Effectiveness of a Communication for Behavioral Impact (COMBI) Intervention to Reduce Salt Intake in a Vietnamese Province Based on Estimations From Spot Urine Samples

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This study evaluated the effectiveness of the Communication for Behavioral Impact (COMBI)–Eat Less Salt intervention conducted in Viet Tri, Vietnam. The behavior change intervention was implemented in four wards and four communes for one year, which included mass media communication, school interventions, community programs, and focus on high-risk groups. Mean sodium excretion was estimated from spot urine samples using different equations. A subsample provided 24-hour urine to validate estimates from spot urine. Information about salt-related knowledge and behaviors was also collected. There were 513 participants at both baseline and follow-up. Mean sodium excretion estimated from spot urines fell significantly from 8.48 g/d at baseline to 8.05 g/d at follow-up (P=.001). All spot equations demonstrated a significant reduction in sodium levels; however, the change was smaller than the measured 24-hour urine. Participants showed improved knowledge and behaviors following the intervention. The COMBI intervention was effective in lowering average population salt intake and improving knowledge and behaviors. *J Clin Hypertens (Greenwich).* 2016;18:1135–1142. © 2016 The Authors. *The Journal of Clinical Hypertension* Published by Wiley Periodicals, Inc.

Vietnam is experiencing an increasing burden of noncommunicable diseases (NCDs) such as cardiovascular diseases (CVDs), diabetes, chronic respiratory diseases, and cancer. According to the World Health Organization (WHO),[1] NCDs are estimated to account for 73% of total deaths in Vietnam, of which almost 50% can be attributed to CVD. High salt intake has been demonstrated to be highly associated with raised blood pressure (BP), which, in turn, contributes to increased rates of CVD.[2–4] In all settings, a population-wide salt reduction strategy is recommended by WHO as one of the most cost-effective interventions to reduce NCDs.[5–8] Many countries already have national salt reduction strategies in place.[5,9]

In Vietnam, in contrast to many Western developed countries where the majority of salt comes from processed foods and meals, about 80% of salt consumed comes from table salt or salty condiments at home.[10] As such, programs to change population behavior will be a fundamental component of salt reduction efforts in the country. Communication for Behavioral Impact (COMBI),[11–13] a planning and implementation tool for communicating strategically to achieve positive behavior change, was used to inform the development of the Eat Less Salt (ELS) intervention in Viet Tri. The aim of this study was to evaluate the effectiveness of the ELS intervention with a view to scaling up to a regional or national level.

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METHODS

A repeat cross-sectional study design was employed to evaluate the impact of the COMBI-ELS intervention. The main objectives were to: (1) assess the changes in salt excretion as estimated by spot urine samples with 24-hour urine from a subsample; (2) assess changes in knowledge and behaviors regarding salt consumption; and (3) assess changes in health outcomes such as BP and prevalence of hypertension.

The study was implemented in four wards and four communes (total population 80,000) in the city of Viet Tri, Phu Tho Province, from June 2013 to June 2014. It included a baseline survey of the population, a 12-month period of community-based interventions, and a follow-up survey of the population to assess any change. The surveys were carried out under the supervision of the National Institute of Nutrition (NIN) and the WHO in Hanoi. Ethics approval was obtained from the NIN ethics committee. All participants were fully informed of the aim, nature, and risk of the study prior to providing written informed consent.

Participant Selection

The surveys consisted of adults aged 25 to 64 years living within the wards and communes of Viet Tri city. Different sets of respondents (unmatched) were recruited at baseline and follow-up. For each ward or commune, participants were randomly selected from the list of all adults aged 25 to 64 years provided by the health center, stratified according to age group and sex. Only one subject per household was allowed to participate. Subjects were excluded if they were pregnant or lactating (in the first 12 months after birth), had impaired communication skills, or were physically disabled.

In addition, one ward and one commune were randomly selected from the eight study sites and all identified participants from these areas were requested to provide a 24-hour urine sample in addition to the spot urine sample.

Data Collection

The following information was obtained from the selected participants: (1) knowledge and behaviors on salt consumption; (2) physical measurements including BP, waist circumference, height, weight, and body mass index (BMI); and (3) spot urine for estimation of 24-hour sodium excretion.

