VOL. 23 | NO. 2 | ISSUE 90 | APRIL-JUNE 2025

Dietary Salt Intake in a Suburban Nepali Community: A Cross-sectional Study Using 24-Hour Urinary Sodium

Bhatt RD,[1] Shrestha A,[2] Karmacharya BM,[2] Timalsena D,[2] Dhimal MN,[3] Pradhan P,[4] Oli N,[5] Bista D,[6] Pyakurel M,[7] Barakoti R,[8] Mishra R,[8] Risal P[1]

[1]Department of Clinical Biochemistry,

[2]Department of Public Health,

Dhulikhel Hospital-Kathmandu University Hospital,

Kathmandu University School of Medical Sciences,

[3]Nepal Health Research Council,

[4]Department of Community Medicine,

Institute of Medicine, TUTH,

[5]Department of Community Medicine,

Kathmandu Medical College,

[6]Department of Pharmacy,

Kathmandu University School of Science,

[7]Green Tara Nepal,

[8]Ministry of Health and Population

Corresponding Author

Prabodh Risal

Department of Clinical Biochemistry,

Dhulikhel Hospital-Kathmandu University Hospital,

Kathmandu University School of Medical Sciences,

Dhulikhel, Kavre.

E-mail: prabodhrisal@kusms.edu.np

Citation

Bhatt RD, Shrestha A, Karmacharya BM, Timalsena D, Dhimal MN, Pradhan P, et al. Dietary Salt Intake in a Suburban Nepali Community: A Cross-Sectional Study Using 24-Hour Urinary Sodium. *Kathmandu Univ Med J.* 2025;90(2):209-15.

ABSTRACT

Background

High dietary salt intake is a recognized contributor to hypertension and cardiovascular diseases, particularly in low- and middle-income countries. Despite the high burden of hypertension in Nepal, robust estimates of salt intake using the gold standard 24-hour urinary sodium collection remain scarce, especially in suburban populations.

Objective

To accurately assess dietary salt intake using 24-hour urinary sodium excretion and evaluate factors influencing salt consumption in a suburban Nepali population.

Method

A cross-sectional study was conducted in 2023-2024 as part of the Dhulikhel Heart Study's second phase. A total of 381 adult participants were recruited from randomly selected wards of Dhulikhel Municipality. Data on sociodemographic characteristics, dietary habits, salt-related knowledge, and anthropometry were collected. Salt intake was estimated from 24-hour urinary sodium excretion. Generalized Estimating Equations (GEE) and multivariate analyses were used to identify associated factors.

Result

The mean age of the participants was 49.9 ± 15.5 years and average salt consumption was 9.55 ± 3.2 g/day. The mean dietary salt intake significantly exceeded WHO recommendations, with notable variations by sex, education, and frequency of eating out.

Conclusion

This study highlights alarmingly high salt intake in a suburban Nepali community and underscores the need for population-specific strategies to reduce sodium consumption. Policy action, public education, and promotion of healthier dietary behaviors are essential to combat the growing burden of salt-related non-communicable diseases.

KEY WORDS

Blood pressure, Dietary salt intake, 24-hours urine sodium

INTRODUCTION

Since ancient times, it has been known that sodium is necessary for the physiological functions of life.[1] Approximately 95% of our daily sodium comes from salt (sodium chloride), and the majority of sodium intake (> 85 %) is excreted by the kidneys.[2] Despite this, a high intake of dietary salt is a well-established risk factor for hypertension contributing to 1.65 to 1.89 million deaths in annually and hypertension is the most prevalent risk factor for cardiovascular diseases (CVDs).[2-6]

Most people consume nearly double the recommended amount of salt, averaging 9-12 g daily, despite the World Health Organization's guideline of less than 5 g per day.[7] A community-based study conducted in Nepal showed that the average salt consumption is 13.3 g/day, while a population-based cross-sectional study measured spot urine sodium and determined that the average dietary salt consumption is 9.1 grams per day.[8-10]

