

Original Research



Sodium content changes between 2015 and 2019 in restaurant menu items selected for sodium reduction in Daegu

Jian Ma  and Yeon-Kyung Lee  ^S

Department of Food Science & Nutrition, Kyungpook National University, Daegu 41566, Korea

OPEN ACCESS

Received: Jun 15, 2021

Revised: Sep 17, 2021

Accepted: Nov 23, 2021

Published online: Jan 28, 2022

^SCorresponding Author:

Yeon-Kyung Lee

Department of Food Science & Nutrition,
Kyungpook National University, 80 Daehak-ro,
Buk-gu, Daegu 41566, Korea.

Tel. +82-53-950-6234

Fax. +82-53-950-6229


Email. yklee@knu.ac.kr

©2022 The Korean Nutrition Society and the Korean Society of Community Nutrition
This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ORCID iDs

Jian Ma 

<https://orcid.org/0000-0001-9201-0166>

Yeon-Kyung Lee 

<https://orcid.org/0000-0002-5975-3969>

Funding

This study was supported by grants from Daegu Metropolitan City in 2015–2019.

Conflict of Interest

The authors declare no potential conflicts of interests.

Author Contributions

Conceptualization: Lee YK; Formal analysis: Ma J; Funding acquisition: Ma J, Lee YK;

ABSTRACT

BACKGROUND/OBJECTIVES: South Korea has been conducting the Sodium Reduction Restaurant Project since 2015 to reduce sodium contents in restaurant menus. The purpose of this study was to analyze changes in the sodium content of menus as determined by the Daegu Sodium Reduction Restaurant Project between 2015 and 2019.

MATERIALS/METHODS: Intervention was aimed at reducing the sodium contents of over 10% of menu items in participating restaurants. On-site inspections and evaluations were conducted using a checklist, and reductions in sodium contents were determined by analyzing the salinities and sodium contents of menus after intervention.

RESULTS: Post-intervention salinities and sodium contents were significantly lower than baseline values in 2016 ($P < 0.001$), 2017 ($P < 0.001$), 2018 ($P < 0.001$), and 2019 ($P < 0.001$). However, sodium contents and salinities differences before and after intervention were not significant in 2015. Sodium contents of more than 20% of menu items offered by restaurants that participated in the Sodium Reduction Restaurant Project for 2 yrs starting in 2016 declined by 28.9%. On the other hand, the sodium reduction rate achieved by restaurants that participated for 4 yrs from 2015 reached 55.4%. The percentage of restaurants that participated in the project increased annually, though some failed to be designated as Sodium Reduction Restaurants because they did not meet sodium reduction rate requirements.

CONCLUSIONS: Positive correlations were found between duration of participation in the project and sodium reduction and designation rates. Sustainable long-term support at the national level is required to expand the project to other regions.

Keywords: Sodium; salinity; restaurants

INTRODUCTION

Excessive sodium intake has become the number one dietary cause of death worldwide [1]. It increases the risk of hypertension, stroke, cardiovascular diseases, gastric cancer, kidney diseases, and Alzheimer's diseases, and causes complications in patients with type 2 diabetes [2-8]. According to some Japanese studies, the incidence of gastric cancer is particularly high among East Asians [9]. Sodium intake affects blood pressure in different ways. In some individuals, high sodium content diets increase blood pressure, and low sodium content

Investigation: Lee YK, Ma J; Methodology:
Lee YK; Project administration: Lee YK;
Supervision: Lee YK; Writing - original draft:
Ma J; Writing - review & editing: Lee YK.

diets reduce blood pressure, but in other individuals, high- or low-sodium diets have no or the opposite effect [10]. Previous studies have shown that cardiovascular disease risk and mortality rates are lower when sodium intake is below 2,300 mg per day [11]. The World Health Organization recommends a daily sodium intake of 2,000 mg or less [12], while the Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013–2020 recommends reducing sodium intake by 30% [13]. However, reducing sodium intake is not an easy task because taste is a key component of dietary choice [14].

Numerous sodium reduction programs have also been reported in many countries. In 1972, Finland launched a sodium reduction program in North Karelia [15]. The program was highly successful and continues to be implemented. In 1990, the United Kingdom launched the heartbeat award (HBA) scheme to reduce sodium, fat, and sugar additives in restaurant menus and to encourage the consumption of foods rich in dietary fiber [16]. Through extensive efforts, including the HBA scheme, the United Kingdom reported a decline in adult sodium intake from 9.5 g per day in 2003 to 8.1 g in 2011 [17]. In September 2015, New York the metropolitan government stipulated restaurants attach warning labels to menu items containing sodium at levels exceeding recommended daily consumption and launched a sodium reduction project targeting processed foods [18].

In 2012, the Ministry of Food and Drug Safety (MFDS) established the Korea Center for Sodium Reduction after the Korean Ministry of Health and Welfare (MOHW) found that average sodium intake was 4,878 mg/day [19]. In Korea, the primary sources of dietary sodium were salt (16.7%) and kimchi (11.3%), followed by soy sauce (10.0%), soybean paste (5.4%), ramen (4.5%) and red pepper paste (4.2%) [20]. Under the National Nutrition Management Act proposed by the MOHW, local governments have been establishing and implementing sodium reduction programs in restaurants and schools since 2012 [21]. In addition, MFDS launched the Sodium Reduction Restaurant Project at the local government level in 2015 to achieve a sodium intake target of 3,500 mg per day by 2020 [22]. According to the National Health and Nutrition Examination Survey [23], daily sodium intake in Korea gradually declined from 4,789.2 mg in 2010 to 3,874.2 mg in 2015, and 3,189.3 mg in 2020. However, the average sodium intake of Koreans is still twice the adequate intake (1,500 mg) of Dietary Reference Intakes for Koreans.

