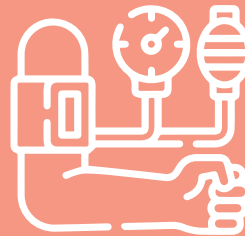


# Low-sodium salt substitutes as a key intervention for prevention, control & management of hypertension and other cardiovascular diseases in India

## *A White Paper*



The George Institute  
for Global Health India





## Acknowledgements

This whitepaper represents an important step toward advancing evidence-informed dialogue and action on the use of potassium enriched low sodium salt substitutes (LSSS), with the objective of generating insights that can inform future strategies, policies, and implementation efforts. The successful development of this work was made possible through the collective contributions and sustained support of several individuals and institutions.

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## List of abbreviations

AHA	American Heart Association
API	Association of Physicians of India
ASHAs	Accredited Social Health Activists
BCC	Behaviour Change Communication
CKD	Chronic kidney disease
CKD-EPI	CKD–Epidemiology Collaboration
CNNS	Comprehensive National Nutrition Survey
CVD	Cardiovascular Diseases
DALYs	Disability Adjusted Life Years
DBP	Diastolic Blood Pressure
ERA	European Renal Association
ESH	European Society of Hypertension
ESC	European Society of Cardiology
FOPL	Front-of-Pack Labelling
FOPWL	Front-of-Package Warning Labels
FSSAI	Food Safety and Standards Authority of India
GDP	Gross Domestic Product
GFR	Glomerular Filtration Rate
HFSS	High in fats, sugar, and salt
ICMR-INDIAB	Indian Council of Medical Research–India Diabetes
KCl	Potassium chloride
KDIGO	Kidney Disease Improving Global Outcomes
KHA CARI	Kidney Health Australia – Caring for Australasians with Renal Impairment
LASH	Latin American Society of Hypertension
LSS	Low-sodium salt
LSSS	Low-sodium Salt Substitutes
LASI	Longitudinal Aging Study in India
LMICs	Low- and Middle-Income Countries
MACE	Major adverse cardiovascular events
MDRD	Modification of Diet in Renal Disease
MoHFW	Ministry of Health and Family Welfare
NCD	Non-Communicable Diseases
NHSRC	National Health Systems Resource Centre
NICE	National Institute for Health and Care Excellence
NIN	National Institute of Nutrition
NFHS	National Family Health Survey
OOH	Out-of-home
PICO	Population Intervention Control Outcome
RDA	Recommended Dietary Allowance
RCTs	Randomised Controlled Trials
REML	Restricted maximum likelihood
RRT	Renal replacement therapy
RTSL	Resolve to Save Lives
SBP	Systolic Blood Pressure
SSaSS	Salt Substitute and Stroke Study
SSiS	Salt Substitute in India Study
WHO	World Health Organisation
YLL	Years of Life Lost

## Executive summary

The World Health Organization (WHO) in 2025, released the “Use of lower-sodium salt substitutes” guidelines. It recommends replacing regular salt to reduce sodium intake and health risks for adults. The guidelines also mention that the vast majority of the population will benefit from lower-sodium salts, a small proportion with severe kidney disease may be at increased risk of harm.

Replacing regular salt with potassium-enriched low sodium salt substitutes (LSSS) could be an effective strategy to reduce population-level sodium intake in India, where an estimated 80% of sodium consumption comes from discretionary salt use. This white paper brings together evidence on the prevalence of hypertension, cardiovascular diseases (CVD) chronic kidney disease (CKD), population-level sodium and potassium intake, and the barriers to adopting LSS in India. It also reviews the efficacy, effectiveness, safety of LSSS, and existing guidelines for LSSS to help inform India-specific recommendations.

Global evidence indicates that the use LSSS is a highly effective strategy for prevention, control and management of hypertension and other CVDs. The use of LSSS is also endorsed by leading international and national guidelines, including those of the European Society of Cardiology (ESC), the American Heart Association (AHA), and the Australian National Hypertension Taskforce. These guidelines acknowledge LSSS as an effective strategy to lower dietary sodium intake, increase potassium intake, and thereby reduce blood pressure and cardiovascular risk at the population level. The WHO Global Report on Hypertension 2025 likewise highlights LSSS as an effective intervention for the prevention and control of hypertension worldwide.

A common concern around LSSS is the risk of hyperkalaemia in individuals who have difficulty excreting potassium. While no randomised trial has shown harm to date, the evidence in these higher-risk groups is limited, so a theoretical risk remains. This underscores the need to understand both CKD prevalence in India and population-level sodium and potassium intake.

The evidence synthesis exercise conducted as part of this white paper, estimated a pooled prevalence of CKD as 12% with confidence intervals (CI) ranging between 8.00 to 15.00,  $I^2 = 99.59\%$ ,  $p < 0.001$ . Additionally, data from specific prevalence studies on stages of CKD in India show a higher prevalence of CKD stage 1-3. Current dietary guidelines recommend low potassium intake only for advanced CKD (stage 4–5). Evidence suggests that increased potassium intake may benefit individuals in early CKD stages, helping reduce blood pressure and potentially slow disease progression.

The evidence synthesis exercise also highlighted that the dietary consumption of potassium among the general population in India is substantially lower than recommended. Dietary methods of assessing potassium intake indicate a consumption of 1826.28 mg/day; and urinary excretion method shows a consumption of  $1428.36 \pm 997.05$  mg/day, far below the intake recommended by ICMR-NIN and WHO (at least 3500 mg/day). Based on the current intake of potassium, an LSSS with 30% sodium being replaced with potassium, if consumed at the level of recommendation of salt intake i.e. 5 gm a day, would provide an additional amount of 779 mg of potassium per day. This amount will add potassium to the total level of intake, providing a potentially beneficial effect, but will be well within the recommended level of intake.

Furthermore, in large-scale pragmatic trials evaluating the effect of LSSS, where people were excluded based only on self-reported CKD or taking potassium-sparing diuretics, there were no reports of excess risk of adverse events, including severe hyperkalaemia. While people with advanced CKD have the highest risk of hyperkalaemia in general, those on Angiotensin-Converting Enzyme (ACE) inhibitors or Angiotensin Receptor Blockers (ARBs) to treat hypertension are at slightly elevated risk in general, although it is not clearly known how LSSS and these drugs interact.

To summarise, current evidence indicates that lower sodium and increased potassium intake from LSSS helps reduce blood pressure and the risk of CVDs. It benefits general population as well as people with CKD in the initial stages of the disease, slowing its progression. However, in the absence of evidence regarding the effects of LSSS on the occurrence of hyperkalaemia in people with advanced kidney disease, LSSS should carry advisories that clearly indicate the risk to patients with advanced kidney disease or those advised to be on potassium-sparing medications.

From a public health perspective, evidence indicates that LSS could play an important role as a population-level sodium reduction strategy in India. Developing recommendations for its use, and improving awareness, acceptability, affordability, and access, could help reduce the burden of hypertension and other CVDs.

## Chapter 1:

# Current burden of hypertension and other cardiovascular diseases (CVD) in India, salt consumption, and its risk related to hypertension and other CVDs

## 1.1 Introduction

The Global Burden of Disease Report 2023 informs that the burden of cardiovascular diseases (CVD) has increased globally by about 1.4 times in the past quarter century, with 320 million Disability Adjusted Life Years (DALYs) attributable to CVDs in 1990 to 437 million in 2023 (1). CVDs are also the leading cause of global mortality, accounting for about 32% of global deaths. Of these, about 80% of deaths from CVDs occur in lower and middle-income countries (2). Comprehensive regression models constructed from the Global Burden of Disease Study, 2019, have predicted that the crude prevalence of CVDs will increase by 109% in Asia, from 2025 to 2050, with 729.5 million cases. South Asia is expected to experience a rise of 85.3% in the mortality rate due to CVDs by 2050 (3). In terms of both land area and population, India occupies a major portion of South Asia. According to a meta-analysis, the prevalence of CVDs in India is 11% (4).

## 1.2 Epidemiology of hypertension and other cardiovascular diseases (CVDs) in India

India has witnessed a drastic epidemiological shift in the last 20 years, with non-communicable diseases (NCDs) taking over infectious diseases and undernutrition as the main cause of death and disability (2,5). The age-standardized CVD death rate in India is 272 per 100,000, which is higher than the global average of 235 per 100,000 people (1).

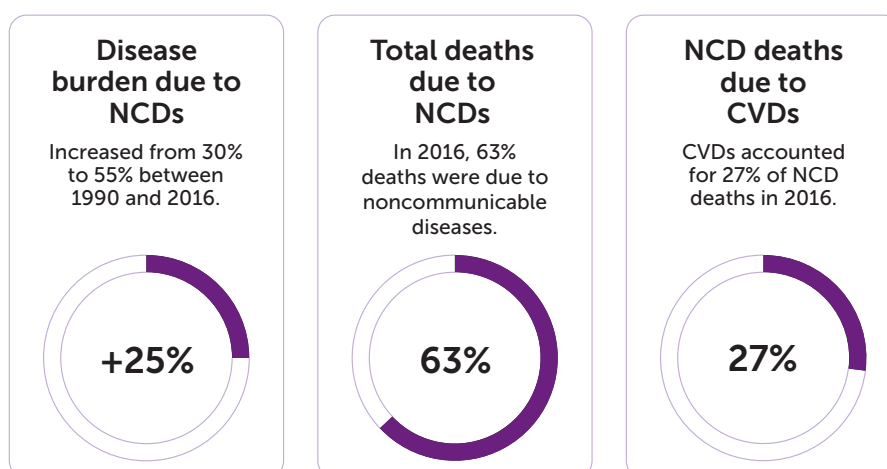
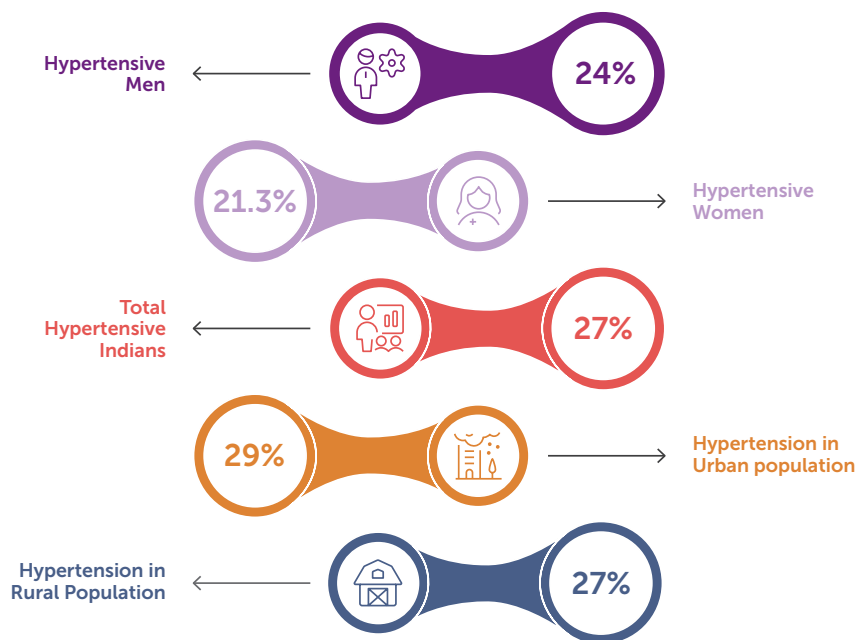


Figure 1.1: India's epidemiological shift

Source. World health organization and Indian council of medical research (2,5)

Indians become a target of CVDs at a much younger age as compared to the Western population (7). This is due to both genetic and environmental factors. Unhealthy diets, sedentary lifestyles, dyslipidaemia, and elevated systolic blood pressure are the major preventable risk factors (8). High blood pressure leads to nearly 10.7 million deaths each year, which accounts for 31% of total deaths that are more than any other condition (6). Out of 1.13 billion adults with raised blood pressure, about 199 million reside in India (9). Lack of awareness, treatment, and control options in low and middle income countries (LMICs) makes their population more vulnerable to hypertension (10). A large-scale study conducted among 44 LMICs that included 1.1 million adults, reported that about 17% had hypertension. Among these individuals 74% had ever got their blood pressure measured. Out of those 39% had been diagnosed with hypertension, 30% received treatment, and less than 10% were able to achieve blood pressure control (11).

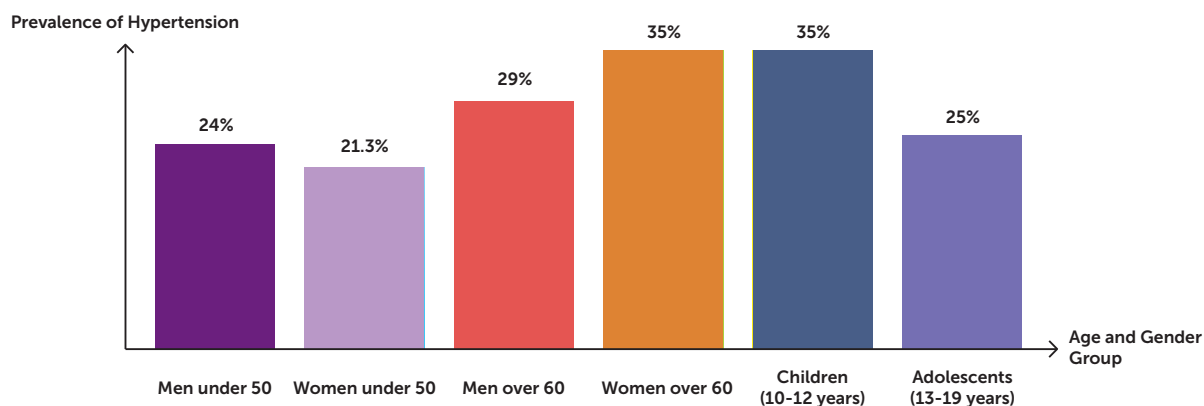
According to the NFHS-5 data, 24% men and 21.3% women in India are hypertensive (12). ICMR-INDIAB study states that the prevalence of hypertension is enormous throughout the country, with about one-third (27%) of the population being affected, with minimal difference between different regions. The prevalence was slightly higher among the urban participants (29%) than their rural counterparts (27%) (13) (Figure 1.2). However, due to the nutrition transition, lack of adequate resources and control options, rural populations now have higher incidence rates (14). Hypertension also affects urban slum dwellers, with an incidence of 28.3% (15).



**Figure 1.2:** Hypertension and cardiovascular diseases prevalence in India  
Source. NFHS-5, ICMR-INDIAB study (11,12)

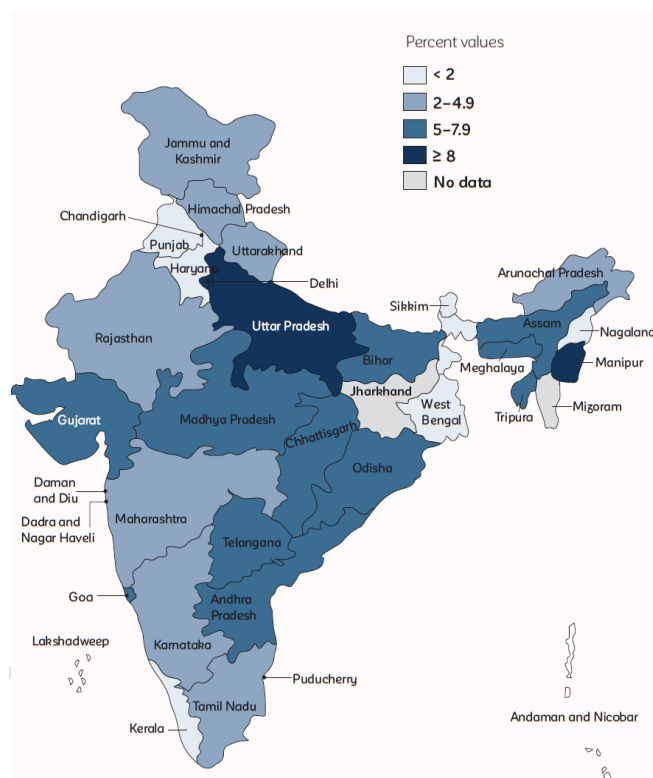
Increasing age has a significant positive association with the incidence of hypertension, making older adults highly vulnerable (15,16). The Longitudinal Aging Study in India (LASI study) reports that the prevalence of CVDs among adults 45-54 years was 22% while among those who are 70 years and above was 38%. Among adults aged 45 years, hypertension contributed to almost half of the CVD burden, with 46.7% overall prevalence (17). Individuals with pre-existing comorbid conditions and cardiometabolic diseases like diabetes, hypertension, or obesity were found to be more salt-sensitive and thus at an increased risk of persistent hypertension (18,19). In terms of Years of Life Lost (YLL) due to CVDs, men are prone to greater premature mortality than women (20). Hypertension

affects a greater number of males than females up to 50 years, but over 60 years, the prevalence of hypertension has been observed to be 6% higher in women as compared to men (21,22). Figure 1.3 shows the influence of demographics on the prevalence of hypertension (21,23,24).



**Figure 1.3:** Prevalence of hypertension by demographics  
Source. Data from multiple studies (14-23)

Various studies have reported that Indian children and youth are also a target of stage 1 or 2 hypertension, affecting about 35% of children between the ages of 10-12 years and 25% adolescents between the ages of 13 to 19 years (24). According to the CNNS Report, 2016-18, 4.9% of adolescents in India are affected by hypertension. Figure 1.4 shows that the prevalence of hypertension among adolescents ranged from 0% to 10% across different regions of India, with the highest prevalence in Delhi, Uttar Pradesh, and Manipur (25). Children who had one or more CVD risk factors, like obesity, dyslipidaemia, or elevated blood glucose, were more likely to suffer from hypertension (23,24).



**Figure 1.4:** Regional differences in the prevalence of hypertension among adolescents in India  
Source. CNNS Report, 2016-18 (24)

Due to industrialization, sodium has become readily available in the diet, either in the form of packaged foods or as common table salt. Over time, humans have developed a salt preference in which one tends to consume more than the physiological requirements (26). The development of salt preference is strongly linked to exposure to salt-rich foods early in life. Infants who are exposed to salty foods develop a preference for NaCl, and this relationship continues throughout life, making them more prone to consuming high-sodium foods (27). The latest advisory released by the Ministry of Women and Child Development, Government of India, has also stated that salt must be kept to a minimal level in the Government supplementary nutrition programs (28). Indians report a greater incidence of adverse events from hypertension as compared to developed countries. This is because of lesser awareness and treatment options, along with unhealthy dietary patterns (29).

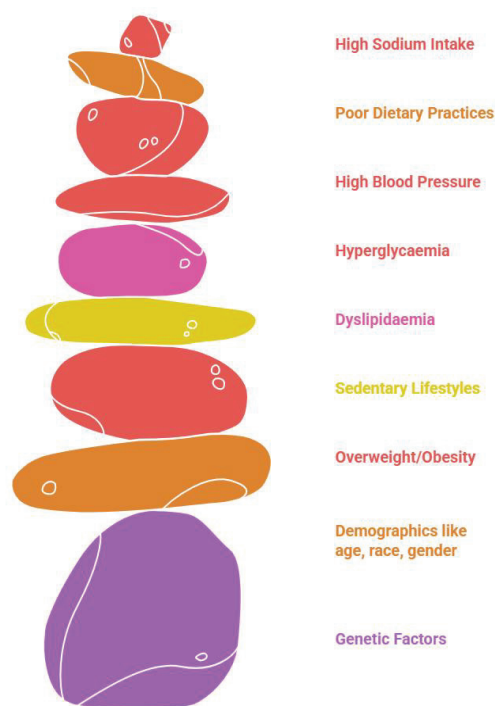
### Key highlights

- NCDs have surpassed infectious diseases as the main cause of death and disability.
- In 2016, 63% deaths were due to NCDs in India, and out of this, 27% were due to CVDs.
- High blood pressure is the leading cause of mortality worldwide leading to 10.7 million deaths each year.
- Out of 1.13 billion adults with raised blood pressure, about 199 million reside in India.
- High blood pressure affects all age groups, including children, adults, and the elderly.
- India reports a greater incidence of adverse events from hypertension as compared to developed countries.

