Cross-Sectional Analysis of Sodium in Chinese Restaurants and Implications for Salt Reduction Initiatives

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Abstract

Background

Sodium intake in China is extremely high. Given the increasing consumption of restaurant foods, and limited research has explored the sodium level of these foods. The present study aims to assess the content and sources of sodium in Chinese restaurants.

Methods

Cross-sectional data were obtained from the baseline survey of Restaurant-based Intervention Study (RIS) in 2019. 8131 best-selling restaurant dishes with detailed recipe information from 192 restaurants in China were selected. Sodium levels per 100g and per serving were calculated according to Chinese Food Composition Table. The proportions of serving-size restaurant dishes exceeding the daily sodium reference intake level and sodium contributions by major sources were also explored.

Results

In total, the median values of sodium in restaurant dishes were 487.3mg per 100g, 3.4mg per kcal, and 2543.7mg per serving. 74.9% of dishes per serving exceeded Chinese adults' daily sodium adequate intake (AI, 1500mg per day), while 62.6% of dishes exceeded the proposed intake for preventing non-communicable chronic diseases (PI, 2000mg per day). Cooking salt was the leading source of sodium in Chinese restaurant dishes, accounting for 45.8%, followed by monosodium glutamate (17.5%), food ingredients (17.1%), soy sauce (9.4%), and other condiments/seasonings (10.2%). More categories of salted condiments/seasonings usage were related to higher sodium level.

Conclusions

The sodium level in Chinese restaurants is high. Coordinated salt reduction initiatives are needed according to the major sources of sodium in restaurant foods.

Background

High sodium intake is a concern for public health worldwide, as it is linked to elevated blood pressure, which leads to cardiovascular diseases [1-3]. In 2010, the global mean level of sodium consumption is 3950 mg/day, nearly twice the WHO recommendation of 2000 mg/day [4,5]. The latest Global Burden of Disease Study showed that 3 million deaths were attributed to the high salt intake in 2017 and about half of these deaths occurred in China [1]. East Asia is one of the regions with highest sodium intake in the world [4]. According to China National Nutrition and Health Surveillance (CNNHS) 2010-2012, Chinese adults consume 5013 mg/day sodium on average, much higher than both WHO and Chinese recommended level [6,7]. High sodium intake is the leading risk factor for cardiometabolic mortality in China, accounting for 17.3% population attributable fraction (PAF) [8]. To tackle with the adverse effects of high sodium consumption, many countries have carried out salt reduction strategies in recent years [9-12].

A national target of 20% reduction in salt intake by 2030 has been proposed in China's health development agenda "Healthy China 2030" [13]. Identification of the local sodium intake level and food sources is critical to develop effective sodium reduction strategy. In developed countries, where the majority of sodium intake is from processed foods, efforts focus on reducing salt added by food industry, through setting incremental targets for different food categories [14,15]. In China, added salt when cooking/preparing a meal is the leading source of sodium accounting for 69.2%, followed by soy sauce (8.2%), processed food (6.0%), and chicken essence (4.5%) [6]. Although the above findings are obtained from the national nutrition and health survey, the design is based on household level, the usage of added salt and condiments for foods away from home were not collected and estimated as the same with foods prepared at home, which may underestimate the total sodium intake [16]. Restaurant foods have higher sodium level than home-made foods [16], thus eating out is reported to be associated with higher intake of sodium [17, 18]. Besides the high level of salt content, restaurant foods also are characteristic as prevalent use of salt substitutes and enhancers [19], indicating the different sources of sodium compared with home-made dishes. With the rapid urbanization and economic development, restaurant plays an increasing role in the overall sodium intake at population level [20]. To achieve the sodium reduction goals, considerable efforts should also be taken to reduce the amount of sodium added to restaurant foods [21].

"Action on Salt China" (ASC) is a collaboration unit for salt reduction, established in June 2017, with collaboration of Queen Mary University of London in the United Kingdom, The George institute for Global Health in China, Chinese Center for Disease Control and Prevention, and other key national organizations [22]. ASC program consists of four randomized controlled trials (RCTs), targeting various sources of salt intake in China. As one of the RCTs in ASC, restaurant-based intervention study (RIS) is designed to test feasibility and effectiveness of the restaurant salt reduction package in 192 restaurants from 6 provinces of China. The present article describes the baseline data of RIS to understand sodium content level and sources of popular restaurant dishes in China, which will be helpful in developing effective strategies to reduce salt in restaurant foods.