In 2015, the Daegu Metropolitan Government launched its Sodium Reduction Restaurant Project, and in 2018, the survey reported a sodium reduction in restaurant menus, a high level of satisfaction with the project among restaurant personnel, and a higher level of customer satisfaction with food taste among customers, which demonstrated the effectiveness and sustainability of the project [24]. In this study, we examined Sodium Reduction Restaurant Project results in Daegu for the 5-yr period 2015 to 2019, and changes in the salinities and sodium contents of certain menu items.

MATERIALS AND METHODS

Study design

Fig. 1 provides an overview of the study design of the Daegu Sodium Reduction Restaurant Project. Participating restaurants were categorized into new restaurants and follow restaurants. New restaurants were those that applied to join the project for the first time or reapplied because they had previously failed to be designated as sodium reduction restaurants.

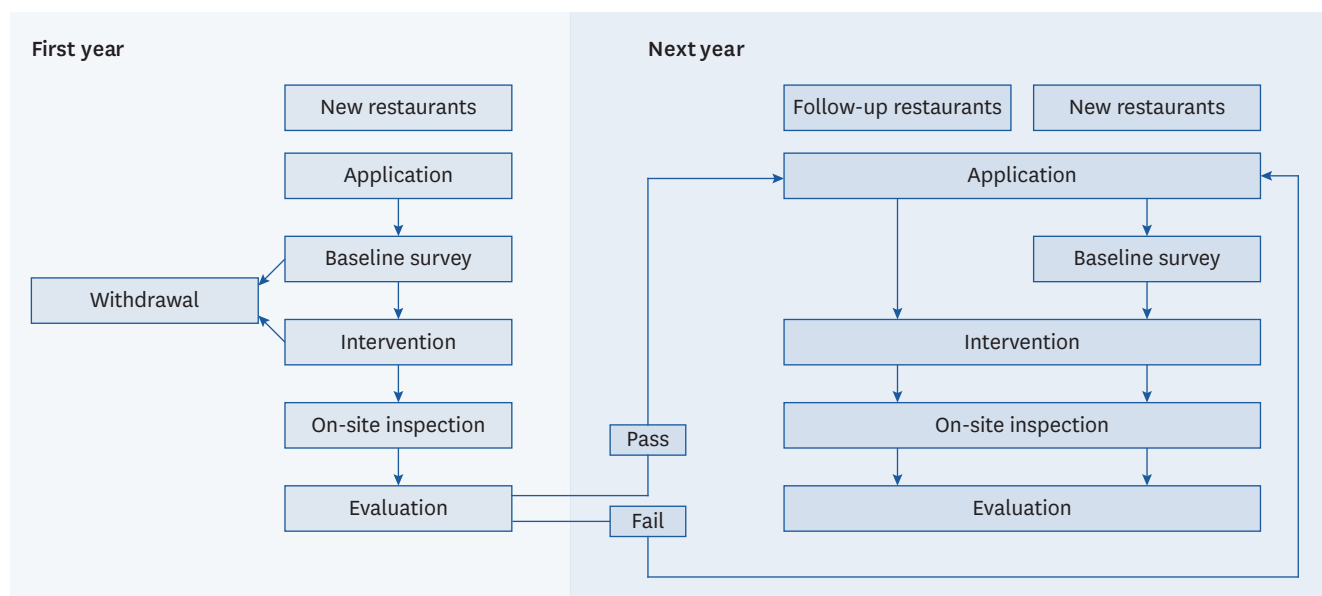


Fig. 1. Study design of Sodium Reduction Restaurant Project.

Follow-up restaurants were those that were designated as sodium reduction restaurants in the previous year and were reapplying to retain their designations. Baseline surveys were conducted to determine the salinities and sodium contents of menu items 1 month after receipt of intervention, which included sodium reduction education and consultation on food preparation and cooking. On-site inspections were conducted in new and follow-up restaurants to determine whether they should be designated Sodium Reduction Restaurants.

Selection of sodium reduction menus

The project required restaurants to select at least 20% of their menu items, excluding non-cooked menu items (e.g., sashimi), seasonal menus, and course menus, as sodium reduction menu items. The cumulative number of menu items selected for sodium reduction by participating restaurants over 5 yrs was 163, that is, 17 cooked rice, 28 noodles, 4 porridges, 2 *jeons*, 9 soups, 43 broths, 26 stews, 7 grilled dishes, 3 salads, 8 stir-fried dishes, 5 steamed dishes, 2 fried dishes, and 9 other dishes.

Baseline survey

Data on single serving amounts of sodium reduction menu items were obtained from participating restaurants to measure baseline salinities and sodium contents before implementing the intervention. Baseline survey findings were used to determine appropriate interventions.

Salinity and sodium content measurements

To measure menu item salinity, a single-serving was cooled to room temperature and homogenized with a hand blender (Philips HR-1672, Hungary). Then, 20 to 50 g of the homogenate was diluted in 3- to 4-fold with distilled water. Salinity meter (ATAGO ES-421; ATAGO Co., Ltd., Tokyo, Japan) readings were recorded, and average salinity was calculated. Sodium contents per serving were calculated using the single serving amount proposed in the Restaurant Menu Nutrient Book [25]. Sodium contents were calculated as follows: salinity (%) / 100 (conversion to %) × single serving amount (g) × 1,000 (conversion to mg) × 0.4 (sodium content in salt).