## 1.3 Risk factors contributing to hypertension and other cardiovascular diseases and salt consumption patterns in India

Various modifiable and non-modifiable risk factors contribute to CVDs (30). These include genetic factors, demographics like age, race, and gender differences, overweight and obesity, sedentary lifestyles, dyslipidaemia, hyperglycaemia, high blood pressure, and poor dietary practices (30) (Figure 1.5). According to the Global Burden of Disease Report 2023, **diets high in sodium are the leading risk factor for death and disability globally, contributing to 5% of all global deaths and 4% of total DALYs. High salt intake leads to 1,75,000 deaths annually in India (6).**

Data shows that the average global salt intake among adults is equivalent to 10.78 g/day (4310 mg/day sodium), which is more than twice the WHO's recommendation of less than one teaspoon or 5 g salt/day (less than 2000 mg sodium/day) (31). The mean weighted salt intake in India is 10.98 g/day (32). National NCD Monitoring Survey Report,



**Figure 1.5:** Cardiovascular diseases risk factors in India  
Source. GBD report, 2023 and bays et al., 2021 (1,29)

2017-18, assessed the urinary sodium excretion by spot urine samples and reported that the mean daily salt intake among Indians was 8.0 g per day (33). A study conducted among hypertensive and dyslipidemic adults in different regions of India reported that mean daily salt consumption was higher among north Indians (14.1 g) as compared to East (10.1 g), South (9.8 g), and West (9.3 g) (34). The major sources of salt in Indian diet are (i) salt added to the food while cooking or eating at home, called the discretionary salt; (ii) foods prepared outside the home, like that obtained from restaurants, or provided at schools or other government institutions; and (iii) packaged and processed foods. **The average daily intake of salt in India is 8-11 grams, and discretionary salt accounts for 80% of total salt consumption (35).**

## 1.4 Salt and its role in hypertension and other cardiovascular disease development

**Salt and Sodium:** One teaspoon of salt (approx. 5g) contains about 2 grams of sodium. According to NIN, ICMR, 2020 recommendations, Indian adults must consume less than 2000 mg/day of sodium or less than 5 g/day of salt (36). Cardiovascular diseases, including hypertension, are linked with high dietary sodium and low potassium intake (37). High salt intake increases blood pressure in a progressive, dose-response manner, which shows an approximately linear relationship between sodium intake and blood pressure. Each 1 g reduction in sodium intake is associated with 2.42 mm Hg decrease in systolic blood pressure (SBP) and 1.01 mm Hg decrease in diastolic blood pressure (DBP). This dose-response effect is stronger and shows a steeper relationship among people living with hypertension, older adults, and women, indicating these groups being highly salt sensitive (38,39).

Various physiological mechanisms link hypertension with high salt intake. One of the earliest mechanisms was proposed by Guyton and Coleman, called the 'pressure natriuresis mechanism', which helps maintain blood pressure. However, a long-term high salt diet can lead to persistently elevated blood pressure as this mechanism gets disrupted (40). Increased sodium intake can also cause vascular remodelling, which can cause stiffness of the arteries, thereby increasing peripheral resistance and leading to elevated blood pressure (8).

**Role of Potassium:** WHO and various other studies have recommended lowering sodium and consequently increasing potassium intakes to prevent morbidity and mortality due to various CVDs, including hypertension (31,37). **Potassium helps prevent hypertension by counteracting the effects of sodium. The greater the potassium consumption, the more the urinary sodium excretion. Also, potassium helps in vasodilatation, thereby reducing blood pressure (8,36).** As per the recommendations by the WHO, the desirable molar ratio of sodium to potassium is 1:1 or lower, with a recommended intake of sodium up to 2000 mg/day and potassium as more than or equal to 3500 mg/day (36). Potassium is mostly found in fruits, vegetables, pulses and legumes, and nuts, and Indian diets are found to be deficient in these food groups. On average, people consume 2.25 g of potassium/day, which is much less than the WHO recommendation of 3.5 g/day (41). Table 1.1 shows the recommended dietary allowance (RDA) for sodium and potassium given by NIN, ICMR, 2020.

**Table 1.1: RDA for sodium and potassium (mg/day)**

Age Group		Molar Ratio	Sodium (mg/day)	Potassium (mg/day)	Salt (g/day)
<b>Adults (18-60 years)</b>	Men	1:1	2000	3500	5.0
	Women	1:1	2000	3500	5.0
<b>Infants</b>	0-6 months	1:1	500	900	1.3
	7-12 months	1:1	650	1100	1.6
<b>Children</b>	1-3 years	1:1	1000	1750	2.5
	4-6 years	1:1	1300	2250	3.3
	7-9 years	1:1	1600	2825	4.0
<b>Hypertensive Adults*</b>	Men and Women	<1:1	<1500 - 2000	>3500	3.8-5.0

Source. NIN, ICMR, 2020 (36), \*American Heart Association (AHA), 2025 (42,43)

## 1.5 Public health implications

Hypertension and increasing levels of dietary sodium intake have become a public health problem that not just impacts the health but also has an overall negative impact on the development and economy of a country (44). Treatment of hypertension is very expensive. In most LMICs, the cost of healthcare in the control of hypertension and other cardiovascular events is much more than per capita expenditure on health (45).

Such a scenario justifies the saying that ‘**prevention is better than cure**’ and thus calls for urgent strategies to reduce dietary sodium intake and hence prevent hypertension. Sodium Reduction is a WHO “best buy” strategy and one of the most cost-effective ways to improve population health. For every US dollar spent on sodium reduction, USD \$12 could be saved (46).

Apart from promoting less dietary salt intake through behaviour change communication strategies, various studies have advocated for the substitution of regular salt with potassium-enriched low-sodium salt substitutes (LSSS) (37,47–49). This has proven to reduce both the systolic and diastolic blood pressure, incidence of stroke, all-cause cardiovascular mortality rate, and also improve the overall quality of life (37,49). This is particularly important for countries like India, where the majority of sodium intake is through food cooked at home. **Recently, the WHO has also released guidelines that propose replacing regular table salt with potassium-enriched low-sodium salt substitutes (LSSS) for adults without renal comorbidities (50).** It can thus be a major cost-saving intervention in the direction of prevention, control, and management of hypertension and other CVDs in developing countries like India.

### Key highlights

- Diets high in sodium are the leading risk factor for death and disability globally.
- High salt intake leads to 1,75,000 deaths annually in India.
- The average daily intake of salt in India is 8-11 grams, which is almost twice the recommendations by WHO and NIN, ICMR, of less than one teaspoon or 5 g salt/day (less than 2000 mg sodium/day).
- Discretionary salt accounts for 80% of total salt consumption in India.
- Each 1 g reduction in sodium intake is associated with 2.42 mm Hg decrease in systolic blood pressure (SBP) and 1.01 mm Hg decrease in diastolic blood pressure (DBP).
- Potassium helps prevent hypertension by counteracting the effects of sodium. The greater the potassium consumption, the more the urinary sodium excretion.
- Recently, the WHO has also released guidelines that propose replacing regular table salt with potassium-enriched low-sodium salt substitutes (LSSS) for adults without renal comorbidities.
- LSSS has proven to reduce both the systolic and diastolic blood pressure, incidence of stroke, all-cause cardiovascular mortality rate, and improve the overall quality of life.

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## Chapter 2:

# Sodium reduction initiatives: global and Indian scenario

WHO member states, including India have committed to a global goal of reducing the average population sodium intake by 30% by 2030 to help prevent and control non-communicable diseases (NCDs). High salt consumption is a key factor contributing to the worldwide burden of cardiovascular diseases (CVDs), including hypertension, stroke, and heart failure.

## 2.1. Frameworks to reduce sodium intake at the population level

### 2.1.1 WHO SHAKE technical package

The World Health Organization's SHAKE Technical Package (2016) provides an evidence-based framework for countries to design and scale effective salt reduction programs. It outlines five strategic pillars—**Surveillance, Harness industry, Adopt standards, Knowledge, and Environment**—and offers tools and policy guidance adaptable to diverse settings (1). The RTSL framework, together with Nutrition International, WHO, and the Iodine Global Network, recommends reducing daily salt intake while simultaneously ensuring sufficient iodine consumption. (2)

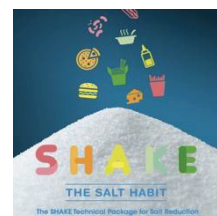
### 2.1.2. Framework for prioritizing high-impact sodium reduction strategies

This framework categorizes sodium reduction interventions according to their sources, which include reduction in the consumption of discretionary salt during food preparation at home, reducing salt intake from food outside of home, and salt consumed through packaged food. These interventions are summarised according to their effectiveness, scalability & sustainability, and large benefits from available evidence (3). This is shown in Table 2.1.

## 2.2. Interventions to reduce sodium intake

### 2.2.1. Reducing sodium from packaged foods

**(a) Front-of-pack labelling (FOPL):** Front-of-pack labelling initiatives have expanded globally. In 2019, 48 countries implemented schemes that included sodium content on labels, and eventually, 16 more countries developed such systems. Programs such as the Health Star Rating in Australia and New Zealand and Nutri-Score in France aim to present clear nutritional information at the point of purchase, helping consumers make healthier choices while encouraging food manufacturers to reformulate products (4). Evidence indicates that front-of-package warning labels (FOPWL) are the most effective tool for helping consumers clearly and accurately recognize products high in nutrients of concern, such as sugars, fats, and sodium (5). Compared with other labelling formats or the absence of labels, these warning labels are particularly effective in enabling consumers to quickly identify less healthy foods and enhancing their awareness of the health risks associated with consuming such products (6).



Current evidence demonstrates that front-of-package warning labels (FOPWL) effectively reduce consumers' perceptions of the healthfulness of products high in nutrients of concern when compared with other types of front-of-package labels. They also decrease consumers' intentions to purchase products containing high levels of sugars, sodium, or saturated fats. Furthermore, FOPWL policies have been shown to reduce the proportion of products in the market with excessive levels of these nutrients within the first year of implementation, encouraging product reformulation and contributing to healthier diets. In addition, they significantly lower children's exposure to advertising for foods and beverages labelled as "high in," since marketing of such products is also restricted. For example, in Chile, the share of child-directed advertisements for "high in" products dropped from 42% before the regulation to 15% afterward. As of August 2024, ten countries, Argentina, Brazil, Canada, Chile, Colombia, Israel, Mexico, Peru, Uruguay, and Venezuela, have adopted or implemented mandatory FOPWL policies (6).

Globally, nutritional labelling standards classify processed food products based on sodium levels: **sodium-free** (<5 mg/serving), **very low sodium** (<35 mg), **low sodium** (<140 mg), **reduced sodium** (≥25% less than regular), and **light sodium** (≥50% less). Products labelled **no salt added** indicate no salt was added after initial preparation (6).

**Table 2.1 Framework for prioritizing high-impact sodium-reduction strategies**

	Scalable and Sustainable	Evidence of Effectiveness or Innovation	Large Benefit
<b>Sodium consumed from packaged foods</b>			
Front-of-pack labelling regulations	Yes	Suggestive evidence of effectiveness	<ul style="list-style-type: none"> <li>Modelling studies available</li> <li>Theoretically large benefit</li> </ul>
Fiscal policies: taxation on high-sodium foods	Yes	Suggestive evidence for sodium, rigorously evaluated for other topic areas (e.g., sugar-sweetened beverages)	<ul style="list-style-type: none"> <li>Modelling studies available</li> <li>Theoretically large benefit</li> </ul>
Food reformulation targets for packaged food (voluntary or mandatory)	Yes	Rigorously evaluated	Impact evaluations conducted on sodium and health outcomes
Regulation of the marketing of foods and non-alcoholic beverages to children	Yes	Suggestive evidence of effectiveness	Theoretically large benefit
<b>Sodium consumed from food prepared outside the home</b>			
Standards for sodium as part of food procurement policies for public institutions	Yes	Suggestive evidence of effectiveness	<ul style="list-style-type: none"> <li>Modelling studies available</li> <li>Theoretically large benefit</li> </ul>
<b>Sodium consumed at home</b>			
Mass media campaigns	Yes*	Some suggestive evidence of effectiveness, rigorously evaluated for other topic areas (e.g., tobacco)	Theoretically large benefit
Increase uptake of low-sodium salt (promotion, distribution, subsidies)	Yes	Innovative approach for sodium added at home	<ul style="list-style-type: none"> <li>Modelling studies available</li> <li>Theoretically large benefit</li> </ul>

Source: Ide et al., 2020

\*May not be sustainable due to recurrent costs for ongoing or repeat campaigns

**(b) Fiscal measures:** Fiscal policies, which include taxing foods high in fats, sugar, and salt (HFSS) and subsidizing healthier foods, have been adopted in a limited number of countries such as Fiji, Hungary, Mexico, Saint Vincent and the Grenadines, and Tonga to discourage consumption of HFSS. Despite their potential to drive reformulation and lower population salt intake, these measures remain underutilized in LMICs (4). A recent modelling study conducted in the Philippines by RTSL found that implementing a 20% tax on packaged foods high in sodium or sugar could prevent approximately 2,800 deaths and 41,000 cases of cardiovascular disease and type 2 diabetes over 20 years. The study also estimated that such a policy could generate around US\$46 million in healthcare cost savings, US\$13 billion in tax revenue, and incur about US\$250 million in implementation costs (7). Similar modelling studies, including those from LMICs such as Mexico and South Africa, have shown that taxing unhealthy foods and beverages can effectively reduce the burden of cardiometabolic diseases and is either cost-effective or cost-saving (7).

**(c) Sodium limits in processed foods:** Alongside fiscal measures, another key policy lever for reducing population sodium intake involves setting sodium limits in commonly consumed processed foods. Several countries have mandated sodium reduction targets in staple foods. Countries like Bahrain, Belgium, Hungary, the Netherlands, Paraguay, Portugal, Qatar, Spain, and Turkmenistan have set limits in breads, while others including Argentina, Belarus, Bulgaria, Finland, Greece, Iran, Slovakia, South Africa, and Uzbekistan extended mandatory targets to meats, cheeses, snacks, soups, canned fish, and processed fruits and vegetables. These regulatory measures represent a shift toward systemic reform of the global food supply to reduce sodium exposure (4).

**(d) Regulation of marketing of foods:** Another high-impact strategy for reducing sodium intake is regulating the marketing of foods high in fat, sugar, and salt (HFSS) or other processed foods (9). Limiting the marketing of HFSS foods to children has been shown to help decrease the sodium content in packaged foods (9,10). Mandatory limits on marketing unhealthy foods help safeguard children's health by reducing their exposure to persuasive advertising that can negatively shape their food choices. By 2024, only 16% of countries had policies restricting the marketing of unhealthy foods in schools. In 2023, just 13 countries limited unhealthy food marketing to children on broadcast media, with 7 of them also applying these rules to digital platforms. Both Chile and the UK have shifted from content-based to broad time-based broadcast restrictions during peak child-viewing hours, and the UK additionally bans paid online advertising of unhealthy foods. (10)

## 2.2.2 Reducing sodium from food prepared outside the home

**Out-of-home (OOH) sector intervention to reduce dietary sodium intake:** Out-of-home (OOH) environments, such as workplaces and educational institutions, provide valuable opportunities for health promotion and dietary interventions (11). However, globally, there are suboptimal efforts towards salt reduction initiatives specifically targeting the OOH sector (11). High-income countries like the United Kingdom and Australia have introduced salt reduction policies aimed at this sector, which include setting sodium targets for various product categories, promoting consumer education, implementing gradual sodium reduction, and engaging food manufacturers in the process (11).

Public food procurement and service systems in India spanning schools, Anganwadi centres, hospitals, and government canteens provide a powerful platform for out-of-home (OOH) interventions to reduce dietary sodium. Capacity-building for cooks and caterers within these public institutions further ensures consistent implementation of reduced-salt practices, creating healthier defaults for millions who rely on publicly provided meals (8,12).

## 2.2.3 Reducing sodium consumed at home

**(a) Public awareness and behaviour change communication (BCC):** Behaviour change communication strategies remain vital for raising awareness about excessive salt consumption, though their success in achieving sustained intake reductions has been mixed. A recent community-based intervention in Telangana, delivered by Accredited Social Health Activists (ASHAs), integrates structured messaging with behavioural frameworks to encourage salt reduction. While promising, such approaches face challenges in scalability, sustainability, limited effectiveness, and resource intensiveness across diverse settings (13). Hence, combining education with supportive measures—such as recommending the use of potassium-enriched low-sodium salt substitutes (LSSS) and policy actions is essential for long-term impact (14).

**(b) Potassium-enriched low-sodium salt substitutes:** For LMICs like India, where discretionary salt intake still comprises a large proportion of salt intake, replacing conventional table salt (sodium chloride) **with potassium-enriched low-sodium salt substitutes (LSSS)** is a proven, cost-effective strategy to reduce sodium intake and improve cardiovascular outcomes (15). Replacing regular salt with LSSS also requires minimal consumer action. These substitutes not only lower sodium consumption but also increase potassium intake, which helps regulate blood pressure (16). These are salts where some of the sodium chloride is replaced with other minerals, most commonly potassium chloride (KCl). Various proportions are available throughout the world, ranging from 0-88% of NaCl and 0-100% of KCl. LSSS produced in India generally has 15% to 30% NaCl replaced with KCl, while in other countries like the Middle East and America, this percentage is 50% (17). According to a large-scale, open, cluster randomised trial, the incidence of stroke, other major cardiovascular events, and overall mortality decreased by about 15% in a 5-year timeframe among the intervention group who used LSSS instead of regular salt (18). Replacing regular salt with LSSS helps lower systolic BP by 4.76 mmHg and diastolic BP by 2.43 mmHg. Along with providing health benefits, LSSS is low-cost, has shown to have no significant effect on hyperkalaemia, and is similar in taste to regular salt (19). Table 2.2 shows a comparison between regular salt and LSSS (18,19). In compliance with the government mandate, LSS available in India is iodised.