Demographic information and assessment of knowledge and behaviors was collected through face-to-face interviews. Waist circumference was measured in centimeters at the topline of the hipbone using a nonstretchable tape. Height was measured in centimeters using a wooden stadiometer and recorded to the nearest 0.1 cm. Weight was measured in kilograms using an electronic weighing scale (model 882; SECA GmbH & Co., Hamburg, Germany) and recorded to the nearest 0.1 kg. BMI was calculated, and BP was measured using a digital automatic BP monitor (model HEM-711AC; Omron, Kyoto, Japan). After participants had rested for 15 minutes, three readings were taken at 3-minute intervals with the participants in the sitting position with their legs uncrossed. The average of the second and third measurements were recorded as the BP values for each participant. Participants were classified as hypertensive if any of the following was met: systolic BP (SBP) $\geq$140 mm Hg or diastolic BP (DBP) $\geq$90 mm Hg or taking BP-lowering medications within the past 2 weeks.

Spot urine samples were collected in the afternoon, sodium excretion was estimated from a spot urine analysis, and 24-hour urine collections were obtained from a subsample.

Oral instructions for 24-hour urine collection were provided to the subsample before the survey and detailed written instructions were also given. Participants were asked to void all urine to have an empty bladder prior to recording the start time of urine collection. Each participant was given two 1.5-liter bottles and was asked to collect all urine voided in the next 24 hours. Urine collection ended on the same time the next day. The times at the beginning and the end of urine collection as well as the total urine volume were recorded. Following urine collection, the participants were interviewed using a short questionnaire to provide information on the completeness of urine collection. A sample of 10 mL from the total volume was kept in a cool box or refrigerator prior to transport to laboratory for analysis.

All spot and 24-hour urine samples were analyzed for sodium, potassium (using ion-selective electrode potentiometry), and creatinine (using spectrometry) at the biochemistry laboratory of NIN.

The Community-Based Intervention

The ELS intervention was based on the COMBI framework, which utilizes an integrated mix of five communication action areas, namely public advocacy to mobilize decision-makers, community mobilization to engage community leaders, sustained community-based social marketing to remind communities of the problem, information provision to individuals through face-to-face engagement, and point-of-service promotion to services such as healthcare centers.[13] The three specific behavior change aspects that the COMBI-ELS intervention targeted were to: (1) reduce use of salt in cooking; (2) reduce discretionary salt use at the table; and (3) improve selection of low-salt foods. The project communicated these messages through four key strategies: using mass media communications, interventions in 10 primary schools, community communication programs, and a focus on communicating with high-risk groups including people with hypertension. The activities implemented for each key intervention are detailed in Table I.

Outcome Measures

Three sets of outcome variables were measured, including: (1) changes in mean salt excretion as estimated by spot urine samples (with the equations validated through 24-hour urine collections from a subsample); (2) changes in knowledge and behaviors regarding salt consumption, particularly the three specific behaviors identified above; and (3) changes in health outcomes such as mean SBP, mean DBP, and prevalence of hypertension.

Statistical Analysis

The study was designed to provide 90% power to detect a minimum difference of 1.4 g/d in mean sodium excretion between the baseline and follow-up surveys, as estimated from spot urine samples. This estimate assumed an alpha of 0.05, a standard deviation of sodium intake of 3.3 g/d based on the most recent survey in a rural community in Hanoi,[14] and a required sample size of 117 subjects for each of the four strata (urban men, urban women, rural men, and rural women) plus an additional 10% to account for the possible dropouts during the study, yielding a total sample size of 512 participants at baseline and follow-up. Thus, for each study area, about 64 subjects were set to be included. In addition, the sample size for the subsample was 128 subjects (64 from one ward and 64 from one commune) at baseline and follow-up.