Intervention

Intervention included education on the importance of sodium reduction, on the relationship between sodium and health, instructions on low-sodium cooking methods, salinity measurement and management methods, and the use of a salinity management app (NaCodi). All personnel in each restaurant underwent 2 tailored consulting sessions on low-sodium cooking and instructed to measure the salinities of sodium reduction menu items more than once per month and input the results in the NaCodi app.

On-site inspection

On-site inspections of restaurants participating in the Sodium Reduction Restaurant Project were conducted according to the Sodium Reduction Restaurant Operation and Management Guidelines [22]. On-site inspections included checklist-based assessments and salinity and sodium analyses of single-serving sodium reduction menu items collected from restaurants by mystery shoppers.

Evaluation

Evaluation items were categorized into mandatory items and optional items. Mandatory items included “sodium reduction menu ratio” (20 points), “sodium reduction rate” (20 points), and “salinity meter placement” (10 points), and optional items included “sodium management for a month” (10 points), “sodium content management” (10 points), “use of measuring tools” (10 points), “no seasoning containers on tables” (10 points), and “sodium management in kimchi” (10 points). Thus, the maximum possible score was 100 points. For follow-up restaurants, 2 additional items were added: “signboard attachment” (10 points) and “menu board attachment” (10 points). Points assigned to “sodium reduction menu ratio” and “sodium reduction rate” were adjusted to 10, respectively, to maintain a total possible score of 100 points.

Sodium reduction menu ratio evaluates whether a restaurant selected at least 20% of its menu items for the project. In contrast, the sodium reduction rate determines whether a restaurant reduced sodium by content by at least 10 to 30% of the reference sodium content for the same items listed in the Restaurant Menu Nutrient Book [25]. For example, if the sodium content of a menu item was below 2,000 mg in the Nutrient Book, the restaurant concerned was required to reduce sodium in the menu item by at least 10% of the reference sodium content, making the sodium content below 1,300 mg. For menu items with sodium contents of $\geq 2,000$ mg per serving, restaurants were required to reduce the sodium content by 30% of the reference. For menu items not listed in the Restaurant Menu Nutrient Book [25], the upper limit was defined based on the sodium contents of other foods with similar main ingredients and prepared using similar cooking methods.

Designation of sodium reduction restaurants

To be designated as a sodium reduction restaurant, a restaurant must have satisfied all mandatory items, acquired a score of at least 70 points, and not have any previous records of administrative disposition. Designated Sodium Reduction Restaurant received appropriate sodium reduction certificate from the MFDS and local government.

Statistical analysis

The statistical analysis of survey data was conducted using SPSS Statistics 26 (IBM, Chicago, IL, USA). The significances of differences between baseline and post-intervention measurements of salinity and sodium contents at participating restaurants between 2015 and 2019 were

determined using the paired *t*-test. Longitudinal trends of sodium contents at restaurants that participated in the project for 2 to 5 yrs were analyzed by 1-way analysis of variance, Duncan's multiple comparison test, and *P*-values for the trend test. Sodium reduction rate variations for restaurants that participated for different durations were analyzed using 1-way analysis of variance and Duncan's multiple comparison test. The longitudinal trends of sodium contents by menu item type were analyzed using the same tests.

RESULTS

Number of participating restaurants

Table 1 lists the number of restaurants that applied, withdrew, or participated in Daegu's Sodium Reduction Restaurant Project on an annual basis. Every year for 5 yrs, 37 to 70 new restaurants applied for their first designation. However, up to 12 new applicants withdrew before on-site inspection, which resulted in only 37 to 58 restaurants participating in the project. In 2016, 13 restaurants applied for follow-up designation, and numbers of sodium reduction restaurants continued to accumulate in subsequent years, and in 2019, 85 follow-up restaurants applied for the designation. However, only 72 restaurants participated, and 13 withdrew before on-site inspections.

Comparison of the salinities and sodium contents of sodium reduction menus after intervention

Table 2 shows the salinities and sodium contents of sodium reduction menus at follow-up restaurants between 2015 and 2019. The cumulative number of participants between 2015 and 2019 was 102, while the cumulative number of menu items for the same period was 163. Post-intervention salinities and sodium contents significantly reduced below baseline values reported in 2016 ($P < 0.001$), 2017 ($P < 0.001$), 2018 ($P < 0.001$), and 2019 ($P < 0.001$). However, sodium content and salinity differences before and after intervention were not significant in 2015.

Table 1. Number of restaurants participating in the Sodium Reduction Restaurant Project

Year of participation	New restaurants			Follow-up restaurants		
	Application	Withdrawal	Participation	Application	Withdrawal	Participation
2015	37	0	37			
2016	55	8	47	13	1	12
2017	70	12	58	25	0	25
2018	44	5	39	60	9	51
2019	47	9	38	85	13	72

Table 2. Comparison of the salinities and sodium contents of all sodium reduction menu items between baseline and on-site inspection after intervention

Year of on-site inspection ¹⁾	Cumulative restaurants	Cumulative menus	Salinity (%)		<i>P</i> -value	Sodium content (mg/portion size)		<i>P</i> -value
			Baseline	After intervention		Baseline	After intervention	
2015	12	15	0.63 ± 0.31	0.51 ± 0.27	0.24	938 ± 308	769 ± 254	0.26
2016	26	38	0.65 ± 0.32	0.48 ± 0.28	< 0.001	1,322 ± 711	927 ± 513	< 0.001
2017	48	71	0.71 ± 0.33	0.48 ± 0.27	< 0.001	1,474 ± 749	965 ± 554	< 0.001
2018	70	110	0.68 ± 0.32	0.45 ± 0.22	< 0.001	1,452 ± 733	972 ± 462	< 0.001
2019	102	163	0.64 ± 0.32	0.41 ± 0.22	< 0.001	1,435 ± 738	911 ± 525	< 0.001

The values are reported as the mean ± SD.