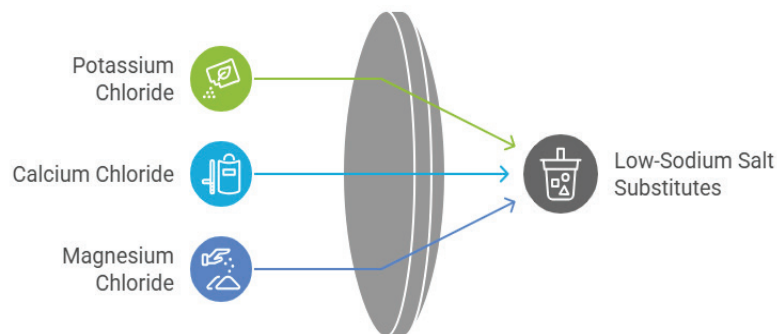
**Table 2.2 Comparison between potassium-enriched low-sodium salt substitutes and regular salt**

Characteristic	LSSS	Regular Salt
Sodium Chloride (NaCl)	0–88%	100%
Potassium Chloride (KCl)	0–100%	0%
Stroke Incidence	Decreased by 15%	No change
Cardiovascular Events	Decreased by 15%	No change
Overall Mortality	Decreased by 15%	No change
Diastolic BP	Lowered by 2.43 mmHg	No change
Systolic BP	Lowered by 4.76 mmHg	No change
Cost	Low-cost	Low-cost
Hyperkalaemia Effect	No significant effect	No effect
Taste	Similar to regular salt	Salty

Source. Neal et al., 2021

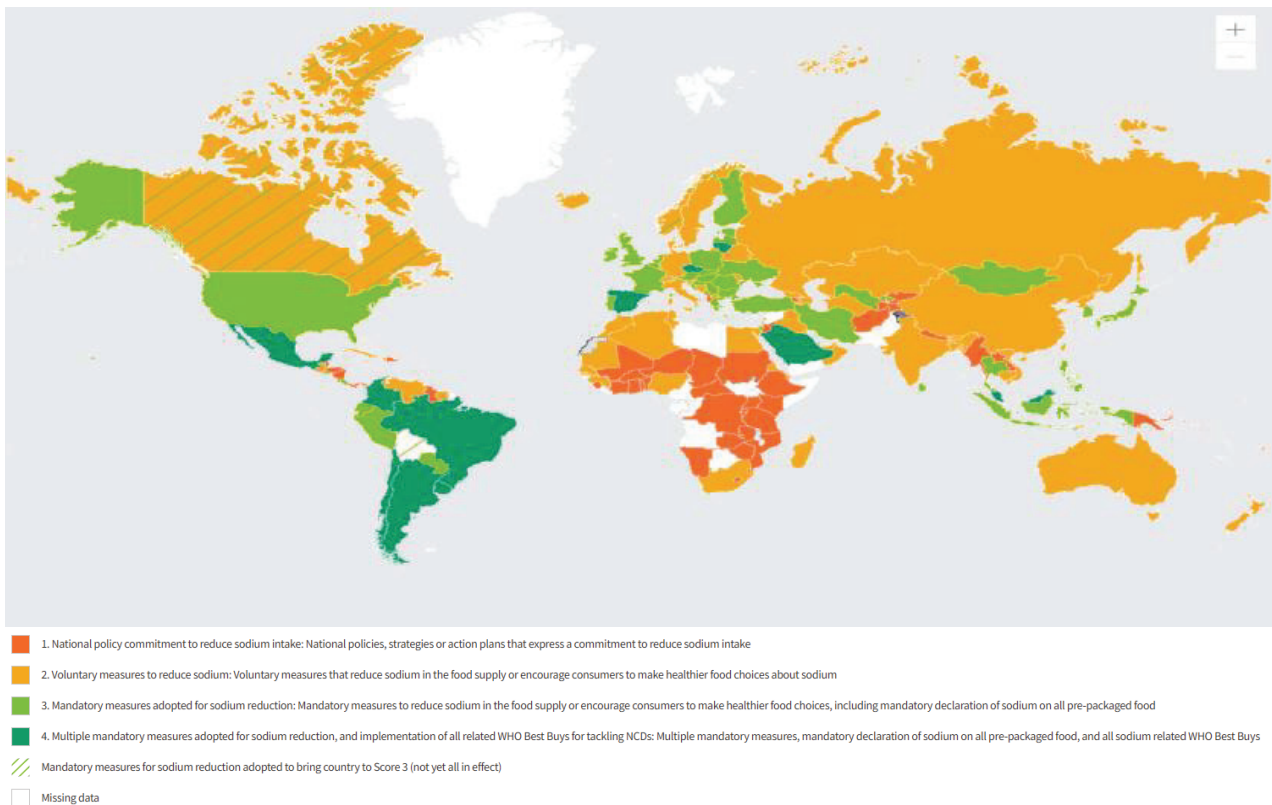
## 2.3. Composition and use of low sodium salt substitutes (LSSS)

Low-sodium salt substitutes replace sodium chloride (NaCl) with compounds such as potassium chloride (KCl), calcium chloride (CaCl<sub>2</sub>), and magnesium chloride (MgCl<sub>2</sub>). These can reduce sodium content by at least 25% while preserving flavour and texture, though careful formulation is required to avoid sensory changes (6). In India, commercially available low-sodium salt substitutes typically contain about **15–30% less sodium**, reflecting growing but still limited adoption of reformulation practices (20).



## 2.4. Global progress on sodium reduction

Many countries have implemented population-level sodium reduction strategies over the past decade. While high-income countries have led sustained efforts, LMICs continue to face challenges in adopting and scaling interventions. A 2014 systematic review reported that 75 countries had national sodium reduction initiatives, using approaches such as food reformulation, public education campaigns, front-of-pack nutrition labelling, fiscal measures, and setting-specific programs in schools, workplaces, hospitals, and government institutions. By 2019, 68 countries had adopted food reformulation strategies to reduce sodium in processed foods (4). According to the WHO Global Report on Sodium Intake Reduction, 2023, 5% of WHO member states have implemented at least one sodium reduction policy, and about 40% have adopted mandatory reformulation of foods. Figure 2.1 depicts the map showing the sodium country scorecard. Around 33% of the countries, which include India, have implemented at least one voluntary policy for the reduction of sodium consumption (21).



**Figure 2.1:** Global sodium reduction measures  
Source. WHO sodium country score card, 2025

## 2.5. India’s sodium reduction strategy

India’s sodium reduction initiatives began with the 2014 project “Developing the Evidence Base for a National Salt Reduction Program for India,” aligned with the WHO Global Action Plan for NCD Prevention and Control (2013–2020). India set a goal to reduce the mean population salt intake by 30% by 2030 (21). The Multisectoral Action Plan for NCDs (2017–2022) emphasized regulatory reforms, possible taxation on high-salt foods, front-of-pack labelling, and mass awareness campaigns (22).

### Key highlights

- WHO Member States, including India, aim to reduce population sodium intake by 30% by 2030 to curb NCDs, particularly cardiovascular diseases.
- Global sodium reduction efforts are informed by the WHO SHAKE technical package and related prioritization frameworks addressing packaged foods, out-of-home foods, and discretionary salt use.
- Interventions include food reformulation, front-of-pack labelling, fiscal measures, marketing regulations, public food procurement, and behaviour change communication.
- Sodium reduction initiatives are uneven globally, with stronger implementation in high-income countries and largely voluntary approaches in many LMICs.
- India’s initiatives, initiated in 2014, align with global goals and focus on voluntary policies, awareness generation, and integration into national NCD strategies.

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## Chapter 3:

# Efficacy, effectiveness and safety of potassium-enriched low sodium salt substitutes (LSSS)

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## 3.1. Introduction

Global evidence demonstrates that the use of Potassium-enriched Low Sodium Salt Substitute (LSSS) is a highly effective strategy for prevention, control and management of hypertension and other cardiovascular disease (CVD) (1). In this white paper we reviewed the commissioned systematic reviews included in the *Use of lower-sodium salt substitutes: WHO guideline 2025*. An umbrella review was also conducted, for evidence synthesis based on other systematic reviews that have assessed the Efficacy, Effectiveness and Safety of Potassium-enriched Low Sodium Salt Substitutes. The use of LSSS is endorsed by leading international and national guidelines, including those of the European Society of Cardiology (ESC) (2) the American Heart Association (AHA), and the Australian National Hypertension Taskforce (3). These guidelines recognise LSSS as an effective strategy to lower dietary sodium intake, increase potassium intake, and thereby reduce blood pressure and cardiovascular risk at the population level. The WHO Global report on hypertension 2025 likewise highlights LSSS as an effective intervention for the prevention and control of hypertension worldwide (4).

In 2025, the WHO endorsed the use of LSSS and published a guideline recommendation, which states *“If choosing to use table salt, WHO suggests replacing regular table salt with lower-sodium salt substitutes that contain potassium (conditional recommendation)”* (5). The conditional recommendation for LSSS reflects caution regarding potential hyperkalaemia, elevated blood potassium levels, in individuals with chronic kidney disease (CKD) or those taking potassium-sparing diuretics or certain antihypertensive medications. While no evidence of harm has been observed in any randomised control trial to date, there remains a theoretical risk due to limited data on these higher-risk groups. As such, the recommendation acknowledges the substantial population-level benefits of LSSS for blood pressure reduction and cardiovascular disease prevention, while emphasising the need for targeted monitoring and further research to clarify safety in individuals with impaired potassium regulation.

## 3.2 Summary of systematic review evidence used in the WHO guideline on use of LSSS

The WHO guideline on the use of LSSS is informed by a commissioned systematic review (6). In the following section, we present the key highlights of this systematic review.

### 3.2.1 Review characteristics

This systematic review identified 26 randomised controlled trials (RCTs) involving 34,961 adult participants. All studies compared LSSS with regular salt or no intervention; LSSS formulations typically replaced 19–50% of sodium chloride with potassium chloride, sometimes combined with magnesium or calcium salts; around half of the studies used  $\geq 30\%$  potassium chloride.

**a. Study designs, duration and locale:** No prospective cohort studies met the inclusion criteria. Sixteen trials randomised individuals, and 10 used cluster designs, with study durations ranging from 2 months to nearly 5 years were included. Most of these studies were conducted in Asia (mainly China), 1 in India, with others in Europe and Latin America.

**b. Study population:** All trials excluded people at risk of hyperkalaemia (e.g., those with kidney disease or using potassium-sparing drugs). One family-based cluster trial included both adults and children, but no studies included pregnant women.

**c. Primary outcomes assessed:** The trials collectively assessed the efficacy and safety of LSSS for blood pressure reduction and cardiovascular risk prevention across diverse populations and settings.

### 3.2.2 Review findings

Across the RCTs involving over 20,000 participants, use of LSSS led to significant reductions in both systolic (20 RCTs) and diastolic (19 RCTs) blood pressure compared with regular salt. NaCl and KCl content of LSSS evaluated in these studies ranged from 41% to 75% and 19% to 50% respectively. Meta-analysis showed an average decrease in systolic blood pressure (SBP) of 4.76 mmHg (95% CI: -6.01 to -3.50) and a decrease in diastolic blood pressure (DBP) of 2.43 mmHg (95% CI: -3.50 to -1.36), both with moderate-certainty evidence. These effects were consistent across individual and cluster trials, low-bias studies, various participant characteristics, study durations (4 weeks–60 months), and intervention types, **indicating robust evidence that LSSS effectively lowers blood pressure at the population level.**

### 3.2.3 Safety concerns around the use of LSSS

The review highlighted concerns related to the possibility that LSSS might increase risks of hyperkalaemia or raised blood potassium levels in people:

- With mild, moderate or severe kidney disease (7)
- Using potassium supplements
- Prescribed antihypertensive drug therapies that raise blood potassium levels by acting on the renin angiotensin aldosterone system (particularly angiotensin converting enzyme inhibitors, angiotensin receptor blockers, mineralocorticoid receptor antagonists, and potassium-sparing diuretics).

## 3.3. Umbrella review: evidence on efficacy and safety of LSSS

An umbrella review was conducted for synthesizing the evidence from existing systematic reviews to examine further the efficacy and safety of LSSS use.

### 3.3.1 Methodology

Following screening, four systematic reviews were included in the analysis (Greenwood et al., 2024; Yin et al., 2022; Brand et al., 2022; Tsai et al., 2022) (8,9,10,11). Searches for existing systematic reviews and meta-analyses were conducted in PubMed, Litmaps, and Google Scholar for the past 10 years. Search terms were guided by the PICO framework, the population included all age groups; the

intervention involved the use of low-sodium salt substitutes at the population level and within specific groups (e.g., the general population, individuals with pre-hypertension, those at risk of hyperkalaemia, and residents of rural or suburban areas); the comparator was regular salt (NaCl); and outcomes were categorized according to measures of efficacy and safety related to LSSS use. All reviews reported findings for adult populations; only one review examined the effects of LSSS among children and adolescents (Brand et al., 2022). No evidence was reported for pregnant women. The trials included in these systematic reviews generally excluded individuals at elevated risk of hyperkalaemia, those with chronic kidney disease, or those taking medications like potassium sparing diuretic, use of a potassium supplement (10).

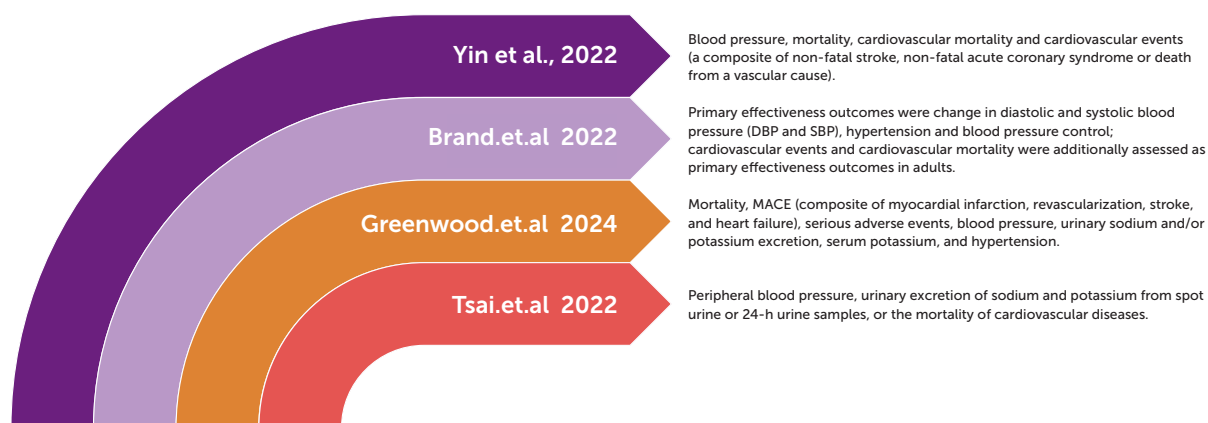
### Search string

“Regular salt” OR “sea salt” OR “common salt” OR “sodium restricted diet” OR “LSS with potassium” OR “LSS with magnesium” OR “LSS with calcium” OR “salt substitute” OR “salt substitution” OR “low sodium substitute” OR “low sodium salt” OR “high potassium substitute” OR “potassium enriched salt” OR “smart salt” OR “mineral salt” OR “salt replacement” OR “diet\*” OR “sodium” OR “salt” OR “consum\*” OR “discretionary” OR “potassium-enriched” OR “sodium reduced salt substitutes” OR “low-sodium salt” OR “potassium salt” OR “mineral salt” OR “sodium-reduced salt”  
 AND  
 “hypertension” OR “SBP” OR “DBP” OR “BP” OR “hypertens\*” OR “blood pressure” OR “cardiovascular disease” OR “CKD” OR “Renal failure” OR “kidney disease” OR “Tubular acidosis” OR “Hyperkalemia” OR “Dialysis”  
 AND  
 “Efficacy” OR “safety”

**Table 3.1 PICO framework**

PICO	Search Terms
<b>P</b>	<ul style="list-style-type: none"> <li>• General population</li> <li>• Pre hypertensive</li> <li>• Hyperkaliaemic patients</li> <li>• Rural or suburban areas</li> </ul>
<b>I</b>	<ul style="list-style-type: none"> <li>• LSSS with potassium/Magnesium/Calcium</li> <li>• Sodium restricted diet</li> <li>• Sodium substitute</li> <li>• Salt substitute</li> <li>• Salt alternative</li> <li>• Mineral salt</li> <li>• Table salt</li> </ul>
<b>C</b>	<ul style="list-style-type: none"> <li>• Regular salt/ Sea salt/ common salt</li> <li>• High sodium intake</li> </ul>
<b>O</b>	<ul style="list-style-type: none"> <li>• Reduction in non-fatal stroke</li> <li>• Reduction in Hypertension</li> <li>• Reduction in CVDs</li> <li>• Reduction in blood pressure</li> <li>• Increase in blood potassium</li> </ul>

## Outcomes



**Figure 3.1:** Outcomes depicted in the 4 reviews

## 3.4 Key findings

### 3.4.1 Review findings

The reviews by Tsai et al and Yin et al highlighted the association of LSSS use with a significant reduction in systolic and diastolic blood pressure compared with regular salt. The blood-pressure lowering effect in the meta-analysis by Yin et al appeared consistent across geographical regions and diverse population subgroups (age, sex, baseline BP, urinary sodium/potassium) with no significant heterogeneity detected. Urinary biomarkers reported in the review by Tsai et al showed lower sodium excretion and higher potassium excretion among LSSS users, confirming effective sodium reduction. Further, the review had limited number of studies reporting mortality with LSSS being associated with a reduction in all-cause mortality (HR  $\approx$  0.88). A protective effect was also observed in the review by Yin et al, which showed a total mortality risk ratio (RR) 0.89 (95% CI 0.85 to 0.94), cardiovascular mortality RR 0.87 (95% CI 0.81 to 0.94) and cardiovascular events RR 0.89 (95% CI 0.85 to 0.94). A reduction in all-cause mortality and cardiovascular mortality among adult populations was also reported by Greenwood et al. There was also a possible slight reduction in major adverse cardiovascular events (MACE) (e.g., cardiovascular death or non-fatal major cardiovascular events (3 RCTs;  $\sim$ 23,215 participants; RR 0.85, 95% CI 0.71 to 1.00; very low certainty). The most used composition of LSSS included 33% to 75% of NaCl and 25% to 65% KCl.

**Table 3.2 Composition Ranges of LSSS**

Component	Minimum (%)	Maximum (%)
NaCl	33	75
KCl	25	65

### 3.4.2 Safety concerns around the use of LSSS

The reviews highlight that while LSSS probably cause only a small increase in serum potassium among healthy adults, their safety in populations with impaired potassium regulation such as individuals with chronic kidney disease, those taking potassium-sparing medications, or other high-risk groups remains uncertain because such individuals were largely excluded from the trials. Additionally, there is very little or no evidence on the safety of LSSS in children, adolescents, or pregnant women. The evidence for serious adverse events including those related to elevated potassium (hyperkalaemia) is of very low certainty.

This is because many of the RCTs included in these reviews have excluded participants who may have elevated risk (e.g., chronic kidney disease, potassium-sparing medication use) and most were conducted among older, higher-risk Asian populations, thus the safety among other populations (younger adults, children, pregnant women, those with kidney impairment) is largely unknown. Many trials did not specifically report hyperkalaemia or serum potassium outcomes, and the meta-analysis did not focus in depth on safety endpoints. As a result, while the evidence support efficacy, the generalisability of safety findings remains uncertain.

