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Progress on sodium reduction in South Korea

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ABSTRACT

Introduction High dietary sodium is a leading contributor to hypertension, and hypertension is the leading underlying cause of death globally. There is a robust body of evidence supporting the health benefits of sodium reduction. Sodium intake in South Korea is high, with about half the population consuming ≥4000 mg/day, twice the recommended upper limit.

Methods In 2012, South Korea implemented its National Plan to Reduce Sodium Intake, with a goal of reducing population sodium consumption by 20%, to 3900 mg/day, by 2020. The plan included five key components: (1) a consumer awareness campaign designed to change food consumption behaviours; (2) increased availability of low-sodium foods at schools and worksites; (3) increased availability of low-sodium meals in restaurants; (4) voluntary reformulation of processed foods to lower sodium content; and (5) development of low-sodium recipes for food prepared at home. Monitoring and evaluation included tracking sodium intake and sources of dietary sodium using the Korea National Health and Nutrition Examination Survey.

Results By 2014, South Korea had reduced dietary sodium consumption among adults by 23.7% compared to a survey conducted in 2010 prior to implementation of a nationwide salt reduction campaign that used this comprehensive, multipronged approach. The reductions in sodium intake were accompanied by reductions in population blood pressure and hypertension prevalence. Although causal associations between the sodium reduction programme and reduced sodium intake cannot be made, the declines occurred with the introduction of the programme.

Conclusion Multicomponent interventions have great potential to reduce population sodium intake. Lessons learnt from South Korea could be applied to other countries and are likely very relevant to other Asian countries with similar food sources and consumption profiles.

Key questions

What is already known?

- High dietary sodium is a leading contributor to hypertension, and hypertension is the leading underlying cause of death globally.
- There is a robust body of evidence supporting the health benefits of sodium reduction.
- However, most people worldwide, including in South Korea, consume far more than the recommended upper limit of sodium due to the increased risk of chronic disease above that level.

What are the new findings?

- The salt reduction programme in Korea is one of the only programmes that has been shown to reduce salt consumption in a population.
- By implementing a comprehensive, multipronged approach to dietary sodium reduction, South Korea reduced dietary sodium intake among adults by 23.7% between surveys conducted in 2010 and 2014.
- The reductions in sodium intake were accompanied by reductions in population blood pressure and hypertension prevalence. Although retrospective observational studies cannot establish causality, the reduction in sodium intake occurred with programme implementation and we were not able to identify other factors that could account for this decline.

What do the new findings imply?

- The results in South Korea confirm that multicomponent interventions have great potential to reduce intake of discretionary and other sources of sodium in a population.
- Lessons learnt from South Korea could be applied to other countries and are likely very relevant to other Asian countries with similar food sources and consumption profiles.

INTRODUCTION

High dietary sodium is a leading contributor to hypertension, and hypertension is the leading underlying cause of death globally.[1 2] High dietary sodium may also increase the risk of gastric cancer.[1] An estimated 3 million deaths and 70 million disability adjusted life years (DALYs) were attributed to excess dietary sodium in 2017.[1] Dietary recommendations from governmental and non-governmental public health organisations find a robust body of evidence supporting the health benefits of sodium reduction.[3] Most recently, the National Academy of Medicine (USA)

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developed dietary guidance for public policy in the USA and Canada that recommends sodium intakes below 2300 mg/day based on the increased risk of chronic disease above that level.[4]

The World Health Organization (WHO) has established a target for adult sodium consumption of less than 2000 mg/day (equivalent to less than 5 g a day of salt).[5] WHO has designated reducing sodium intake as a 'best buy' to avoid premature deaths and reduce the economic impact of non-communicable diseases (NCDs) in low-income and middle-income countries.[6] It is estimated that for every dollar invested to reduce dietary sodium, there is a return of $13-18.[7 8]

Although at least 75 countries have begun to work in this area,[9] there are few success stories other than the documented programmes in the United Kingdom[10] and Finland.[11] The greatest successes appear to be in those programmes that adopt multicomponent strategies and incorporate interventions that address the structural nature of the content of food, such as food product formulation and food procurement policies.[9 12] This manuscript presents a retrospective analysis of the impact of the successful implementation of South Korea's multicomponent national programme to reduce dietary salt in South Korea between 2011 and 2014 using representative national surveys of the South Korean population.

Because of the limitations of this type of retrospective population study, we cannot document direct causality of this programme to reductions in sodium intake. However, the causal association between the sodium reduction programme and reduced sodium intake is suggested by temporal factors, and the decline in sodium consumption occurred only after the described programme was implemented. There were no other factors we can identify that could account for this decline.