The World Health Organization recommends a 30% reduction in salt intake by 2025.[4] Most people in Nepal consume discretionary amounts of salt from meals prepared at home.[11] The gold standard for evaluating salt intake is the 24-hour urinary sodium excretion measurement, but there are limited data on salt consumption patterns in Nepali communities, particularly in suburban settings. Moreover, there is a lack of information on the frequency of dining out in previous studies. Thus, the main objective of this study was to accurately assess the dietary salt intake in a suburban Nepali community by measuring 24-hour urinary sodium excretion.

METHODS

This cross-sectional study was a component of the second phase of the Dhulikhel Heart Study (DHS) conducted in 2023-2024 in the Dhulikhel municipality of Bagmati Province, Nepal. In the second phase, this open cohort, participants were randomly selected from different administrative ward of the Dhulikhel municipality. Participants aged ≥ 18 years who consumed at least two home-cooked meals daily, not pregnant, and not using diuretics were enrolled. Five trained research assistants with a health science background (Nurse, Health Assistant, Lab Technician) were involved in data collection using a structured questionnaire survey, sociodemographic information and 24 hours urine sample collection. The required sample size was calculated using $n=Z^2 \times p \times (1-p)/E^2$, where n=required sample size, Z=score corresponding to the desired confidence level (1.96 for 95%), p=expected proportion (0.71), and E=margin of error (0.05); a total of 317 participants were obtained.[10] We added 20% to adjust for possible incomplete urine collection, and the final sample size was 381.

Trained research assistants interviewed participants to complete semi-structured questionnaire about their age, sex, education, salt consumption, history of diabetes mellitus and hypertension, frequency of eating out and processed foods, knowledge of medical conditions linked to high salt consumption, and frequency of food consumption per day.

Anthropometric data including height, weight, and blood pressure were collected. Trained research assistants interviewed with semi-structured questionnaires to all eligible participants and measured blood pressure three times using a OMRON digital blood monitor (Model BP6350) and mean value was used for analysis.[12] Body weight and height were measured using a digital body composition scale and a height meter, respectively. Average systolic and diastolic blood pressure was analyzed and BMI was calculated as weight (kg) divided by height (m^2).

Each participant received an explanation booklet from trained research assistants outlining the 24-hour urine sample collection process in the local language. The 24-hour urine collection process was initiated by asking the participants to urinate into the toilet to empty their bladders. The participants were instructed to collect all the urine voided between 24 hours in a 5-liter container provided by the research team. The urine was stored at room temperature during collection. Participants were humbly requested to eat regular meals on the urine sample collection day and to avoid parties and outside meals. If they were unable to avoid parties due to social or cultural obligations, they were requested to collect urine sample another day only. Collected urine specimen was transported immediately to the Dhulikhel Hospital-Kathmandu University Hospital (DH-KUH).

A laboratory technician at the Department of Clinical Biochemistry laboratory of DH-KUH immediately measured the volume of urine using a cylinder and noted the volume. Ten milliliter of urine was taken for 7 minutes at 4000 rpm and measured sodium, potassium, and creatinine were measured, and the remaining urine was discarded. Urinary sodium and potassium levels were measured using the ion selective electrode (ISE) method (iSMART 30, South Korea).[13] Creatinine levels were measured using a Jaffe reaction (BA 400; Biosystems, Spain).[14] With a consistent rate of urinary creatinine excretion, 24-hour creatinine excretion was utilized as a benchmark to assess the completeness of urine collections. The method developed by Joossens et al. was adopted to determine the completeness of the 24 hour urine collection.[15] If the 24 hours urine volume was less than 500 ml or if participants reported that they missed any episode of urination to collect in the given container, they were excluded. Sodium excretion was determined using the conversion factor, where 1 mmol of sodium corresponds to 58.5 mg of NaCl.

