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Development and validation of a self-assessment instrument for sodium intake in the population aged 30-44 years in 4th Regional Health, Thailand

Krich Ruangchai* **and Artitaya Wangwonsin**

Faculty of Public Health, Naresuan University, Phitsanulok Province, Thailand.

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ABSTRACT

Background: Laboratory-based urine tests are the current standard for assessing sodium intake but are complex and costly. This study aimed to develop a valid, self-assessment questionnaire aligned with laboratory findings using a six-step instrument development process.

Objective: To develop and validate a self-assessment instrument for estimating sodium intake among individuals aged 30–44 years.

Materials and methods: The six-step process involved (1) defining sodium intake by reviewing existing research; (2) creating a list of items based on different food types and how they are eaten; (3) deciding on the format and scale for assessment; (4) checking face validity with feedback from expert advisors; (5) evaluating content validity with five experts and calculating the Item-Objective Congruence (IOC); and (6) testing construct and concurrent validity using ROC analysis.

Results: We categorized a total of 157 food items for inclusion. The questionnaire used a checklist format with frequency ratings (1–7 times/day). Content validity yielded IOC values between 0.6 and 1.0, with 151 items retained. Construct validity showed strong alignment with sodium excretion levels, with a cut-off point of 3.46 and an ROC of 93.3%. Of 120 participants, 112 were correctly classified, yielding 92.8% sensitivity, 95.2% specificity, a 6.7% false positive rate, and 86.7% accuracy (95% CI = 0.880-0.987).

Conclusion: The developed self-assessment tool is practical for single-day dietary evaluation and demonstrates high specificity and accuracy. It offers a reliable, cost-effective alternative for assessing sodium intake at the population level.

Introduction

Sodium is an essential mineral for maintaining blood electrolyte balance. Consumed primarily through diet, excessive or insufficient sodium intake can disrupt blood pressure and contribute to health problems.[1] In developing countries, NCDs are causing a public health crisis, with rising rates of illness and premature death, especially among those aged between 30-60.[2,3] Globally, NCDs account for 41 million deaths annually, representing a 71% increase in recent years. The Easthand Southeast Asian regions are particularly hard hit, with approximately 10.4 million deaths attributable to NCDs each year.[4]

Hypertension (45.0%) and diabetes (28.7%) accounted for the highest mortality rates among individuals with non-communicable diseases (NCDs). Dietary habits high in sugar, fat, and salt were the primary risk factors.[5,6] Thailand has approximately 14 million NCD patients, with

* **Corresponding contributor.**
Author's Address: *Faculty of Public Health, Naresuan University, Phitsanulok Province, Thailand.*
E-mail address: krichrua@gmail.com
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over 300,000 deaths annually.[7] The working-age cohort aged 30-44 exhibits early hypertension risk indicators coupled with a diminished engagement in preventive health behaviors, encompassing self-assessment and routine examinations.[8,9] The average age of onset is 40.5 years, with hypertension (21.4%) and hyperlipidemia (19.4%) being the most common NCDs.[10] Lifestyle factors, particularly dietary habits deeply rooted in Thai culture, can be linked to the disease. The high and frequent consumption of sodium-rich foods, such as sukiyaki, shabu-shabu, and instant noodles, combined with the traditional use of salt in cooking, contributes significantly to the problem.[11]