Dietary sodium intake and attributable diseases in South Korea prior to the sodium reduction intervention

Sodium intake in South Korea is high, with about half the population consuming ≥4000 mg/day, twice the recommended upper limit.[13] Between 2007 and 2010, there was a steady and continuous increase in population mean sodium intake, from 4464 to 4831 mg/day, with a concurrent increase in prevalence of hypertension among adults aged 30 years and older, from 24.5% to 26.9%.[14] In 2010, South Korea had among the world's highest rates of sodium intake, with an estimated 12% of deaths from cardiovascular disease—more than 10 000—attributed to excess sodium intake (>2000 mg/day).[15] The major sources of sodium intake in Korea were kimchi (27%), processed foods (20%) and condiments (38%; salt 16%, soy sauce 9% and soybean paste 8%).[13]

METHODS

Interventions to reduce dietary sodium in children

The first effort by South Korea to reduce dietary sodium consumption was initiated in 2007. A national taskforce formed by the government to improve the safety of children's diet recommended a set of integrated measures that included reducing sodium in food served to children. Based on the taskforce report, the Special Act on Safety Management of Children's Dietary Lifestyle[16] went into effect in 2009. The Act included restrictions on the sale and advertisement of energy-dense, nutrition-poor foods commonly consumed by children (categories include cookies/candies/popsicles, breads, chocolates, dairy products, sausage, some beverages, instant noodles and fast food). Further, the Act required that packaged food and chain restaurant (>100 outlets) foods carry nutrition labels, including sodium content. The Act also recommended that these foods carry a traffic light-style front-of-package label with a red–yellow–green colour scheme to indicate whether they contain excessive levels of sodium and other unhealthy nutrients.[17]

Expansion to adults

To address the increase in dietary sodium consumption among adults, the South Korea Ministry of Health and Welfare released the National Plan to Reduce Sodium Intake in 2012, with a goal of reducing population sodium consumption by 20%, to 3900 mg/day, by 2020.[18] The budget for the dietary sodium reduction programme was secured following cost–benefit analyses showing that for every $1 spent, there would be nearly $78 saved in averted medical costs and economic losses to society from reduced productivity and premature CVD-related mortality.[19] The interventions to reduce sodium intake in children formed the basis of sodium reduction strategies for the entire South Korean population.

The National Plan included five key components: (1) an awareness campaign among consumers designed to lead to changes in food consumption behaviours; (2) increases in availability of low-sodium foods at school and worksite meal services; (3) increases in availability of low-sodium meals in restaurants; (4) voluntary reformulation of processed foods to lower the sodium content; and (5) development of low-sodium recipes for food prepared at home. Monitoring and evaluation of the plan included using the Korea National Health and Nutrition Examination Survey (KNHANES) to track sodium intake and sources of dietary sodium (survey methods are described elsewhere).[20] The Korea Food and Drug Administration (KFDA) collected data on the level of sodium in foods to ensure that changes in sodium content of processed food were incorporated in KNHANES estimates of sodium intake.

Awareness

To create awareness, a national movement that included all key stakeholders (non-governmental organisations, academia, health professionals, food industry and media) was launched in conjunction with the KFDA. As part of this, the Diet and Health Subgroup of the WHO Nutrition Guidance Expert Advisory Group was invited to convene its third meeting on sodium and potassium

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guidelines in Seoul in December 2011. Attention to salt reduction in the media was increased by the timely publication of a paper outlining sodium sensitivity in the Korean population.[21]

The National Movement to Reduce Sodium Intake (NMRSI) was launched in March 2012, with cochairs from the Korean National Academy of Medicine and the Korea National Council of Consumer Organizations, in conjunction with the KFDA. A popular comedian, Soo Hong Park, was appointed as an ambassador to provide additional visibility and public support for the programme. To enhance food industry awareness regarding excess dietary salt, NMRSI, with the support of the KFDA, developed an autonomous and voluntary Action Hub that included consumer, academic and food industry organisational representatives. The Action Hub established subcommittees on (1) meal service (food provided at worksites and schools), (2) restaurants, (3) the processed food industry, (4) consumers and (5) academia and media relations. The Action Hub worked to reduce the sodium content of food across sectors to the greatest extent feasible. Changes in the sodium content of the food supply, made gradually over time, were advocated as a critical mechanism to put choice back into consumers' hands.[22] Specific examples from each sector are noted below.