The table below provides the details on the efficacy and safety outcomes measured as part of the reviews:

**Table 3.3: Details on the efficacy and safety outcomes measured**

Outcome Category	Yin et al (2022)	Tsai et al (2022)	Brand et al (2022)	Greenwood et al (2024)
<b>Efficacy</b>				
Blood Pressure (Adults)	SBP Reduction: -4.61 mmHg DBP Reduction: -1.61 mmHg	SBP Reduction (MD): -4.80 mmHg DBP Reduction (MD): -1.48 mmHg	SBP Reduction Range: 1.5 to 15.25 mmHg DBP Reduction Range: 0.6 to 11.33 mmHg.	
Blood Pressure (Children)			SBP Reduction: 5.87 mmHg DBP Reduction: 6.05 mmHg.	
Cardiovascular Events			Risk Ratio (RR): 1.22 (for various events) 95% CI 0.49 to 3.04. Very low-certainty evidence.	
Non-fatal Stroke			Risk Ratio (RR): 0.90 Absolute Effect: 20 fewer per 100,000. Moderate-certainty evidence.	
Non-fatal Acute coronary syndrome			Rate Ratio: 0.70 Absolute Effect: 150 fewer per 100,000 person-years. Moderate-certainty evidence.	
Mortality	All-cause Mortality (RR): 0.89 Cardiovascular Mortality (RR): 0.87. All p<0.001.	All-cause Death (HR): 0.88 Cardiovascular Deaths (HR): 0.72. Overall 12% reduction in all-cause mortality.	Cardiovascular Mortality (Rate Ratio): 0.77. Absolute Effect: 180 fewer per 100,000 person-years. Moderate-certainty evidence.	All-cause Mortality (RR): 0.88 Cardiovascular Mortality (RR): 0.83. Both low certainty.
Urinary Excretion	↓ Urinary Sodium: -0.48 g/day	↓ 24-h Urine Na: -22.96 mmol/24-h.		
<b>Safety outcomes</b>				
Hyperkalaemia			Risk Ratio (RR): 1.04 95% CI 0.46 to 2.38. No difference between groups at risk.	
Serum Levels	No difference in hyperkalaemia events/serum K. No serious adverse events attributed to hyperkalaemia.	Serum potassium ↑ by 0.1 mmol/L. NS	Mean Difference (MD) in blood potassium: 0.12 mmol/L Small difference, NS	
Urinary Excretion	↑ Urinary Potassium: 0.45 g/day. Age ↑10 years → -0.45 g/day greater ↓ in Na excretion.	↑ 24-h Urine K: 14.41 mmol/24-h. ↓ in Na/K ratio reported.	↑ Urinary Potassium (MD): 11.44 mmol/24-h	
NS-Non significant; MD – Mean difference				

### 3.4.3 Gaps in the evidence

Across the four systematic reviews, there is no evidence of clinical harm from hyperkalaemia, but trials largely excluded high-risk individuals including those with CKD, impaired potassium excretion, or on potassium-sparing medications. Evidence in older adults is limited to relatively healthy participants, hence safety in frail or multi-morbid elderly remains uncertain. Pregnant women and children were largely or entirely absent from trials, hence the safety and long-term effects of LSSS in these groups cannot be determined. In summary, LSSS are effective for blood pressure reduction in adults, but data are insufficient to guide use in high-risk, elderly, pregnant, or paediatric populations.

## 3.5 Review of specific trials on LSSS

We have explored some of the large-scale trials that have assessed the efficacy and safety of LSSS either at the population level or among different population groups with a cardiac comorbidity. Table 3.4 provides details of these studies. Very few studies have assessed the safety of LSSS among individuals with renal impairment.

**Table 3.4 Summarizing trial characteristics on Low-Sodium Salt Substitutes (LSSS)**

Title	Population	Study Design	Outcome measures (Efficacy)	Outcome measures (Safety)
Secondary Analysis of the Salt Substitute and Stroke Study (SSaSS)	Adults with a history of stroke or aged $\geq 60$ years with hypertension	Cluster-randomized, unblinded trial	Effect of potassium enriched salt compared to regular salt on major cardiovascular events (stroke, acute coronary syndrome, cardiac arrhythmia, heart failure and sudden death)	Clinically recognized hyperkalaemia and other events related to high potassium.
Salt Substitute in India Study (SSiS)	Adults ( $\geq 18$ years) with a diagnosed history of hypertension	Randomized, double-blind controlled trial	Effect of LSSS on SBP, DBP, and 24-hour urinary sodium and potassium	High potassium levels.

LSSS: Low-sodium salt substitutes, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure

### 3.5.1 The salt substitute and stroke study (SSaSS)

The Salt Substitute and Stroke Study (SSaSS) was a large-scale, open label, cluster-randomized controlled trial done in 600 villages across 5 provinces in China, enrolling 20,995 adults with either past history of stroke or who were  $\geq 60$  years of age with hypertension. Villages were randomized into 1:1 to receive potassium enriched low sodium salt (75% sodium chloride and 25% potassium chloride) for their all-household cooking, seasonings and food preservation, while the other group consumed regular salt (100% sodium chloride). The mean follow up was approximately 4.7 years. The study assessed the efficacy of LSSS in reducing stroke and major cardiovascular events. The study excluded individuals with serious kidney diseases, those taking potassium sparing diuretics or those who consumes their most of the meals outside. The study is summarized as a table 3.5 (PICO).

**Table 3.5 SSaSS PICO table**

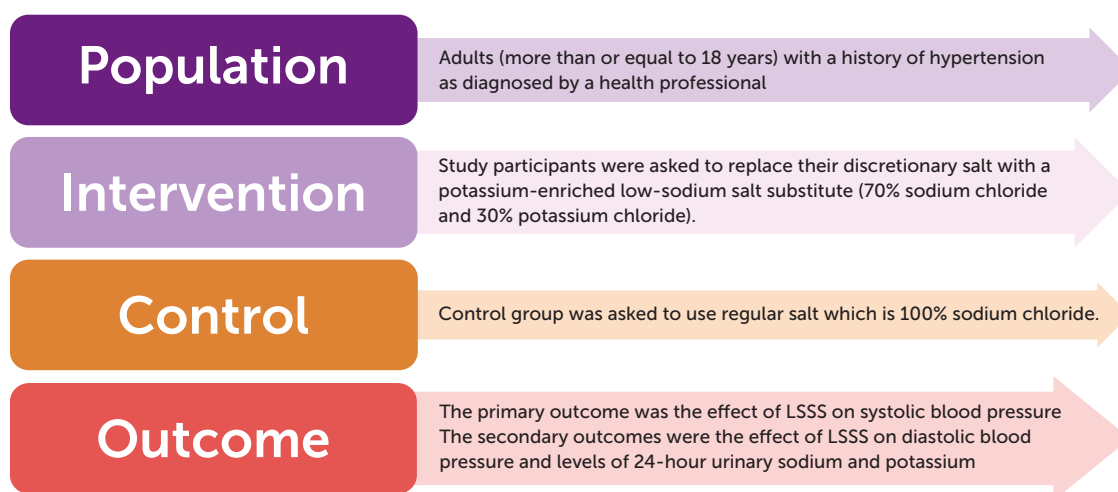
PICO	Description
<b>Population (P)</b>	Total of 20,995 adults living in 600 rural villages in five provinces of China (Hebei, Liaoning, Ningxia, Shanxi and Shaanxi) with either a previous history of stroke or older than 60 years with high blood pressure.
<b>Intervention (I)</b>	Low-sodium, potassium-enriched salt with a combination of 75% sodium chloride and 25% potassium chloride was given for all cooking, seasoning and food preservation at home.
<b>Comparator (C)</b>	Used usual household salt (100% sodium chloride) with no change or substitute
<b>Outcomes (O)</b>	The primary outcome was reduction in fatal and non-fatal stroke. Other important outcomes were reduction in major cardiovascular events (including acute coronary syndrome, heart failure, arrhythmia) and death from any of these causes.

**a. Study findings:** This trial showed that the patients in LSSS group in comparison to regular salt group had lower ratios of outcome events including stroke (RR, 0.86), major cardiovascular events including acute coronary syndrome, heart failure, arrhythmia (RR, 0.87) and death (RR 0.88). There was no significant increase in serious adverse events attributed to clinical hyperkalaemia (RR1.04) indicating that LSSS delivers substantial cardiovascular benefit to individuals without advance renal impairment or potassium sparing therapy (12).

### 3.5.2 Salt substitute in India study (SSiS)

Most of the studies that have assessed the efficacy and safety of low-sodium salt substitutes, most of them were conducted in China. Only one study represented the Indian population and is called the Salt Substitute in India Study (SSiS) (13,14). This is a randomized, double-blind controlled trial that was conducted in 7 villages from the Siddipet District of Telangana, India. It comprised an intervention with a potassium-enriched low-sodium salt substitute over a period of 3 months. The study included males or females who were 18 years or above, had a diagnosed history of hypertension, consumed mostly home-cooked meals, and gave their consent to participate. This study provided reduced sodium-added potassium salt substitute (70% NaCl, 30% KCL blend).

The study assessed the efficacy of LSSS in those with hypertension and excluded individuals with renal function impairment or those who used a potassium-sparing diuretic or any potassium supplements. The study characteristics are summarized in Figure 3.2 using the PICO framework.



**Figure 3.2:** PICO framework for SSiS

**a. Study findings:** Salt Substitute in India Study (SSiIS) showed that replacing regular salt with LSSS had a significant impact in lowering systolic blood pressure by 4.58 mmHg and diastolic blood pressure by 1.14 mmHg. Also, there was a significant decrease in the average 24-hour urinary sodium of 0.91 g/day. However, there was an increase of 0.24 g/day in urinary potassium when LSSS was used but this change was considered minimal, though statistically significant. The Salt Substitute in India Study (SSiIS) studied the efficacy of LSSS but couldn't completely report the safety aspects due to exclusion of individuals with self-reported renal dysfunction or those on potassium-sparing diuretics. However, it is worth mentioning that people with early stages of CKD in the Indian population might be unaware of their status and hence, did not self-report.

### 3.6 Studies that have modelled the role of potassium in LSSS towards lowering BP and the overall effect of LSSS

The George Institute for Global Health modelled the impact of a switch to LSSS in a number of jurisdictions. Switching from regular salt to LSSS worldwide was estimated to avert 3 million deaths and 10 million new cases, from cardiovascular disease or chronic kidney disease each year.

The SSaSS study presented in the previous section demonstrated significant reductions in systolic blood pressure (SBP), and the risk of stroke, major cardiovascular events and total mortality with the use of LSSS. However, it was not known whether these reductions could be attributed to sodium reduction or an increase in potassium intake from LSSS. Using a modelling study, a series of models were fitted to estimate the SBP reductions expected for the differences in sodium and potassium intake in SSaSS, derived from 24-hr urine collections. The proportions of the SBP reduction were then separately attributable to sodium reduction and potassium supplementation were calculated. **In every model, the majority of the SBP lowering effect in SSaSS was estimated to be attributable to the increase in dietary potassium rather than the fall in dietary sodium. (15)**

A nationwide modelling study in China using intervention from SSaSS predicted that replacement of regular salt with potassium-enriched salt substitutes would prevent 460000 deaths from cardiovascular disease, 740000 non-fatal cardiovascular events, and 8 million disability adjusted life years annually in China (16).

Another modelling study in India on nationwide salt substitution used comparative risk assessment models to estimate the number of (1) cardiovascular deaths averted due to blood pressure reductions; (2) potential hyperkalemia-related deaths from increased potassium intake in individuals with advanced chronic kidney disease; and (3) net averted deaths from nationwide salt substitution in India. A large long-term pragmatic trial in rural China and the LSSS trial in India were used to create an optimistic scenario. This modelling study on a nationwide salt substitution in India consistently estimated substantial net benefits, preventing around 8% to 14% of annual cardiovascular deaths. Even allowing for potential hyperkalemia risks there were net benefits estimated for individuals with chronic kidney disease (17).

Xu et al., 2025 recommend that substituting table salt with LSSS can meaningfully lower sodium intake while increasing potassium consumption, leading to reductions in blood pressure. They also consider safety; although there is concern about hyperkalemia (especially in individuals with reduced renal function), the authors suggest that for many hypertensive patients this risk is small and

outweighed by cardiovascular benefits. Hence, they recommend that clinicians consider advocating LSSS as a practical lifestyle modification for hypertension management (18).

### 3.7 New evidence and future research

Almost all completed trials of LSSS made efforts to exclude participants with self-reported kidney disease, (there is a possibility that these trials may have had people who were not aware of their CKD status) except for one, which reported increased rates of hyperkalaemia but no adverse effects on clinical outcomes. A challenge with that study was that while adverse event recording was strong, the completeness of the blood sample data was very low. Additionally, many of the completed trials have **included individuals using antihypertensive drug therapies, and while none have reported increased risks of hyperkalaemia in patient subsets using blockers of the renin angiotensin aldosterone system, few have recorded serial measures of blood potassium.**

Recent studies have also documented that though the potential risks of hyperkalaemia are often highlighted, hypokalaemia, low blood potassium levels, is a much more common clinical abnormality, particularly among individuals using thiazide or thiazide-like diuretics for hypertension management. In two recent trials, antihypertensive regimens that included a thiazide-like diuretic led to hypokalaemia in 34% and 5.3% of participants, respectively (19) (20). Hypokalaemia is associated with serious adverse clinical outcomes, including an increased risk of cardiac arrhythmias, kidney dysfunction, and mortality, similar to the dangers posed by hyperkalaemia (21). Another community-based screening programme of hypertensive patients in Bangladesh, who were receiving renin-angiotensin inhibitor (RASi) or diuretics found that 3.2% of them had hypokalaemia and none of them showed hyperkalaemia (22). The co-administration of LSSS with antihypertensive therapies containing thiazide or thiazide-like diuretics is therefore likely to mitigate the risk of hypokalaemia and its associated renal and cardiovascular consequences by improving dietary potassium intake.

Future research priorities identified in the WHO guideline focus on strengthening the evidence base for population-level implementation of LSSS. Key areas include assessing the safety implications of widespread LSSS use, both discretionary and in processed foods, particularly regarding hyperkalaemia, and impacts on vulnerable groups. Much of this research is underway.

### 3.8 Implications for LSSS use in India

Replacing regular salt with LSSS, is a promising intervention for reducing India's high burden of hypertension and CVDs. Its use can help people lower sodium intake without drastically changing taste or cooking practices, making it a practical strategy in a country requiring minimal consumer action where most salt is added during home cooking. However, affordability and accessibility remain a challenge, as LSSS is often more expensive than regular salt, limiting its reach among rural and lower-income households. Awareness is another barrier as many consumers are not fully informed about the health risks of excess sodium or the potential benefits of switching to low-sodium alternatives. At the same time, its use requires some caution: individuals with kidney disease or those taking certain medications may need to avoid excess potassium. With supportive policies, clear public health messaging, and industry engagement, LSSS could play an important role in India's broader efforts to prevent non-communicable diseases and promote healthier diets.



## Key highlights

- WHO (2025) and major international cardiovascular guidelines recognise potassium-enriched low-sodium salt substitutes (LSSS) as an effective population-level intervention to reduce sodium intake, increase potassium intake, and lower blood pressure.
- Evidence from RCTs, systematic reviews, and large trials shows consistent reductions in systolic and diastolic blood pressure, with associated reductions in stroke, cardiovascular events, and mortality among adult populations.
- Safety data are largely limited to low-risk adults, as most trials excluded individuals with chronic kidney disease, those on potassium-sparing medications, pregnant women, and children.
- The Salt Substitute and Stroke Study demonstrated significant reductions in stroke, major cardiovascular events, and total mortality over nearly five years of follow-up, with no significant increase in serious adverse events related to hyperkalaemia among participants without advanced renal disease.
- The Salt Substitute in India Study showed significant reductions in systolic and diastolic blood pressure and urinary sodium excretion with potassium-enriched salt use among adults with hypertension, though safety outcomes were limited due to exclusion of individuals with known renal impairment.

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## Chapter 4:

# Kidney health and level of sodium & potassium intake in India: existing evidence to inform safe use of low-sodium salt substitutes (LSSS) at the population level

Low-sodium salt substitutes (LSSS) are an effective solution to help lower sodium intake in population groups while simultaneously increasing potassium intake, which could help reduce the burden of hypertension and other cardiovascular diseases (CVDs). However, the use of LSSS for Chronic Kidney Disease (CKD) patients and their use at a population level in India which has a high burden of kidney disease requires an understanding of the consumption patterns of sodium and potassium, as well as the current prevalence of CKD and other high-risk groups (who can have potential health risks associated with the consumption of LSSS).

Kidney Disease Improving Global Outcomes (KDIGO) has defined CKD as any abnormality present in the kidney's structure or function for a minimum period of 3 months, which leads to impaired kidney function. The stage of damage to the kidney is classified according to the glomerular filtration rate (GFR) and albuminuria category, with stage 1 being the lowest risk, and stage 5 indicating kidney failure (Figure 4.1) (1). People with CKD stage 3-5, or those on renal replacement therapy (RRT), are advised to limit their sodium intake to less than 2 g/day (2). On the other hand, potassium intake from diet, supplements, or LSSS is based on individual tolerance and degree of hyperkalemia and is not necessarily dependent on the stage of CKD (3).

KDIGO Prognosis of Chronic Kidney Disease (CKD) by Glomerular Filtration Rate (GFR) and Albuminuria categories				Persistent albuminuria categories		
				A1	A2	A3
				Normal to mildly increased	Moderately increased	Severely increased
				<30 mg/g <3 mg/mmol	30-300 mg/g 3-30 mg/mmol	>300 mg/g >30 mg/mmol
GFR Categories (ml/min/1.73 m <sup>2</sup> )	G1	Normal or high	≥90	Green	Yellow	Orange
	G2	Mildly decreased	60-89	Green	Yellow	Orange
	G3a	Mild to moderately decreased	45-59	Yellow	Orange	Red
	G3b	Moderate to severely decreased	30-44	Orange	Red	Red
	G4	Severely decreased	15-29	Red	Red	Red
	G5	Kidney failure	<15	Red	Red	Red

**Figure 4.1:** Stages of chronic kidney disease

Green: Low risk; yellow: moderate risk; orange: high risk; red: very high risk  
Source: Kidney disease: improving global outcomes (KDIGO) guidelines, 2024

Potassium is the principal intracellular cation and plays a crucial role in maintaining blood plasma volume and overall cell function (2). Various studies have reported that potassium intake benefits kidney health and prevents overall CKD progression in patients. A multicentre, observational cohort study conducted on non-dialysis CKD patients from Japan reported that post 5-year follow-up, patients who had a lower intake of dietary potassium had greater CKD progression (4). Similar findings were also reported in a systematic review, which suggests that high potassium intake is cardioprotective and helps prevent CKD progression in its early stages (5). The National Institute for Health and Care Excellence (NICE, 2018) recommends that for CKD patients, unnecessary potassium restriction must be avoided and should be decided based on the serum potassium levels and overall disease condition (6). Thus, while sodium intake targets are set for CKD patients, there is a lack of consensus and paucity of literature on the advised potassium intake levels.

## 4.1. CKD prevalence

The Global Burden of Disease Report, 2023, suggests that the number of deaths from CKD has substantially increased from 0.6 million in 1990 to 1.4 million in 2016 (7). Out of 697.5 million global cases of CKD, one-third reside in two countries i.e. China(132.3) and India (115.1 million) (8). A study reported that globally, the prevalence of CKD stages 3-5, varied between 4.83 to 4.98% between 2008 to 2012 (9). According to a recent systematic review by Talukdar et al. 2025, about 5.46% [CI 3.46 to 7.88] of Indian adults have stage 3 CKD (8). Overall, there is a lack of literature on the prevalence of different stages of CKD in India. This evidence synthesis reports that the CKD prevalence patterns in India show a wide range depending on the region, the type of population being studied, and the stage of CKD considered.