¹⁾Only the start year is displayed. The project is expected to be completed in 2019.

Trends in sodium reduction menus at 5-yr follow-up restaurants

Table 3 shows the sodium contents and reduction rates of sodium reduction menu items offered by 2- to 5-yr follow-up restaurants. Sodium contents fell across all follow-up restaurants regardless of the duration of participation. Restaurants that joined the project in 2015 (P for trend < 0.001), 2016 (P for trend < 0.001), 2017 (P for trend < 0.001), or 2018 (P for trend = 0.003) showed significant declines in post-intervention sodium contents until 2019.

Sodium reduction rates in 2019, as compared with baseline sodium contents, were 44.8%, 55.4%, 34.0%, and 28.9% for 5-, 4-, 3-, and 2-yr participants, respectively. In addition, the 4-yr participant rate was significantly higher than the 3- and 2-yr rates (P < 0.05).

Comparison of the sodium content of broth, stew, and noodle dishes from baseline to 2019

Table 4 shows the sodium contents of broth, stew, and noodle dishes of 5-yr participants and that sodium contents declined significantly from baseline to 2019 (P < 0.05). In addition, the sodium contents of broth dishes offered by restaurants that participated in the project since 2016 continued to decrease until 2019 (P for trend < 0.001). Sodium content reductions were also evident for the noodle and broth dishes offered by participant restaurants in 2017 (P for trend < 0.003; P for trend < 0.001) and in 2018 for broth dishes (P for trend = 0.014). However, significant changes were not observed in 2018 for stew dishes (P for trend = 0.644).

Broth dishes had the highest sodium content reduction rate from baseline in 2019 (60.9%). This was not significantly higher than reduction rates for noodle and broth dishes in 2017 (46.1% and 53.0%, respectively) but was significantly higher than those of broth and stew dishes in 2018 (33.9% and 13.5%, respectively).

Table 3. Comparison of the sodium contents of sodium reduction menu items from baseline to 2019

Year of participation	Restaurants	Menus	Baseline	Sodium content (mg/portion size)					Sodium reduction rate (%) ¹⁾	
				2015	2016	2017	2018	2019		P for trend
2015	12	15	938 ± 308 ^b	769 ± 254 ^{ab}	765 ± 310 ^{ab}	693 ± 281 ^{ab}	639 ± 313 ^{ab}	507 ± 275 ^a	< 0.001	44.8 ± 27.5 ^{AB}
2016	14	23	1,580 ± 774 ^b		1,026 ± 589 ^a	780 ± 488 ^a	724 ± 440 ^a	695 ± 443 ^a	< 0.001	55.4 ± 21.3 ^B
2017	22	33	1,626 ± 776 ^b			1,200 ± 600 ^a	1,085 ± 432 ^a	925 ± 537 ^a	< 0.001	34.0 ± 32.9 ^A
2018	22	39	1,429 ± 715 ^b				1,153 ± 428 ^a	1,008 ± 586 ^a	0.003	28.9 ± 27.4 ^A

The values are reported as the mean ± SD.

^{a-b}Means with different small letters in the same row are significantly different according to Duncan's multiple range test (P < 0.05).

^{A-C}Means with different capital letters in the same column are significantly different according to Duncan's multiple range test (P < 0.05).

¹⁾Sodium reduction rate (%) = (baseline sodium content – 2019 sodium content)/baseline sodium content × 100.

Table 4. Comparison of sodium contents of broth, stew, and noodle dishes from baseline to 2019

Year of participation	Dish group	No.	Sodium content (mg/portion size)					Sodium reduction rate (%) ¹⁾	
			Baseline	2016	2017	2018	2019		P for trend
2016	Broths	11	1,497 ± 538 ^b	972 ± 484 ^a	635 ± 440 ^a	636 ± 445 ^a	562 ± 338 ^a	< 0.001	60.9 ± 20.4 ^C
2017	Noodles	7	1,495 ± 307 ^c		1,062 ± 373 ^{bc}	1,254 ± 327 ^{ab}	754 ± 351 ^a	0.003	46.1 ± 29.8 ^{BC}
	Broths	6	1,911 ± 542 ^b		1,330 ± 481 ^a	945 ± 359 ^a	810 ± 426 ^a	< 0.001	53.0 ± 27.3 ^{BC}
2018	Broths	13	1,407 ± 653 ^b			1,088 ± 317 ^{ab}	911 ± 387 ^a	0.014	33.9 ± 18.9 ^{AB}
	Stews	6	1,496 ± 926 ^b			1,299 ± 362 ^{ab}	1,294 ± 1,077 ^a	0.644	13.5 ± 28.1 ^A

The values are reported as the mean ± SD.

^{a-c}Means with different small letters in the same row are significantly different according to Duncan's multiple range test (P < 0.05).

^{A-C}Means with different capital letters in the same column are significantly different according to Duncan's multiple range test (P < 0.05).

¹⁾Sodium reduction rate (%) = (baseline sodium content – 2019 sodium content)/baseline sodium content × 100.

Evaluation of on-site inspection results

Table 5 shows the scores of annual on-site inspections. In 2015, 14 of 37 new applicants were designated as sodium reduction restaurants. In contrast, 35 of 38 new applicants were designated, and 68 of 72 follow-up restaurants obtained re-designation in 2019 when 103 restaurants were designated as sodium reduction restaurants.