Schools

The sodium reduction programme in schools was voluntary, but was facilitated through the Korean Dietetic Association and the Korean Ministry of Education. As part of the Special Act, the government funded a 4-year research and development effort to reduce sodium in meals. Because schools have dietitians on staff, the Korean Dietetic Association was able to use its networks to share the recipes widely. With government support and dietitians as the nutrition teachers responsible for the school lunch programme at each school, reducing sodium content in school lunches was implemented smoothly through introduction of new lower salt recipes. A mothers' group that oversees the school lunch programme also added its support. Additionally, the Korean Ministry of Education facilitated the provision of educational materials developed by the KFDA to schools.

Worksites

Worksites proceeded with sodium reduction in a similar manner. Although the worksite programme was also voluntary, worksites that feed more than 100 people are required to have a dietitian on staff, so it was possible for the Korean Dietetic Association to share lower salt recipes and more broadly influence meals prepared in other venues, including in the home. For both schools and worksites, a 'healthier meal service' programme promoted interventions such as 'Wednesdays without soups' (soup is one of the main sources of sodium intake in Korea),[20] smaller soup bowls to reduce portion size and sodium consumption, and lower sodium menu options generally.

Restaurants

Restaurants were encouraged to join a voluntary 'healthier restaurants' programme, which helped recognise and publicise food service establishments that provided at least some lower sodium food options. Consumers could track sodium consumption from food eaten at restaurants through a mobile app. Some local governments developed customised programmes and provided participating restaurants with plaques to recognise their involvement in the programme. There was also significant education about lower salt recipes and contests for recipe development of lower sodium food among culinary students, which could influence the sodium content of restaurant food in the future.

Food industry

The NMRSI processed food subcommittee, with support from the KFDA, convened meetings with the food industry. Food manufacturers, especially those making packaged foods and condiments, were encouraged to voluntarily reformulate products to contain less sodium. The KFDA suggested that industry reduce the sodium content of key food categories (based on an analysis of the major sources of sodium in the South Korean diet)[20] by 10%, with the ultimate goal of achieving reductions significant enough to decrease sodium intake by 20% by 2020. Processed food producers committed to reduce sodium by between 1% and 50% in a variety of food categories.[23 24] To help industry successfully reduce sodium, the KFDA funded the Korea Food Industry Association (KFIA) to develop a guideline for sodium reduction in processed foods.

The most important category of food addressed was kimchi (a staple side dish made from fermented pickled cabbages, radishes and other vegetables that is preserved with salt), the single biggest contributor to salt intake in South Korea.[13 20] A special refrigerator dedicated to kimchi, a so called 'kimchi refrigerator', first introduced in 1995, had gained public interest by 2003 and spread to more than 92% of South Korean households by 2015. This coincidental change allowed for a reduced sodium content of packaged kimchi because of the lower storage temperature. Industry concerns over the taste, shelf life and food safety of kimchi when lowering the sodium content were also addressed through government sponsored research and the ability to maintain the kimchi refrigerator temperature at –2 to 2°C. Other key food dishes contributing to sodium intake were noodles, soups, stews and rice dishes (figure 1).[20]

Consumers

Consumers were a major target of the awareness efforts. Home preparation of kimchi was also targeted, as a considerable proportion of kimchi is still prepared and preserved at home. Consumers were encouraged to

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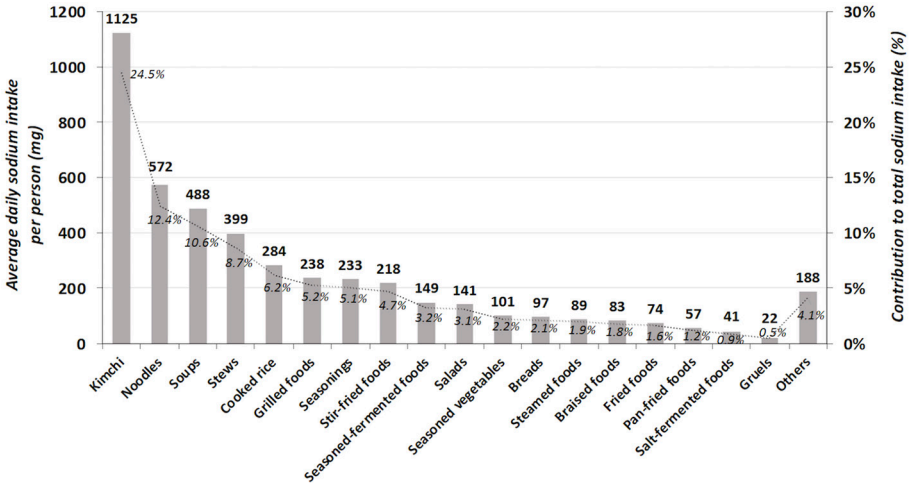

Figure 1 Mean sodium intake and contribution to total sodium intake by individual food type, 2008–2009. Adapted from: Yon *et al.*[20]

use kimchi refrigerators to preserve the lower sodium kimchi. They were also provided with reduced-sodium recipes for kimchi and other popular dishes. The recipes were developed as part of the research and development effort funded under the Special Act discussed above. There were also educational efforts through classes given by the National Council of Homemakers.