To effectively assess sodium intake within a general population, it is necessary to employ assessment instruments with high specificity for dietary behavior. This approach facilitates the collection of comprehensive data, crucial for accurately evaluating population sodium intake and informing precise dietary behavior interventions and policies aimed at reducing consumption. Currently, two primary categories of instruments are available for this purpose. The first is 24-hour urinary sodium excretion, which is considered the gold standard for sodium intake assessment.[12] However, this method is expensive and not easily accessible to the general population. The urine collection process is also complex, requiring specialized training for sample collectors, making it impractical for large-scale population studies. For the second, four primary methods employing questionnaires or interviews are utilized in Thailand for the assessment of dietary behavior: the Food Record, the 24-hour Dietary Recall, the Food Frequency Questionnaire (FFQ), and the Diet History. Each of these methodologies presents distinct advantages and limitations, and the selection of a particular method is contingent upon the specific objectives of the research or evaluation endeavor.[13] Based on the examination of research instruments utilized in international studies, 1) the Food Frequency Questionnaire (FFQ) is limited by its reliance on exhaustive food lists, which can hinder respondents' accurate recall of dietary intake. Consequently, validation through supplementary assessment instruments, such as food diaries or urinary sodium excretion assessment, is often necessary,[14,15] 2) the Sodium Food Frequency Questionnaire (FFQ-Sodium)[16] was developed to provide a quick and minimally burdensome method for assessing sodium intake. By focusing on high-sodium foods relevant to high-risk groups in specific communities, it maintains a relatively low error rate.[17] However, it is limited by delays in providing results and the time required to calculate sodium content from the collected data.[18] This tool requires participants to log all meals, food items (including sodium-rich sources), and quantities over at least three days. To ensure data accuracy, simultaneous data collection is needed across all participants within a standardized timeframe.[19] Similarly, the Dietary Record and Discretionary Salt Questionnaire (DSQ) assesses sodium intake through the self-recording of food consumption and added sodium over a minimum of three days. Data are captured electronically via websites, mobile apps, or computer programs to reduce recall errors and facilitate easy recording across different formats.[20]

An analysis of available data reveals a limited range of standardized and accessible tools for assessing sodium intake in Thailand, with reliance mainly on laboratory testing.

To address this gap, this study aimed to develop a self-assessment instrument for sodium consumption, targeting the 30-44 age group in the 4th Health Region, Thailand. This demographic was chosen due to age-related declines in physiological functions, the high prevalence of chronic non-communicable diseases linked to excessive sodium intake, and limited engagement in sodium reduction strategies. National survey data show this group consumes an average of 3,200 mg of sodium per day, exceeding the recommended intake. The region's diverse population allows for a broad representation of dietary behaviors, making it ideal for developing and validating a comprehensive sodium intake assessment tool.[21,22] The instrument development involved two integrated assessment methods, comprising the Food Frequency Questionnaire (FFQ) and food record, allowing for Receiver Operating Characteristic (ROC) analysis to determine an optimal cut-off point based on urinary sodium excretion data as the gold standard. The development process included defining sodium consumption, following a standardized protocol, and rigorously validating the tool's psychometric properties to ensure reliability and ease of self-assessment. The resulting data is expected to inform evidence-based policy changes and the design of targeted community interventions.

Materials and methods

This research obtained ethical approval from the Naresuan University Ethics Committee (IRB No. P3-0013/2565, COA No.215/2022). The research employed a methodological study design[23] and followed a six-step process[24] for the development and validation of the instrument.

Step 1: Definition of sodium intake

To assess sodium consumption patterns, a literature review was conducted using databases related to nutrition, health, and academic theses, with keywords such as "sodium intake," "dietary sodium sources," "high-sodium foods," "Thai diet," and "sodium intake assessment." Key definitions and food categories were synthesized from the literature.

Concurrently, a community-based survey was administered within the 4th Regional Health area using both online (Google Forms) and offline (paper-based) open-ended questionnaires to identify the kinds of sodium-rich foods commonly consumed. For participants without internet access, paper surveys were distributed via community coordinators and returned using a secure, opaque drop box placed in a central community location. This approach facilitated the inclusion of locally relevant foods not captured in existing literature.

The survey targeted 270 individuals aged 30-44 years, selected through simple random sampling based on Cohen's formula for sample size estimation.[25,35] Inclusion criteria required basic literacy and the ability to recall and report past food consumption. Individuals with cognitive or medical conditions affecting data reliability were excluded.

The findings from the literature and field survey were integrated to compile a context-specific food item list. Selected items were analyzed using Inmucal-N software developed by the Institute of Nutrition, Mahidol University, to determine standardized sodium content per serving and per day, supporting accurate estimation of daily sodium intake.[26]

Step 2: Generate an item pool

Based on the findings from Step 1, a preliminary list of food items was categorized into nine culturally specific groups (e.g., Central, Northern, and Northeastern Thai cuisines). A draft Food Frequency Questionnaire (FFQ) was developed to assess sodium intake, incorporating food types, portion sizes, and sodium content. A Case Record Form (CRF) was also designed to facilitate systematic data collection and analysis.