## 4.2 Methodology

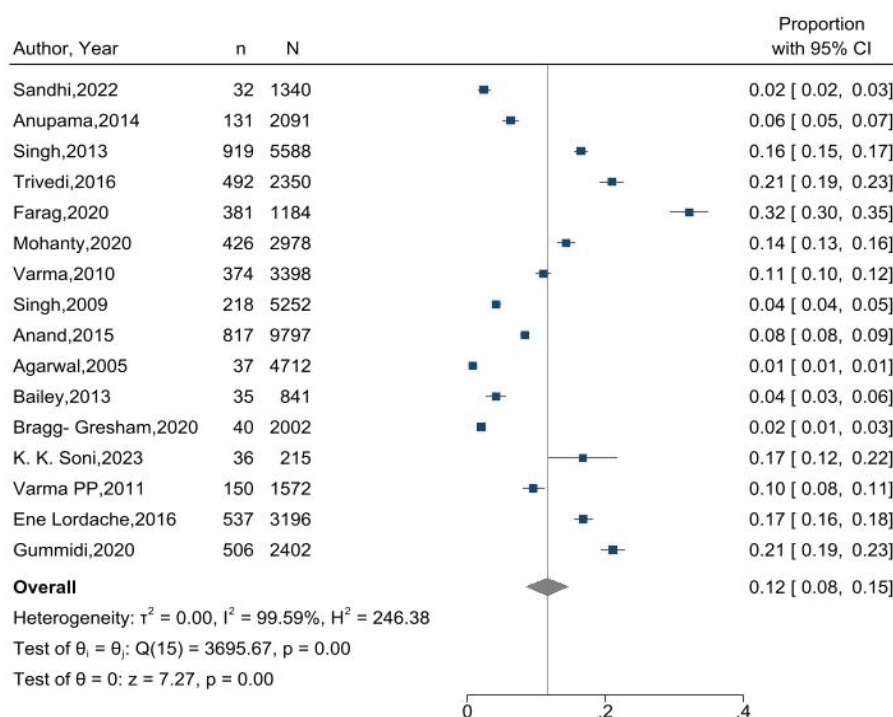
A narrative review was carried out, and different databases like PubMed, Google Scholar, and Litmaps were searched, and citation screening was done from different studies. Our search strategy included the terms "chronic kidney disease prevalence," "CKD grade", "CKD prevalence by gender", and "CKD prevalence by region". The studies that included CKD prevalence in the Indian population in any age group were included in the study. The literature comprised the primary research articles, while the secondary research or reviews were not included. Our title and abstract search yielded 80 studies, and a further full-text review gave us 16 studies for final analysis. The studies represented different regions from India, including the states of Delhi and Punjab in the North (10–13), Gujarat from the West (14), Odisha from East (15), Andhra Pradesh, Karnataka, Telangana, and Tamil Nadu from the South (11,16–21), and Uttar Pradesh and Madhya Pradesh from Central India (22,23). Subgroup analysis was further conducted using the variables – gender, region, and CKD stages.

Data about CKD prevalence were extracted independently by two reviewers. For studies where prevalence was not explicitly stated, it was calculated from the reported number of participants with CKD and the total sample size. For continuous outcomes, we extracted the mean, standard deviation (SD), and sample size. Where available, these data were also collected for pre-specified subgroups, including sex, geographic region, and CKD stage. We conducted meta-analyses using random-effects models to account for anticipated heterogeneity among the included studies. Pooled prevalence estimates were derived using the DerSimonian and Laird method for between-study

variance estimation. For continuous outcomes, the restricted maximum likelihood (REML) method was employed as the variance estimator. The results of all meta-analyses are presented graphically using forest plots.

## 4.3 Results

Out of the 16 studies reviewed, 7 community-based studies assessed the CKD prevalence each through the MDRD (Modification of Diet in Renal Disease) equation, and the CKD-EPI (CKD-Epidemiology Collaboration) equation. The overall pooled prevalence of CKD was reported to be 12% as depicted by the forest plot, with confidence intervals (CI) ranging between 8.00 to 15.00,  $I^2 = 99.59\%$ ,  $p < 0.001$ . The prevalence of CKD in India, as reported by a systematic review of community-based studies including population above 15 years and covering all stages of CKD is 13.2% (8) which shows that the results from our study align with the recent prevalence data.



**Figure 4.2:** Forest plot illustrating the pooled CKD prevalence reported by different studies

### 4.3.1 Gender and regional effects

From the selected studies, 9 studies assessed the gender difference patterns in the prevalence of CKD. The overall pooled prevalence of CKD was 19% [CI 12.00, 26.00],  $I^2 = 99.39\%$ ,  $p < 0.001$  among males and 15% [CI 11.00, 19.00],  $I^2 = 98.65\%$ ,  $p < 0.001$  among females. Significant heterogeneity was found across all the estimates. Similar findings were reported in the systematic review by Talukdar et al. 2025, wherein the prevalence of CKD was observed to be higher among men (14.8%) as compared to women (13.5%).

After regional sub-group classification, it was observed that the CKD prevalence rates were almost equal in different zones of India. Table 4.1 shows the pooled prevalence of CKD from different regions of India.

**Table 4.1 Summary of studies assessing CKD prevalence from different regions of India**

S.No.	Region	States Included	Pooled prevalence (%)	Pooled prevalence (%)	References
1.	North India	Delhi Punjab	17.13	5.82 – 28.42	Singh, 2009 (10) Agarwal, 2005 (12) Bragg-Gresham, 2020 (13) Varma PP, 2011 (23)
2.	South India	Andhra Pradesh Telangana Karnataka Tamil Nadu	16.85	7.32 - 26.38	Gummidi, 2020 (21) Sandhi, 2022 (16) Bailey, 2013 (19) Anupama, 2014 (17) Ene lordache, 2016 (20) Singh, 2013 (24) Frag, 2020 (18)
3.	Central India	Uttar Pradesh Madhya Pradesh	13.51	8.04 - 18.98	K.K. Soni, 2023 (22) Singh, 2013 (24)
4.	Western India	Gujarat	12.78	4.31 - 21.25	Singh, 2013 (24) Trivedi, 2016 (14)
5.	Eastern India	Odisha	14.30	13.03 - 15.58	Mohanty, 2020 (15)

### 4.3.2 CKD stages and subgroups

To explore the prevalence of different stages of CKD in Indian population, we reviewed a large community-based systematic review and meta-analysis (8) assessing the prevalence of chronic kidney disease (CKD) in India, drawing on representative studies published between 2011 and 2023. The review included 18 community-based studies from across different regions of the country and provided prevalence estimates by sex, region, and rural–urban status. Overall, CKD prevalence was 13.24%, with men exhibiting slightly higher rates than women. Regionally, the southern zone had the highest burden, and rural populations showed higher prevalence compared to urban groups.

Although the review comprehensively evaluated the overall CKD burden, only a small number of the included studies reported prevalence by CKD stage. Consequently, the meta-analysis did not generate pooled estimates for stages 1–5. Individual studies suggested that early-stage CKD (stages 1 and 2) might be more common, indicating a predominance of milder disease at the population level in India; however, this pattern cannot be directly inferred from the pooled data from this study.

The study highlighted several limitations, including very high heterogeneity across studies ( $I^2 = 99\%$ ), wide prediction intervals indicating uncertainty, potential publication bias, and incomplete resolution of heterogeneity despite multiple subgroup analyses. They also noted that differences in sampling methods, eGFR estimation equations, and geographic coverage limit comparability, emphasizing the need for higher quality, standardized, and more geographically inclusive prevalence studies in India.

The studies that documented prevalence estimates of different stages of CKD, showed variable prevalence of stage 1 CKD ranging from 2.3 to 18.6%, stage 2 CKD: 1.9 to 64.7% (documented in limited studies in populations with co-morbidities and design issues) , stage 3 of CKD: 1.04 to 16.7%, stage 4 for CKD: 0.04 to 3.4% and stage 5 for CKD: 0.0 to 1.9%. This limited data on stage specific prevalence from this systematic review indicates that at population level India has higher prevalence of stages 1-3.

## 4.4 Potassium and sodium intake in the Indian population

Synthesized evidence suggests that chronic kidney disease (CKD) affects almost 12% of the people in India. Hypertension and other cardiovascular diseases are one of the leading causes of CKD, and high sodium intake is the top-most risk factor (25). Diet plays a major role in the effective management of people living with CKD. To integrate LSSS in the guidelines for CKD patients, it is essential to understand the actual intake of sodium and potassium among the population groups.

### 4.4.1 Nutritional roles of potassium and sodium

Sodium and potassium play key roles in the functioning of the body. While sodium is the main cation present in the extracellular body fluid, potassium is the principal intracellular cation. Both sodium and potassium are required to maintain the blood plasma volume, regulate the body's acid-base balance, and promote normal cell function by transmission of nerve impulses (26). Cardiovascular diseases, including hypertension, are linked with high dietary sodium and low potassium intake.

High salt intake increases blood pressure in a progressive, dose-response manner, which shows an approximately linear relationship between sodium intake and blood pressure. Each 1 g decrease in sodium intake is associated with 2.42 mm Hg lower systolic blood pressure (SBP) and 1.01 mm Hg lower diastolic blood pressure (DBP) (27,28). High dietary salt intake causes greater water retention in the body, which increases plasma volume and leads to a greater cardiac output and kidney perfusion pressure. To maintain blood pressure, the kidneys must excrete greater amounts of sodium and water. However, when the kidneys are not able to perform this mechanism properly, hypertension sets in, and thus, a long-term high salt diet can lead to persistently elevated blood pressure (29,30). Increased sodium intake can also cause vascular remodelling, which can cause stiffness of the arteries, increasing peripheral resistance, and lead to elevated blood pressure (31). Potassium further helps prevent hypertension by counteracting the effects of sodium. The more potassium consumption, the greater the urinary sodium excretion. Potassium helps in vasodilatation, thereby reducing blood pressure (32).

As per the recommendations by the WHO, the desirable molar ratio of sodium to potassium is 1:1 or lower, with a recommended intake of sodium up to 2000 mg/day and potassium as more than or equal to 3500 mg/day (26). There is a lack of systematic balance studies for both sodium and potassium in the Indian population, and thus, the National Institute of Nutrition, Indian Council of Medical Research (NIN, ICMR) follows the recommendations given by WHO (26). Table 4.2 shows the recommended dietary allowance (RDA) for sodium and potassium for different age groups.

**Table 4.2 RDA for sodium and potassium (mg/day)**

Age Group		Molar Ratio	Sodium (mg/day)	Potassium (mg/day)	Salt (g/day)
Adults (18-60 years)	Men	1:1	2000	3500	5.0
	Women	1:1	2000	3500	5.0
Infants	0-6 months	1:1	500	900	1.3
	7-12 months	1:1	650	1100	1.6
Children	1-3 years	1:1	1000	1750	2.5
	4-6 years	1:1	1300	2250	3.3
	7-9 years	1:1	1600	2825	4.1
Hypertensive Adults *	Men and Women	<1:1	<1500 - 2000	>3500	3.8-5.0

Source: NIN, ICMR, 2020 (26),\*American Heart Association (AHA), 2025 (32,33)

#### 4.4.2. Sources of potassium and sodium in Indian diets

About 90% of sodium in the Indian diet comes from sodium chloride (salt), and only 10-15% of sodium is naturally present in food. Naturally, foods like dairy products, fish and seafood, and meat have sodium and contribute to only 300-400 mg of daily sodium (26,34). Common or table salt is by mass 40% sodium and 60% chloride, and is the major contributor to dietary sodium (2). The major sources of salt in the Indian diet are (i) salt added to the food while cooking or eating at home, called the discretionary salt; (ii) foods prepared outside the home, like those obtained from restaurants, other eating outlets, or provided at schools or other government institutions; and (iii) packaged and processed foods (35). Sodium obtained through processed and packaged foods like salted butter, breads, packed soups, preserved foods, etc., is usually in the 'hidden' form and also significantly contributes to the daily intake (36).

Potassium consumption is reported to be low globally, and also among Indians (37). Naturally, potassium is mainly found in coconut water, pulses, nuts, dairy, vegetables like broccoli, potatoes, carrots, tomatoes, leafy greens, peas, and fruits like bananas and citrus fruits, which are also promoted in the DASH diet. A significant amount of potassium is lost while cooking and processing (38,39). Indian diets are deficient in the food groups that are rich sources of potassium and are mainly dependent on cereals, which leads to low potassium intake (26,40).

In this context, LSSS can have a crucial role in enhancing potassium consumption and reducing sodium consumption in India (41). Replacing regular salt with LSSS helps lower systolic BP by 4.76 mmHg and diastolic BP by 2.43 mmHg. Along with providing health benefits, LSSS is comparatively low-cost as it is required in a limited amount, has been shown to have no significant effect on hyperkalemia, and is similar in taste to regular salt (42). However, the adoption of LSSS in the daily diets of people with CKD needs further exploration.

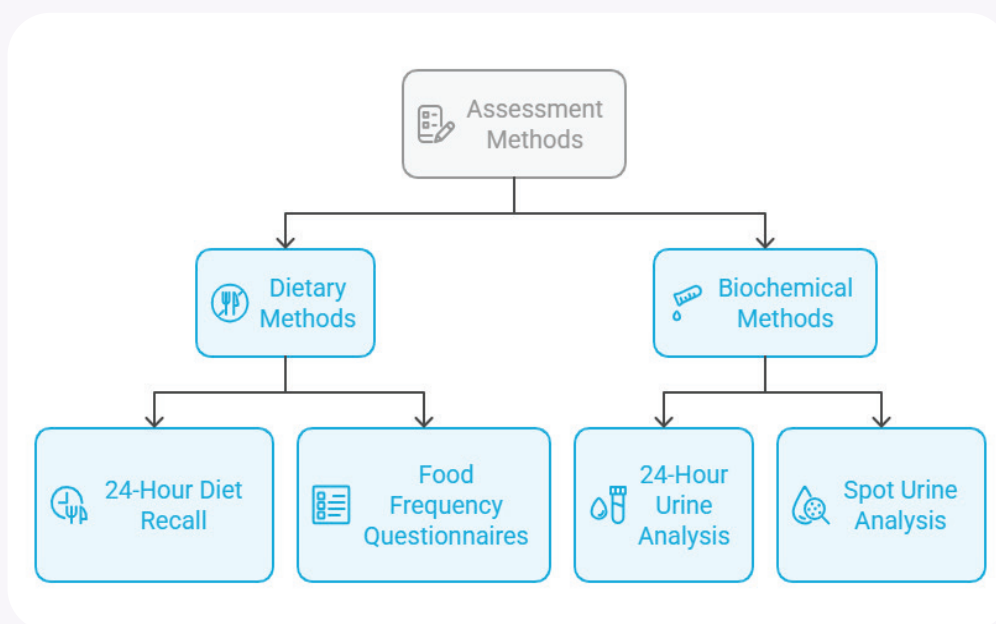
#### 4.4.3 Intake patterns in different populations – sodium and potassium

To assess the intake patterns of sodium and potassium, narrative reviews were conducted. The studies included for the review assessed sodium and potassium intake either through dietary assessment or the urinary excretion method.

## Insights

### How does the literature assess the intake of sodium and potassium?

Various methods of assessment are used to evaluate the sodium and potassium consumption by population groups. These include dietary and biochemical methods. Dietary methods include 24-hour diet recall and food frequency questionnaires (20–22). Both these methods are retrospective in nature and may lead to inaccurate reporting due to recall bias, respondent burden, and incorrect portion size estimation (24,27).



Due to such limitations of dietary methods, the biochemical method of estimating sodium and potassium intake is considered more appropriate (28,29). The total amount of sodium consumed daily is almost equal to the quantity excreted, which makes up about 95% loss through urine and the remaining through sweat and faeces (2). Urinary sodium excretion is either measured through 24-hour urine analysis or spot-urine analysis. A **24-hour urine sodium analysis** involves collecting all voided urine throughout the day. Even though this method is cumbersome, it provides the most accurate estimate of total sodium excreted through the day and is hence **considered the gold standard** (20,30,31).

**Spot-urine analysis** is regarded as a quick and easy method for urine collection wherein a single, random sample of urine is collected, generally the first void of the morning. The 24-hour urine sodium is then estimated from spot-urine using various equations like INTERSALT, Kawasaki, and Tanaka, which use demographics along with urinary sodium, potassium, and creatinine concentrations (32,33). The daily salt intake is calculated from 24-hour sodium excretion by multiplying the former by a factor of 2.54, which is based on the Na: Cl molecular mass ratio (2,4). Like sodium, the majority (95%) of potassium consumed is also excreted in the urine, and hence, 24-hour urine potassium analysis or spot urine analysis is used for potassium estimation. The spot urine potassium excretion is converted to 24-hour potassium excretion by equations like Kawasaki and Tanaka, which are based on the urine potassium to creatinine ratio (34).

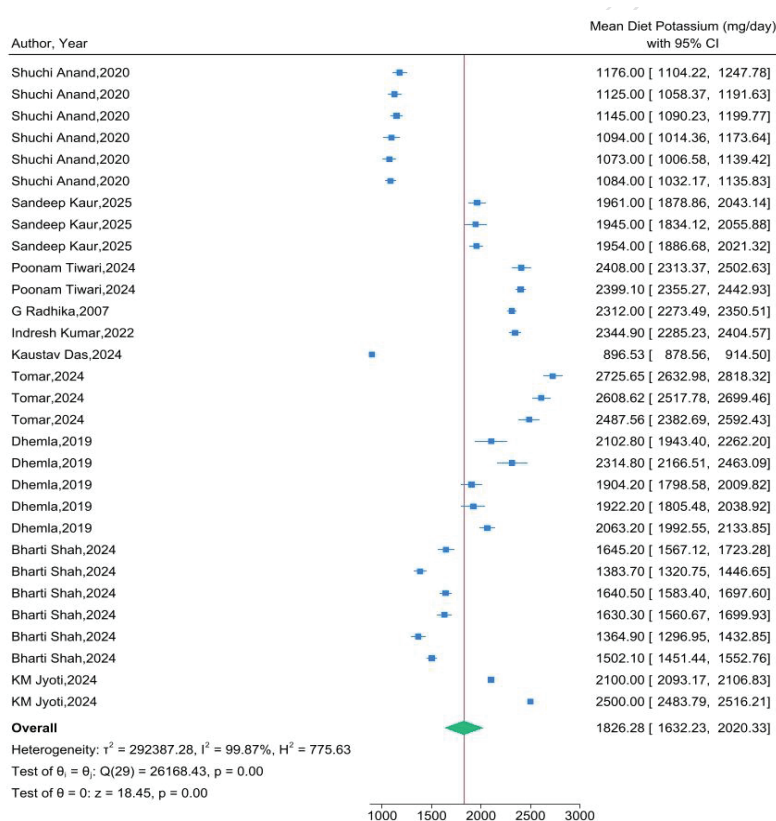
**Figure 4.3:** Methodology

## 4.5 Intake patterns of salt and sodium

Data shows that the average global salt intake among adults is equivalent to 10.78 g/day (4310 mg/day sodium), more than twice the WHO’s recommendation for adults which is less than one teaspoon or 5 g salt/day (less than 2000 mg sodium/day) (43). Estimates of sodium intake are typically derived either from dietary assessment or from biomarkers such as urinary sodium excretion, while dietary estimates reflect sodium obtained from food sources, urinary sodium excretion reflects sodium eliminated after metabolic processing (44). In India, the mean weighted salt intake is 10.98 g/day (45). National NCD Monitoring Survey Report, 2017-18, assessed the urinary sodium excretion by spot urine samples and reported that the mean daily salt intake among Indians was 8.0 g per day (46). A study conducted among hypertensive and dyslipidemic adults in different regions of India reported that mean daily salt consumption was higher among north Indians (14.1 g) as compared to East (10.1 g), South (9.8 g), and West (9.3 g) (47). Another review paper documents **the average daily intake of salt in India in the range of 8-11 grams, out of which discretionary salt accounts for 80% of total salt consumption** (35).

## 4.6 Intake patterns of potassium

We reviewed 9 studies from India that provided potassium intake data. The pooled mean consumption of potassium per day as assessed through dietary methods was 1826.28 mg/day [CI 1632.23, 2020.33]. Only 4 studies included in the review assessed the potassium through the urinary excretion method and reported a mean consumption of  $1428.36 \pm 997.05$  mg/day. The potassium assessed through both methods shows that the overall intake is almost half the recommended intake suggested by WHO and NIN, ICMR, (>3500 mg/day). Our findings are supported by another systematic review, which reports that on average, people consume 2.25 g of potassium/day, which is much less than the WHO recommendation (37).