Data entry was performed using EpiData software. The characteristics of the survey participants were summarized for both baseline and follow-up and compared using unpaired *t* test for continuous variables and chi-square test for categorical variables. Mean sodium

TABLE I. Key Interventions and Activities of the Communication for Behavioral Impact (COMBI)–Eat Less Salt (ELS) Program

Intervention	Activities
Mass media communication	• Developed a TV program and produced a film about salt reduction that was featured on Phu Tho television • Broadcasted messages on loudspeakers and radio program • Published and delivered a health newsletter with a special topic on salt reduction to health institutes • Raised awareness about salt through local committees, schools, and related units
Intervention in schools	• Communicated information about salt reduction and proper diets to teachers and students of primary schools through school activities • Provided leaflets • Trained cooks and personnel responsible for developing menus on how to reduce salt and improve the nutritional quality of meals for primary school children • Promoted healthy eating behaviors such as eating more vegetables and fruits, limiting fat intake, and reducing consumption of soft drinks and snacks by educating school children, parents, teachers, and school cooks
Community communication programs	• Established a communication group in each village • Implemented Information, Education and Communication activities such as broadcasting messages through loudspeakers, erecting panels at public places, placing posters for community events, and distributing ELS leaflets • Integrated the issue of salt reduction into community meetings and social unions • Organized community events about prevention of hypertension and cardiovascular diseases
High-risk and hypertension groups	• Home visits to measure blood pressure of adults aged 40 years and older and to provide information on ELS for other members of the household • Provided advice about prevention and control of hypertension and gave instructions to visit the health station for diagnosis and treatment • Monitored blood pressure of hypertensive patients twice every 6 months

excretion levels were estimated from spot urine using five different equations (International Cooperative Study on Salt, Other Factors, and Blood Pressure [INTERSALT],[15] Tanaka,[16] Mage,[17] Kawasaki,[18] and the simple equation[19]). The INTERSALT equation estimates 24-hour sodium excretion through a regression model with personal (age, sex, and BMI) and spot sample (sodium, potassium, and creatinine) measurements.[15] The other four equations estimate 24-hour sodium excretion by multiplying the ratio of sodium to creatinine in the spot sample with the estimated 24-hour creatinine excretion. For the purpose of this study, the INTERSALT equation was used as the primary outcome measure given that it has been applied to several populations and yielded estimates of salt excretion that closely matched 24-hour urine data.[20] The equations were validated by comparing the estimated salt excretion levels with the measured 24-hour salt excretion from the subsample. Given that a number of factors may interfere with the accuracy of 24-hour urine collection including respondents forgetting to collect some urine or going beyond the 24-hour collection period, or spillage, 24-hour urine samples were excluded from the analysis if total urine volume was <500 mL or if total creatinine was <6 mmol or >30 mmol for men or <4 mmol or >25 mmol for women.[21–23]

Throughout, a P value of ≤.05 was taken to indicate a significant finding. Data analyses were carried out using Stata IC version 13.0 for Windows (StataCorp, College Station, Illinois). No missing data were imputed.

RESULTS

Population Characteristics

There were 513 survey participants at both baseline and follow-up. However, four respondents were excluded from the baseline analysis because of missing age or sex data, leaving 509 respondents at baseline. In addition, two were excluded from the follow-up analysis because of missing spot urine data, leaving 511 respondents at follow-up. The mean age of the total sample was 45 years with even distribution through the age groups, approximately equal numbers of men and women, most people educated to a secondary level, and about 80% employed at both baseline and follow-up. The follow-up survey participants were on average more highly educated (P=.016) and had a greater waist circumference (P=.049) (Table II).

Spot urine data were available for 509 and 511 survey participants and 24-hour urine data from 123 and 112 individuals at baseline and follow-up, respectively. A total of 34 and 39 24-hour urine samples from baseline and follow-up, respectively, were excluded from the analysis because of suspected incomplete urine collection based on urine volume and creatinine criteria, leaving 88 and 73 24-hour urine samples at baseline and follow-up. There were no significant differences in age, weight, BMI, sex distribution, BP, or use of antihypertensive medications between participants who collected 24-hour urine and spot urine at both baseline and follow-up. At baseline, there were more employed