Methods

Study Design

RIS baseline assessment survey was carried out in 6 provinces of China (Qinghai, Hebei, Heilongjiang, Hunan, Sichuan and Jiangxi), in May 2019. Two counties with similar socioeconomic level in the provincial capital city were selected from each province. Then, according to the inclusion and exclusion criteria, 16 restaurants mainly offering Chinese cuisine, were selected from each county, including 4 large-size, 8 medium-size and 4 small-size restaurants

[23]. The detailed recipe information of top 50 dishes based on sales from each restaurant were collected by trained investigators. For restaurants with number of total dishes <50, all the dishes were included.

Definitions of key analytic characteristics for restaurant dishes

To understand the sodium level by different characteristics in restaurant dishes, we included area, restaurant size and dish type in the major analysis. Area was divided into north (Qinghai, Hebei and Heilongjiang) and south (Hunan, Sichuan and Jiangxi). Restaurant size was classified into large (area>500 and ≤3000m2, or seats>250 and ≤1000), medium (area>150 and ≤500m2, or seats>75 and ≤250) and small (area≤150m2, or seats≤75), according to the surface area (m2) or number of seats. Chinese cuisine varied dramatically across geography areas, which was summarized into four types based on the cooking method in the current article, including cold dish, fried dish, soup and staples/snacks.

Assessment of Sodium Content

A mobile-based electronic data collection system (EDC) developed by the Beijing University of Aeronautics and Astronautics was used for data collection. The recipe information of the selected popular dishes from each restaurant was collected by the in-depth interview with chefs who were familiar with the preparation and cooking of the dishes. The detailed information included name of the dish, edible percentage, amount of all food ingredients and condiments/seasonings used in a given dish, as well as the dish type and cooking method. To ensure an accurate account of the amount of condiments/seasonings, the investigators showed the weighed amount using a usual spoon or other measuring instruments before the interview. Sodium content of each dish was calculated according to the Chinese Food Composition Table, combining the sodium from all the food and condiments/seasonings within the dish. In this paper, sodium content was expressed as sodium density (mg per 100g, mg per kcal), as well as sodium (mg) per serving dish.

Comparison to Chinese Dietary Reference Intakes (DRIs)

Sodium levels in serving-size restaurant dishes were compared to the Chinese daily AI (adequate intake, 1500 mg per day) and PI (proposed intakes for preventing non-communicable chronic diseases, 2000 mg per day) for adults aged 18 to 49 years old. 7 Restaurant dishes were compared to Chinese DRIs because restaurant sodium reduction targets have not been established in China. The proportions of restaurant dishes exceeding the daily sodium AI and PI were calculated, respectively.

Assessment of Sodium Sources

According to the major contributors of sodium in restaurant dishes, we classified the sodium sources to the following categories, such as food ingredients, cooking salt, monosodium glutamate (including chicken powder, and chicken essence), soy sauce, and other condiments/seasonings. The proportions of sodium from all the above sources were described, respectively.

Statistical Analysis

We described the median (Percentile 25, Percentile 75) for sodium per 100 g, sodium per kcal, and sodium for serving in restaurant dishes, by subgroups of area (north, south), restaurant size (large, medium and small), and dish type (cold dish, fried dish, soup and staples/snacks). Descriptive statistics for restaurant dishes, including %AI (sodium per serving divided by 1500 mg), and % of restaurant dishes exceeding the daily sodium AI and PI were tabulated. The contributions from the main sources to total sodium content in restaurant dishes were calculated. Because the sodium values were abnormally distributed, so that the non-parametric Wilcoxon signed-rank test was used to compare the median of sodium content among restaurant dishes stratified by area, restaurant size and dish type. We used SAS 9.4 (SAS Institute, Cary, NC) for data cleaning and analyses, and considered two sided $P<0.05$ as statistical significant.

Results

Sodium density level of popular restaurant dishes in China

The analysis included a total 8131 menu foods from 192 restaurants in 6 provinces of China. The sample encompassed 3829 (47.1%) and 4302 (52.9%) foods from north and south area, 2285 (28.1%), 4162 (51.2%) and 1684 (20.7%) foods from large, medium and small restaurants, respectively. The dish type was mainly fried dish (83.9%), followed by cold dish (11.7%), soup (3.0%) and staples/snacks (1.4%).