Step 3: Determine the format for the measurement and assessment scale

An ordinal scale was used to assess consumption frequency, ranging from "rarely/never" to "7 times/day." Each respondent reported both the frequency and quantity of food intake, recorded in standardized serving sizes (e.g., teaspoons for sauces, bowls or grams for solid foods, and milliliters for liquids). Serving sizes were defined in the questionnaire with visual aids and examples. Sodium intake estimation was calculated by multiplying consumption frequency with the average sodium content per portion, allowing conversion into milligrams/day.[27]

Step 4: Face validity

The draft instrument underwent preliminary face validity checks by the research team. Data were organized and sequenced by sodium source category. The instrument was reviewed by academic advisors, focusing on content clarity, item relevance, and redundancy. Revisions were made according to the feedback to improve the overall readability and cultural appropriateness of the items.

Step 5: Content validity

The instrument for assessing sodium consumption was submitted to five experts possessing a minimum of five years of experience in research instrument evaluation and nutrition. Subsequently, the item-objective congruence index (IOC) was calculated.[28]

Step 6: Conduct a construct validity of the questionnaire

The construct validity of the instrument used to assess sodium consumption was evaluated. Before this assessment, the instrument underwent evaluations for face validity, content validity, reliability analysis, and concurrent validity. We conducted the evaluation of construct validity in two main steps.

Step 6.1:

Concurrent validity assessment involved collecting self-reported sodium intake data and 24-hour urinary sodium excretion data from a sample of 120 individuals aged 30-44 years from the 4th Health Region. We calculated the sample size using the proportion estimation method.[34] The multi-stage sampling technique commenced with a stratified random selection of geographical areas at the sub-district level. This process yielded Sam Khok subdistrict, Sam Khok district, Pathum Thani province, with a total population of 6,664 individuals. Subsequently, a proportionate allocation based on the population size within this sub-district resulted in a sample of 68 participants. Concurrently, Lam Sam Phung sub-district, Muak Lek district, Saraburi province, with a total population of 5,096 individuals, was also selected. Following a similar proportionate allocation, this sub-district contributed 52 participants to the sample. Finally, a systematic random sampling method was employed, utilizing numerical codes to represent the personal data of individuals aged 30-44 years within each selected area, culminating in a total sample size of 120 participants. Inclusion criteria comprised participants who were 30-44 years old, able to read, listen, and write in Thai, free from serious illnesses (e.g., chronic kidney failure), not undergoing diuretic treatment, not menstruating during data collection, and provided informed consent. Exclusion criteria included individuals with severe chronic non-communicable diseases or those who had lived in the 4th Health Region for less than one year. Participants were contacted to gather information about the collection, timing, and delivery of their 24-hour urine samples. Concurrently, the researchers collected self-reported sodium intake data using a validated sodium intake questionnaire. Prior to the actual collection, participants were invited to attend a briefing session to introduce and explain the proper 24-hour urine collection procedures. Additionally, participants were provided with an illustrated pamphlet outlining the step-by-step urine collection process, which they could review at their convenience to reinforce their understanding. To ensure proper compliance, a direct communication channel was established, allowing participants to contact the research team in case of questions or uncertainty regarding the collection process.[21,24]

The criteria for sample selection included 24-hour urine output data, urine volume greater than 750 ml per day, serum creatinine for males between 0.98-2.2 gm/24 hrs and between 0.72-1.51 g/24 hrs for females, and sodium intake assessment collected at the same time.[29,30] The measured 24-hour urine indices were calculated as follows: 24-hour urinary sodium excretion (mg/day) = concentration of 24-hour urinary sodium excretion (mmol/L) × 24-hour urine volume (L/day) × molecular weight of Na^+ (23 mg/mmol).[21,24,31]

Step 6.2:

The instrument's consistency (concurrent validity) was analyzed by inputting data into a Receiver Operating Characteristic (ROC) curve analysis. This analysis determines the optimal cut-off point for classifying individuals. The ROC curve, using sensitivity and specificity, can help identify groups at risk of consuming more than 2,000 mg/day.[32]

Results

Step 1: The results defined sodium consumption patterns. A literature review yielded 102 food items, and a local food survey added 55 more.

Step 2: The results generated 157 research questions, categorized by food groups, based on defined parameters.

Step 3: Specified measurement and evaluation methods. Food intake was measured in milligrams (mg), milliliters (mL), grams (g), or standard servings. Serving sizes were associated with the measurements specified in Section 1, such as 1, 1.5, and 2 servings. We evaluated the frequency of consumption for each food item (ranging from 1 to 7 times per day) using a checklist.