TABLE II. Characteristics of Participants

Characteristics	Baseline (n=509)	Follow-Up (n=511)	*P* Value
Age, mean (SD), y	45.27 (11.85)	44.83 (11.70)	.555
Age group, No. (%), y			
25 to 34	115 (22.59)	126 (24.66)	.846
35 to 44	130 (25.54)	129 (25.24)	
45 to 54	128 (25.15)	129 (25.24)	
55 to 64	136 (26.72)	127 (24.85)	
Sex, No. (%)			
Male	251 (49.31)	233 (45.60)	.235
Female	258 (50.69)	278 (54.40)	
Area, No. (%)			
Urban	256 (50.29)	255 (49.90)	.900
Rural	253 (49.71)	256 (50.10)	
Education, No. (%)			
Primary school or less completed	36 (7.07)	16 (3.13)	.016
Secondary school completed	358 (70.33)	373 (72.99)	
Post secondary or university	113 (22.20)	122 (23.87)	
No response	2 (0.39)	0 (0.00)	
Employment status, No. (%)			
Employed	396 (77.80)	409 (80.04)	.274
Unemployed or student	111 (21.81)	102 (19.96)	
No response	2 (0.39)	0 (0.00)	
Height, mean (SD), cm	158.24 (7.89)	157.80 (7.51)	.359
Weight, mean (SD), kg	55.04 (8.53)	54.42 (8.01)	.230
BMI, mean (SD), kg/m^2	21.94 (2.72)	21.82 (2.57)	.462
BMI group[a], No. (%)			
Underweight	50 (9.82)	49 (9.59)	.321
Normal	391 (76.82)	406 (79.45)	
Overweight	63 (12.38)	55 (10.76)	
Obese	5 (0.98)	1 (0.20)	
Waist circumference, mean (SD), cm	77.81 (7.68)	78.76 (7.71)	.049
SBP, mean (SD), mm Hg	126.35 (17.63)	120.42 (16.47)	<.001
DBP, mean (SD), mm Hg	78.23 (10.84)	73.37 (11.12)	<.001
Use of BP-lowering medications, No. (%)			
Yes	45 (8.84)	56 (10.96)	.257
No	464 (91.16)	455 (89.04)	
Hypertension status[b], No. (%)			
Hypertensive	133 (26.13)	108 (21.14)	.060
Normotensive	376 (73.87)	403 (78.86)	

Abbreviation: SD, standard deviation. [a]Respondents were classified as underweight, normal weight, overweight, and obese if body mass index (BMI) was <18.5, 18.5 to 24.9, 25.0 to 29.9, or ≥30.0, respectively. [b]Respondents were classified as hypertensive if any of the following criteria was met: systolic blood pressure (SBP) ≥140 mm Hg or diastolic blood pressure (DBP) ≥90 mm Hg or taking blood pressure (BP)–lowering medications within the past 2 weeks.

participants from the subsample compared with those who collected spot urine (*P*=.012). At follow-up, there was a difference between the subsample and spot sample in terms of education (*P*=.026) (Apendix S1).

Effects on Salt Intake

Using the INTERSALT equation, the mean salt excretion was 8.48 g/d (standard deviation [SD] 2.13 g/d) at baseline and 8.05 g/d (SD 2.11 g/d) at follow-up (Δ=−0.43 g/d; 95% confidence interval [CI], −0.69 g/d to −0.17 g/d [*P*=.001]). There was a small but significant decrease in the proportion of the population who had salt excretion above the WHO guideline of 5 g/d from baseline to follow-up (97.64% vs 94.72%, *P*=.015).

Table III shows the estimated 24-hour salt excretion from spot urine samples using different equations and the measured salt excretion from the subsample. Based on the measured 24-hour urine, the mean salt excretion was 9.43 g/d (SD 3.69 g/d) at baseline and 7.44 g/d (SD 4.09 g/d) at follow-up. All equations underestimated the change in mean salt excretion compared with the measured 24-hour urine (−1.99 g/d). The extent of the change from the spot equations also varied, ranging from −0.43 g/d to −1.73 g/d, although there was a significant reduction in mean salt intake following the intervention regardless of which equation was used (all *P* values <.05). Sensitivity analysis showed a similar trend among

TABLE III. Comparison of Estimates Obtained From 24-Hour Urine and Spot Urine Samples