Monitoring and evaluation

South Korea has an extensive, high-quality surveillance and monitoring system for population blood pressure measurement and dietary salt consumption, with data on blood pressure and dietary intake collected routinely as part of KNHANES.[25] Implemented in 1998, KNHANES was expanded in 2007 from a triennial survey to ongoing year-round data collection from a representative population sample of 10 000 Koreans annually.[25]

Dietary sodium intake and sources of sodium intake are assessed by 24 hours dietary recall using a food composition table. The food composition database is updated every 5 years, which limits analysis of the sodium content of foods to that interval. However, during the sodium reduction initiative, the KFDA tracked sodium levels in packaged foods and provided this information to the Korea Centers for Disease Control and Prevention (KCDC) annually to include in the food database for KNHANES. The KCDC issues annual health statistics compiled from KNHANES surveys, including population food and nutrient intake.[25] In 2015, the Ministry of Food and Drug Safety (formerly KFDA) supported a study to analyse the sources of sodium in the South Korean diet using the detailed sodium level data collected by KFDA, and looked at changes between 2010 and 2013 based on the corresponding KNHANES data.[26]

With the raw data from KNHANES (https://knhanes.cdc.go.kr/knhanes/eng/index.do) released annually by KCDC, we analysed changes in population sodium intake, systolic blood pressure, diastolic blood pressure and hypertension prevalence by sex and age group between 2010 and 2014. Because the KNHANES data were collected using a complex sampling design involving cluster and stratified samplings, data were analysed by applying integrated weights reflecting primary sampling units, strata (Kstrata) and response rate. Continuous variables are presented as a mean value ± standard error (SE). Categorical variables are presented as a percentage and verified for significance through complex sample general linear model t-tests and complex sample χ^2 tests using the SURVEYREG procedure of SAS (release V.9.2). Hypertension was defined as systolic blood pressure over 140 mm Hg, diastolic blood pressure over 90 mm Hg, or taking medication to treat hypertension.

Patient and public involvement

Patients and the public were involved with the data collection process for this study through participation in the KNHANES, for which they provided informed consent. KNHANES reports only aggregate population-level data on health status and does not use personally identifiable patient information. Because KNHANES is conducted by the government for the public welfare, beginning in 2015, it is exempt from ethics approval by the Institutional Review Board (IRB); this study is a secondary analysis of population-level data from the IRB exempted study. Before 2015, KNHANES had been conducted under IRB approval in the KCDC (IRB 2012-01EXP-01–2C, 2013-07CON-03–4C and 2013-12EXP-03–5C).

RESULTS

The changes in sodium intake in the South Korean population 1 year of age and older are shown in figure 2A. There was a 19.5% reduction in average sodium intake, from 4831 mg/day to 3890 mg/day, between 2010 and 2014 ($p<0.0001$). Both males and females (1 year and older) reduced their daily sodium intake by about 20%, from 5666 mg/day to 4557 mg/day for males and from 3991 mg/day to 3223 mg/day for females (figure 2A,