Step 4: An initial face validity assessment was conducted. The content validity, measurement properties, and evaluation criteria of the instrument for assessing sodium consumption developed by the researchers were reviewed by the advisor. The instrument's content clarity, redundancy, and academic rigor were assessed through a face-to-face validation process. Based on the feedback received, the instrument was revised, and food items were categorized into nine groups: condiments, single-dish meals, processed foods, fruit dips, beverages and snacks, northeastern Thai food, southern Thai food, northern Thai food, and international food.

Step 5: Content validity was evaluated by five experts with over five years of experience in nutrition and research instrument assessment. The Item-Objective Congruence (IOC) index was calculated, with values ranging from 0.6 to 1.0 indicating high consistency between items and objectives. Experts recommended revisions to six questions due to duplicate food items and suggested adjustments to food groupings. The finalized questionnaire included 151 items.

Step 6: Concurrent validity of the research instrument was evaluated via ROC curve analysis, which facilitated the examination of the association between self-reported sodium intake and 24-hour urinary sodium excretion.

Participant characteristics and sodium excretion

The study included 120 participants. The majority (51.7%) were older than 37 years, with a mean age of 37.6 years. Females comprised 55.8% of the sample. Most participants (60.8%) had not completed a bachelor's degree, and 52.5% reported a monthly income below 20,000 baht (mean income: 17,848.25 baht). Regarding health status, 72.5% reported no history of chronic diseases, while the remaining participants indicated having conditions such as hypertension or diabetes.

Importantly, 70.8% of participants had daily urinary sodium excretion levels exceeding 2,000 mg. The mean urinary sodium excretion was 3,020.81 mg/day. Although this study adopted the World Health Organization's (WHO) recommendation of 2,000 mg/day as the threshold for excess sodium intake, it is acknowledged that other literature (e.g., McCarron *et al*., 2013)[33] identifies a broader normal range (2,622–4,830 mg/day). Nonetheless, the 2,000 mg/day benchmark was used for ROC analysis to align with international dietary guidelines and public health goals (Table 1).

Table 1. Demographic and other characteristics of 120 participants for the ROC curve from a population aged 30-44 years in the 4th Health Region, Thailand.

Variable	Frequency	%
Age		
≤37 years	58	48.3
>37 years	62	51.7
(Mean=37.60, SD=3.58, min=30, Max=44)		
Gender		
Male	53	44.2
Female	67	55.8
Education		
Below bachelor's d egree	73	60.8
Higher than a bachelor's degree	47	39.2
Occupation		
Government employee/private sector/trading/private business	63	52.5
General contractor/farmer/animal raising	57	47.5
Monthly income		
≤20,000 Bht	69	57.5
>20,000 Bht	51	42.5
(Mean=17,848.25, SD=10,693.58, min=6,900, Max=61,000)		
Illness/disease		
Not illness	87	72.5
Illness	33	27.5
24-hour sodium excreted in urine		
≤2,000 mg/day	35	29.2
>2,000 mg/day	85	70.8
(Mean=3,020.81, SD=1,689.09, min=1,155.3, Max=10,658.4)		

ROC curve analysis and cut-off determination

Validation of the food frequency questionnaire (FFQ) and food record methods was conducted using ROC curve analysis, with 24-hour urinary sodium excretion as the reference standard. The optimal cut-off point for the FFQ was determined to be 3.46, derived from the ROC analysis using both Youden's index and Euclidean distance methods. These mathematical criteria were used to identify the point with the best balance between sensitivity and specificity.

The analysis of the Receiver Operating Characteristic (ROC) curve demonstrates that Euclidean's Index (i) and Youden's Index (J) are mathematically derived measures, which, while theoretically sound, may not be directly applicable or interpretable in research settings involving practical health science. In contrast, the optimal cutoff point determined by the Weight NMC (C=3, pr=0.3) appears more suitable for applied research, particularly in the context of assessing the concurrent validity of the developed instrument.[15,42] This cutoff effectively distinguishes appropriate sodium intake levels when compared against the 24-hour urinary sodium excretion, using a benchmark of less than 2,000 milligrams per day as the reference standard for adequate sodium elimination (Table 2).