**Figure 4.4:** Forest plot illustrating the mean dietary potassium

### Key highlights

- Our evidence synthesis exercise reports the overall pooled prevalence of CKD in India as 12%.
- There is a lack of literature on the prevalence of different stages of CKD in India. However, one systematic review on community-based prevalence studies indicates that the prevalence of stages 1-3 is higher than stages 4&5
- Diet plays a major role in the effective management of people living with CKD.
- The mean sodium intake assessed in Indian studies through urinary analysis was  $4455.66 \pm 2261$  SD mg/day, which is more than double the sodium intake recommendations given by the WHO.
- The pooled mean consumption of potassium per day, as assessed through dietary methods, is 1826.28 mg/day [CI 1632.23, 2020.33] and through the urinary analysis is  $1428.36 \pm 997.05$  mg/day which is almost half the recommended intake suggested by WHO and NIN, ICMR.

The evidence synthesis suggests that Indians have a very low intake of potassium and a high sodium intake as compared to the recommendations of the WHO and NIN, ICMR. Given the benefits of low-sodium salt substitutes in lowering blood pressure and risk of other CVDs, it has the potential to be effectively integrated into the diets of people both clinically and at the population level. LSSS may also be beneficial in delaying the progression of CKD for those in early stages. Since, majority of those affected by CKD lie in stages 1-3, it seems safe at this stage to explore the possibility of including the LSSS in their regular diets. However, advocating for the safe use of LSSS for people with late CKD stages must be dealt with caution and must be based on the degree of hyperkalemia and the individual's clinical condition.

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## Chapter 5:

# Review of sodium reduction guidelines and positioning of potassium-enriched low-sodium salt substitutes: the global and Indian scenario

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## 5.1. Introduction

This chapter summarises the review of global, regional and Indian guidelines provided by various agencies and organisations, which have focused on sodium reduction strategies along with different levels of recommendations on Potassium-enriched Low-sodium Salt Substitutes (LSSS).

## 5.2 Summary of global, regional and Indian guidelines on sodium reduction

We conducted a review of 63 guidelines (clinical and national) and policies from global, regional (LMICs) and national (India) levels on non-communicable diseases, hypertension and CVD prevention, salt reduction, health, and public health in general. Out of these, 25 guidelines were included for detailed review. These guidelines were from organisations like World Health Organisation (WHO), European, American, Australia and South Asian including Indian cardiology, hypertension and nephrology societies and medical associations, the National Institute of Nutrition (NIN), National Health Systems Resource Centre (NHSRC), Ministry of Health and Family Welfare (MoHFW), and National Institute for Health and Care Excellence (NICE), United Kingdom and highlighted sodium reduction as a critical public health strategy for the prevention and management of hypertension and related cardiovascular diseases (CVD), along with the mention of LSSS as one of the sodium reduction strategies (except for the Indian guidelines (1,2,3,4)).

**Reviewing the Guidelines with recommendations on LSSS:** The figure below summarises the systematic process followed for identifying, screening, and selecting guidelines related to sodium reduction with a mention of LSSS. A total of **13,228 records** (in English) were initially identified through database searches of PubMed, Google Scholar, and expert suggestions. After screening and eligibility assessment, **63 guidelines** were found to be relevant for full-text review. Of these, **38 guidelines** were excluded according to the predefined criteria, which specified the removal of documents that did not include any mention of LSSS as a salt reduction strategy. The remaining **26 guidelines** were included as they primarily focused on dietary salt reduction, with specific mention of LSSS (except for the Indian guidelines (1,2,3,4)). Guidelines from India have been summarised in Section 5.6.

### Search string

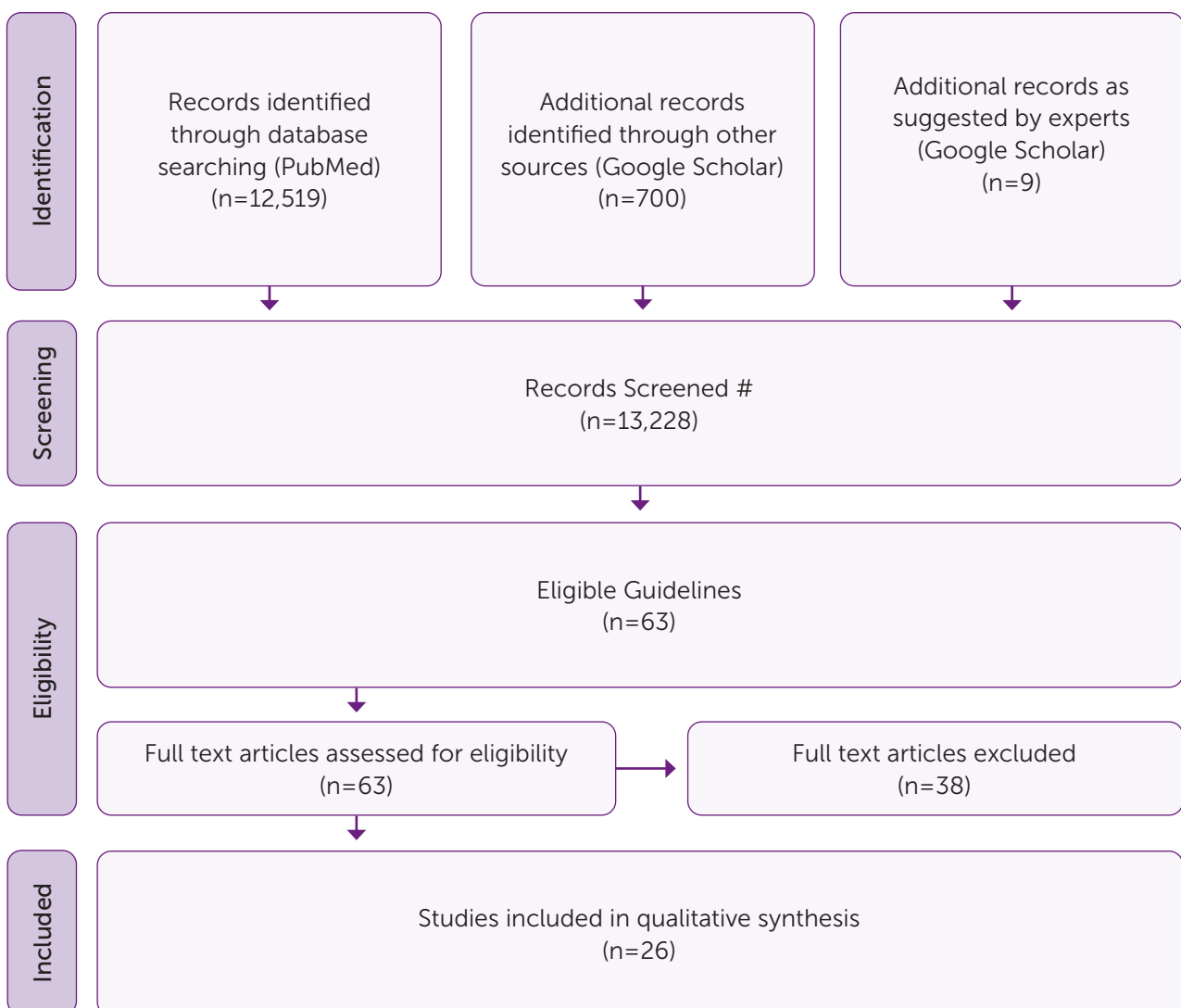
"Salt substitute" OR "low sodium salt" OR "sodium free salt" OR "salt replace" OR "mineral salt" OR "sodium reduced salt" OR "health salt" OR "potassium salt" OR "lite salt" OR "sodium chloride" OR "potassium chloride" OR "LSSS" OR "SHAKE" OR "low sodium" OR "potassium-enriched salt" OR "salt reduction" OR "dietary potassium" OR "DASH diet" OR \*salt\* OR "potassium" OR "sodium"

AND

"guidelines" OR "policy" OR "strategy" OR "review" OR "report"

AND

"CVD" OR "Hypertension" OR "CKD" OR "Stroke" OR "hyperkalemia" OR "hyperkalaemia"



\*Reason for exclusion: LSSS was not mentioned in the guideline.

#Screening: A single screening approach was used.

**Figure 5.1:** Systematic process for identifying, screening, and selecting guidelines on LSSS

The regional distribution and the organisation/societies developing these guidelines and the guideline themes are listed below:

**Table 5.1: Regional distribution of key themes of reviewed guidelines**

Region / Medical Societies	Guidelines Theme	Total Number of Guidelines reviewed
Global / International (WHO, Kidney Disease: Improving Global Outcomes (KDIGO) (5,6,7,8,9,10,11)	Hypertension management, CKD management, complete guidelines on use of LSSS	7
Europe (European Society of Hypertension (ESH), European Society of Cardiology (ESC), European Renal Association (ERA)) (12,13,14)	Hypertension and CVD management	3
Latin America (LASH) (15)	Hypertension management and related comorbidities	1
China (Chinese Society of Cardiology, Chinese Medical Association, Cross-Straits Medicine Exchange Association) (16,17,18,19,20)	Hypertension prevention and treatment, complete guideline on use of LSSS	5
Taiwan (Taiwan Society of Cardiology, Taiwan Hypertension Society) (21)	Hypertension management	1
India (API, ISN, NIN, NHRSC, MoHFW) (1,2,3,4)	Hypertension management, CKD management, dietary sodium, and dietary guidelines	4
Australia (KHA-CARI) (22,23) HTN task force guidelines (30)	CKD detection, prevention, and management, hypertension, LSSS	3
United Kingdom (NICE) (24)	Hypertension in adults' diagnosis and management	1
United States (AHA) (25)	Sodium reduction and healthy eating	1

### 5.2.1 Key recommendations from the 26 included guidelines

The guidelines recommend to reduce sodium intake to about 2 grams per day (about 5 grams of salt) in adults (5,6) and stress the need for multiple approaches, such as public education, regulating the food industry to reduce sodium content, improving labels, and promoting healthier eating habits. Lowering sodium intake is considered essential for reducing blood pressure levels in the population and decreasing cardiovascular risk. Many guidelines aim for global sodium reductions by 2030 (5,12).

Further, many of the health agencies and organisations are in consensus that swapping out some normal salt for LSSS, which replaces a portion of sodium chloride with potassium chloride, effectively lowers blood pressure and reduces the risk of heart disease. Guidelines, from the WHO and regional health bodies and societies such as the ESH (12) and ESC (13), and guidelines from China (16), Taiwan (21), and the United States (25) recommend LSSS to bring down daily sodium intake to under 2 g.

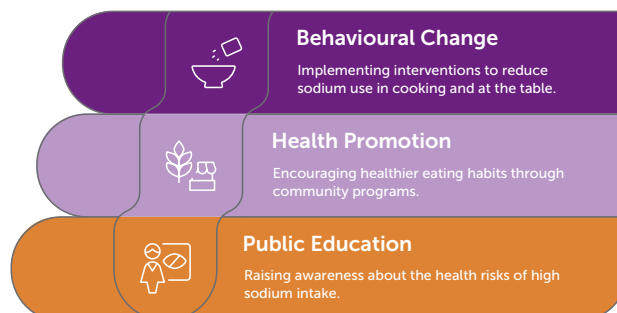
Kidney-focused clinical guidelines such as KDIGO and KHA-CARI, along with other disease-specific guidelines, point out that individuals with kidney disease, hyperkalaemia, heart failure or anyone on potassium-sparing therapy should steer clear of LSSS since those can drive potassium levels up.

Synthesising the recommendations on these guidelines, it is evident that although LSSS may be recommended for individuals to lower blood pressure however caution is advised for people with kidney disease, risk of hyperkalaemia or those on potassium-sparing diets.

## 5.3 Target audience for the guidelines

The guidelines are directed towards different target audiences for implementation. These include

- Public Health policymakers and the Government
- Doctors and medical professionals in all settings
- Managers and implementers of programmes relating to nutrition and non-communicable diseases (NCD) prevention
- Non-governmental, governmental and other organisations, including professional societies, involved in managing and implementing programmes relating to nutrition and NCD prevention
- Scientists and others involved in nutrition and NCD-related research
- Representatives of the food industry and related associations
- Media
- The population in general
- Patients with Hypertension, other CVD and NCD



## 5.4 Recommendation on LSSS under sodium reduction strategy

- General population
- Specific population groups

### 5.4.1 Recommendations for general population

The guidelines on salt reduction strategies with a mention of LSSS at the population level include the following ones: 1) *Use of lower-sodium salt substitutes: WHO guideline 2025*; 2) *How to Reduce Sodium in Your Diet, American Heart Association, 2024*; 3) *The Guidelines for use and promotion of low-sodium salt in China, 2024*; 4) *Chinese Guidelines for Prevention and Treatment of Hypertension – A Report of the Revision Committee of Chinese Guidelines for Prevention and Treatment of Hypertension, 2018*

**a. Key Highlight:** These guidelines provide population-level recommendations for the use of LSSS as an intervention to reduce sodium intake.

**Use of lower-sodium salt substitutes: WHO guideline 2025:** To lower blood pressure and reduce the risk of cardiovascular diseases, the WHO strongly recommends limiting sodium intake to less than 2 g per day. When table salt is used, the WHO suggests choosing lower-sodium salt substitutes that contain potassium instead of regular salt (6).

*“To reduce blood pressure and risk of cardiovascular diseases, WHO has recommended reducing sodium intake to less than 2 g/day (strong recommendation). In this context, using less regular table salt is an important part of an overall sodium reduction strategy. If choosing to use table salt, WHO suggests replacing regular table salt with lower-sodium salt substitutes that contain potassium”*

- Use of lower-sodium salt substitutes: WHO guideline 2025

**The guidelines for use and promotion of low-sodium salt in China, 2024**, indicate that using LSSS can significantly lower blood pressure and reduce the risk of major CVD and all-cause mortality and is both safe and cost-effective (17). Replacing regular salt with LSSS in home cooking has been shown to lower blood pressure across different populations and decrease cardiovascular events and deaths among individuals at high risk of cardiovascular disease. The guideline also outlines the implementation and encouragement of LSSS adoption across the country. The document emphasizes on the fact that LSSS use helps lower blood pressure, decreases the risk of cardiovascular disease, and is both safe and cost-effective. The recommendations are directed toward households, older adults, and the food industry (17).

Characteristic	Description
 <b>Problem</b>	High Sodium, Low Potassium, CVD Deaths
 <b>Objective</b>	Develop National LSS Guidelines
 <b>Evidence</b>	Lowers BP, Reduces CVD, Safe, Cost-Effective
 <b>Recommendations</b>	Households, Elderly Care, Food Industry, Avoid Hyperkalemia
 <b>Policy Impact</b>	Supports Healthy China 2030, Reduces Hypertension

**How to reduce sodium in your diet, American Heart Association, 2024;** The AHA guidelines suggest that most people can try potassium salt, but certain medical conditions (like kidney disease) and medications can have implications on your body’s potassium and seeking advice from a health care professional is suggested (25).

### 5.4.2 Recommendations for specific groups of the population

Some of the guidelines provide specific considerations, tailored advice or cautions for use of LSSS in different population groups, like people with different physiological status and disease conditions, such as pregnant women, elderly people, people with diabetes, hypertension and CKD.

Examples of such guidelines are the 1) WHO guideline on lower-sodium salt substitutes, 2025; 2) ESH guidelines, 2023 and Management of Hypertension in Patients with Type 2 Diabetes Mellitus; 3) Management of Blood Pressure in Patients with Chronic Kidney Disease Not Receiving Dialysis: Synopsis of the 2021; 4) Hypertension in adults: diagnosis and management, NICE guidelines, 2023, KDIGO Clinical Practice Guideline; 5) KDIGO Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease, 2024; 6) Indian Guideline by Association of Physicians of India and Indian College of Physicians, 2024.

**a. Key considerations for people with CKD on use of LSSS:** These specific guidelines (6,12,13,25) though have mentioned LSSS but have specifically excluded individuals with kidney impairments or other conditions that might compromise potassium excretion, such as those with CKD or those on potassium-sparing medications.

Further some of these guidelines highlight that in some low-resource settings, a considerable portion of the population may have undiagnosed kidney disease, raising concerns about increased potassium intake through LSSS. **The guidelines emphasise the cautious use of potassium-enriched LSSS or supplements in individuals with impaired kidney function or who are at high risk of hyperkalaemia (6,12,22,15).**

*“Concerns have been raised about the safety of LSSS that contain potassium, because too high a level of blood potassium (hyperkalaemia) may be harmful, especially to individuals with impaired kidney function.”*

**- Use of lower-sodium salt substitutes: WHO guideline, 2025**

**b. For pregnant women and children:** The recommendation from the WHO LSSS guidelines (6) does not apply to pregnant women or children due to inadequate evidence regarding safety and effects of LSSS for these groups (6,12)

**c. Key highlights on recommendation for people with diabetes and elderly:** As outlined in the guidelines from *ESH Guidelines for the Management of Arterial Hypertension, 2023*; and *Hypertension in adults: diagnosis and management, NICE guidelines, 2023*, larger reductions in blood pressure have been observed among hypertensive individuals, as well as in other groups including non-white populations, older adults, and patients with diabetes, metabolic syndrome, or CKD with low sodium diets (12). While the *NICE guidelines* caution that LSSS may not be suitable for older adults, people with diabetes, pregnant women, individuals with kidney disease, and those taking specific antihypertensive medications (e.g., ACE inhibitors or angiotensin II receptor blockers), they continue to emphasise the importance of reducing sodium intake within these groups (24). It should be noted that only some of the guidelines listed above have provided key considerations for people with diabetes and elderly population.

## 5.5 The outcome measures assessed/ mentioned in the guidelines

### 5.5.1 Efficacy outcomes of sodium reduction in the guidelines

The main efficacy outcomes measured in the sodium reduction guidelines include

**a. Drop in blood pressure:** Reductions in both systolic and diastolic blood pressure, with expected decrease of about 3 to 5 mm Hg systolic and roughly 2 mm Hg diastolic is noted after sodium restriction or salt substitution (12).



**b. Incidence of stroke, and other cardiovascular diseases (CVDs):** Beyond blood pressure reduction, many guidelines mention significant reductions in stroke incidence. Cardiovascular morbidity and mortality are lower in populations adhering to low-sodium diets. Salt substitution trials demonstrate a notable reduction in the risk of major cardiovascular events (12). Epidemiologic and clinical outcomes showing lower stroke rates, particularly ischemic stroke, along with declines in cardiovascular issues and mortality, are linked to successful sodium reduction strategies (9,14,19).



**c. Clinical outcomes in CKD:** Guidelines have mentioned that sodium restriction assists in controlling hypertension and reducing proteinuria among CKD patients. Lower sodium intake contributed to slower progression of kidney disease. *The Chinese Clinical Practice Guideline for the Management of "CKD-Peri Dialysis" the Periods Prior to and in the Early-Stage of Initial Dialysis, 2022* mentions sodium restriction as an important non-pharmacological strategy, noting that lower sodium intake is associated with a slower rate of kidney disease progression (16).



Additionally, guidelines focused on CKD, report benefits like reduced albuminuria and slowed progression of kidney impairment tied to lower sodium intake (16,23). The 2024, KDIGO guidelines, encourages the use of optimal potassium intake in those with chronic kidney disease (CKD), and the 2024 KDIGO Guidelines encourage the use of potassium-containing foods in the diet for most individuals with CKD. Potassium restriction is recommended only in those with advanced CKD stages or if hyperkalemia develops (8). Other international guidance suggests caution with unnecessary potassium restriction, since a lower intake may worsen nutritional status and potentially accelerate CKD progression, unless persistent hyperkalemia is present (27,28).

**d. Other Efficacy outcomes:** Specific guidelines have also mentioned that sodium reduction may positively impact additional markers, such as albuminuria, endothelial function, and arterial compliance (12).

### 5.5.2 Safety outcomes

*Guidelines of the Taiwan Society of Cardiology and the Taiwan Hypertension Society for the Management of Hypertension, 2022* states that use of LSSS showed no increase in adverse events attributed to hyperkalaemia compared to regular salt (21).