In total, the restaurant dishes contained 487.3 (291.1, 781.9) mg sodium per 100g. The sodium level varied significantly by area, restaurant size, and dish type (Table 1). The highest sodium categories were south area (566.3mg per 100g), medium (497.5mg per 100g) and small (491.3mg per 100g) restaurants, soup (687.0mg per 100g), cold dish (528.4mg per 100g) and fried dish (480.9mg per 100g). Sodium mg per kcal showed similar trends, with the average sodium 3.4 (1.9, 6.4) mg per kcal. Categories with the highest sodium level per kcal were south area (3.6 mg), medium (3.5mg) and large (3.4mg) restaurant, cold dish (4.8mg), soup (4.3mg) and fried dish (3.3mg).

Table 1 Sodium level in Chinese restaurant dishes.

	N	Sodium (mg) per 100g				Sodium (mg) per kcal			
		Median	P25	P75	*P* value	Median	P25	P75	*P* value
Area									
North	3829	415.7	250.7	682.8	<0.0001	3.2	1.7	6.1	<0.0001
South	4302	566.3	337.9	858.4		3.6	2.0	6.5	
Restaurant size									
Large	2285	466.1	278.1	763.3	0.0286	3.4	1.8	6.7	0.0006
Medium	4162	497.5	297.7	798.0		3.5	1.9	6.5	
Small	1684	491.3	302.1	767.1		3.1	1.8	5.7	
Dish type									
Cold dish	950	528.4	292.1	898.4	<0.0001	4.8	2.1	10.3	<0.0001
Fried dish	6819	480.9	291.1	762.3		3.3	1.9	6.0	
Soup	246	687.0	409.6	1143.3		4.3	2.3	9.3	
Staples/snacks	116	278.4	40.1	541.6		1.1	0.2	2.3	
Total	8131	487.3	291.1	781.9		3.4	1.9	6.4	

Sodium level per serving in restaurant dishes and compared to Chinese dietary reference intakes

Table 2 showed serving size, sodium (mg) per serving, %AI, and proportions of restaurant dishes exceeding the daily sodium AI (1500mg) and PI (2000mg) by categories. The average serving size was 575.6±318.0g, providing 3331.2±4156.9mg sodium per serving, 222.1% AI. In total, 74.9% of restaurant menu foods exceeded Chinese adults' daily sodium AI, while 62.6% of foods exceeded the adults' PI. Foods in categories of north area, large and medium restaurant, fried dish and soup had larger serving size and higher sodium (mg) per serving. In some instances, the higher sodium per serving was mainly due to higher sodium density, such as south area, cold dish, and small restaurant, while in other instances, it was due to larger serving size, such as north area, large restaurant, and staples/snacks, or due to the combination of both serving size and sodium density, such as medium restaurant, fried dish, and soup.

Table 2 Sodium levels of restaurant dishes in China compared to the dietary reference intakes (DRIs)

	N	Mean serving size (g)		Sodium (mg) levels per serving						% of dishes exceeding the sodium DRIs levels ‡	
		Mean	SD	Mean	SD	%AI †	Median	P25	P75	AI: 1500 mg	PI: 2000 mg
Area											
North	3829	620.0	340.2	3270.2	4849.9	218.0	2345.5	1409.3	3734.5	72.1	58.9
South	4302	536.1	291.2	3385.5	3423.7	225.7	2759.3	1596.3	4220.1	77.4	65.9
Restaurant size											
Large	2285	611.4	377.9	3447.0	4774.4	229.8	2604.3	1527.5	4040.7	75.7	63.8
Medium	4162	576.4	291.3	3397.6	4219.8	226.5	2642.6	1579.3	4081.5	76.7	64.1
Small	1684	525.0	283.6	3010.1	2894.8	200.7	2283.6	1368.8	3901.9	69.5	57.4
Dish type											
Cold dish	950	426.6	237.2	2975.5	4540.7	198.4	2018.3	1091.0	3251.5	62.3	50.5
Fried dish	6819	598.9	317.3	3356.1	3887.3	223.7	2614.1	1575.8	4082.2	76.9	64.4
Soup	246	574.0	357.3	4805.4	8190.7	320.4	3373.0	2112.2	4852.2	85.8	77.6
Staples/snacks	116	431.3	454.6	1653.1	2011.6	110.2	934.7	107.6	2354.3	36.2	27.6
Total	8131	575.6	318.0	3331.2	4156.9	222.1	2543.7	1496.9	4030.9	74.9	62.6

AI, adequate intake; PI, PI-NCD, proposed intake for preventing non-communicable chronic diseases.