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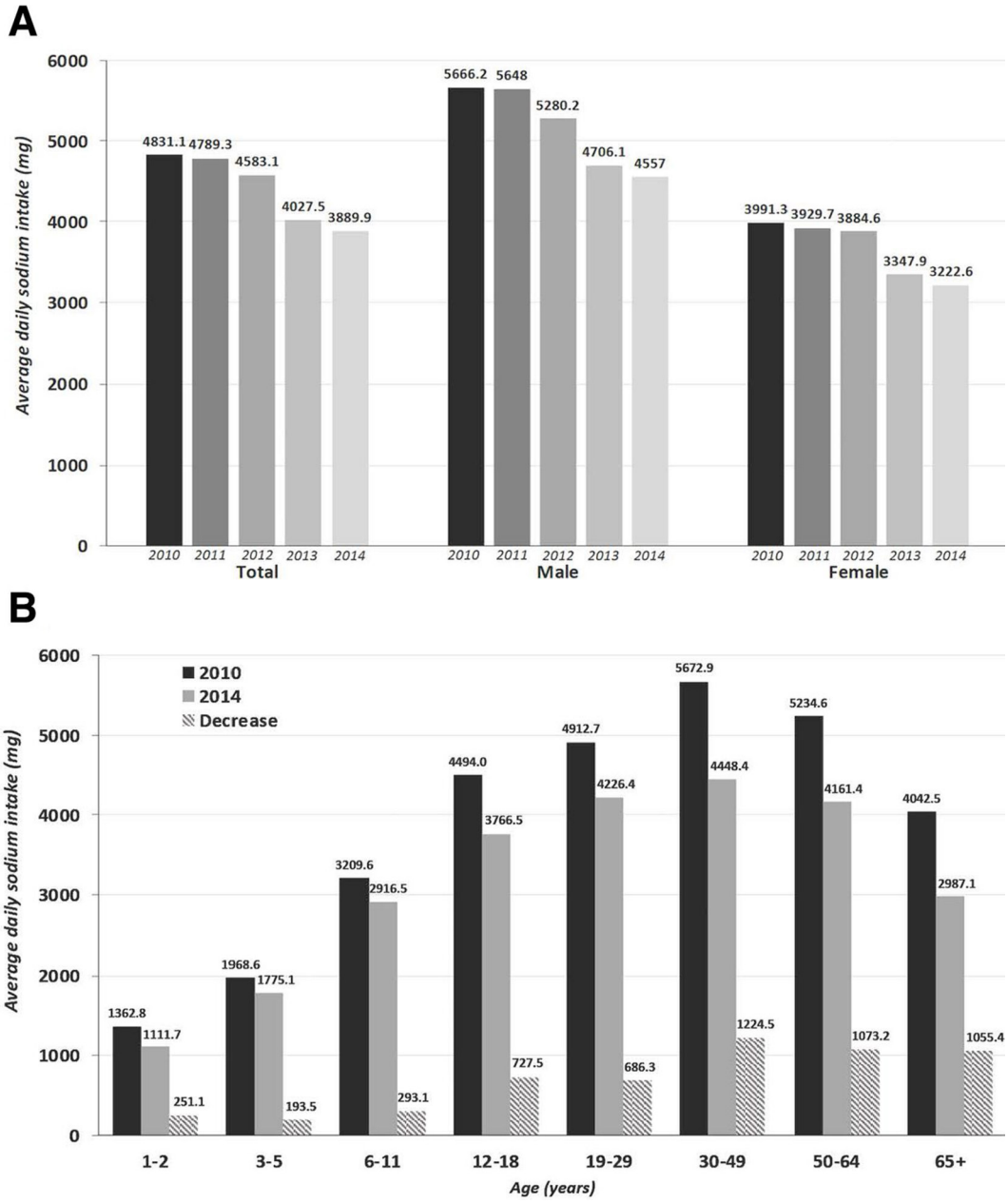

Figure 2 (A) Average daily sodium intake per person, 2010–2014. (B) Average change in daily sodium intake per person, by age group, 2010–2014.

p<0.0001 for all comparisons). Declines in sodium intake were 23.7% in adults overall and greatest (1346 mg/day) among people aged 30–49 years (table 1, p<0.0001).

More than 80% of the reduction in dietary sodium intake between 2010 and 2013 (665 mg/day of the 800 mg/day average reduction) was due to the change in sodium content of foods.[26] There was also a reduction in consumption of foods high in sodium (figure 3A). Food manufacturers successfully reformulated many processed foods, particularly instant noodles, soy sauce, dressings and kimchi, to contain less sodium (table 2). For example, the sodium content of the top-selling brands of instant noodles, which are typically high in sodium, was reduced by between 13% and 33%. There was a 30%–40% reduction in the sodium content of kimchi over 5 years. Sales of low-sodium soy sauce increased by 257% between 2012 and 2014, and sales of regular soy sauce decreased more than 12% over that period.[26]

The contribution of restaurant foods to sodium intake increased from 27.0% in 2010 to 32.6% in 2013, with a decline in the proportion of sodium intake from food prepared at home from 53.7% to 43.0% (figure 3B).[26] In the 3 years prior to 2010, there was little change in the contribution from worksite meal service foods, restaurant foods and home foods. Sodium density (per 1000 kcal) decreased in food consumed at worksite meal services, restaurants and home, but increased in convenience store foods and other snack foods.[26]

