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Model Development for Reducing Sodium Consumption at the District Level Using a District Health Board Mechanism

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Abstract

High levels of dietary sodium are associated with hypertension and non-communicable diseases. We aimed to develop a model for reducing sodium consumption at the district level using a mechanism developed by the District Health Board (DHB). Hankha District in Chai Nat Province was selected as the study area. The study was conducted between June and December 2022. Research methods included the development of a model to reduce sodium consumption, questionnaires and focus group discussions, and measuring the amount of salt in food and blood pressure levels among study participants. The developed model comprised three measures; monitoring people's sodium consumption; creating a mechanism for driving and managing the environment contributing to behavioral changes; and providing knowledge and promoting behaviors among groups at high risk for hypertension. After model development, the mean knowledge scores among DHB members and their skills in managing plans and projects were significantly higher than those before the process. Mean knowledge scores, health literacy and proper sodium consumption behaviors among at-risk groups were also higher. In addition, the increased knowledge scores significantly correlated with proper sodium consumption behaviors. Our results should encourage authorities at the policy level to apply a DHB mechanism to reduce sodium consumption in communities.

Keywords: model, sodium consumption, District Health Board

Introduction

In Thailand the prevalence of non-communicable diseases such as hypertension, stroke, and diabetes has been increasing each year.[1] The high incidence of these diseases is mainly related to the changing context and structure of Thai society, the economy, and the environment that affect livelihood and health, such as lack of exercise, inappropriate consumption behaviors, and easy access to food. Other related factors include an increase in the amount of spicy, salty and sweet foods, and low consumption of fruit and vegetables.[2] The mean dietary sodium intake in Thailand was estimated to be 3,636 mg/day, which is much higher than the World Health Organization recommendation for adults of 2 g/day (equivalent to 5 g salt/day).[3,4] Several studies demonstrated that reduced sodium intake can lower hypertension and reduce the risk of coronary heart disease, stroke, and chronic kidney disease.[4–7]

In 2018, the Regulations of the Office of the Prime Minister on the establishment of the District Health Board (DHB) were issued with the objective of encouraging participation and integration in developing people's quality of life and health.[8] With a lack of community solutions to reduce people's sodium consumption, researchers developed a logic model as a tool for creating engagement and integration from all sectors.[9–10] This type of model has proven effective in changing alcohol consumption behaviors and for prevention and control of dengue fever.[11–12]

According to the issues selected by the DHB to improve the quality of life of people in Thailand in 2021, a study of the hypertension situation from 2017–2021 indicated that Health Region 3 had the country's highest rate of hypertension per 100,000 population and the highest prevalence of non-communicable diseases and related risk factors.[13] Provincial statistics in Health Region 3 indicated that the morbidity rate of

hypertension per 100,000 population in Chai Nat Province sharply increased from 17,343 in 2017 to 20,533 in 2021.[14–15]

The district level is considered a suitable strategic location for solving chronic health problems that requires long-term solutions. The use of the DHB's mechanism, whereby the district chief is the leader as required by law, would likely be the best solution to the sodium consumption problem. In the past, no study using an appropriate model was conducted to reduce sodium consumption among at-risk groups using the DHB's mechanism. The objective of this study is to develop a model for reducing the sodium consumption of people at risk of hypertension. The findings can be applied and expanded to other areas to prevent and control non-communicable diseases and related risk factors.

Methods

An action research model and purposive sampling method were used in this study. Health Region 3 was selected because of the high prevalence of hypertension among its residents. Selection criteria for districts included: 1) an increase in the morbidity rate of hypertension in the past 5 years, and 2) high rates of non-communicable diseases, notably diabetes and hypertension, in 2021. There were 28 districts that met these two criteria.[13] Hankha District, which consists of eight sub-districts, was randomly selected as the study district.[15] The study was conducted from June to December 2022.

The study sample consisted of two groups. The first group were members of the DHB (age 18 years and over) in Hankha District. We invited 17 people to participate in the study: one district chief, one district public health officer, three representatives of government agencies, two representatives of local administrative organizations and two representatives of sub-district headmen or village headmen, one representative of the private sector, five village health volunteers (VHVs), and two representatives from the community sector.