Table 2. Determination of the optimal sodium intake cutoff point by comparing it with 24-hour urinary sodium excretion.

Consideration	Cut-off point for FFQ-Na	Cut-off point for food record (mg/day)
Euclidian's index (i)	2.87	2,052
Youden's index (J)	2.98	2,094
Weight NMC (C=3, pr=0.3)	3.46	2,146

24-hour urinary biomarkers

All urine samples met the inclusion criteria, with a volume of at least 750 mL. Among males, the average 24-hour urinary sodium excretion was 134.8 mEq (SD=68.72), while it was 128.74 mEq (SD=53.16) for females. Average potassium excretion was 86.09 mEq (SD=34.16) for males and 63.46 mEq (SD=24.74) for females. The mean creatinine excretion was 1.34 gm/24 hrs (SD=0.31) in males and 0.98 gm/24 hrs (SD=0.18) in females. These values confirm physiological plausibility and support the reliability of the urine collection method used for validation (Table 3).

The normal reference ranges for laboratory test results are as follows: sodium excretion: 40.00-220.00 mEq/24 hrs, potassium excretion: 25.0-125.0 mEq/24 hrs; creatinine excretion for males was 0.980-2.200 gm/24 hrs, and 0.720-1.510 gm/24 hrs for females.

Table 3. 24-hour urine excretion laboratory test

Urine laboratory test	Male		Female	
	Mean (Min-Max)	SD	Mean (Min-Max)	SD
Volume (mL)	1150.5 (750-2,100)	108.41	890.3 (750-1,750)	86.75
Sodium (mEq)	134.08 (50.0-201.7)	68.72	128.74 (48.5-198.3)	53.16
Potassium (mEq)	86.09 (26.6-105.4)	34.16	63.46 (27.9-86.7)	24.74
Creatinine (gm/24 hrs)	1.34 (1.08-2.16)	0.31	0.98 (0.79-1.43)	0.18

Diagnostic performance of the instruments

The FFQ demonstrated excellent discriminatory performance for detecting sodium intake above 2,000 mg/day. The ROC curve area was 93.3% (95% CI: 0.880-0.987), with a sensitivity of 92.8%, specificity of 95.2%, and overall accuracy of 86.7%. Of the 120 participants, 112 were correctly classified, with only 8 false positives (6.7%) (Figure 1).

In contrast, the food record method showed weaker performance, with a cut-off point of 2,146 mg/day and an AUC of 67.6% (95% CI: 0.577-0.776). Sensitivity and specificity were 63.8% and 70.4%, respectively, while overall accuracy was 60.3%. This method correctly classified only 81 participants and resulted in a higher false positive rate (36.2%, or 39 individuals) (Table 4).

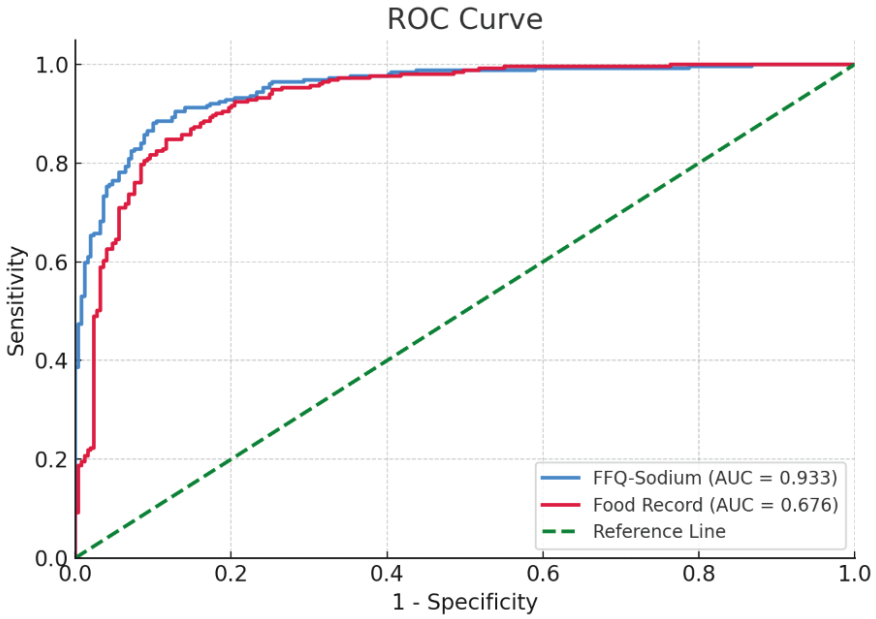

Figure 1. ROC curve of the sodium intake questionnaire.