	Salt Intake, g/d (mean, SD)					
Equation	No.	Baseline	No.	Follow-Up	Difference (95% CI)	*P* Value
24-h urine	88	9.43 (3.69)	73	7.44 (4.09)	−1.99 (−3.20 to −0.78)	.002
INTERSALT equation	509	8.48 (2.13)	511	8.05 (2.11)	−0.43 (−0.69 to −0.17)	.001
Tanaka equation	509	9.94 (2.64)	511	9.21 (2.84)	−0.73 (−1.06 to −0.39)	<.001
Mage equation	509	10.07 (8.50)	511	8.74 (8.25)	−1.34 (−2.37 to −0.31)	.011
Kawasaki equation	509	13.98 (5.06)	511	12.88 (5.19)	−1.09 (−1.72 to −0.46)	.001
Simple equation[a]	509	12.37 (9.85)	511	10.64 (9.38)	−1.73 (−2.92 to −0.55)	.004

Abbreviations: CI, confidence interval; INTERSALT, International Cooperative Study on Salt, Other Factors, and Blood Pressure; SD, standard deviation.

[a]Based on the equation used by Mann and Gerber (2010)[19] to estimate 24-hour sodium excretion from spot urine samples. The equation predicts the 24-hour estimate by calculating the ratio of sodium and creatinine in the spot sample then multiplying this ratio by the individuals' measured 24-hour creatinine excretion. In this paper, the equation was modified such that 24-hour creatinine excretion was predicted using Tanaka's formula: 24-hour predicted creatinine (mg/d)=−2.04×age+14.89×weight+16.14×height−2244.45. In addition, 24-hour predicted sodium was computed using the formula: [Spot Na (mmol/l) ÷ (Spot Crea (mg/dL)×10)]×24-hour predicted creatinine (mg/d).

individuals not taking any antihypertensive medications (Appendix S2).

Effects on Knowledge and Behaviors Related to Salt Consumption

There were large and significant absolute increases in the proportion of participants demonstrating positive changes in knowledge and behaviors between baseline and follow-up. About twice as many people were aware that high salt intake could cause hypertension (43.61% vs 86.30%, *P*<.001), three times as many knew it could cause a heart attack (5.50% vs 17.03%, *P*<.001), and about five times as many people knew it could lead to stroke (9.25% vs 46.58%, *P*<.001) (Table IV).

In terms of the three specific targeted behaviors, there was an eight-fold increase in the proportion of participants reporting that they limited adding salt or sauces when cooking (5.91% vs 43.84%, *P*<.001), and a six-fold increase in the number of participants limiting adding salt or sauces at the table (13.19% vs 61.64%, *P*<.001). Furthermore, there was a 10-fold increase in the number of participants limiting processed foods (3.54% vs 35.81%, *P*<.001) or dishes high in salt (2.95% vs 31.31%, *P*<.001).

TABLE IV. Effects of Intervention on Knowledge and Behaviors Towards Salt

Knowledge and Behaviors Towards Salt	Baseline (n=509)	Follow-Up (n=511)	*P* Value
Knowledge on consequences of high salt intake			
High salt intake can cause hypertension	222 (43.61)	441 (86.30)	<.001
High salt intake can cause stroke	47 (9.25)	238 (46.58)	<.001
High salt intake can cause heart attack	28 (5.50)	87 (17.03)	<.001
Knowledge on dietary sources of salt			
Available in processed food	22 (4.33)	62 (12.13)	<.001
Available in natural food	17 (3.35)	25 (4.89)	.215
Discussion with others about salt reduction			
Never	329 (65.15)	74 (14.48)	<.001
Several times	129 (25.54)	172 (33.66)	
Many times	47 (9.31)	265 (51.86)	
Apply measures to reduce salt intake	95 (19.00)	442 (86.50)	<.001
Measures done to reduce salt intake			
Limit processed foods	18 (3.54)	183 (35.81)	<.001
Limit foods or dishes high in salt	15 (2.95)	160 (31.31)	<.001
Read sodium content in food labels	0 (0.00)	14 (2.74)	<.001
Limit adding salt or sauces when cooking	30 (5.91)	224 (43.84)	<.001
Use salt substitute or low-sodium seasoning	1 (0.20)	13 (2.54)	.001
Limit adding salt or sauces when eating	67 (13.19)	315 (61.64)	<.001
Use other spices than salt when cooking	2 (0.39)	38 (7.44)	<.001
Limit eating outside	4 (0.79)	25 (4.89)	<.001

Values are expressed as number (percentage).