The second group included members of the community aged 18 years and over, screened by public health officers in 2021 to be at risk of hypertension. The sample size of 18 was based on the formula for a quasi-experimental study design (single group before and after the experiment).[16] However, to account for a 50% drop-out rate, the sample size was increased to 35. Villagers from a list of 1,998 eligible people were randomly selected.

Research Operation: A solution model comprising four steps, as shown in Figure 1, was developed.

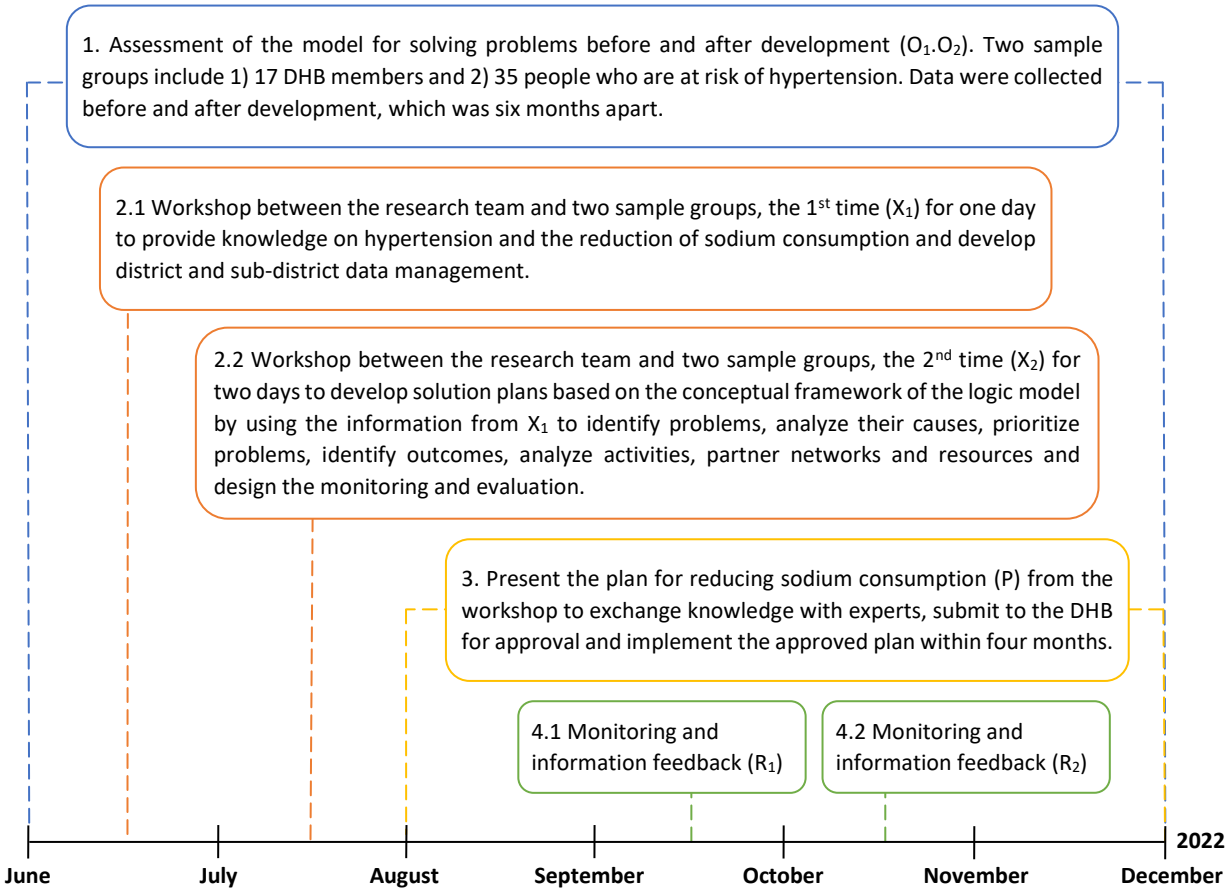

Figure 1. Research procedures of the model development

Data Collection Tools

The tools for the DHB group comprised of 1) a test of their knowledge on project/plan preparation (25 questions with each question worth 1 point), and 2) a plan/project management skills test (10 questions with total scores ranging from 10–50). Items from these two assessments have the Kuder Richardson Formula 20 of 0.84 and 0.82, respectively, based on Cronbach's alpha coefficients.