The evaluation scores of new restaurants over the 5-yr study period ranged from 78.5 to 81.1, and those of follow-up restaurants were between 81.5 and 90.7, which exceeded the pass threshold (70). Evaluation scores of rejected new and follow-up restaurants ranged between 55.5 and 65.5 and 69.0 and 79.2, respectively.

Final on-site inspection evaluation scores in 2019 are listed in **Table 6**. The maximum score of the newly designated restaurants was 85.0, whereas the maximum score of the rejected new restaurants was 65.0 and the score of sodium reduction rate was 0. The maximum score of the follow-up restaurants designated as sodium reduction restaurants was 95.0, while the maximum score of rejected follow-up restaurants was 89.0. Though these restaurants received a perfect score for percentage sodium reductions for many menu items and salinity meter use, they only received a score of 4.5 for sodium reduction rate.

Fig. 2 shows pass ratios between 2015 and 2019. The pass ratio of new restaurants increased annually, from 37.8% in 2015 to 74.5% in 2019, and that of follow-up restaurants also increased from 58.3% to 80.0%.

Table 5. Annual on-site inspection score and pass ratios

Year of participation	New restaurants					Follow-up restaurants				
	Total	Pass	Score of pass	Fail	Score of fail	Total	Pass	Score of pass	Fail	Score of fail
2015	37	14	81.1 ± 7.3	23	55.5 ± 13.2					
2016	47	19	80.2 ± 6.5	28	56.1 ± 8.9	12	7	90.7 ± 9.8	5	79.2 ± 9.3
2017	58	37	78.5 ± 5.6	21	65.5 ± 6.3	25	23	83.7 ± 5.7	2	76.0 ± 11.3
2018	39	26	79.9 ± 5.9	13	60.3 ± 8.8	51	41	81.5 ± 7.7	10	69.0 ± 8.7
2019	38	35	78.9 ± 5.4	3	61.2 ± 4.7	72	68	83.7 ± 6.5	4	73.8 ± 10.7

The values are reported as the mean ± SD.

Table 6. Evaluation scores of on-site inspections conducted in 2019

Evaluation items	New restaurants		Follow-up restaurants	
	Pass (n = 35)	Fail (n = 3)	Pass (n = 68)	Fail (n = 4)
Mandatory items				
Sodium reduction menu ratio (20/10) ¹⁾	15.7 ± 1.5	15.0 ± 0.0	6.7 ± 1.3	10.0 ± 0.0
Sodium reduction rate (20/10) ¹⁾	18.4 ± 1.5	0.0 ± 0.0	9.4 ± 0.9	4.5 ± 5.3
Salinity meter placement (10)	10.0 ± 0.0	10.0 ± 0.0	10.0 ± 0.0	10.0 ± 0.0
Signboard attachment (10) ²⁾	-	-	10.0 ± 0.0	10.0 ± 0.0
Menu board attachment (10) ²⁾	-	-	10.0 ± 0.0	10.0 ± 0.0
Optional items				
Sodium management for a month (10)	10.0 ± 0.0	10.0 ± 0.0	9.4 ± 1.7	8.5 ± 3.0
Sodium content management (10)	9.4 ± 2.4	10.0 ± 0.0	8.5 ± 3.6	5.0 ± 5.8
Use of measuring tools (10)	10.0 ± 0.0	10.0 ± 0.0	10.0 ± 0.0	10.0 ± 0.0
No seasoning containers on tables (10)	5.1 ± 5.1	10.0 ± 0.0	8.1 ± 4.0	5.0 ± 5.8
Sodium management in kimchi (10)	0.3 ± 1.7	0.0 ± 0.0	10.0 ± 0.0	5.0 ± 5.8
Maximum score	85.0	65.0	95.0	89.0

The values are reported as the mean ± SD.

¹⁾The total score for new restaurants was 20 points, and the total score for follow-up restaurants was 10 points.

²⁾Items for follow-up restaurants.

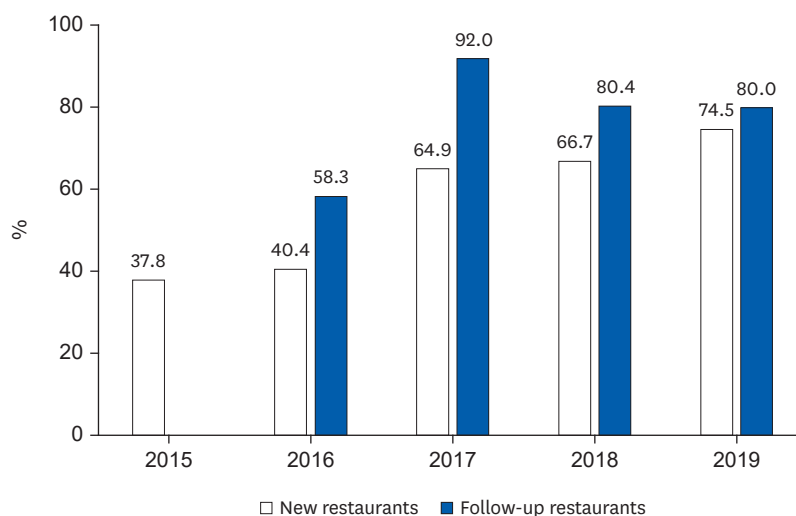


Fig. 2. Annual pass ratios of new and follow-up restaurants.

