤติกรรมการบริโภคโซเดียม ปริมาณโซเดียมที่บริโภค และมีค่าเฉลี่ยความดันโลหิตขณะหัวใจบีบตัวและคลายตัวลดลงกว่ากลุ่มเปรียบเทียบภายหลังการทดลอง 8 สัปดาห์ ผลการศึกษานี้ มีข้อเสนอแนะว่า พยาบาลและบุคลากรทางการแพทย์สามารถนำแอปพลิเคชัน "รู้ทันโซเดียม" ไปใช้ในผู้ป่วยโรคความดันโลหิตสูงได้ อย่างไรก็ตาม การศึกษาครั้งต่อไปควรศึกษาวิจัยรูปแบบการทดลองแบบสุ่มและมีกลุ่มควบคุม รวมทั้ง ควรประเมินปริมาณโซเดียมในปัสสาวะ 24 ชั่วโมง

Pacific Rim Int J Nurs Res 2024; 28(1) 164-180

คำสำคัญ: แอปพลิเคชัน แนวทางการบริโภคอาหารต้านโรคความดันโลหิตสูง ความรอบรู้ด้านสุขภาพ ภาวะก่อนความดันโลหิตสูง การบริโภคโซเดียม เทคโนโลยีด้านสุขภาพ บุคลากรมหาวิทยาลัย

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