† Mean sodium levels per serving, expressed as a percentage of the daily AI for adults (1500mg per day).

‡ Percentage of dishes in the groups that exceed the daily AI (1500 mg per day) or PI (2000 mg per day) per serving.

Sodium sources of restaurant dishes in China

For the total sample, cooking salt was the leading source of sodium in Chinese restaurant dishes, accounting for 45.8% (Figure 1). Monosodium glutamate was the second contributor (17.5%), followed by food ingredients (17.1%), soy sauce (9.4%), and other condiments/seasonings (10.2%). Beside sodium from food ingredients, the majority (82.9%) of sodium came from salted condiments/seasonings added in cooking procedure. However, cooking salt only contributed to less than half of sodium in restaurant dishes. On the other hand, monosodium glutamate, soy sauce and other condiments/seasonings (such as other sauces, compound condiments/seasonings) contributed to more than one third of total sodium in restaurant dishes.

Condiments/seasonings usage and association with sodium level in Chinese restaurant dishes

Figure 2 presented the prevalence of major salted condiments/seasonings by dish types in Chinese restaurants. In total, 76.8% of foods contained cooking salt, while 71.1% and 41.7% of foods contained monosodium glutamate and soy sauce, respectively. However, other condiments/seasonings beside the above three categories of salted condiments/seasonings, were found in the 94.2% of restaurant dishes, and were most prevalent in all food types. Cooking salt was another major salted condiment for all type restaurant dishes, especially for soup (91.9%) and fried dish (77.8%). Monosodium glutamate was more often used in soup (80.9%) and fried dish (73.0%), followed by cold dish (60.0%). Soy sauce was a popular salted condiment/seasonings in China, being found in 43.8% of fried dish and 33.0% of cold dish. In staples/snack, prevalence of condiments/seasonings was below 50%, except for that of other condiments/seasonings.

Among all the samples included, nearly one half of restaurant dishes (45.1%) contained 3 categories of salted condiments/seasonings, followed by those contained 2 categories (24.2%) and 4 categories (23.3%) condiments/seasonings (Table 3). Only 7.4% of foods was added 1 category salted condiments/seasonings in cooking. Foods in south area, small restaurants and fried dish were more likely to contain all 4 categories of salted condiments/seasonings. Generally, foods that contained more categories of condiments/seasonings were significantly likely to have higher sodium level than those contained less categories of salted condiments/seasonings. This trend was seen in all subgroups, and the difference was significant (P<0.0001). The median value of sodium (mg) per 100g in foods with 4 categories of condiments/seasonings (644.4mg per 100g) was 4.8 times that of foods with 1 category of condiments/seasonings (134.8mg per 100g), 1.7 times of those with 2 categories (380.7mg per 100g), 1.3 times of those with 3 categories (506.4 mg per 100g).

Table 3. Sodium level by category amounts of salted condiment/seasonings in Chinese restaurant dishes (N=8131).

	P value*	Category amounts of salted condiment/seasonings †													
		1 category				2 categories				3 categories				4 categories	
		%	sodium (mg) per 100g			%	sodium (mg) per 100g			%	sodium (mg) per 100g			%	sodiu
			Median	P25	P75		Median	P25	P75		Median	P25	P75		Media
Area															
North	<0.0001	8.8	113.2	29.9	396.4	22.0	342.1	191.9	539.2	49.1	445.5	290.8	713.2	20.1	500.6
South		6.2	146.2	43.9	488.8	26.1	408.0	259.6	705.6	41.6	578.9	370.1	911.0	26.1	704.3
Restaurant size															
Large	<0.0001	8.9	138.2	38.0	432.0	21.9	344.0	214.6	538.1	45.4	481.2	303.4	797.1	23.8	648.7
Medium		7.3	121.7	30.6	455.9	24.9	399.2	235.3	646.2	45.2	527.6	335.5	827.9	22.7	644.4
Small		5.9	138.7	35.6	405.8	25.7	386.2	234.5	666.3	44.5	486.7	317.0	763.0	24.0	640.3
Dish type															
Cold dish	<0.0001	15.1	139.4	36.0	479.9	25.1	470.2	272.9	709.2	47.3	615.4	372.4	970.3	12.6	729.6
Fried dish		5.8	145.1	48.6	456.6	24.3	367.4	221.8	598.5	44.9	486.7	313.3	764.4	25.1	637.8
Soup		5.3	73.7	21.4	309.7	22.0	667.0	401.1	1141.9	52.4	696.4	388.2	1239.0	20.3	791.3
Staples/snacks		48.3	39.5	5.3	178.1	14.7	393.0	276.7	554.7	24.1	507.0	360.8	777.6	12.9	461.1
Total	<0.0001	7.4	134.8	35.9	441.6	24.2	380.7	228.3	630.7	45.1	506.4	321.6	810.0	23.3	644.4