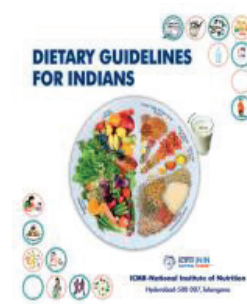
## 5.6 Summary of some relevant guidelines related to CVD and sodium reduction from India

This section summarises all the relevant Indian guidelines related to CVD and Sodium Reduction in India. It should be noted that not all of these guidelines suggest using LSS and a majority of them have been drafted before sufficient evidence on LSSS was available.

*The Indian public health and clinical guidelines such as the dietary guidelines for Indians, 2011* and the Indian society of nephrology CKD guidelines, 2013 have highlighted the need to reduce sodium intake, each with its own focus that relate closely to the specific needs of the population they serve.

### 5.6.1 The dietary guidelines for Indians, 2024

This guideline which is recently revised in 2024 gently urges people to keep their salt intake not more than 5 grams. This guideline doesn't yet promote LSSS but emphasizes the importance of fortified salts enriched with iron and iodine to support overall nutrition and health. The guideline also emphasises minimizing the use of processed foods rich in salt (4).

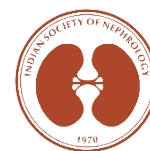


**Table 5.2 Sodium and potassium intake targets in India**

Nutrient	RDA / Recommended Limit	Key References
Sodium	<2 g/day (≈5 g salt)	ICMR-NIN 2011; ICMR – NIN (26) 2020; Indian CKD 2013
Potassium	≥3.5 g/day	DASH diet API 2024

### 5.6.2 Indian society of nephrology CKD guidelines 2013

The Indian Society of Nephrology’s CKD Guidelines take a more clinical tone, stressing the importance of sodium restriction to manage blood pressure and slow kidney disease progression (2).



### 5.6.3 Indian guideline 2024 by association of physicians of India and Indian college of physicians

Encourages following the Dietary Approaches to Stop Hypertension (DASH) diet that promotes potassium intake, particularly highlighting lower targets for consumption of sodium for older adults. While this guideline doesn’t explicitly endorse LSSS, it underscores a practical, cautious approach to reducing sodium as part of overall dietary management in chronic conditions (1).



### 5.6.4 Standard treatment guideline for India, 2017

This guideline recommends salt reduction as a dietary recommendation for patients with hypertension and for those at risk of developing hypertension but also shares a caution for people on ACE inhibitors like Enalapril, that “hyperkalemia can occur if there is renal impairment or patient is on potassium containing salt substitutes”. This guideline also mentions that ‘Hyperkalemia can develop with high doses of ACE inhibitors, but also more commonly in patients with renal insufficiency, diabetes, concurrent use of potassium sparing diuretics, and the elderly.’ (3).

The above summary of guidelines from India indicates the need to update them on the basis of recent scientific evidence on sodium reduction and LSSS, advancement in use of LSSS globally and in light of global and regional guidelines on the use of LSSS.

## 5.7 Summary of positioning of LSSS in key clinical guidelines

The global and regional guidelines incorporate LSSS to differing degrees. These reflect variability in evidence synthesis as part of these guidelines and policy recommendations.

A new position statement from The National Hypertension Taskforce, on LSSS, showed evidence that replacing regular salt with LSSS (75% NaCl and 25% KCl) can significantly reduce the risk of CVDs and blood pressure (29). The taskforce suggests that the following statement should be added in the management guidelines for patients with hypertension:

*'If patients add salt to their food, they should make a 1: 1 switch from regular salt to potassium-enriched salt with a composition of approximately 75% sodium chloride and 25% potassium chloride, unless they are at risk of hyperkalaemia because of kidney disease, use of a potassium supplement, use of a potassium sparing diuretic or for another reason.'*

-The National Hypertension Taskforce, 2025

The following section provides key highlights from the guidelines specifically on LSSS:

### Key highlights

- The Global WHO guidelines on use of lower-sodium salt substitutes: 2025 support using LSSS as a safe and effective way to reduce sodium intake and lower blood pressure (this recommendation however doesn't include pregnant women, children and individuals with kidney impairments or with other circumstances or conditions that might compromise potassium excretion) (6).
- European and Asian hypertension guidelines from the ESC and ESH suggest substituting about 25–30% potassium chloride in salt as an ideal alternative; it also recommends providing potassium supplementation (13,14). However, caution is advised for patient groups at risk of hyperkalaemia, especially those with kidney problems or on potassium sparing medications (1,3,22,23)
- The Australian guidelines titled Kidney Health KHA-CARI, 2013, suggest adherence to a low sodium diet (<100mmol or 2300mg/day) to reduce risk of developing CKD. Patients with CKD should not use salt substitutes that contain high amount of potassium (23).
- The National Hypertension Taskforce, on LSSS, showed evidence that replacing regular salt with LSSS (75% NaCl and 25% KCl) can significantly reduce the risk of CVDs and blood pressure (29).
- The 2024 Guidelines for the Use and Promotion of Low-Sodium Salt in China describe strategies for implementing and promoting the use of LSSS nationwide. The guidelines emphasize that LSSS consumption effectively lowers blood pressure, reduces the risk of cardiovascular diseases, and is both safe and cost-efficient. The recommendations focus on households, older adults, and the food industry (17).
- While the sodium intake targets are set for CKD patients, with the current evidence on the role of potassium on renal health, there is a lack of consensus and paucity of data on optimal intake of potassium at different stages of CKD. This sometimes leads to over restriction of potassium especially in patients of CKD stages 1-3 which may do more harm than benefit.

The reviewed guidelines highlight LSSS as a potential, evidence-based strategy for reducing sodium intake at the population level as well as for the prevention and management of hypertension and other CVD. However, most of the guidelines provide conditional recommendation for its use and adoption in specific population groups such as pregnant women and children and individuals with co-morbidities, especially renal impairment or those at risk of hyperkalaemia. It is important to note that the conditional recommendation is owing to the lack of evidence on the effectiveness of LSSS in these specific population groups. It is therefore important to develop recommendations and guiding principles for the use of LSSS in India, which could optimise benefits of LSSS in reducing the burden of hypertension and other CVDs and also serve as an example of a responsive public health approach.

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## Chapter 6:

# Promoting use of potassium-enriched low sodium salt substitutes – challenges and solutions

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Promoting the use of potassium-enriched low-sodium salt (LSSS) is an important step toward reducing sodium intake and improving cardiovascular health. The growing awareness and policy interest in this area can provide a good opportunity to increase its use. The outlines of the efforts to promote the use of LSS in India could be based on the 4A's framework – i.e. improving *Availability, Affordability, Accessibility, and Acceptability* (1). The framework indicates that both the supply and demand-side need to be strengthened. Additionally, concerted action is also required to improve the acceptability of LSSS as a key intervention in India's sodium reduction efforts.

The main areas for action include increasing production, improving supply chains to ensure wider availability, and making LSSS more affordable. Improving acceptability entails creating awareness among consumers and health professionals about its benefits, correct use, and good taste. Strong collaboration, support and communication between government, industry, and health experts can make LSSS become a regular part of Indian households and contribute to better public health (2).

## 6.1 Potassium-enriched low sodium salt substitutes (LSSS) in India

### 6.1.1 Availability of LSSS in India

LSSS makes up only about 0.4% of the total edible salt market in India (2). LSSS is currently positioned as a premium product, reducing its affordability and access. LSSS available in the Indian market replace some proportion of sodium chloride with potassium chloride and is iodized. The majority contain up to 10–15% potassium chloride (KCl), with a few containing up to 30% KCl. The availability is concentrated in metropolitan cities such as Delhi, Mumbai, Bengaluru, and Pune, which together account for about 70% of the total LSSS sold, with no availability in smaller towns and rural areas (3).

### 6.1.2 Technology & production

LSSS production involves mixing regular iodized salt with food-grade potassium chloride, which is the main sodium-reducing ingredient. Potassium chloride imported from countries such as Canada, Russia, and Belarus is either food grade or chemical-grade which needs domestic refining to reach food-grade quality. This can result in variability in product quality. This can result in variability in product quality.

### 6.1.3 Pricing of LSSS in India

LSSS is currently at 2–4 times higher in price than regular iodized salt. This is because the import cost of potassium chloride, accounts for 60–75% of the total production cost, which depends on its formulation. In addition, high markups and packaging by brands contribute to increase in price. These factors make LSSS less accessible to non-urban markets.

## 6.1.4 Regulations on LSSS products

The Food Safety and Standards Authority of India (FSSAI) in a draft regulation F. No. STD/FA/A-1.30/No.1/2020-FSSAI (4) defines LSSS as crystalline solid material with reduced sodium content obtained from evaporation of natural brines (sea/subsoil or lake brines) by replacement of sodium chloride with potassium chloride as per the permitted levels. It shall be white in colour, free from visible contamination with clay, grit or other extraneous adulterants or impurities and may be fortified with Iodine as per the provisions prescribed under Food Safety and Standards (Fortification of Foods) Regulations, 2018.

It shall conform to the following requirements:

S. No	Requirements	Limit
1.	Moisture content, % by weight (Maximum)	1.0
2.	Sodium Chloride % by weight on dry basis	60.0 – 75.0
3.	Matter insoluble in water % by weight on dry basis (Maximum)	1.0
4.	Alkalinity (as Na <sub>2</sub> CO <sub>3</sub> ), %(Maximum)	0.15
5.	pH (5% aqueous solution)	6.0-7.5

Additionally, the draft regulation also proposes a warning label for LSSS as *“To be consumed under medical supervision. There is a risk of hyperkalemia on consumption of a high potassium containing salt when there is renal or cardiac dysfunction, diabetes, or in case of consumption along with certain drugs that can substantially impair potassium excretion.”*

While the draft warning label provides caution to vulnerable population like people with kidney disease and those on potassium sparing diets, it could be interpreted as too restrictive for the general population who would benefit from LSSS. The draft standard also essentially defines LSSS as having at least 25-40% sodium being replaced by other minerals.

## 6.2. Barriers to adoption of LSSS at population level

One of the major barriers to using LSSS in addition to low availability, awareness and affordability is the concern about the side effects. The substitution of sodium with potassium chloride raises fears of hyperkalemia, particularly in people with kidney disease or those taking medications like ACE inhibitors or potassium-sparing diuretics (5). Large-scale trials like Salt Substitute and Stroke Study (SSaSS) in China have shown cardiovascular benefits without major adverse effects (5). However, this has not been extensively communicated among Indian policymakers or the medical community.

### 6.2.1 Barriers at the consumption level

Cultural habits and taste preferences play a major role in salt consumption in India. Salt is an integral part of Indian cooking. Public awareness campaigns or adaptation in cooking practices, can improve consumer acceptance (2).

## 6.2.2 Barriers at the prescription and public health promotion level

Clinicians and dietitians play an essential role in transforming dietary recommendations, especially in chronic disease management. However, awareness and prescription of LSSS among clinicians in India remain limited. Studies indicate that most general practitioners and dietitians continue to recommend conventional salt restriction rather than substitution strategies for management and prevention of hypertension (5). The National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) also emphasize reducing sodium but does not provide adequate guidance on using low sodium salt substitutes. This necessitates clear guidance from policymakers on the use of LSSS in India especially in light of the 2025 WHO guidelines.

While LSSS is well-established in international guidelines, such as those by the World Health Organization and American Heart Association (AHA, 2021), it needs to be adequately incorporated into India's clinical nutrition and hypertension management frameworks (1).

Clinicians in India currently lack practical recommendations for incorporating within their standard care protocols. The potential for clinician-driven adoption is significant. With hypertension affecting nearly one in four adults in India (6), even a modest increase in the use of LSSS could provide public health benefits. Evidence from meta-analyses and controlled trials shows that partially replacing of sodium chloride with potassium chloride can reduce systolic blood pressure by 4–5 mmHg and diastolic by 2–3 mmHg (7), comparable to first-line pharmacological interventions. This can complement existing treatment regimens.

To support clinicians in promoting LSSS, targeted education and clear evidence-based guidelines are essential. Medical councils and associations could include LSSS awareness into hypertension and cardiovascular disease management. Dietitians can play a pivotal role in guiding patients on taste adaptation, appropriate usage and identifying contraindications (1).

Further, patients tend to overestimate their adherence to "low-salt diets" while still consuming excess sodium through processed foods, pickles, and snacks. Clinicians should combine LSSS recommendations with lifestyle counselling. The successful adoption of LSSS in India depends as much on clinical confidence and patient behaviour as on product availability and affordability.

Multi-sectoral concerted action involving policymakers, researchers, public health experts, physicians, dietitians, consumers and industry is required to ensure efficacious use of LSSS in India. The challenges of low awareness, acceptability, availability and affordability can be mitigated through collective action. This would put India on the path to achieve its goal of reducing population-level sodium intake by 30% by the year 2030.

### Key highlights

- In India, potassium-enriched low-sodium salt substitutes constitute a very small share of the edible salt market and are priced significantly higher than regular salt being mainly available in urban areas.
- Dependence on imported potassium chloride, production and pricing factors shape the availability and positioning of LSSS in India.
- Low awareness among consumers and clinicians, taste preferences, safety concerns related to hyperkalaemia, and limited integration into public health and clinical guidance constrain wider uptake despite strong international evidence.

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## Chapter 7:

# Recommendations from the Consensus Conference

## Use of Potassium-enriched low-sodium salt substitutes (LSSS) as a public-health intervention in India

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### Introduction: consensus development

The George Institute India, in collaboration with Resolve to Save Lives (RTSL), organized a consensus conference titled “Bridging Evidence and Practice: A Consensus Conference on the Use of Low-Sodium Salt Substitutes as a Public Health Intervention” on 02 December 2025. The conference aimed to review the global evidence and build consensus on the use of potassium-enriched low-sodium salt substitutes (LSSS) focussing on the effectiveness, efficacy, and safety of LSSS for the prevention and management of hypertension and cardiovascular diseases. It also explored potential pathways toward the implementation of LSSS use in India.

The conference brought together leading cardiologists, nephrologists, researchers, physicians including family practitioners, public health experts, and nutritionists from across India. Discussions were informed by global evidence and guidelines including the latest World Health Organization (WHO) guidelines on the use of LSSS, with an emphasis on developing context-specific recommendations and identifying next steps relevant to the Indian setting.

### Methods: Delphi survey

A Delphi process was conducted as part of the consensus conference. The Delphi technique is a structured scientific method used to facilitate group communication and generate insights into current or emerging challenges, particularly in settings where evidence may be limited (1). In medical and clinical research, Delphi studies commonly employ rank-order questions, rating scales, or open-ended questions and are frequently used to assess the level of consensus among experts (1).

A modified Delphi methodology was used to achieve expert consensus through a structured rating of predefined statements. The Delphi approach was chosen for its strength in synthesizing expert judgment in areas where empirical evidence is available but requires contextual interpretation for policy and programmatic application.

### Development of statements

The statements were developed after a review of evidence from systematic reviews and meta-analyses of trials evaluating low-sodium salt substitutes (LSSS), findings from large-scale effectiveness studies, guidance from the World Health Organization and national sodium reduction policies, and India-specific considerations related to dietary patterns and health systems context.

Statements were grouped under four domains:

1. **Efficacy of LSSS in addressing CVD** (impact on blood pressure and CVD outcomes)
2. **Effectiveness of LSSS** (real-world applicability and population-level impact)
3. **Safety** of LSSS (risk of hyperkalemia and use in special populations)
4. **Adoption and Implementation** of LSSS in clinical and public health settings (acceptability, affordability, regulation, and scalability)

**Rating Scale:**

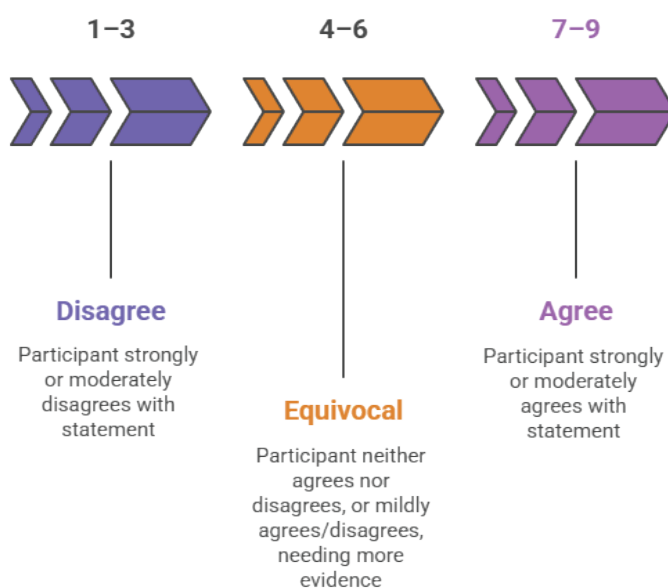
Participants rated each statement using a 9-point Likert scale:

## Definition of consensus

Consensus was defined a priori as:

- **Agreement:**  $\geq 70\%$  of participants scoring a statement between 7 and 9
- **Equivocal:**  $\geq 50\%$  of participants scoring between 4 and 6
- **Disagreement:**  $\geq 70\%$  scoring between 1 and 3

### 9-Point Likert Scale Response Categories



Descriptive statistics were used to summarize the responses.

## Results

An expert panel (N = 19, Table 7.1) reviewed the evidence on efficacy, safety, policy implications, and implementation strategies for LSSS in the Indian context. The experts sought agreement on domains including clinical use, safety, public health relevance, regulatory considerations, and future research needs. The responses from the Delphi survey have been summarized in Table 7.2.