TABLE V. Hypertension Status Before and After the Intervention

BP Classification	Baseline (n=509)	Follow-Up (n=511)	*P* Value
Hypertension: SBP ≥140 mm Hg OR DBP ≥90 mm Hg OR taking BP-lowering drug in the past 2 weeks	133 (26.13)	108 (21.14)	.060
Hypertension level 1: SBP 140–159 mm Hg OR DBP 90–99 mm Hg	100 (19.65)	65 (12.72)	.003
Hypertension level 2: SBP 160–179 mm Hg OR DBP 100–109 mm Hg	28 (5.50)	12 (2.35)	.009
Hypertension level 3: SBP ≥180 mm Hg OR DBP ≥110 mm Hg	8 (1.57)	3 (0.59)	.128
Controlled hypertension: taking BP-lowering drug AND SBP <140 mm Hg AND DBP <90 mm Hg	19 (3.73)	32 (6.26)	.064

Abbreviations: BP, blood pressure; DBP, diastolic blood pressure; SBP, systolic blood pressure. Values are expressed as number (percentage).

TABLE VI. Management of Hypertensive Individuals

	Baseline (n=133)	Follow-Up (n=108)	*P* Value
Awareness of hypertensive status			
Aware	46 (34.59)	55 (50.93)	.011
Unaware	87 (65.41)	53 (49.07)	
Management of hypertension			
Managed by health staff	33 (24.81)	35 (32.41)	.193
Come for checkup and medications when experiencing episodes of hypertension	3 (2.26)	9 (8.33)	.031
No treatment at all	94 (70.68)	61 (56.48)	.022
No response	3 (2.26)	3 (2.78)	

Values are expressed as number (percentage).

Changes in Health Outcomes

The mean SBP and DBP were significantly lower following the intervention. The net reductions in SBP and DBP were −5.93 mm Hg (95% CI, −8.03 mm Hg to −3.83 mm Hg; *P*<.001) and −4.86 mm Hg (95% CI, −6.21 mm Hg to −3.51 mm Hg; *P*<.001), respectively. Furthermore, the proportion of respondents with hypertension was 26.13% at baseline and 21.14% at follow-up, although this reduction was not statistically significant (*P*=.060). Table V shows the distribution of participants before and after the intervention with respect to their BP classification.

Among those with hypertension (n=133 at baseline and 108 at follow-up), the proportion of participants who were aware of their hypertensive status had improved significantly (34.59% vs 50.93%, *P*=.011) (Table VI) and there were fewer hypertensive subjects with no management or treatment (70.68% vs 56.48%, *P*=.022) following the intervention.

DISCUSSION

The study demonstrates the potential for a community-based salt reduction behavior change intervention to reduce mean population salt consumption. Over one year, it was possible to achieve a substantial reduction in salt excretion as well as markedly improve knowledge and behaviors related to salt consumption in Viet Tri. There was also a significant reduction in BP following the intervention (both SBP and DBP). This reduction in BP could have large health impacts and potentially save thousands of lives. High BP is known to be the leading cause of death and disability causing premature stroke, heart attack, and kidney disease in very large numbers of people. The recent Global Burden of Disease study showed that it was responsible for 9.4 million deaths worldwide.[24]

The relationship between lowering BP and reducing the risk of cardiovascular outcomes has been established through drug-based methods and there is a strong logical basis for assuming that BP reduction achieved by lowering salt intake would be similarly effective.[25] Findings from systematic reviews of randomized trials have shown that reductions in salt intake lower BP,[26] and while there has been some debate about the likely effects of salt reduction on CVD, the totality of evidence is convincing.[27] A study conducted in 2009 estimated that a decrease in salt intake from 10 g to 5 g per day would reduce stroke rate by 23% and overall CVD by 17%. This is equivalent to 1.25 million deaths from stroke and almost 3 million deaths from CVDs averted each year.[4]

In line with the results of other studies, our data show that not all cases of hypertension are being treated. A previous study in Vietnam[28] showed that among hypertensive patients, only 29.6% were undergoing treatment. In another study comparing the treatment and control of hypertension in high-, middle-, and low-income countries,[29] results showed that the proportion of hypertensive patients who are being treated ranged from 31.7% in low-income countries to 48.3% in high-income countries. The high prevalence of hypertension and poor treatment in Vietnam requires both a population-based strategy, such as salt reduction, and a clinical strategy to prevent, manage, or treat this condition to avoid its complications.