The tools for the at-risk group included 1) a test of sodium consumption knowledge (10 questions and 30 sub-questions with a total score of 46), 2) an assessment test of health literacy with 22 questions (five parts with scores ranging from 22 to 110), and 3) an assessment of sodium consumption behaviors (nine questions and 31 sub-questions with scores ranging from 0 to 114). Items from the first have the Kuder Richardson Formula 20 of 0.75, second and third assessment forms have Cronbach's alpha coefficients of 0.78 and 0.80, respectively.

Qualitative data on policy development/district solution measures, plan, and project management mechanisms, and project monitoring were collected by focus group discussions among the DHB participants. Solutions for reducing sodium consumption were compared between the project pre-operation and post-operation phases, while knowledge about policies, measures, plans, projects, and activities to reduce sodium consumption, and satisfaction with the proposed methods, were collected from the at-risk group.

Data on the amount of salt consumed was collected using a salt meter.[17] The amount of salt was classified into three levels: 1) low (<275.1 mg sodium/100 mL), 2) medium (275.1–353.7 mg sodium/100 mL), and 3) high (>353.7 mg sodium/100 mL).[18] The data were collected one week prior to the collection of questionnaires on various kinds of foods using the salt meter. Samples were collected from at-risk groups on Monday, Wednesday, and Saturday for three meals a day or a total of nine meals per week.

Blood pressure was measured using a digital blood pressure monitor with standard calibration on the day of questionnaire collection. The two measurements were performed 1–2 minutes apart and the average value was determined.

Statistical Analysis

Data were summarised descriptively using percentages, means, and standard deviations (SD) as appropriate. The paired t-test was used to compare mean scores of knowledge and skills in project/plan management, knowledge of sodium consumption, health literacy, sodium consumption behavior, the difference in mean blood pressure values, and the amount of salt in cooked foods before and after the development of the model. The relationship between knowledge, literacy, and sodium consumption behavior was further determined based on a multiple linear regression model which knowledge and literacy before the development were adjusted. The 95% confidence intervals (CI) or a p-value of <0.05 were used to determine statistical significance. Content analysis was used to analyze the qualitative data.

This study was approved by the Ethics Committee of the Department of Disease Control, FWA 00013622, Code 64058, and by the DHB.

Results

Model for Reducing Sodium Consumption among at-Risk Groups (Part 1)

According to the focus group discussion, attended by 17 members of the DHB group and 35 participants of the at-risk group, a summary of lessons learned from the model development was provided. It was revealed that the participatory problem-solving model of the public, private, and community sectors comprised sodium consumption solution plans and plan driving mechanisms with the following details.

Sodium Consumption Solution Plans

Surveillance of people's sodium consumption behaviors

The first plan comprised the following activities: 1) The DHB, together with the Sub-district Health Board (SHB), VHVs and community leaders, cooperated in developing local data collection tools to be used for surveillance and preparing solution plans, 2) The SHB and all local administrative organizations (LAOs) integrated the district plans approved by the DHB into the sub-district health fund plan and royal health projects, and 3) LAOs support use of salt meters and blood pressure monitors for surveillance of the sodium levels in food and measuring blood pressure levels of the community.

Construction of a driving mechanism and arrangement of an environment

The second plan contributing to behavioral changes consisted of the following activities: 1) the DHB, SHB, VHVs, and community leaders organized a village forum to formulate measures to seek cooperation from food shops and hosts in adapting recipes to reduce sodium intake and reduce the amount of salty foods provided at traditional merit-making ceremonies, 2) sub-district health promoting hospitals (SHPH) provided practical training on the use of salt meters to VHVs, LAOs networks, and food shop operators, and 3)

VHVs set a timeline and publicized how to measure blood pressure levels among all groups of people. Using salt meters to measure the amount of salt in cooked foods in all households by randomly checking various types of foods on Monday, Wednesday and Saturday. This was conducted once a month by one VHV who is responsible for 15 households.