DISCUSSION

In this study, we analyzed salinity and sodium content changes in sodium reduction menu items at restaurants participating in the Daegu Sodium Reduction Restaurant Project. This project was launched in 2015 with 37 participants, and in 2019, 110 restaurants participated in the project, and 103 of these were designated Sodium Reduction Restaurants.

Restaurants must obtain a total score of at least 70 points during on-site inspections to pass, and they also must meet operational requirements for sodium reduction ratio and sodium reduction rate criteria. A review of 2019 on-site inspection results showed that new restaurants designated as Sodium Reduction Restaurants received a total score of 78.9 and satisfied all operational requirements even if they did not receive any points for kimchi sodium control. On the other hand, rejected restaurants failed to score ≥ 70 points and received zero points for sodium reduction rate. Unlike new restaurants, follow-up restaurants scored 10 out of 10 for kimchi sodium control and achieved a high total score of 83.7. On the other hand, rejected restaurants scored ≥ 70 but did not meet the 10% sodium reduction rate requirement.

When the sodium reduction rates of participating restaurants (2015–2019) were analyzed that of 4-yr participants (2016–2019) was found to be 55.4%, and the reduction rate for broth dishes was 60.9%. The sodium reduction rate of 3-yr participants was 34.0%, and reduction rates for their noodle and broth dishes were 46.1% and 53.0%, respectively. Two-year participants reduced sodium content by 28.9% and achieved a 33.9% reduction in broth menu items. These findings show sodium reduction rates increased with duration of participation.

In this study, follow-up restaurants reported higher pass ratios than new restaurants, which indicates restaurants that continued with the project found it easier to pass evaluations, which indicates the support of government is required to ensure continuation of the project.

For evaluations, salinities of all menu items were measured and converted to sodium contents based on single serving data in the Restaurant Menu Nutrient Book [25]. In 2013 and 2014, a research project conducted in the United States [26] examined how adults and adolescents

estimate sodium contents in fast-food restaurant menus, and concluded that subjects underestimated menu item sodium contents by 50–100%. Thus, sodium content labels are needed to determine the sodium contents of restaurant menu items and home-cooked dishes. On the other hand, salinity can be assessed by the gustatory system. According to the results of the 2018 Sodium Reduction Restaurant Project in Daegu, personnel at participating restaurants were highly perceptive of the salinities of different foods and reported high satisfaction with the salinity measurement method [24]. In addition, the use of salinity meters increased sodium reduction awareness among restaurant personnel [27].

Throughout history, Koreans have relied on microorganisms and fermentation techniques to preserve foods. Sauces, such as soybean sauce (*ganjang*), soybean paste (*doenjang*), and red pepper paste (*gochujang*), are key components of the Korean diet [28] and serve as primary sources of sodium [20]. In addition, Koreans typically consume rice, soup, and other side dishes during single meals [28]. As this study presents sodium contents of main dishes, sodium intakes from single meals are higher because of the sodium contents of side dishes. For some sodium reduction menu items such as bone soup (*gomtang*) and ginseng chicken soup (*samgyetang*), salt is added by customers after dishes are served, and thus, surveyed salinity and sodium contents are lower than actual sodium intakes.

Taste plays an important role in food choices. A moderate level of salinity (isotonicity, 150 mM, around 0.875%) is known to provide the most attractive taste, and as a result, daily salt intakes do not vary significantly regardless of culture [14]. According to a 2013 study, Korean men and women preferred saline concentrations of 270.6 mM and 213.1 mM, respectively [29]. In the present study, baseline salinity was lower than 0.875% (150 mM) and dropped to 0.41% in 2019, depending on participation duration. Hence, our findings confirm the argument that lower salt intake results in a preference for less salty diets [30]. According to Ma *et al.* [24], restaurant owners that participated in Daegu's Sodium Reduction Restaurant Project reported high project satisfaction (41.1 out of 50). Furthermore, according to the findings of a customer satisfaction survey of sodium reduction menu items, customers received the items positively, and 25.0% and 48.9% of surveyed customers responded that the dishes were “very delicious” or “delicious,” respectively.

Lee *et al.* [31] suggested the following barriers to the sodium reduction project: people's nutrition knowledge, restaurant use of processed foods, and the limited cooking techniques of restaurant personnel. Under the Sodium Reduction Restaurant Project, the Daegu Metropolitan Government made extensive efforts to spread and publicize nutrition knowledge among its citizens and provided training on low-sodium cooking methods in restaurants, and required signboards and salinity or sodium content labels for evaluation items in follow-up restaurants. The project also set required sodium reduction percentages for menu items at 20%, which reduced the compliance burden on restaurants. Although it would have been ideal had participating restaurants avoided the use of processed foods as ingredients, a franchise restaurant that participated in the project was required by its head office to use at least a certain amount of kimchi each month. For this reason, the restaurant used a large amount of kimchi when preparing kimchi stew (*kimchi jjigae*), which was one of its main menu items, and thus, because kimchi has a high sodium content, this restaurant could not join the sodium reduction project.

Overall, the Daegu Sodium Reduction Restaurant Project appears to have overcome the barriers mentioned above. However, labels at participating restaurants only indicated the

sodium contents of sodium reduction menu items, which demonstrates a need for warning labels on high sodium menu items. According to a previous study, nutrition labels with warning messages raise customer awareness of the sodium contents of menu items and promote the consumption of food items with lower sodium contents [32].