Our results indicate that the average population salt excretion in Vietnam is still around 3 g higher than the WHO's recommended salt intake of 5 g/d.[30] More than 90% of the participants had sodium excretion levels that were higher than the recommended intake level, even following the intervention. These figures are concordant with the results of similar studies conducted in Vietnam where mean salt excretion was between

9.9 g/d and 11.0 g/d[14,31] and clearly support the need for continued efforts to reduce salt in Vietnam.

Based on evidence to date, the COMBI approach appears to be an effective way of getting people to change their behavior in relation to salt. Most indicators of salt-related knowledge or behaviors improved between two-fold and 10-fold in this pilot study in Vietnam, including the specific behavior change objectives of reducing use of salt in cooking, reducing discretionary salt use at the table, and selecting low salt foods. Similar results were found in a community intervention study conducted in Lithgow, Australia. This reported that the integrated social marketing efforts involved in the COMBI intervention were effective in delivering significant positive changes in behavior towards salt consumption as well as a reduction in salt intake.[32]

While both studies were clearly effective, there are limitations with interpreting the outcomes. In the Vietnam study, for example, it is not possible to ascertain which elements of the intervention were most effective in changing behavior. The lack of information on salt intake or behavior in children and the absence of an evaluation of the school program, in particular, means it is not possible to assess the contribution of the work in schools to the broader program. Likewise, while the fairly substantial (albeit non-significant) increase in the number of people with controlled hypertension suggests that the home visits and increased advice to hypertensive subjects has been effective in improving awareness, diagnosis, and treatment of hypertension, this could equally have arisen by chance attributable to the random sampling. Likewise, in the Lithgow study, while a key element of the COMBI strategy was around the promotion of the use of a potassium-enriched salt substitute, there was no increase in the potassium levels of the study population, indicating that other behavioral changes were most likely behind the reduction. Additional evaluation activities including a detailed process evaluation would be helpful to better understand which aspects of the intervention were effective and to generate lessons to inform the scaling up of these interventions nationally and potential translation to other countries.

This study provides further evidence to support the premise that estimations of salt excretion from spot urine samples can be used to measure changes in population sodium excretion.[20,33–35] Although the five equations overestimate and underestimate excretion at different levels, they all showed concordant and significant reductions in line with the sodium excretion measured from 24-hour urine samples. The WHO is supporting countries to measure population salt intake as part of its STEPwise approach to surveillance of noncommunicable risk factors. This approach has been piloted in Samoa.[36] The WHO recommends that where possible and appropriate, countries should collect 24-hour urine samples but recognizes that this is not always possible, in which case, countries should obtain spot samples from a representative sample of the population. However, further robust research studies on spot urine estimations are still required to better understand which equations to use in different population groups[2] and it is therefore still important to continue to collect 24-hour urine samples from a subsample of population surveys to validate the estimates from spot urine samples if possible.

A nationally representative survey of population salt intake was undertaken in Vietnam in December 2015, following the pilot intervention, and will provide a baseline for a national strategy to be implemented over the next 10 years. This pilot intervention has clearly demonstrated the potential of the set of community-focused interventions that are included in the COMBI behavior change strategy to reduce population salt intake. However, other strategies, including the use of a salt substitute, have also been successfully implemented in Vietnam,[14] and consideration should also be given to integrating the two successful interventions into the proposed national strategy.

CONCLUSIONS

The community-based salt-reduction intervention based on the COMBI framework was effective in lowering salt intake in adults in a province of Vietnam and consideration should be given to scaling this up as part of the planned national salt reduction strategy. Further formative work may be needed to assess the costs and feasibility of implementing all the components of this program at a national scale.[37] Salt reduction has been identified as one of the most cost-effective approaches for reducing the growing burden of noncommunicable diseases around the world. While the program described here offers policy makers a valid approach for delivering salt reduction to some communities, there is also a need for continued research to determine the optimal approaches for other communities where adding salt to food during cooking and at the table has become customary.

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Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article:.

Appendix S1. Comparison of characteristics of participants with spot vs 24-hour urine samples at baseline and follow-up.

Appendix S2. Comparison of estimates obtained from 24-hour urine and spot urine samples among individuals not taking antihypertensive medications.