Descriptive statistics were used to summarize participants' characteristics and estimated salt intake levels. Categorical variables are reported as n (%), whereas continuous variables are expressed as the mean ± standard deviation.

Group comparisons were conducted using the chi-square test for categorical data and the student's t-test for continuous data. Subsequently, multiple logistic regression analysis was conducted to identify the risk factors associated with daily salt intake. These data were analyzed using STATA 14 for Windows, and two-tailed p-values less than 0.05 were considered statistically significant.

To explore the factors influencing daily dietary salt intake, we utilized a Generalized Estimating Equation (GEE) model with an identity link function and a Gaussian family distribution. This modeling approach was chosen to account for potential clustering of participants within wards, acknowledging that individuals residing in the same ward may exhibit similar dietary behaviors and environmental exposures, such as shared eating-out patterns.

We applied an exchangeable correlation structure to account for intra-cluster correlations, ensuring that the model captured the dependence among individuals within the same cluster. To produce reliable statistical inferences, robust (sandwich) standard errors were employed. The analysis included a range of explanatory variables: age, sex, ethnicity, marital status, educational attainment, frequency of eating meals outside the home, categorized number of meals consumed outside per week, behaviors related to adding salt to food, intake of processed foods, use of salty condiments, and the number of meals consumed per day. These statistical analyses were performed using R software (version 4.4.3), and a two-sided p-value of less than 0.05 was considered indicative of statistical significance.

To enhance the rigor and depth of our investigation, several additional analyses were conducted. First, linear regression analysis was performed to identify independent predictors of daily dietary salt intake. To explore variations in consumption patterns, sub-group analyses were carried out by age group and sex. Furthermore, the sodium-to-potassium ratio was analyzed to assess its potential relationship with hypertension, given its established role as a cardiovascular risk indicator. We also conducted interaction analyses to determine whether the association between salt-related knowledge and salt intake was modified by key factors such as ethnicity or frequency of dining out. Finally, a sensitivity analysis was undertaken to evaluate the robustness of our findings in relation to the criteria used for assessing completeness of urine sample collection, ensuring the validity of biomarker-based salt intake estimations.

This study was approved by the Institutional Review Committee of Kathmandu University School of Medical Sciences (IRC-KUSMS-271/2021) and the Nepal Health Research Council (NHRC- 482/2021P). Informed consent was obtained from all the participants, and the study protocol adhered to the principles outlined in the Declaration of Helsinki.

RESULTS

A total of 381 participants (139 females and 142 males) living in the Dhulikhel municipality were enrolled in the study. We further excluded 72 participants (44 females and 28 males) as they were unable to provide criteria matched 24-hours urine specimens; therefore, the final study population consisted of 309 patients (197 females and 112 males. Demographic and baseline characteristics are shown in table 1.

Table 1. Baseline and sociodemographic, anthropometric, uriniary variables and Salt intake for baseline characteristics of participants (n=309)

Variables	N=309 (Mean ± SD)
Age (years)	49.9 ±15.5
Age Groups (years)	
18-29	32 (10.3%)
30-39	60 (19.4%)
40-49	62 (20.0%)
50-59	54 (17.4%)
60-69	65 (21.0%)
> 70	36 (11.6%)
Sex	
Females	197 (63.7%)
Males	112 (36.2%)
Ethnicity	
Newar	115(37.2%)
Chhetri	74 (24.2%)
Brahmin	75 (23.9%)
Tamang/Rai/Limbu/Magar	25 (8.0%)
Dalit	16 (5.2%)
Sherpa/Bhote	4 (1.3%)
Height (cm)	154.6 ± 9.1
Weight (kg)	62.1 ± 12.6
BMI (kg/m²)	26.0 ± 5.3
BMI category	
< 18.5	10 (3.2%)
18.5-24.9	135 (43.6%)
25-29.9	106 (34.3%)
> 30	58 (18.7%)
Systolic BP	124.9 ± 18.0
Diastolic BP	82.6 ± 10.8
Normotensive	137 (44.3%)
Pre-hypertensive	105 (33.9%)
Hypertensive	82 (26.5%)
Mean urine volume (24 hours) mL	1905.1±688.8
Mean urinary sodium excretion (mmol/24hours)	163.2±55.7
Mean urinary potassium excretion (mmol/24 hours)	47.0±21.2
Mean urinary creatinine excretion (mg/24 hours)	944.8±202.9
Mean of estimated daily NaCl intake (g/day)	9.55±3.2