Many countries are taking a keen interest in the sodium contents of restaurant food items. Based on the results of a study conducted on 66 top-earning chain restaurants between 2012 and 2016 in the United States, the government encouraged restaurants to voluntarily reduce sodium contents in accordance with the National Salt Reduction Initiative. However, surveyed restaurants did not change their existing recipes but rather introduced new low sodium menus to meet consumers' demands and government policies. Disappointingly, the menus produced reduced sodium contents by only 104 mg in 2016 as compared with 2012 [33]. Canada also failed to report a significant decline in the sodium contents of restaurant menus between 2012 and 2016 [34]. These studies indicate the need for government intervention to regulate and incentivize restaurants to reduce the sodium contents of menu items.

In conclusion, this study shows that the Sodium Reduction Restaurant Project effectively reduced the sodium contents of menu items in participating Daegu restaurants. In particular, multi-year participants had significantly greater sodium reduction rates. We hope the success of this project encourages other regions to implement sodium reduction projects to improve the health of their citizens.

REFERENCES

1. GBD 2017 Diet Collaborators. Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2019;393:1958-72.
[PUBMED](#) | [CROSSREF](#)
2. Okayama A, Okuda N, Miura K, Okamura T, Hayakawa T, Akasaka H, Ohnishi H, Saitoh S, Arai Y, Kiyohara Y, et al. Dietary sodium-to-potassium ratio as a risk factor for stroke, cardiovascular disease and all-cause mortality in Japan: the NIPPON DATA80 cohort study. *BMJ Open* 2016;6:e011632.
[PUBMED](#) | [CROSSREF](#)
3. Mente A, O'Donnell M, Rangarajan S, McQueen M, Dagenais G, Wielgosz A, Lear S, Ah ST, Wei L, Diaz R, et al. Urinary sodium excretion, blood pressure, cardiovascular disease, and mortality: a community-level prospective epidemiological cohort study. *Lancet* 2018;392:496-506.
[PUBMED](#) | [CROSSREF](#)
4. Li Y, Huang Z, Jin C, Xing A, Liu Y, Huangfu C, Lichtenstein AH, Tucker KL, Wu S, Gao X. Longitudinal change of perceived salt intake and stroke risk in a Chinese population. *Stroke* 2018;49:1332-9.
[PUBMED](#) | [CROSSREF](#)
5. Umesawa M, Iso H, Fujino Y, Kikuchi S, Tamakoshi A; JACC Study Group. Salty food preference and intake and risk of gastric cancer: the JACC Study. *J Epidemiol* 2016;26:92-7.
[PUBMED](#) | [CROSSREF](#)
6. Deckers IA, van Engeland M, van den Brandt PA, Van Neste L, Soetekouw PM, Aarts MJ, Baldewijns MM, Keszei AP, Schouten LJ. Promoter CpG island methylation in ion transport mechanisms and associated dietary intakes jointly influence the risk of clear-cell renal cell cancer. *Int J Epidemiol* 2017;46:622-31.
[PUBMED](#)
7. Faraco G, Hochrainer K, Segarra SG, Schaeffer S, Santisteban MM, Menon A, Jiang H, Holtzman DM, Anrather J, Iadecola C. Dietary salt promotes cognitive impairment through tau phosphorylation. *Nature* 2019;574:686-90.
[PUBMED](#) | [CROSSREF](#)
8. Horikawa C, Yoshimura Y, Kamada C, Tanaka S, Tanaka S, Hanyu O, Araki A, Ito H, Tanaka A, Ohashi Y, et al. Dietary sodium intake and incidence of diabetes complications in Japanese patients with type 2 diabetes: analysis of the Japan Diabetes Complications Study (JDACS). *J Clin Endocrinol Metab* 2014;99:3635-43.
[PUBMED](#) | [CROSSREF](#)