† Category of salted condiments/seasonings includes: cooking salt, monosodium glutamate, soy sauce, and other condiments/seasoning.

* Non-parametric Wilcoxon signed-rank tests of sodium level among different category amounts groups of salted condiment/seasonings.

Discussion

Commercially processed and restaurant foods are the main contributors for sodium intake in many developed countries, e.g. the UK, USA [14,24]. Although the current sodium intake among Chinese population is still mainly from salt and other salted condiments/seasonings added during cooking [6], there has been a rapid increase in consumption of foods outside the home in the past decades. As such, reducing sodium in the out-of-home sector plays in increasing important role for China to achieve the salt reduction targets by 2030.

Taking into account both the high sodium level and increasing consumption of eating-out, restaurant dishes become the important contributors to sodium intake in China. However, data on sodium content of restaurant dishes in China is limited. The current study describes the sodium density and serving content level, as well as ingredient sources of 8131 popular restaurant dishes from six provinces in China. Our results show that both the average level of sodium per 100g and sodium per serving are extremely high in Chinese restaurant dishes, with significant varieties among subgroups by geography area, restaurant size and dish type. One serving-size restaurant food provides almost 2.2 times that of daily recommended AI for Chinese adults, on average. Sodium levels per serving in 74.9% and 62.6% of restaurant dishes exceed the Chinese daily recommended AI (1500mg) and PI (2000mg), respectively. Our findings of the very high and wide-range sodium levels in restaurant dishes are in agreement with those reported in several other studies [25-28]. Such high sodium levels of restaurant foods are attributed to either large serving sizes or high sodium density, or the combination of both depending on the food categories [25]. In our study, the higher sodium per serving restaurant dishes, in some instances, is mainly due to higher sodium density, such as south area, cold dish, and small restaurant, while in other instances, it is mainly due to larger serving size, such as north area, large restaurant, and staples/snacks, or due to the combination of both serving size and sodium density, such as medium restaurant, fried dish, and soup. These differences may imply the specific salt reduction strategies for restaurant dishes in different situations.

Prevalent usage of condiments/seasonings is another explanation for the high sodium content in restaurant dishes. In the leading Canadian chain restaurants, more than 60% of foods contained a salt substitute/enhancer, such as yeast extracts, calcium chloride, monosodium glutamate and potassium chloride [19]. In our study, salted condiments/seasonings provide 82.9% sodium of restaurant dishes, those excluding cooking salt provide 37.1% of sodium. It makes sodium sources of Chinese restaurant dishes more complex and diversified. With increasing development of compound condiments/seasonings, restaurants prefer to add kinds of flavorings rather than add cooking salt only. We observed that more than two thirds of restaurant dishes contained three or four categories of salted condiments/seasonings. The sodium density in dishes ascended with increasing category numbers of added condiments/seasonings. Due to the close relationship with food industry, effective salt reduction in restaurants also requires cooperation with food manufactures [29,30].

Many countries have implemented national or regional initiatives on salt reduction in restaurants [9,31-35], mainly including: menu labelling, set sodium targets by food category, reformulation, promote awareness of consumer, chef training, and toolkits delivery. However, there are many potential barriers for reducing sodium content in restaurant dishes. Monitoring system on nutrition values of restaurant dishes has shown that the sodium level continues to be high and the change trend varies by food categories, with decrease only found in minority of the sampled foods [26,27]. More effective salt reduction strategies with multi-stakeholders' cooperation are needed.