The mean age of the participants was 49.9 ± 15.5 years with an age distribution of 60-69 years (21.0%), followed by 40-49 years (20.0%), 30-39 years (19.4%) and 50-59 years (17.4%). Ethnic distribution revealed that the Newar ethnic group was the most represented, comprising 37.2% (n=115) of the participants, followed by Chhetri (24.2%, n=74), and Brahmin (23.9%, n=75). Surprisingly 97.09% of participant consumed > 5.0 gm of salt/day. And in subgroup of female and male participants consumed 9.2 ± 3 and 10.2 ± 3.6 gram of salt respectively which was statistically significant (p=0.015).

Anthropometric measurements indicated that the mean height of participants was 154.6 ± 9.1 cm, while the mean weight was 62.1 ± 12.6 kg. The mean body mass index (BMI) was 26.0 ± 5.3 kg/m². Regarding BMI categories, 43.6% had normal BMI, 34.3% were overweight, and 18.7% were obese. Blood pressure (BP) measurements showed that the mean systolic BP was 124.9 ± 18.0 mmHg, and the mean diastolic BP was 82.6 ± 10.8 mmHg.

Among the participants, 44.3% (n=137) were normotensive, 33.9% (n=105) were prehypertensive, and 26.5% (n=82) were hypertensive. The mean 24-hour urine volume was 1905.1 ± 688.8 mL. The mean urinary sodium excretion was 106.4 ± 43.7 mmol/24 hours, and the mean urinary potassium excretion was 46.9 ± 21.3 mmol/24 hours. The mean urinary creatinine excretion was 944.8 ± 202.9 mg/24 hours. The estimated mean daily salt (sodium chloride/ NaCl) intake was 9.55 ± 3.2 g/day.

Comparision of salt intake among different age group analyzed Kruskal-Wallis rank sum test showed (Fig. 1), there was statistically significant (p=0.02) difference between different age groups. The highest mean of salt intake was found among the age group between 30 - 44 (10.4 ± 3.6) and the lowest was among aged above 60 years (9.2 ± 2.7).

As shown in table 2, participants who dined out regularly had a significantly higher mean estimated daily NaCl intake (10.4 ± 3.2 g/day) than those who did not dine out (9.1 ± 2.9 g/day) (p = 0.0005). Among different ethnic groups, Newar participants who dined out had the highest mean NaCl intake (11.0 ± 3.6 g/day), which was significantly higher than their home-cooked counterparts (9.0 ± 2.9 g/ day) (p = 0.002). Similarly, Brahmin participants who dined out also exhibited a higher mean NaCl intake (10.1 ± 4.4 g/ day) than those consuming home-cooked meals (8.5 ± 2.4 g/day) (p = 0.044) table 2.

An increase in dining-out frequency was associated with higher sodium intake. Participants who dined out more than twice a week had the highest mean NaCl intake (10.5 ± 3.7 g/day), followed by those dining out less than twice a week (10.4 ± 3.6 g/day), while participants consuming only home-cooked meals had the lowest NaCl intake (9.1 ± 2.9 g/day) (p = 0.002). However, the habit of adding salt to food did not show a statistically significant difference with NaCl intake. Knowledge of the health risks of high salt intake was not associated with a significant difference in actual NaCl consumption. Participants who knew that high salt intake causes hypertension had a mean daily NaCl intake of 9.8 ± 3.2 g/day, compared to 9.2 ± 3.1 g/day for those who were unaware (p = 0.118).