Table 4. Analysis of the ROC curve for the sodium intake questionnaire.

Parameter	Assessment instrument	
	FFQ-Sodium	Food Record
ROC	0.933	0.676
Cut-off point	3.46	2,146
Number of true positive	112	81
Number of true negative	8	39
Sensitivity	92.8	63.8
Specificity	95.2	70.4
Accuracy	86.7	60.3
95%CI of ROC	0.880-0.987	0.577-0.776
$\chi 2$	6.173	4.807
p value	<0.001	0.001

Discussion

Summary of key findings

This study aimed to develop and validate a culturally tailored sodium intake questionnaire for adults aged 30-44 years in Thailand. The final instrument, based on a food frequency questionnaire (FFQ) format, demonstrated strong diagnostic performance when validated against the 24-hour urinary sodium excretion, a gold standard for sodium intake measurement. Among 120 participants, the instrument achieved a sensitivity of 92.8%, a specificity of 95.2%, and an area under the ROC curve (AUC) of 93.3%, indicating excellent discriminatory ability. In contrast, a food record-based instrument showed lower sensitivity (63.8%), specificity (70.4%), and AUC (67.6%), suggesting relatively poor performance. Furthermore, the FFQ classified 112 participants correctly, with only 8 false positives, compared to 39 false positives for the food record method. The 24-hour urine analysis confirmed the population's sodium and potassium excretion levels, supporting the physiological plausibility of the FFQ's estimates.

Comparison with existing tools

The newly developed Food Frequency Questionnaire (FFQ) offers several advantages over traditional sodium intake assessment tools. Firstly, the FFQ demonstrates a high accuracy with an AUC of 93.3%, strongly correlating with 24-hour urine sodium excretion, compared to only 67.6% AUC for the food record method. The culturally specific food list, comprising 151 items from Thai regional cuisines, enhances accuracy by better capturing the dietary sodium profile.[35] In terms of feasibility, the FFQ significantly reduces participant burden. Unlike the 24-hour urine collection, which is invasive, time-consuming, and logistically challenging, the FFQ can be self-administered or conducted by trained interviewers, minimizing effort and time for both participants and researchers. This makes the FFQ a practical and cost-effective alternative for routine sodium intake monitoring, particularly in resource-limited settings.[36,37] Moreover, the FFQ developed in this study stands out when compared to conventional FFQs in Thailand due to its focus on high-sodium foods and a one-day consumption assessment, eliminating the need for participants to recall their food intake over several days, thus reducing memory bias. This also alleviates the training requirements associated with food record tools, which rely on participants' ability to accurately log and recall food quantities, often leading to inaccurate data. Additionally, the instrument's ROC analysis with 24-hour urinary sodium excretion data adds specificity, offering a more reliable measure of sodium intake than traditional FFQs. In contrast, food record instruments require higher skill levels in writing and understanding food quantities and can be prone to recall bias or errors, making them less efficient for large-scale studies.[12]

In summary, the FFQ developed in this study provides an efficient, reliable, and culturally tailored tool for assessing sodium intake, making it suitable for large-scale public health surveillance and interventions, especially in settings where resources are limited.

Cultural and demographic applicability

This study focused on adults aged 30-44 years in the 4th Health Region, incorporating culturally diverse food categories representative of dietary patterns in the Northern, Central, and Northeastern regions. While this enhances the instrument's internal validity, its generalizability to other cultural or ethnic populations may be limited without adaptation.[38] Given that sodium intake patterns vary by age, ethnicity, and region, future applications of this tool should consider localized validation and modification. For instance, extending the instrument to older adults or adolescent populations would require revising food item lists and frequency categories to align with their distinct consumption behaviors. Additionally, adaptation for use in other countries or cultural contexts would necessitate pilot testing as well as recalibration of the sodium values and cut-off thresholds based on local dietary surveys.[15] The validated FFQ demonstrates strong performance as a culturally tailored, accurate, and cost-effective tool for assessing sodium intake among Thai adults aged 30-44. Its high sensitivity, specificity, and user-

friendliness make it a valuable resource for public health surveillance and dietary interventions. However, broader use across different regions and age groups should be preceded by appropriate cultural and demographic adaptations to maintain its validity and effectiveness.