Educating and promoting behaviors of at-risk groups

This plan consisted of the following activities: 1) SHPH provided knowledge to VHVs/community leaders and developed their communication skills to communicate with at-risk groups, 2) VHVs and community leaders applied knowledge to educate people and communicate district policies that promote people to reduce the consumption of sodium in their foods via the village forum, 3) community leaders/VHVs acted as role models, visited at-risk groups, randomly checked foods, measured blood pressure levels, returned the measured salt content in foods and blood pressure levels to raise awareness and encouraged housewives to reduce the amount of salt they add when cooking household meals, and 4) produced social media using community information and launched a communication campaign in the community and shops.

The Mechanism for Driving Plans

It was evident that driving the DHB's sodium consumption solution plans by pushing the reduction of sodium consumption is the DHB's issue. The policy shall be transferred from the district chief to the president of LAOs/sub-district headmen/village headmen. According to the results of the plan operation, the roles of a team at each level are summarized as follows:

The DHB had roles in formulating district policies by selecting the sodium consumption issue as an agenda for improving the quality of life of people, communicating policies and plans through the monthly meetings with heads of government agencies and subdistrict headmen/village headmen, and creating a mechanism for driving SHB and village plans to carry out household activities.

SHB had roles in integrating district plans and sub-district health fund plans/royal public health projects.

LAOs had roles in providing a budget, personnel, and material and equipment, e.g., salt meters and blood pressure monitors.

The roles of the Village Committee, which comprised of sub-district headmen or village headmen, members of LAOs and VHVs, consisted of communicating policies from the district chief, raising awareness, acting as a role model in reducing sodium consumption, visiting at-risk groups, randomly checking foods, measuring blood pressure, returning the information on the amount of salt in foods and blood pressure levels to the participants to raise awareness and encourage them via housewives who prepare household meals.

The SHPH had roles in providing academic support and knowledge of sodium consumption and the use of salt meters in foods to the DHB and the village committee via VHVs, and reporting the results of the operation via the SHB's mechanism and the sodium consumption solution sub-board to submit to the DHB for consideration.

VHVs had roles in providing education and creating awareness in regards to sodium/salt consumption, acting as role models, visiting at-risk groups, randomly checking food, measuring blood pressure levels, returning the measured salt content in foods and blood pressure levels, and encouraging them via housewives to raise awareness, as detailed in Figure 2.

The Results of the Solution Model (Part 2)

In part 2, the results of the solution model were divided according to the two study groups. In the DHB group, of the 17 members, more than half were female (52.9%), and most were aged between 51 and 60 years with an average (standard deviation) age of 48.1 (7.9) and 64.7% had completed a bachelor's degree. Knowledge of plan/project preparation and skills in plan/project management increased significantly after development of the model (Table 1).

Table 1. Comparison of mean scores of the DHB's knowledge on plan/project preparation and management skills before and after model development (n=17)

Variable	Before development		After development		Mean difference (95% CI)	*P*-value
	Mean	SD	Mean	SD		
Knowledge on plan/project preparation	4.59	1.73	17.23	2.75	12.65 (10.94, 14.35)	<0.001
Skills for plan/project management	22.18	9.75	33.12	6.40	10.94 (5.35, 16.53)	<0.001

In the at-risk group, of the 35 participants, two-thirds were female (60.0%) and almost half were aged 41-50 years (42.8%). The average (standard deviation) age was 42.3 (8.0) years. Almost half had either graduated from high school/vocational school (22.9%) or received a diploma/high vocational certificate (22.9%). Most were farmers (65.8%). More than two-thirds received information from public health officers/VHVs (69.1%), followed by online methods such as Line/Facebook/ YouTube/Email (59.5%). Knowledge on sodium consumption and health literacy in

all skills significantly increased after model development (Table 2). Sodium consumption behaviors and salt content in meals were also changed to preferable levels. Blood pressure levels also decreased (Tables 2 and 3).