Table 2. Dinning habits, knowledge and behavior on salt consumption

Dinning out (weekly)	Frequency	Mean of estimated daily NaCl intake (g/day)	p-value (< 0.05)
No	210	9.1 ± 2.9 (95% CI 8.7-9.5)	0.0005
Yes	99	10.4 ±3.2 (95% CI 9.7-11.2)	
Newar (dining out)	38	11.0±3.6 (95% CI 9.8-12.2)	0.002
Newar (home- cooked)	77	9.0±2.9 (95% CI 8.4-9.7)	
Chhetri (dining out)	22	9.9±2.8 (95% CI 8.6-11.1)	0.481
Chhetri (home-cooked)	52	9.3±3.1(95% CI 8.4-10.2)	
Brahmin (dining out)	20	10.1±4.4(95% CI 8.0-12.2)	0.044
Brahmin (home-cooked)	55	8.5±2.4(95% CI 7.8-9.1)	
Tamang/Rai/Limbu/ Magar (dining out)	11	10.8±4.1 (95% CI 8.0-13.6)	0.883
Tamang/Rai/Limbu/ Magar (home-cooked)	14	10.6±3.8 (95% CI 8.4-12.8)	
Dalit (dining out)	7	10.2±3.8 (95% CI 6.6-13.7)	0.454
Dalit (home-cooked)	9	9.0±2.4 (95% CI 7.1-10.8)	
Dinning out Frequency (weekly)			
Home cooked only	210	9.1 ± 2.9	0.002
Dinning out < 2 meals/ week	64	10.4±3.6	
Dinning out > 2 meals/ week	35	10.5±3.7	
Habits of salt adding to food at the table			
Never add	161	9.2±2.9 (95% CI 8.8-9.7)	0.147
Add (Always, often, rarely, sometimes)	148	9.8±3.5 (95% CI 9.2-10.4)	
Habits of use salty seasoning			
Never use	238	9.4±3.1 (95% CI 9.0-9.8)	0.159
Use (Always, often, rarely, sometimes)	71	10.0±3.6 (95% CI 9.1-10.8)	
Do you know high salt causes hypertension			
Yes	165	9.8±3.2 (95% CI 9.3-10.3)	0.118
No	144	9.2±3.1 (95% CI 8.7-9.7)	

The Generalized Estimating Equation (GEE) model (table 3) revealed several statistically significant predictors of

24-hour dietary salt consumption, while accounting for potential clustering at the ward level. Age was found to be negatively associated with daily salt intake (β = -0.040, p = 0.009), indicating that salt consumption slightly decreased with increasing age. Sex showed a significant association, with males consuming on average 1.39 grams more salt per day compared to females (β = 1.390, p < 0.001). Regarding meal frequency outside the home, individuals who ate 1-3 meals outside per week consumed significantly more salt compared to those who ate no meals out (β = 1.076, p = 0.017). This effect was more pronounced among those who consumed more than 3 meals per week outside, who had a higher average salt intake (β = 1.759, p = 0.011). Other variables including ethnicity, marital status, education level, salt-adding behavior, use of salty seasonings, and meal frequency per day were not significantly associated with salt intake in this model (p ≥ 0.05).