In China, cooking habit and consumers' preferred taste make salt reduction difficult in restaurant foods. However, attempts to explore effective salt reduction strategies for restaurant in China have been implemented [36]. The RIS program affiliated to Action on Salt China (ASC), aims to understand the sodium level and evaluate the effectiveness of comprehensive restaurant salt reduction package in China, which consist of menu labelling, chef and waiter/waitress training, reformulation, supportive environment building, and salt reduction campaign. Besides that, monitoring system of sodium content in restaurant foods is vital to set the specific salt reduction targets by food categories and help consumers understand the benefits of selecting low-sodium options when eating out.

The strengths of our study include a large number of restaurant dishes based on both major types of food served in the restaurants and foods frequently ordered by consumers from 6 provinces in China. The notable differences of restaurant food types between China and other countries [37,38], call for data based on local studies. Furthermore, we use standard reporting formats (sodium mg per 100g) would facilitate comparisons across geography area, restaurant size and dish types. Sodium per serving would help customers understand sodium content among various restaurant options. Finally, the large sample size in our study could reflect the variability of sodium level in restaurant dishes to a certain extent, making the results more stable.

A number of limitations also exit. Sodium content assessing methods usually include laboratory analysis, menu labelling or online nutrition information provided by restaurant companies, and analysis with a nutrient database [39]. There are assessment differences between laboratory and menu items analysis, which may be induced by the lag in stated versus actual portion size and recall bias by chefs. However, due to the lack of publicly available menu nutrient values and expensive cost of laboratory analyses, we still consider menu items analysis is a cost-effective method to assess sodium content of restaurant foods in China, especially for studies with large sample size. In addition, with the rapid pace of restaurant foods development, the cross-sectional survey could not catch with the change of sodium levels. Furthermore, the results in this study could not represent the sodium level for all Chinese restaurant dishes due to wide variations of restaurant foods. Some countries start monitoring system to track the sodium content in restaurant foods [40], which will provide dynamic data to guide restaurants increase availability of lower-sodium foods and help consumers decrease sodium intake.

Conclusions

In conclusion, our study shows that the sodium content for the majority of popular restaurant dishes in China are extremely high and variable. Further, the large number of restaurant dishes that exceeded the daily AI and PI, along with prevalent usage of salted condiments/seasonings, demonstrate the need for a Chinese sodium reduction strategy that take all the major sodium sources into account. Coordinated government-led efforts should be implemented involving the participation of restaurants, food manufacturers, and consumers to reduce sodium level in restaurant foods, promote salt-reduction awareness and finally lower population sodium intake.

Abbreviations

RIS: Restaurant-based Intervention Study; AI: Adequate Intake; PI: Proposed Intake for Preventing Non-Communicable Chronic Diseases; CNNHS: China National Nutrition and Health Surveillance; PAF: Population Attributable Fraction; ASC: Action on Salt China; RCT: Randomized Controlled Trial; EDC: Electronic

Data Collection System; DRIs: Dietary Reference Intakes.

Declarations

Ethics approval and Consent to participate

The study was approved by the Review Board of the National Institute for Nutrition and Health, China CDC (20180314), and Queen Mary Research Ethics Committee (QMERC2018/14).

Consent for publication

Not applicable.

Availability of data and material

The datasets generated and/or analysed during the current study are not publicly available due to considerations of intellectual property. However, they may be available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' Contributions

WWD contributed to the conceptualization of the study, analyzed and interpreted the data, and drafted the manuscript; HJW contributed to the study design and data interpretation; JGZ contributed to data collection and statistical analyses; XFZ and NW contributed to data collection and cleaning; YL and PHZ contributed to study design and data interpretation; FJH acquired the funding and contributed to data interpretation. All authors provided comments on the draft manuscript and approved the final version.