9. Suzuki A, Katoh H, Komura D, Kakiuchi M, Tagashira A, Yamamoto S, Tatsuno K, Ueda H, Nagae G, Fukuda S, et al. Defined lifestyle and germline factors predispose Asian populations to gastric cancer. *Sci Adv* 2020;6:eav9778.
[PUBMED](#) | [CROSSREF](#)
10. Shin SJ, Lim CY, Rhee MY, Oh SW, Na SH, Park Y, Kim CI, Kim SY, Kim JW, Park HK. Characteristics of sodium sensitivity in Korean populations. *J Korean Med Sci* 2011;26:1061-7.
[PUBMED](#) | [CROSSREF](#)
11. Merino J, Guasch-Ferré M, Martínez-González MA, Corella D, Estruch R, Fitó M, Ros E, Arós F, Bulló M, Gómez-Gracia E, et al. Is complying with the recommendations of sodium intake beneficial for health in individuals at high cardiovascular risk? Findings from the PREDIMED study. *Am J Clin Nutr* 2015;101:440-8.
[PUBMED](#) | [CROSSREF](#)
12. World Health Organization. Guideline: sodium intake for adults and children [Internet]. Geneva: World Health Organization; 2012 [cited 2020 November 23]. Available from: https://www.who.int/elena/titles/guidance_summaries/sodium_intake/en/.
13. World Health Organization. Global action plan for the prevention and control of noncommunicable diseases 2013–2020 [Internet]. Geneva: World Health Organization; 2013 [cited 2019 April 25]. Available from: https://apps.who.int/iris/bitstream/handle/10665/94384/9789241506236_eng.pdf?sequence=1&isAllowed=y.
14. Breslin PA. An evolutionary perspective on food and human taste. *Curr Biol* 2013;23:R409-18.
[PUBMED](#) | [CROSSREF](#)
15. Puska P, Vartiainen E, Tuomilehto J, Salomaa V, Nissinen A. Changes in premature deaths in Finland: successful long-term prevention of cardiovascular diseases. *Bull World Health Organ* 1998;76:419-25.
[PUBMED](#)
16. Holdsworth M, Haslam C, Raymond NT. Does the heartbeat award scheme change employees' dietary attitudes and knowledge? *Appetite* 2000;35:179-88.
[PUBMED](#) | [CROSSREF](#)
17. He FJ, Brinsden HC, MacGregor GA. Salt reduction in the United Kingdom: a successful experiment in public health. *J Hum Hypertens* 2014;28:345-52.
[PUBMED](#) | [CROSSREF](#)
18. World Action on Salt & Health. World Action on Salt & Health in USA [Internet]. London: Wolfson Institute of Preventive Medicine, Queen Mary University of London; 2020 [cited 2020 November 23]. Available from: <http://www.worldactiononsalt.com/worldaction/north-america/usa/>.
19. World Action on Salt & Health. World Action on Salt & Health in Korea [Internet]. London: Wolfson Institute of Preventive Medicine, Queen Mary University of London; 2020 [cited 2020 November 23]. Available from: <http://www.worldactiononsalt.com/worldaction/asia/korea/>.
20. Korea Health Industry Development Institute. National Food & Nutrition Statistics 2019: based on 2019 Korea National Health and Nutrition Examination Survey [Internet]. Cheongju: Korea Health Industry Development Institute; 2019 [cited 2022 February 17]. Available from: <https://www.khidi.or.kr/kps/dhraStat/result16?menuId=MENU01670&gubun=&year=2019&category=sodium>.
21. Ministry of Health and Welfare. 1st National nutrition management basic plan 2012–2016 [Internet]. Sejong: Ministry of Health & Welfare; 2012 [cited 2019 November 21]. Available from: <http://www.korea.kr/common/download.do?tblKey=EDN&fileId=205580>.
22. Ministry of Food and Drug Safety. Guidelines for operating and managing sodium reduction restaurants 2018 [Internet]. Cheongju-si: Ministry of Food and Drug Safety; 2017 [cited 2019 September 27]. Available from: https://www.foodsafetykorea.go.kr/portal/board/boardDetail.do?menu_no=2880&bbs_no=bbs110&ntctxt_no=1065772&menu_grp=MENU_NEW05.
23. Ministry of Health and Welfare, Korea Disease Control and Prevention Agency. Korea Health Statistics 2020: Korea National Health and Nutrition Examination Survey (KNHANES VIII-2) [Internet]. Cheongju: Ministry of Health and Welfare.
24. Ma J, Lee S, Kim K, Lee YK. Sodium reduction in South Korean restaurants: a Daegu-based intervention project. *Asia Pac J Clin Nutr* 2020;29:404-13.
[PUBMED](#)
25. Ministry of Food and Drug Safety. Restaurant menu nutrient book 2012–2017. Cheongju: Ministry of Food and Drug Safety; 2019 [cited 2019 October 21]. Available from: https://www.foodsafetykorea.go.kr/portal/board/board.do?menu_grp=MENU_NEW05&menu_no=3601&id%20x_1=8.
26. Moran AJ, Ramirez M, Block JP. Consumer underestimation of sodium in fast food restaurant meals: results from a cross-sectional observational study. *Appetite* 2017;113:155-61.
[PUBMED](#) | [CROSSREF](#)

27. Nakadate M, Ishihara J, Iwasaki M, Kitamura K, Kato E, Tanaka J, Nakamura K, Ishihara T, Shintani A, Takachi R. Effect of monitoring salt concentration of home-prepared dishes and using low-sodium seasonings on sodium intake reduction. *Eur J Clin Nutr* 2018;72:1413-20.
[PUBMED](#) | [CROSSREF](#)
28. Kim SH, Kim MS, Lee MS, Park YS, Lee HJ, Kang S, Lee HS, Lee KE, Yang HJ, Kim MJ, et al. Korean diet: characteristics and historical background. *J Ethn Food* 2016;3:26-31.
[CROSSREF](#)
29. Shim E, Ryu HJ, Hwang J, Kim SY, Chung EJ. Dietary sodium intake in young Korean adults and its relationship with eating frequency and taste preference. *Nutr Res Pract* 2013;7:192-8.
[PUBMED](#) | [CROSSREF](#)
30. Bobowski N. Shifting human salty taste preference: potential opportunities and challenges in reducing dietary salt intake of Americans. *Chemosens Percept* 2015;8:112-6.
[PUBMED](#) | [CROSSREF](#)
31. Lee J, Park S. Management of sodium-reduced meals at worksite cafeterias: perceptions, practices, barriers, and needs among food service personnel. *Osong Public Health Res Perspect* 2016;7:119-26.
[PUBMED](#) | [CROSSREF](#)
32. Musicus AA, Moran AJ, Lawman HG, Roberto CA. Online randomized controlled trials of restaurant sodium warning labels. *Am J Prev Med* 2019;57:e181-93.
[PUBMED](#) | [CROSSREF](#)
33. Wolfson JA, Moran AJ, Jarlenski MP, Bleich SN. Trends in sodium content of menu items in large chain restaurants in the U.S. *Am J Prev Med* 2018;54:28-36.
[PUBMED](#) | [CROSSREF](#)
34. Murphy SA, Weippert MV, Dickinson KM, Scourboutakos MJ, L'Abbé MR. Cross-sectional analysis of calories and nutrients of concern in Canadian chain restaurant menu items in 2016. *Am J Prev Med* 2020;59:e149-59.
[PUBMED](#) | [CROSSREF](#)