Along with the 23.7% reduction in sodium consumption by adults between 2010 and 2014, there were also

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Table 1 Changes in hypertension and dietary sodium intake in Korean adults between 2010 and 2014

	Hypertension prevalence (%)			SBP (mm Hg)			DBP (mm Hg)			Sodium intake (mg/day)		
	2010	2014	P value	2010	2014	P value	2010	2014	P value	2010	2014	P value
All adults	29.3±0.9	23.8±0.8	<0.0001	119.6±0.4	116.3±0.3	<0.0001	77.2±0.3	74.8±0.3	<0.0001	5194±62	3961±50	<0.0001
Men	33.5±1.3	26.0±1.2	<0.0001	122.2±0.4	119.1±0.4	<0.0001	80.3±0.4	77.5±0.3	<0.0001	6185±85	4657±75	<0.0001
Women	25.2±1.1	21.7±1.1	0.0286	117.1±0.5	113.6±0.4	<0.0001	74.2±0.3	72.1±0.3	<0.0001	4230±68	3278±50	<0.0001
19–29 years	6.6±1.1	2.2±0.7	0.008	110.3±0.6	110.2±0.6	0.9341	72.9±0.5	71.5±0.4	0.0446	4913±140	4035±133	<0.0001
30–49 years	18.6±1.0	12.7±0.9	<0.0001	115.5±0.4	112.3±0.4	<0.0001	77.4±0.3	75.6±0.3	<0.0001	5673±89	4327±65	<0.0001
50–64 years	47.7±1.3	34.9±1.6	<0.0001	126.6±0.6	120.7±0.5	<0.0001	81.1±0.4	78.0±0.3	<0.0001	5235±114	3960±89	<0.0001
65 years+	63.9±1.6	60.5±1.7	0.0009	133.8±0.7	126.5±0.5	<0.0001	76.4±0.4	71.3±0.4	<0.0001	4043±100	2946±70	<0.0001

Data reported as mean value±SE.
DBP, diastolic blood pressure; SBP, systolic blood pressure; SE, Standard error.

decreases in population blood pressure and in hypertension prevalence between 2010 and 2014 in both men (from 33.5% to 26.0%, p<0.0001) and women (from 25.2% to 21.7%, p<0.0286) aged 30 years and older (table 1). From 2010 to 2014, the rate of death from cerebrovascular diseases (ICD-10 I60-I69) decreased from 53.2 to 48.2 per 100 000 population (changes are not statistically significant).[27] There was a statistically insignificant change in the overall rate of mortality from circulatory system diseases (ICD-10 I00-I99), from 112.5 to 113.9 per 100 000 population during the same period.[27]

DISCUSSION

In 2007, South Korea launched a programme to reduce dietary salt consumption by children. By 2009, the KFDA had begun to work on reducing dietary salt in the full population. Between 2010 and 2014, there was a reduction in dietary sodium consumption by adults of 23.7% with a corresponding 19% reduction in hypertension prevalence. Sodium intake was also reduced in children. The reductions in sodium intake over 4 years are impressive when compared with other successful national programmes such as in Finland, which over 30 years reduced sodium intake 36% with approximately a 10 mm Hg reduction in diastolic blood pressure,[28] and in England, which reduced dietary sodium by 15% over 9 years with a decline in systolic blood pressure of 2.7 mm Hg and a decline in diastolic blood pressure of 1.1 mm Hg.[10] Other less well-described national population sodium reduction programmes have also reduced dietary sodium consumption, but at a slower rate.[9]

In South Korea, there was opposition and resistance from the food industry, as was anticipated based on the experiences of other countries and jurisdictions attempting to reduce the sodium content of food. Engaging in dialogue with the food industry and having its representatives participate in educational forums sponsored by non-governmental organisations, providing research and development support for product reformulation efforts, and allowing the KFIA to develop and disseminate guidelines for sodium reduction of processed foods facilitated industry engagement and ownership of the issue. Questions on the feasibility of sodium reduction in kimchi were successfully addressed through government-funded research and the increased popularity of kimchi refrigerators. Vociferous support for this initiative from consumer groups, and in particular from mothers' groups, was likely essential to its success.

Budgetary concerns about the programme's cost were allayed by economic analyses showing a large net fiscal benefit from reductions in healthcare and other costs,[19] and the implementation of a stepwise approach eased worries that the programme was going too far, too fast. Initial public indifference towards the programme and its goals was countered with a continuous process of awareness-raising and publicity.