Table 3. Generalized estimating equation (GEE)

24 hours salt consumption	Coefficient	p > z	95% conf.	Interval
Age	-0.0404485	0.009	-0.0707345	-0.0101624
Sex				
Male	1.39015	0.000	0.6197191	2.160581
Ethnicity				
Newar	-0.0341915	0.941	-0.9361975	0.8678145
Others	0.3292814	0.533	-0.7068517	1.365415
Marital Status				
Never Married	-1.130089	0.134	-2.609763	0.3495859
Education Level				
No formal education	0.7720982	0.224	-0.4726622	2.016859
School education	0.2004864	0.709	-0.8507428	1.251716
Dining Out				
1–3 meals	1.075531	0.017	0.1909541	1.960108
> 3 meals	1.759178	0.011	0.4014462	3.116909
Add Salt during meal				
Yes	0.1986551	0.593	-0.5288523	0.9261625
Add salty Season				
Yes	0.3648268	0.413	-0.5085615	1.238215
Processed food				
Yes	-0.8505325	0.027	-1.604062	-0.0970027
Meal Frequency				
≤ 3 times/day	-0.0875105	0.824	-0.8602349	0.6852138

DISCUSSIONS

To the best of our knowledge, this is the first study in the Bagmati province and the second community-based survey in Nepal to estimate daily salt intake using 24-hour urinary sodium analysis, which is considered the gold standard for estimating salt intake.[9] Our findings indicate that the average daily salt intake in the population is 9.55 ± 3.2 g per person/day, nearly twice the recommended level. This highlights the persistently high dietary salt consumption in the region, underscoring the need for targeted public health intervention.

The daily salt intake observed in our study aligns with findings from a previous study conducted in Nepal. For instance, a nationwide survey using spot urine analysis found an average salt intake of 9.1 g/day, whereas a community-based study using 24-hour urinary sodium excretion reported a higher average of 13.3 g/day.[9,10] These differences likely stem from variations in dietary habits, study populations, and the methods used to estimate sodium levels. Despite these discrepancies, all studies have consistently highlighted excessive salt consumption, underscoring the urgent need for public health interventions.

Participants who reported frequent consumption of meals prepared outside the home exhibited significantly higher daily sodium intake. This finding indicates that restaurant-prepared foods may contribute substantially to excess dietary salt. Public health strategies should consider engaging restaurant owners and culinary professionals to promote adherence to recommended sodium guidelines during food preparation. Additionally, further research is warranted to quantitatively assess the actual salt content in meals served by restaurants. Similar findings were reported in Japanese adults by national survey reports.[16]

There was notable difference in the amount of salt consumption among different age groups and highest (10.4 ± 3.6) was found between the age group of 30 to 44 years. According to data from the National Health and Nutrition Examination Survey (NHANES) 2013-2014, age group between 20-50 had the highest mean daily sodium intake in the United States.[17] Adults in this age range often consume more processed and restaurant-prepared foods, which are typically high in sodium and busy lifestyles may lead to a reliance on convenience foods, which often contain higher sodium levels.

Our study found significantly lower salt consumption than the study conducted by Neupane et al. Communities with teaching hospitals often experience improved health outcomes, possibly due to increased health education efforts and resources.[18] This difference may be attributed to the study location being near Dhulikhel Hospital, where many participants had relatives working in the hospital. Additionally, the Department of Community Programs and Public Health has actively conducted health education initiatives in these communities, particularly regarding non-communicable diseases, which may have contributed to greater awareness and reduced salt intake.

High dietary sodium intake is a significant global risk factor for hypertension and cardiovascular disease (CVDs) and research showed that reducing salt intake to recommended levels can reduce blood pressure by 7/4 mmHg in people with hypertension and by 4/2 mmHg in those with normal blood pressure.[19] As hypertension is highly prevalent in Nepal, lowering dietary salt consumption could be a key strategy for reducing the burden of hypertension-related health issues.

Despite the high levels of salt intake observed, our study found that awareness of the harmful effects of excessive salt consumption did not significantly affect dietary habits. While 53.4% of participants knew that high salt intake is linked to hypertension, their actual sodium consumption was not significantly different from that of those who were unaware ($p = 0.118$). This indicates that simply knowing the risks is not sufficient to change behavior.[18] This underscores the importance of combining education with practical actionable strategies to help people reduce their salt intake effectively.