We found a relationship between knowledge and sodium consumption behaviors (Table 4). However, there was no relationship between health literacy and sodium consumption behavior.

Table 2. Comparison of knowledge, health literacy and sodium consumption behaviors of risk groups before and after model development (n=35)

Variable	Before development		After development		Mean difference (95% CI)	*P*-value
	Mean	SD	Mean	SD		
Knowledge on sodium consumption	28.0	5.38	36.5	5.09	8.51 (6.15, 10.9)	<0.001
Overall health literacy	70.3	17.5	84.2	9.58	13.9 (7.39, 20.4)	0.0001
Data access skills	15.5	5.53	19.3	2.56	3.77 (1.74, 5.80)	0.0006
Understanding skills	13.7	3.35	16.1	1.39	2.46 (1.14, 3.77)	0.0006
Inquiry skills	15.0	4.84	17.8	4.34	2.80 (0.75, 4.84)	0.0088
Decision-making skills	13.3	3.81	16.0	1.54	2.77 (1.43, 4.11)	0.0002
Application skills	12.9	2.43	15.0	2.53	2.11 (1.05, 3.17)	0.0003
Sodium consumption behaviors	61.2	24.9	76.7	32.7	15.6 (1.06, 30.1)	0.0362

Table 3. Comparison of mean sodium levels in consumed or cooked foods and the mean blood pressure before and after model development (n=35)

Variable	Before development		After development		Mean difference (95% CI)	*P*-value
	Mean	SD	Mean	SD		
Amount of sodium in consumed or cooked foods (mg/100 mL)	306.5	86.5	161.1	78.6	-145.4 (-98.2, -176.8)	<0.001
Blood pressure level (mmHg)						
Systolic blood pressure	132.8	5.69	123.5	8.29	-9.31 (-5.33, -13.3)	<0.001
Diastolic blood pressure	84.0	2.97	80.4	4.84	-3.57 (-1.32, -5.82)	0.0028

Table 4. Relationship between sodium consumption knowledge and health literacy with sodium consumption behavior after model development

Characteristic	Number	Mean	SD	Mean difference			*P*-value
				Un-adjusted	Adjusted	95% CI	
Sodium consumption knowledge	35	36.5	5.09	2.60	2.54	0.51, 4.68	0.016
Health literacy	35	84.2	9.58	1.07	1.13	-0.52, 4.68	0.265

Discussion

Following the model development, the DHB determined that the model was successful at reducing sodium consumption, made it a district policy, and formulated a plan for the project at the district level by using a mechanism to drive project plans via the sodium consumption reduction sub-board. Plans transferred from the district level were integrated to the local health assurance fund (sub-district health fund) and royal public health projects subsidized by LAOs. This integration lets communities/villages prepare the sodium consumption solution projects to cover all sub-districts. This may be a result of plans and driving mechanisms from the district policy, whereby the district chief is the leader of the committee that is responsible for driving the plans. This will affect sub-mechanisms at the sub-district level because the district chief is the leader who has authority and duties in accordance with the provincial administration system and indirect power in supervising LAOs.[19] In addition, a key characteristic that is the strength of the DHB's mechanism relates to laws on the establishment of the board consisting of members from the public, private and community sectors. Their roles and duties in solving problems to improve the quality of life of the people were also clearly defined.[8] If the model to reduce sodium consumption is pushed through the DHB's non-communicable disease prevention and control issue based on empirical data, cooperation will be obtained and awareness of the model will be raised.