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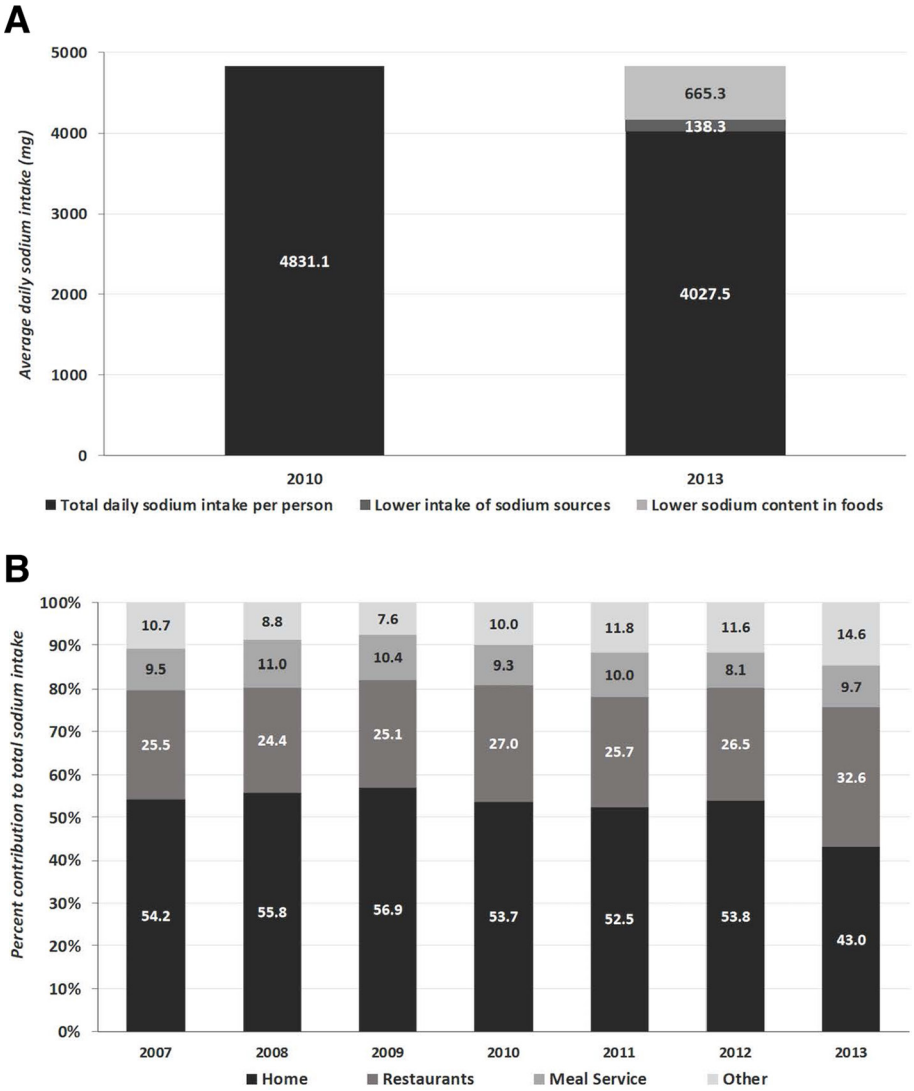

Figure 3 (A) Causes of reduction in sodium intake, 2010 and 2013. (B) Change in proportion of sodium intake by meal source, 2007–2013. Adapted from: Kim *et al*.[26]

Interventions to substitute potassium chloride salt for standard sodium chloride table salt did not gain much traction in South Korea. Potassium chloride is more expensive and can be bitter tasting in high concentrations. This effect is amplified when potassium chloride is suspended in liquids such as sauces and soups. There were also fears that increased potassium would lead to increased complications among people with kidney disease, which reduced support for low-sodium salt substitutes.

Limitations

This study of the South Korean population is based on statistical analysis of population health data. Because this was a retrospective population study, there was no control population. Surveys were cross-sectional, limiting our ability to conduct longitudinal analyses, thus, direct causality cannot be inferred between the specified interventions and changes in population dietary sodium intake. However, the surveys were large and were representative of the South Korean population.