The WHO has set a global target to reduce salt intake by 30% by 2025.[19] However, Nepal has not yet taken concrete policy steps to achieve this goal. Countries such as Indonesia, Sri Lanka, and Thailand have made progress by introducing measures such as mandatory sodium labeling of packaged foods, front-of-pack labels, and public awareness campaigns, which have led to noticeable reductions in salt consumption. By contrast, Nepal is still at the earliest stage of implementation, with only national policy commitments in place and no actual enforcement of regulations.[20]

One of the key strengths of our study was the use of 24-hour urinary sodium excretion, which is considered the gold standard for accurately measuring dietary salt intake. Furthermore, the study focused on a well-defined suburban population, providing important insights into the salt consumption habits within this specific group.

However, there are some limitations to this study. First, the study was carried out in only one municipality, which means that the results may not fully represent the wider Nepali population. Second, although we took steps to ensure accurate urine collection, there is a chance that under- or over-collection of samples could have introduced measurement errors. Third, relying on self-reported dietary habits and knowledge assessments might have been influenced by recall bias or the tendency of participants to provide socially desirable answers.

CONCLUSION

In conclusion, this study revealed that a suburban Nepali community consumes excessive amounts of dietary salt, with dining-out habits playing a significant role. Despite widespread awareness of the health risks associated with high salt intake, this knowledge has not translated into sufficient behavioral changes. These findings emphasize the urgent need for coordinated efforts across sectors, including policy reforms, community involvement, and targeted public health campaigns, to effectively reduce sodium consumption and address the rising burden of hypertension and cardiovascular disease in Nepal. Moving forward, research should aim to broaden the study population, track long-term trends in salt intake, and evaluate how policy measures affect sodium consumption and overall health outcomes.

ACKNOWLEDGEMENTS

We would like to extend our sincere gratitude to the University Grants Commission (UGC) Nepal for their generous partial financial support for this study. Our heartfelt thanks also go to the Dean of Kathmandu University School of Medical Sciences (KUSMS) for their valuable technical and administrative support throughout the research process. We are especially grateful to the dedicated staff of the Department of Clinical Biochemistry at Dhulikhel Hospital for their expert technical assistance and consistent support.

REFERENCES

1. Kotchen TA, Cowley AW Jr, Frohlich ED. Salt in health and disease--a delicate balance. *N Engl J Med*. 2013 Mar 28;368(13):1229-37. doi: 10.1056/NEJMra1212606. PMID: 23534562.
2. O'Donnell M, Mente A, Yusuf S. Sodium intake and cardiovascular health. *Circ Res*. 2015 Mar 13;116(6):1046-57. doi: 10.1161/CIRCRESAHA.116.303771. PMID: 25767289.
3. Mozaffarian D, Fahimi S, Singh GM, Micha R, Khatibzadeh S, Engell RE, et al. Global Burden of Diseases Nutrition and Chronic Diseases Expert Group. Global sodium consumption and death from cardiovascular causes. *N Engl J Med*. 2014 Aug 14;371(7):624-34. doi: 10.1056/NEJMoa1304127. PMID: 25119608.
4. Sodium reduction. Accessed January 13, 2025. https://www.who.int/news-room/fact-sheets/detail/salt-reduction
5. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012 Dec 15;380(9859):2224-60.
6. Sarki AM, Nduka CU, Stranges S, Kandala NB, Uthman OA. Prevalence of Hypertension in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis. *Medicine (Baltimore)*. 2015 Dec;94(50):e1959. doi: 10.1097/MD.0000000000001959. PMID: 26683910; PMCID: PMC5058882.
7. Indicator Metadata Registry Details. Accessed April 6, 2025. https://www.who.int/data/gho/indicator-metadata-registry/imr-details/3082
8. Ghimire K, Mishra SR, Neupane D, Kallestrup P, McLachlan CS. Association between Salt-Related Knowledge, Attitudes, and Behaviours and 24 h Urinary Salt Excretion in Nepal. *Nutrients*. 2024 Jun 18;16(12):1928. doi: 10.3390/nu16121928. PMID: 38931282; PMCID: PMC11206565.
9. Neupane D, Rijal A, Henry ME, Kallestrup P, Koirala B, Mclachlan CS, et al. Mean dietary salt intake in Nepal: A population survey with 24-hour urine collections. *J Clin Hypertens (Greenwich)*. 2020 Feb;22(2):273-279. doi: 10.1111/jch.13813. Epub 2020 Jan 22. PMID: 31967732; PMCID: PMC8029777.