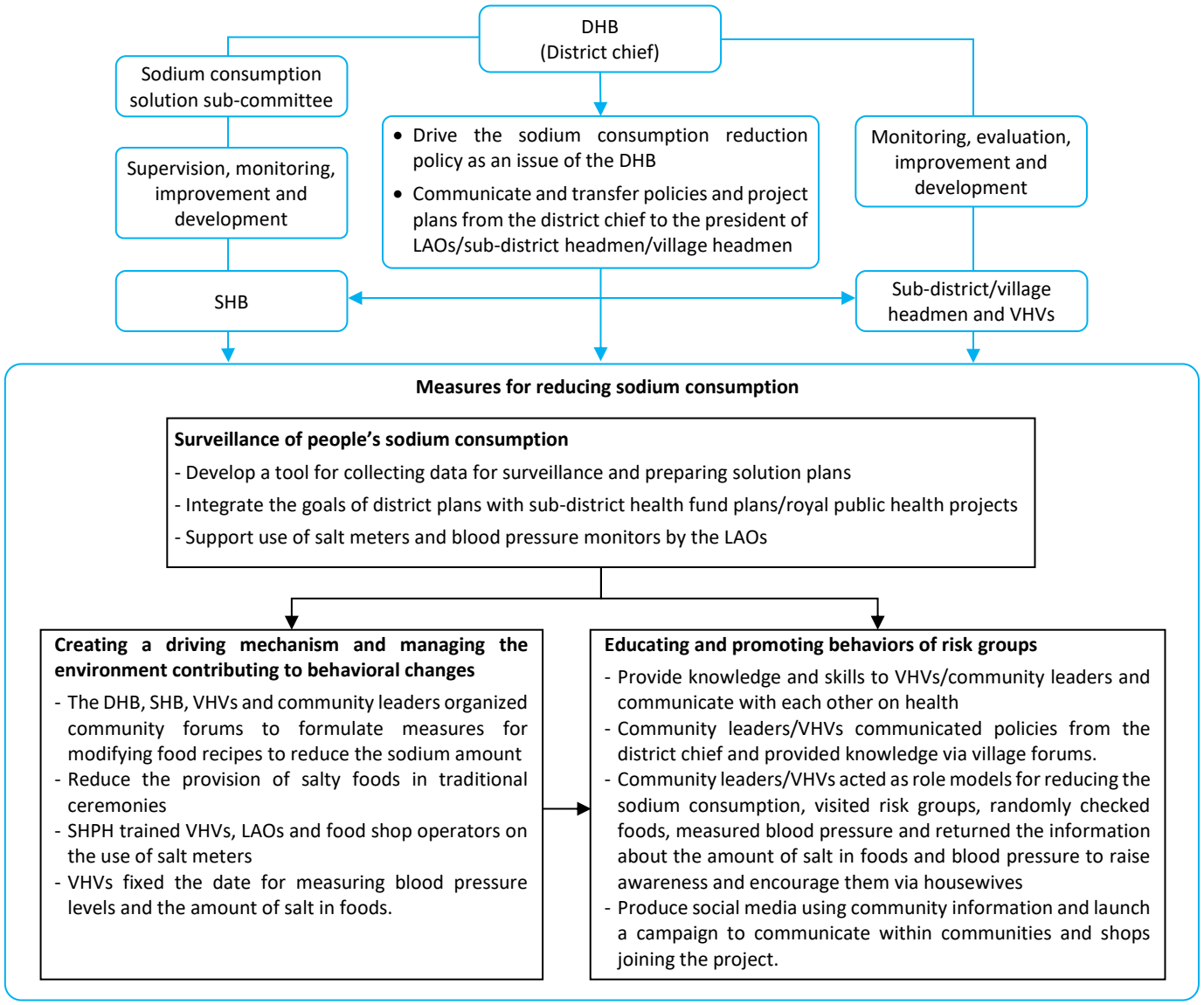

Figure 2. Model for reducing sodium consumption in districts using the DHB's mechanism

Reducing sodium consumption is a difficult behavior to change. However, in the case of communication to raise awareness from the district level through existing mechanisms, e.g., meetings among heads of government agencies, monthly meetings among sub-district headmen and village headmen, and regular reminders, this will eventually raise awareness in the society. The DHB's mechanism will be used to drive sub-district plans to the village. Involvement of VHVs in the project will lead to household changes resulting in changes in solving local problems. This is consistent with the concept of participation which posts that individuals or groups of people must take part in making decisions at different steps on their own, such as joint decision-making, co-development, and benefit-sharing.[20] Quality development for maximum efficiency must, therefore, start from setting common goals to emphasizing participatory operations of public, private, and community sectors through the planning, monitoring, and evaluation process based on all relevant committees.[21] Local information systems should be utilized to assess situations and problems and realize them by means of brainstorming meetings to respond to public needs or necessities. Clear policies and action plans, as well as engagement and strict monitoring, are necessary to enable improvements to quality of life to obtain good outcomes.[22] This is consistent with a study by Khongsateinpong K. who found that communities can be self-reliant because of the operation structure that encourages them to participate in decision-making to create engagement so that they can solve problems quickly.[23]