A limitation of the South Korean salt reduction programme is that sodium intake was measured by dietary recall, which may not be a reliable standard measure of sodium intake.[29] Dietary recall data on sodium consumption were self-reported, introducing the danger of a social response bias, but because surveys were anonymous, we have no reason to expect a large effect from such a bias. While spot urine samples were collected once by KNHANES before the initiative took place, this method is also not very reliable,[30] and 24 hours urine samples (the gold standard measure) have not been collected by KNHANES. In a meta-analysis by McLean *et al*, dietary recall underestimated dietary sodium intake compared with sodium excreted in 24 hours urinary collections by 466 mg/day in high-income countries (with higher underestimates in middle-income countries).[31] It is also notable that 24 hours urine sodium excretion is lower by 7% than the amount of sodium ingested in carefully conducted metabolic studies.[32] However, validation studies of 24 hours dietary recall versus 24 hours urine

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Table 2 Top five food sources of sodium intake in 2010 and 2013

2010						2013					
		Sodium intake (mg/day)		Sodium in food (mg/100 g)	Food intake (g)			Sodium intake (mg/day)		Sodium in food (mg/100 g)	Food intake (g)
Rank	Type of food/ ingredient	Mean	Proportion (%)	Mean	Mean	Rank	Type of food/ ingredient	Mean	Proportion (%)	Mean	Mean
1	Salt	904.4	18.7	NA	2.7	1	Salt	957.2	25.0	NA	2.9
2	Kimchi, Nappa cabbage	817.5	16.9	1151	71.3	2	Kimchi, Nappa cabbage	406.5	10.6	600	65.1
3	Soy sauce	410.1	8.5	6121	6.7	3	Soy sauce	392.8	10.3	6043	6.5
4	Soybean paste	285.8	5.9	4610	6.2	4	Soybean paste	285.7	7.5	4926	5.8
5	Red pepper paste	203.6	4.2	3232	6.3	5	Red pepper paste	157.9	4.1	2547	6.2

Adapted from: Kim *et al*.[26]

collection performed in South Korea found no substantive difference in sodium intake between the recall and urine studies.[33 34] This may reflect better food composition databases and methodology of 24 hours dietary recall studies in South Korea; hence, dietary sodium intake may be more accurate in this report than the average error reported by McLean *et al*. KNHANES also used the same methodology and trained interviewers (licensed dietitians) for 24 hours dietary recalls in each survey period, so that the decrease in sodium intake over the 4-year study period is likely valid regardless of the potential for a small underestimation in the 24 hours recall methodology.

Other limitations include the generalisability of the South Korean experience to other countries. The Korean food environment based on soy sauce and salty pastes is similar to several other Asian countries, and several of the interventions such as education and working with a reluctant food service industry are likely to be similar in other countries. We do not have comparable data for sodium consumption in countries with similar dietary profiles, which prevents any direct geographic comparison. Kimchi is relatively unique to Korea, and a unique, previously introduced kimchi refrigerator was heavily promoted to increase its use for storing kimchi at lower temperatures without the need for high salt content for preservation. Thus, it may be difficult to generalise this intervention to other countries. However, colder refrigerator temperatures as used in the kimchi refrigerator may also be generalisable to maintain shelf-life for other foods that currently rely in part on high sodium concentrations for preservation.

The causal association between the sodium reduction programme and reduced sodium intake is suggested by temporal factors, as sodium intake increased during the years preceding implementation of the programme, while after implementation a large, statistically significant decrease occurred. There were no other factors we can identify that could account for this decline. It is theoretically possible that other factors contributed to reductions in sodium intake, however, the decline in sodium consumption occurred only after the described programme was implemented.

CONCLUSION

Because South Korea's initial National Plan to Reduce Sodium Intake reached its target 6 years ahead of the original schedule, a second plan was prepared, with a goal of reducing sodium intake even further, to 3500 mg/day per capita by 2020. The second plan incorporates continued change to individual dietary habits, expanded production of low-sodium foods, maintaining technical support to the food industry, enhanced data collection and dissemination and reinforcement of the national policy towards dietary sodium reduction.

South Korea's programme achieved success because it took a comprehensive, multisectoral approach to reducing the sodium content in the food supply by

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attacking the problem on many fronts. This included addressing the sodium content in packaged, processed and manufactured foods; meals prepared by commercial establishments including restaurants, school and workplace cafeterias; and food prepared by consumers at home. Further, the sources of sodium in South Korea were well understood and key sources were targeted, particularly kimchi.

The progress made by South Korea can be translated to other countries, and in particular Asian countries with similar food sources and consumption profiles. Although kimchi is not common outside Korea, instant noodles and soy sauce are eaten widely across the Asia-Pacific region; reducing the sodium content of these items can contribute to substantial reductions in sodium intake. These successes have already reduced sodium consumption, hypertension and CVD, and continued strengthening of sodium reduction programmes should be expected to produce even better results and larger improvements in health.

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