**Table 7.1 List of experts who participated in the Delphi survey (N=19)**

Name	Area of Expertise	Designation and Institution
Dr. Ambuj Roy	Cardiology	Professor, Department of Cardiology AIIMS, New Delhi
Dr. Arpana Iyengar	Paediatric Nephrology	Professor, Dept. of Paediatric Nephrology, St. John's Academy of Health Sciences
Dr. CS Surya Goud	Public Health Nutrition	Scientist C, NIN, ICMR, Hyderabad
Dr. Edwin Fernando	Nephrology	Professor and Head of Nephrology, Stanley Medical College, Chennai
Ms. Edwina Raj	Nutrition and Dietetics	Chief Dietitian, Aster, Bangalore
Dr. Meenakshi Sharma	NCD research	Ex Scientist G, NCD Division, ICMR, Delhi
Dr. N Gopalakrishnan	Nephrology	Member Secretary, Transplant Authority of Tamil Nadu
Dr. P. Raghavendra	Public Health Nutrition	Scientist C, NIN, ICMR, Hyderabad
Dr. Ramakrishna Prasad	Family Medicine	Chair, National Centre for Primary Care Research & Policy at Academy of Family Physicians of India (AFPI)
Dr. Roopa Shivashankar	Community Medicine, NCDs	Scientist E, ICMR, Delhi
Prof. Sailesh Mohan	NCD research	Deputy Director Centre for Chronic Disease Control Delhi
Prof. Sandeep Mahajan	Nephrology	Prof, Nephrology, AIIMS, New Delhi
Ms. Sandhya Pandey	Nutrition and Dietetics	GM and Chief Dietitian, Department of Clinical Nutrition and Dietetics, Medanta, Gurugram
Dr. Satyavir Yadav	Cardiology	Associate Professor, Department of Cardiology, AIIMS, New Delhi  Secretary, Cardiological Society of India (Delhi branch)
Dr. S B Bansal	Nephrology	Secretary, Indian Society of Nephrology
Dr. Sirimavo Nair	Nutrition, Public Health	Professor, Dept. of Food and Nutrition, The Maharaja Sayajirao University of Baroda, Gujarat
Dr. Sourabh Sharma	Nephrology	Associate Professor Nephrology, Vardhman Mahavir Medical College and Safdarjung Hospital
Dr. Thout Sudhir Raj	NCDs, community health	Research Fellow, Health Systems Science, The George Institute for Global Health, India
Dr. Vinay Rathore	Nephrology	Nephrologist, AIIMS, Raipur

**Table 7.2. Expert consensus on the use of Low-Sodium Salt Substitutes (LSSS) in India (N = 19)**

Question	Disagree N (%)	Equivocal N (%)	Agree N (%)	Missing N (%)
1. <u>Replacing regular salt with potassium-enriched low-sodium salt substitutes in India</u> To reduce cardiovascular risk, regular table salt (100% Sodium Chloride) should be replaced with Low-Sodium Salt Substitutes (LSSS) composed of approximately 70-85% Sodium Chloride and 15-30% Potassium Chloride for the general population and patients with hypertension.	0 (0)	2 (10.53)	17 (89.47)	
2. <u>Mechanism of action</u> The benefits of LSSS are derived from both sodium reduction and potassium supplementation. Analysis of the SSaSS data suggests that approximately 75% of the blood pressure-lowering effect is attributable to increased potassium rather than to sodium reduction alone.	0 (0)	1 (5.26)	18 (94.74)	
3. <u>LSSS as an adjunctive intervention for hypertension</u> For patients with hypertension, LSSS should be recommended as routine adjunctive intervention unless contraindicated (advanced CKD, use of potassium supplements, or potassium-sparing diuretics)	0 (0.00)	0 (0.00)	19 (100.00)	
4. <u>Safety of LSSS</u> 4.1 Adults with early CKD (e.g., stages 1–3, eGFR $\geq$ 30 mL/min/1.73 m <sup>2</sup> ) who do not have baseline hyperkalemia and are not taking potassium-sparing diuretics or potassium supplements may use LSSS in place of regular salt. 4.2 LSSS may not be prescribed for patients with advanced (Stages 4-5) chronic kidney disease (CKD). 4.3 LSSS may not be prescribed for patients who are on potassium-sparing diuretics.	0 (0.00)	3 (15.79)	16 (84.21)	
	0 (0.00)	2 (10.53)	17 (89.47)	
	1 (5.26)	2 (10.53)	16 (84.21)	
5. <u>LSSS as a public health intervention</u> 5.1 Given that approximately three-fourths of sodium intake in India comes from discretionary salt used in home cooking, LSSS should primarily target household consumption. Population-level substitution at homes, community kitchens, and mid-day meal programmes may offer the highest potential impact. 5.2 LSSS should be mandatorily iodised at appropriate concentrations to maintain adequate population iodine intake while reducing sodium. The iodisation should follow the WHO recommendation (adjusting iodine fortification levels based on salt intake recommendations)	0 (0.00)	1 (5.26)	18 (94.74)	
	0 (0.00)	0 (0.00)	18 (94.74)	1 (5.26)
6. <u>Implementation approaches for LSSS use in India</u> 6.1 LSSS should be a core component of national sodium reduction strategies and receive policy endorsement. 6.2 National NCD and hypertension guidelines should recommend routine use of LSSS in place of regular salt for the general adult population, with well-defined contraindications (advanced CKD, potassium-sparing drugs, potassium supplements, known hyperkalemia). 6.3 FSSAI should update standards and labelling rules to recognise potassium-enriched, iodised LSSS as an approved “edible salt” category, require a clear label, and align iodine levels with lower salt intake to preserve universal salt iodisation goals. 6.4 The production capacity of LSSS needs to increase, with salt manufacturers supported in securing potassium supplies, adapting technology, and maintaining iodisation.	0 (0.00)	0 (0.00)	19 (100.00)	
	0 (0.00)	1 (5.26)	18 (94.74)	
	0 (0.00)	0 (0.00)	19 (100.00)	
	0 (0.00)	0 (0.00)	19 (100.00)	

Question	Disagree N (%)	Equivocal N (%)	Agree N (%)	Missing N (%)
6.5 Potassium-enriched salts are typically priced roughly twice as much as regular iodised salt and are concentrated in urban markets. Fiscal instruments, such as providing production subsidies, can narrow the price gap.	1 (5.26)	3 (15.79)	15 (78.95)	
6.6 Behaviour-change strategies to promote LSSS would require creating familiarity, trust, and demand. Social marketing campaigns should focus on simple, concrete messages: "same saltiness, less sodium, lower blood pressure," backed with visuals and endorsements from clinical and public health leaders and celebrities.	0 (0.00)	0 (0.00)	19 (100.00)	
6.7 Health professionals should be appropriately educated so that LSSS becomes a routine part of hypertension counselling.	0 (0.00)	0 (0.00)	19 (100.00)	
6.8 Food industry reformulation policies should require partial replacement of sodium chloride with potassium salts in packaged foods and restaurant meals, especially in high-salt categories such as snacks, instant mixes, and condiments.	0 (0.00)	0 (0.00)	19 (100.00)	
7. <u>Future research on LSSS</u>				
7.1 Research is needed to quantify the effectiveness and safety of LSSS in high-risk groups through large pragmatic trials in adults with hypertension, diabetes, and early CKD (stages 1–3) to measure effects on blood pressure, incident hypertension, cardiovascular events, and hyperkalemia, using locally relevant diets and co-medications.	0 (0.00)	0 (0.00)	19 (100.00)	
7.2 Dedicated trials or prospective observational studies are needed for carefully monitored LSSS use in CKD stages 4–5, dialysis, transplant recipients, and elderly patients on RAAS inhibitors, powered to detect hyperkalemia, arrhythmias, and hospitalizations.	0 (0.00)	2 (10.53)	17 (89.47)	
7.3 Modelling studies using Indian CKD prevalence, drug-use patterns, and lab data are needed to estimate benefit–risk trade-offs and to refine contraindication language for national guidelines	0 (0.00)	1 (5.26)	18 (94.74)	
7.4 Cluster trials and qualitative studies comparing different delivery models of LSSS, and to map and identify acceptable solutions in diverse regions.	0 (0.00)	0 (0.00)	19 (100.00)	
7.5 There is a need to assess the economics, equity, and market dynamics of scaling up LSSS in the Indian market	0 (0.00)	0 (0.00)	19 (100.00)	

## Key findings

The panel strongly agreed that switching from regular iodized salt to potassium-enriched LSSS can significantly lower the risk of heart disease in both the general population and people with high blood pressure by both reducing sodium and increasing potassium intake.

The panellists recommended that for patients with hypertension, LSSS should be considered as a routine adjunctive intervention, except for specific groups, such as people with advanced kidney disease, and those with already elevated potassium levels. This is based on the recent CKD guidelines which point out that evidence for strict long-term potassium restriction in CKD is limited, and higher dietary potassium may be protective in early CKD. The guidelines do not recommend routinely prohibiting the use of LSSS among people in the early stages of CKD. More than 80% of the panel

recommended that for adults with early-stage kidney disease (stages 1–3, eGFR  $\geq$ 30 mL/min/1.73 m<sup>2</sup>) who do not have baseline hyperkalemia and are not taking potassium-sparing diuretics or potassium supplements, LSSS can be used with proper medical supervision.

The panel emphasized that population groups like diabetics, or patients on ACE inhibitors/ARBs, should not be routinely excluded from the recommended use of LSSS.

## Public health and policy implications

Since about three-quarters of sodium intake in India comes from salt added during cooking or at the table (discretionary salt), as opposed to the high-income countries where processed food accounts for most sodium intake, the panel agreed that LSSS should mainly be substituted in homes, community kitchens, and government food programs.

About 95% of the panellists agreed that iodization of LSSS should be retained while formulating and promoting LSSS for population-level consumption. This is consistent with WHO recommendations (adjusting iodine fortification levels based on population-level recommendations on low salt intake) to maintain the benefits of universal salt iodization.

Owing to the high burden of hypertension in India, along with higher than recommended sodium and low potassium intake, the panel unanimously recommended that LSSS be integrated into national sodium-reduction strategies, hypertension and other NCD guidelines, and regulatory frameworks. This includes recognition of potassium-enriched iodised low sodium salt as an approved “edible salt” category by FSSAI, clear evidence-based labelling, and alignment of iodine fortification policies.

## Implementation considerations

The experts were unanimous in emphasizing the need to increase local production of LSSS, support salt manufacturers in securing potassium supplies, adapt technology and maintain universal iodisation goals. The majority (79%) of the panellists recommended that it is essential to make LSSS affordable through measures like the reduction of GST and providing production linked subsidies.

They unanimously agreed upon public education campaigns and capacity building of healthcare professionals as key strategies for increasing uptake of LSSS. For effective implementation, behaviour change strategies and social marketing campaigns must focus on simple, concrete messages and be backed with pictorial depictions and endorsements from clinical and public health leaders and celebrities. Women’s groups, ASHAs, self-help groups, and local champions should be involved to demonstrate cooking with LSSS.

Appropriate capacity building for health professionals was suggested so that LSSS becomes a routine part of hypertension prevention and management counselling in clinical and community settings. The panel also strongly recommended that food manufacturers and restaurants should reformulate their products and cooked dishes by partially replacing sodium chloride with potassium salts.

## Research priorities

While the panel recommends that switching from regular iodized salt to potassium-enriched LSSS can significantly lower the risk of heart disease in both the general population and people with high blood pressure, the panel also identified priority research gaps, and strongly recommended the necessity of quantifying effectiveness and safety of LSSS in high-risk groups through appropriately designed studies including pragmatic and quasi-experimental trials in adults with hypertension, diabetes, and early CKD (stages 1–3) to measure long-term effects like mortality, CVD risk, primary hypertension, and change in kidney function, including persistent hyperkalemia, using locally relevant diets and co-medications. Around 90% of the experts agreed that there are research gaps in assessing safety aspects of LSSS in patients with advanced CKD and recommended carefully monitored studies in those with advanced stage CKD and modelling studies using Indian prevalence data to refine contraindications. All the panellists agreed that to ensure effective scalability of LSSS in the Indian market, it is essential to evaluate the cost-effectiveness, equity, and market dynamics.

## Conclusion

This consensus strongly supports LSSS as a safe, effective, and scalable intervention to reduce sodium intake and cardiovascular risk in India. Coordinated action across policy, regulation, health systems, industry, and research is essential to realise the full public health potential of LSSS.

## Key recommendations from the consensus conference

### Recommendations on the effectiveness, efficacy, and safety of low-sodium salt substitutes (LSSS)

- Switching from regular iodized salt to potassium-enriched LSSS can significantly lower the risk of heart disease in both the general population and people with high blood pressure. The benefits of LSSS are derived from both sodium reduction and potassium supplementation, with potassium providing most of the benefits.
- For people with hypertension, LSSS should be recommended as a routine adjunctive intervention unless contraindicated (advanced CKD or potassium-sparing diuretics).
- For people with CKD, LSSS must be used in a stratified manner. Adults with early CKD (e.g., stages 1-3, eGFR  $\geq 30$  mL/min/1.73 m<sup>2</sup>) who do not have baseline hyperkalaemia and are not taking potassium-sparing diuretics or potassium supplements may reasonably use LSSS in place of regular salt under proper medical supervision. We recommend that elderly patients, patients with diabetes, and those receiving ACE inhibitors/ARBs not be routinely excluded from using LSSS, as current evidence does not support such exclusion.
- The benefits of LSSS are derived from both sodium reduction and potassium supplementation. Analysis of the SSaSS data suggests that approximately 75% of the blood pressure-lowering effect was attributable to increased potassium rather than to sodium reduction alone. We also observe that the recent CKD guidelines point out that evidence for strict longterm potassium restriction in CKD is weak and that higher dietary potassium may be protective in early CKD.

## Public health and policy recommendations

- In India, where there is a dual burden of hypertension along with a higher than recommended sodium and low potassium intake, it is recommended to integrate LSSS into national sodium reduction strategies, hypertension and NCD guidelines, and regulatory frameworks only 2.9-6.6% of Indians meet the recommended sodium-to-potassium ratio. The SSiS trial has demonstrated the feasibility of salt substitution (70% NaCl/30% KCl) in rural hypertensive patients.
- FSSAI should update standards and labelling rules to recognise potassium-enriched, iodised low sodium salt substitutes as an approved “edible salt” category, requiring a clear label aligned with scientific evidence that provides appropriate caution for those at risk, without being overly restrictive for the general population that stands to benefit from the use of LSSS.
- Given that approximately three-fourths of sodium intake in India comes from discretionary salt used in home cooking, LSSS must primarily target household consumption. This differs from high-income countries, where processed foods account for most sodium intake. Population-level substitution in homes, community kitchens, and mid-day meal programmes offers the highest potential impact.
- LSSS should be iodised at appropriate concentrations in line with WHO recommendations to maintain adequate population iodine intake while simultaneously reducing salt intake. The iodisation should follow the WHO recommendation (adjusting iodine fortification levels based on salt intake—for example, if intake is reduced to 5 g/day, iodine should be fortified at approximately 39 mg/kg salt)

## Recommendations for implementation

- LSSS should become a core component of national sodium reduction strategies and receive policy endorsement. The national NCD and hypertension guidelines should recommend routine use of LSSS in place of regular salt for the general adult population, with well-defined contraindications (advanced CKD, potassium-sparing drugs, potassium supplements, known hyperkalemia). FSSAI should update standards and labelling rules to recognise potassium-enriched, iodised LSSS as an approved “edible salt” category, requiring a clear label aligned with scientific evidence that provides appropriate caution for those at risk, without being overly restrictive for the general population that stands to benefit from the use of LSSS.
- The production capacity needs to increase, with salt manufacturers supported in securing potassium supplies, adapting technology, and maintaining iodisation. Affordability is a major barrier. Potassium-enriched salts are typically priced roughly twice as much as regular iodised salt and are concentrated in urban markets. Fiscal instruments, such as reducing GST and providing production subsidies, can narrow the price gap.
- Behaviour changes strategies require creating familiarity, trust, and demand. Social marketing campaigns should focus on simple, concrete messages: “same saltiness, less sodium, lower blood pressure,” backed with visuals and endorsements from clinical and public health leaders and celebrities. Women’s groups, ASHAs, self-help groups, and local champions should be co-opted to demonstrate cooking with LSSS and address myths about potassium
- The capacity of healthcare professionals should be developed so that LSSS becomes a routine part of hypertension prevention and management counselling in clinical and community settings, with simple screening questions to identify those who should avoid potassium-enriched products and clear instructions for everyone else to switch all household salt to LSSS.
- Governments should support public procurement for school mid-day meals, ICDS, PDS rations, hospital kitchens, railways, and large institutional canteens to build volume and normalise use. Food industry reformulation policies should require partial replacement of sodium chloride with potassium salts in packaged foods and restaurant meals, especially in high-salt categories such as snacks, instant mixes, and condiments.

### Recommendations for research

- It is critical to quantify the effectiveness and safety of LSSS in high-risk groups through trials that test effectiveness while reporting safety outcomes, which may be most appropriate given the ethical challenges of studies focused mainly on determining safety.
- It is essential to conduct dedicated trials or prospective observational studies of carefully monitored LSSS use in CKD stages 4–5, dialysis, transplant recipients, and elderly patients on RAAS inhibitors, explicitly powered to detect hyperkalemia, arrhythmias, and hospitalisations.
- Modelling studies should be conducted using Indian CKD prevalence, drug-use patterns, and lab data to estimate benefit–risk trade-offs and to refine contraindication language for national guidelines.
- It is important to conduct cluster trials and qualitative studies comparing different delivery models and to map and identify acceptable solutions in diverse regions.
- It is critical to assess economics, equity, and market dynamics of scaling up LSSS in the Indian market.

## Annexure 1

### List of attendees for the Consensus Conference

S.No.	Name	Designation	Institution
1.	Dr. Ambuj Roy	Professor, Department of Cardiology	All India Institutes of Medical Sciences New Delhi
2.	Ms. Anju	Government Engagement Advisor	The George Institute for Global Health, India
3.	Dr. Arpana Iyengar	Professor	Dept. of Paediatric Nephrology, St. John's Academy of Health Sciences
4.	Prof. Bruce Neal	Executive Director	The George Institute for Global Health Australia
5.	Ms. Chhavi Bhandari	Head, Impact and Engagement - India and Multilaterals	The George Institute for Global Health, India
6.	Dr. CS Surya Goud	Scientist C	NIN, ICMR, Hyderabad
7.	Dr. Edwin Fernando	Professor and Head of Nephrology	Stanley Medical College, Chennai
8.	Ms. Edwina Raj	Chief Dietitian	Aster, Bangalore
9.	Ms. Garima Sharma	Consultant	The George Institute for Global Health, India
10.	Dr. Manika Sharma	Principal Advisor, Food Policy	Resolve to Save Lives India
11.	Dr. Meenakshi Sharma	Ex Scientist G, NCD Division	Indian Council of Medical Research, Delhi
12.	Dr. N Gopalakrishnan	Member Secretary	Transplant Authority of Tamil Nadu
13.	Ms. Naina Gandhi	Consultant	The George Institute for Global Health, India
14.	Ms. Neha Upadhyay	Consultant	The George Institute for Global Health, India
15.	Dr. P. Raghavendra	Scientist C	NIN, ICMR, Hyderabad
16.	Dr. R Aishwariya	Project Officer	The George Institute for Global Health, India
17.	Dr. Ramakrishna Prasad	Chair	National Centre for Primary Care Research & Policy at Academy of Family Physicians of India (AFPI)
18.	Dr. Roopa Shivashankar	Scientist E	Indian Council of Medical Research Delhi
19.	Prof. Sailesh Mohan	Deputy Director	Centre for Chronic Disease Control, Delhi
20.	Prof. Sandeep Mahajan	Prof. Sandeep Mahajan	All India Institutes of Medical Sciences New Delhi
21.	Ms. Sandhya Pandey	GM and Chief Dietitian	Department of Clinical Nutrition and Dietetics Medanta Hospital Gurugram
22.	Dr. Satyavir Yadav	Associate Professor, Department of Cardiology Secretary	AIIMS, New Delhi Cardiological Society of India (Delhi branch)
23.	Dr. S B Bansal	Secretary	Indian Society of Nephrology
24.	Dr. Sirimavo Nair	Professor, Dept. of Food and Nutrition	The Maharaja Sayajirao University of Baroda, Gujarat
25.	Ms. Soli Padi	Project Assistant	The George Institute for Global Health, India
26.	Dr. Sourabh Sharma	Associate Professor Nephrology	Vardhman Mahavir Medical College and Safdarjung Hospital

S.No.	Name	Designation	Institution
27.	Dr. Suparna Ghosh-Jerath	Program Head, Nutrition, Food Policy	The George Institute for Global Health, India
28.	Ms. Swati C Nair	Research Officer	The George Institute for Global Health, India
29.	Dr. Syed Imran Farooq	Executive Director	Resolve to Save Lives India
30.	Dr. Thout Sudhir Raj	Research Fellow, Health Systems Science	The George Institute for Global Health, India
31.	AIIMS, Raipur	Consultant	The George Institute for Global Health, India
32.	Dr. Vinay Rathore	Nephrologist	All India Institutes of Medical Sciences Raipur
33.	Mr. Vivek Asreker	Technical Advisor - Sodium Reduction	IPE Global Limited
34.	Prof. Vivekanand Jha	Executive Director	The George Institute for Global Health, India

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7.	Dr. Pravat Bhandari	The George Institute India
8.	Ms. Rashmi Pant	The George Institute India
9.	Dr. Neha Gupta	The George Institute India
10.	Dr. Adhishree Verma	The George Institute India
11.	Ms. Garima Sharma	The George Institute India
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