The analysis of the model developed by the researchers stated that it can enhance skills in managing plans of the health solution scheme. This may be a result of the process of workshop arrangement based on the conceptual framework of the logic model. Following the above-mentioned workshops, the sodium consumption solution plan at the district level was initiated through the participation of the DHB and at-risk groups. During the preparation of plans, the knowledge,

practices, suggestions, and consultations were provided by the research team. This corresponds to studies by Thammakun T. and Prompunjai P. which reported that the application of a logic model to develop a disease prevention and control model enabled the sub-district and district health team to have more knowledge and skills in preparing plans.[11,12]

After the model had been developed, the high-risk groups had better knowledge, better health literacy, and improved sodium consumption behaviors than before. We also found that the knowledge was related to sodium consumption behaviors because the project plans were initiated from the logic model conceptual framework, which was the outcome-based plan. The key activities were related to the knowledge and behavior changes of the at-risk group and consisted of the training and practices of the VHVs/community leaders who can communicate health policies through village forums and act as role models to reduce sodium consumption. In addition, there were also people's sodium consumption surveillance activities and mechanisms for changing the environment that contributes to behavioral changes by DHB, SHB, VHVs, and community leaders.[24–26]

However, we found no relationship between health literacy and sodium consumption behaviors, which is somewhat inconsistent with previous studies and may be explained by the fact that, although the participants had improved health literacy, this literacy may not be applicable for improving their health. However, the development of health literacy on people's sodium consumption, especially in rural areas, leading to their behavioral changes takes time to develop.[27,28] Beside knowledge, health literacy should be assessed and enhanced so that at-risk groups can apply their skills to properly reduce their sodium consumption, thus leading to more sustainable outcomes.

Behavioral changes related to sodium consumption of our participants led to a decreasing amount of salt added in prepared meals and decreasing blood pressure levels of at-risk groups compared to those before model development. This is in line with a study by Mente A et al, which found that the mean systolic blood pressure increased by 2.86 mmHg per 1 g increase in mean sodium intake.[29]

This study has one limitation which should be acknowledged. We used salt meters for measuring sodium intake instead of 24-hour urinary excretion, which is the standard method. However, the measurement of urine sodium excretion has limitations in the community. A further experimental study should be conducted in communities with a comparison group, including the measurement of 24-hour urinary excretion.

Conclusion and Recommendations

The development of a model for reducing sodium consumption among those at risk for hypertension using the DHB's mechanism led to increases in knowledge and health literacy, and improved sodium consumption behaviors. Significant success factors include the use of the district chief's leadership through the roles of the chairman of the DHB plus technical knowledge in formulating and communicating policies, as well as supervising and plan-driving mechanisms. However, without the academic process leading to participation of the DHB in solving community problems, the strengths of the above factors will not be utilized.

To ensure that the model is sustainable, the Ministry of Public Health and the Department of Disease Control, in collaboration with the Institute of Administration Development, Ministry of Interior, should develop problem-solving concepts to allow district chiefs to apply their technical knowledge to solve community problems. Thus, policy units should encourage the DHB to select non-communicable diseases, apply the model for reducing sodium consumption and develop the DHB's knowledge and skills as a mechanism for driving plans. The DHB should also formulate measures for providing education on sodium consumption through community leaders and VHVs and social media so that at-risk groups can apply their skills to change their sodium consumption behavior. This will lead to a reduction in blood pressure levels and, in turn, lower their risk of developing coronary heart disease, stroke and chronic kidney diseases.

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