10. Bhattarai S, Bista B, Yadav BK, Gynawali P, Poudyal A, Jha AK, et al. Estimation of mean population salt intakes using spot urine samples and associations with body mass index, hypertension, raised blood sugar and hypercholesterolemia: Findings from STEPS Survey 2019, Nepal. *PLoS One.* 2022 Apr 12;17(4):e0266662. doi: 10.1371/journal.pone.0266662. PMID: 35413065; PMCID: PMC9004746.
11. Aryal KK, Mehata S, Neupane S, Vaidya A, Dhimal M, Dhakal P, et al. The Burden and Determinants of Non Communicable Diseases Risk Factors in Nepal: Findings from a Nationwide STEPS Survey. *PLoS One*. 2015 Aug 5;10(8):e0134834. doi: 10.1371/journal.pone.0134834. PMID: 26244512; PMCID: PMC4526223.
12. OMRON H. Instruction Manual 7 Series Wrist Blood Pressure Monitor. https://omronhealthcare.com/blood-pressure-monitors
13. Point of Care - i-SENS, Inc. December 27, 2018. Accessed April 6, 2025. https://i-sens.com/point-of-care-testing/
14. Bio Systems | BA400 biochemistry analyser. BioSystems. Accessed April 6, 2025. https://biosystems.global/service/clinical-analysis/biochemistry-systems/analysers/ba400
15. Hikita N, Batsaikhan E, Sasaki S, Haruna M, Yura A, Oidovsuren O. Evaluation of salt intake estimated from 24-h urinary sodium excretion in medical professionals in Darkhan-Uul Province, Mongolia: a cross-sectional study. *Sci Rep*. 2023 Jun 28;13(1):10456. doi: 10.1038/s41598-023-37631-x. PMID: 37380730; PMCID: PMC10307767.
16. Matsumoto M, Saito A, Okada C, Okada E, Tajima R, Takimoto H. Consumption of meals prepared away from home is associated with inadequacy of dietary fiber, vitamin C and mineral intake among Japanese adults: analysis from the 2015 National Health and Nutrition Survey. *Nutr J*. 2021 Apr 23;20(1):40. doi: 10.1186/s12937-021-00693-6. PMID: 33892732; PMCID: PMC8066977.
17. Quader ZS, Zhao L, Gillespie C, Cogswell ME, Terry AL, Moshfegh A, et al. Sodium Intake Among Persons Aged ≥2 Years - United States, 2013-2014. *MMWR Morb Mortal Wkly Rep*. 2017 Mar 31;66(12):324-328. doi: 10.15585/mmwr.mm6612a3. PMID: 28358799; PMCID: PMC5657955.
18. Presence of Teaching Hospitals Improves Outcomes | Harvard Medical School. February 1, 2023. Accessed March 6, 2025. https://hms.harvard.edu/news/presence-teaching-hospitals-improves-outcomes
19. He FJ, MacGregor GA. A comprehensive review on salt and health and current experience of worldwide salt reduction programmes. *J Hum Hypertens*. 2009 Jun;23(6):363-84. doi: 10.1038/jhh.2008.144. Epub 2008 Dec 25. PMID: 19110538.
20. WHO global report on sodium intake reduction. Accessed March 6, 2025. https://www.who.int/publications/i/item/9789240069985