Cut-off point justification and public health implications

This study validated a sodium intake assessment tool based on consumption frequency and dietary records. The optimal cut-off point of 3.46 in the food frequency questionnaire (FFQ) was identified through ROC curve analysis using 24-hour urinary sodium excretion as the reference standard. This threshold corresponds to approximately 2,000 mg/day, aligning with the WHO's recommended maximum intake for adults. It was chosen to optimize sensitivity (92.8%) and specificity (95.2%), effectively identifying individuals with excessive intake while minimizing false positives. The FFQ is unique in its day-to-day intake scale and was validated through concurrent urinary sodium collection, ensuring consistency between reported behavior and biochemical outcomes. Unlike conventional FFQs or dietary records used internationally, this tool offers enhanced precision for the Thai population. From a public health perspective, the 3.46 threshold enables targeted interventions by accurately identifying individuals exceeding the recommended intake. This supports personalized dietary counseling, risk stratification, and regional monitoring of sodium reduction efforts. As high sodium intake is a modifiable risk factor for hypertension and cardiovascular disease, this validated tool contributes to national strategies for non-communicable disease (NCD) prevention. Those instruments measure general food consumption by asking about frequency (FFQ) and sodium intake (DR) at the same time. In contrast, instruments developed internationally,[40] such as the Discretionary Salt Questionnaire (DSQ) and Food Frequency Questionnaires for Sodium (FFQ-Sodium), focus specifically on sodium intake assessment.[20] This study introduces a specific measurement instrument to assess sodium intake, which is currently unavailable in Thailand. Although its application in Thailand might encounter cultural and dietary consumption contexts that differ from other countries, this instrument offers a unique advantage by measuring both the frequency and quantity of sodium consumption, leading to more precise assessments.

Seasonal variation in food consumption among the Thai population may also influence dietary intake data. In this study, data collection was conducted during the rainy season, a period when access to a wider variety of food sources is more feasible compared to other seasons. This is particularly relevant for local foods, as many ingredients are naturally available and more accessible during the rainy season in each region. We have validated the instrument against 24-hour urine sodium collection.[39] This study validates a newly developed sodium intake assessment tool, which offers an accurate evaluation of sodium intake through urinalysis, comparable to the gold standard laboratory test. Research by DeVellis RF and Matsuno *et al*.[15] supports the importance of contextually appropriate content validity analysis in developing instruments that yield both behavioral and laboratory assessments, ensuring practical applicability, particularly in distinguishing healthy from unhealthy behaviors. The reliability of this tool facilitates the creation of targeted interventions for improved health outcomes. Our study differs from that of Li J. *et al*.,[19] a retrospective 7-day dietary assessment paired with 24-hour urine collection, which showed over 20% misclassification as well as lower sensitivity and specificity due to the retrospective nature and reliance on participant recall. Similarly, our study contrasts with Wong *et al*.'s[20] instrument, which included a 7-day retrospective dietary record, a 24-hour dietary recall, and urinary sodium excretion. Despite an 84.6% discrimination rate, the method by Oria M, Yaktine AL, Strom BL,.[41] had challenges with non-completion rates (over 50%) and required extensive training for accurate data collection, limiting its feasibility and acceptability.[42]

Conclusion

The development of a sodium intake assessment instrument is a process that facilitates easier access to sodium intake results and provides a more accurate understanding of dietary behaviors related to sodium consumption. Health assessment is an integral part of addressing health issues, particularly in identifying specific high-sodium foods. This information can guide more precise dietary choices, ultimately reducing overall sodium intake in daily life.

Conflicts of interest

The authors declare no conflicts of interest.

Suggestions

1. Future studies should validate the instrument using different age groups and cultural contexts to enhance its generalizability and ensure accurate sodium intake assessment across diverse populations.
2. The FFQ-sodium can be incorporated into national health surveys, primary care screenings, and mobile health applications to support public health monitoring, dietary counseling, and salt reduction initiatives.
3. The tool could be improved by integrating digital platforms (e.g., mobile apps with real-time feedback) and combining it with biological markers like repeated 24-hour urine sodium tests to increase precision and user engagement.

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