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Figures

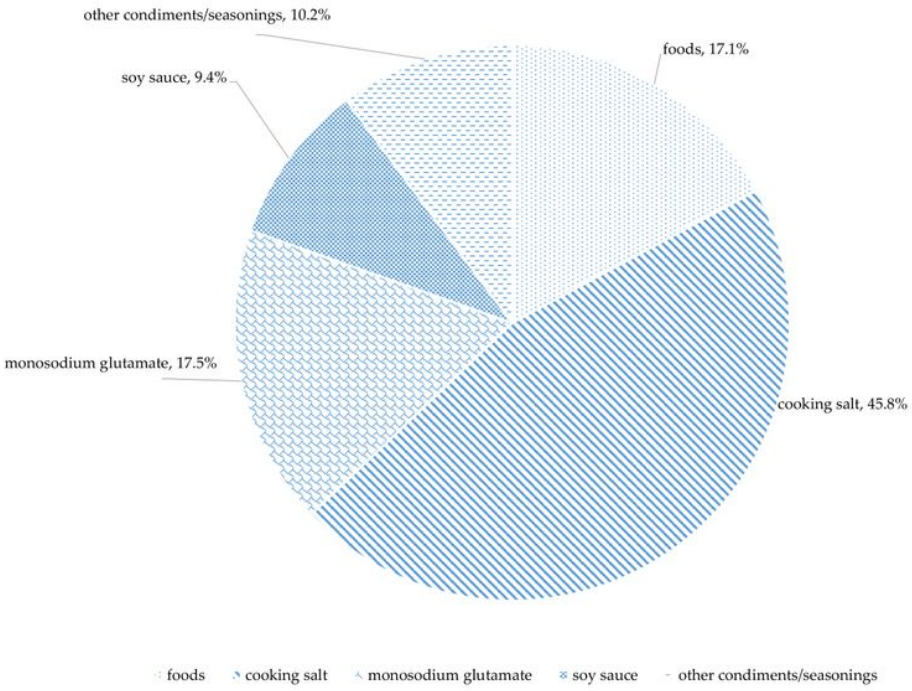

Figure 1

Sodium sources of restaurant dishes in China.

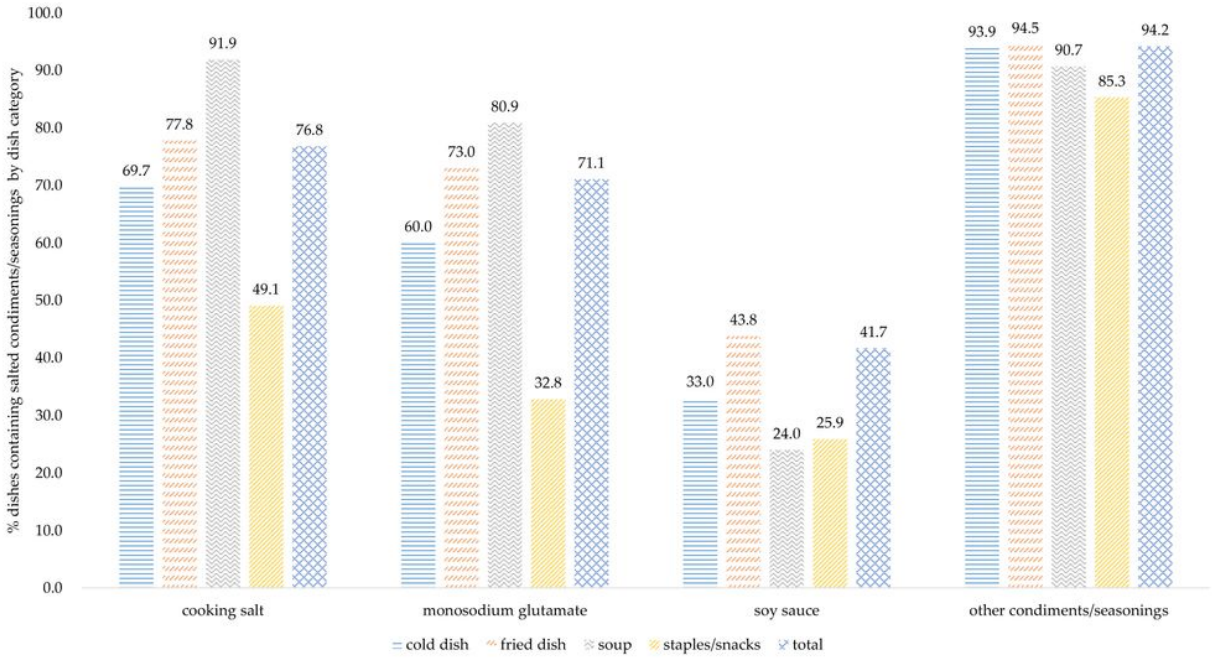

Figure 2

Percentage of restaurant dishes containing salted condiments/-seasonings by dish category in China.