

# Adolescents' Salt Reduction Consciousness, Attitudes and Behavior

Jialiang Jin, Xingjian Wang, Jiatong Chen, Jiayv Fu

## I. INTRODUCTION

The Chinese Dietary Guidelines, released in 2022, implemented a reduction in the recommended daily salt intake from 6 grams to 5 grams. This modification indicates a growing awareness of the dangers of salt in China and a decreasing trend of daily salt intake per capita year by year. However, despite these changes, the per capita daily salt intake in China still exceeds the recommendation set forth by the World Health Organization (WHO). Most studies on salt intake have focused on the adult population, and relatively few studies have been conducted on the adolescent population. Therefore, the present study aims to investigate the awareness, attitude, and behavior of Beijing adolescents regarding salt reduction. Specifically, we will investigate their knowledge of salt intake and explore the factors that influence their attitudes, perceptions, and decision-making processes related to salt reduction. Our null hypothesis is that there is no relationship between knowledge score and adolescents' salt control behavior. We expected to find the factors that influence salt reduction behavior and willingness to salt reduction

## II. RESEARCH

A high-salt diet can cause cardiovascular damage to human beings. Studies have shown that a high-salt diet over a long period tends to harden blood vessels in humans [6] and increases the risk of hypertension [5] [1]. Therefore, it is necessary to control the salt intake in the diet.

Despite the significant health risks posed by excessive salt intake, a considerable portion of the Chinese population remains insufficiently informed. A nationwide study revealed that 66% of participants lacked awareness of or were unable to accurately state the recommended daily salt intake [2]. Additionally, 27% of subjects admitted to haphazardly adding salt before tasting their food [2]. Although many individuals express an intention to reduce salt consumption, the actual implementation of salt reduction behaviors is limited. For instance, Bao et al. (2014) reported that while 83% of respondents expressed interest in improving their salt intake, only 30% took specific actions toward achieving this goal. This discrepancy may be attributed to the prevalence of eating out, which has become increasingly common among individuals who rely on restaurant-prepared meals. A lack of awareness regarding the precise salt content in restaurant dishes may inadvertently lead to excessive salt consumption. Notably, young consumers such as office workers and students are more prone to eating out or ordering take-out meals, thereby increasing their risk of surpassing recommended salt limits [4].

Adolescents are in the most critical stage of growth and development, and their dietary habits and awareness are particularly important for their health. Even though a high salt diet poses a more serious risk to adolescents' physical and psychological health, there are insufficient studies on salt intake in the adolescent population. Existing studies have focused on adult populations, resulting in limited knowledge regarding adolescents' salt consumption patterns.

Dietary behaviors and awareness during adolescence tend to continue into adulthood, and if a high-salt diet is formed during this critical period, it will further increase health risks in adulthood [11]

However, adolescents are not sufficiently aware of the dangers of a high-salt diet and have a low overall knowledge rate of sodium, making it difficult for them to actively reduce salt. For instance, research conducted in Beijing revealed that primary and secondary school students exhibited a mere 64.3% overall knowledge rate of 15 health-related facts concerning oil and salt intake, with the lowest rate recorded at a meager 7.32% [8]. In addition, teenagers performed poorly in terms of in-depth knowledge of salt-related knowledge and salt control behaviors, and the frequency of high-salt food consumption remained relatively high [9]).

Although the issue of a high-salt diet among adolescents has attracted widespread attention. However, further research is necessary to gain a more comprehensive understanding of adolescents' salt reduction awareness and behaviors. This study aimed to investigate in depth the salt reduction awareness attitudes as well as the actual behavioral performance of adolescents in Beijing, to provide a scientific basis for the development of salt reduction strategies and interventions for adolescents.

### III. METHODS AND PROCEDURES

#### A. Sampling Method:

We used a simple random sampling (SRS) method to get our sample. First, we obtained a list of names of all students in BNDS International Department (718 students in total) and assigned each student with numbers 1, 2, 3.....717, 718. We then used a random number generator to generate 65 random numbers, ignoring repeats and numbers from 719 to 999, inclusive. The matching students are selected to take the survey. During the data collection, we determined that among the 65 answer sheets, 61 answer sheets are valid.

#### B. Condition check:

- The 61 sample is randomly selected using SRS
- The sample size (61) is large enough and is less than 10% of the all students in international department at BNDS.
- All expected counts are larger than 5

#### C. Data collection:

The data is collected using a questionnaire designed by the group. The first part is mainly to investigate the basic diet of students, including the frequency of paying attention to the personal daily salt intake, and the attention to the acquisition of nutrition knowledge, etc.

The second part is mainly about the nutritional knowledge test for high salt, including the daily salt intake per capita of Chinese residents, the daily salt content recommended by the Chinese Dietary Guidelines, diseases caused by high salt, and the role of salt on the human body. There are 10 questions in this part, all of which appear in the form of single-choice questions, including multiple-choice questions and judgment questions. At the same time, the test question is based on relevant research paper [10].

The third part is an overview of demographic variables, including the year of birth, gender, height, weight, school, etc. The reason why this part is placed at the end of the article is to avoid the impact of respondents' deviation on the data after filling in first.

### IV. RESULTS

Table I: Summary of Demographic Characteristics of the Sample

|             | Grade      |            |            |            | X <sup>2</sup> (df) | p     |
|-------------|------------|------------|------------|------------|---------------------|-------|
|             | Freshmen   | Junior     | Senior     | Total      |                     |       |
| BMI Level   |            |            |            |            |                     |       |
| Underweight | 7.4%(2)    | 23.1%(3)   | 9.5%(2)    | 11.5%(7)   | 9.267(6)            | 0.159 |
| Normal      | 81.5%(22)  | 69.2%(9)   | 66.7%(14)  | 73.8%(45)  |                     |       |
| Overweight  | 3.70%(1)   | 7.70%(1)   | 23.80%(5)  | 11.50%(7)  |                     |       |
| Obese       | 7.40%(2)   | 0%(0)      | 0%(0)      | 3.30%(2)   |                     |       |
| Sex         |            |            |            |            | 3.138(2)            | 0.208 |
| Male        | 59.30%(16) | 30.80%(4)  | 57.10%(12) | 52.50%(32) |                     |       |
| Female      | 40.70%(11) | 69.20%(9)  | 42.90%(9)  | 47.50%(29) |                     |       |
| Age         |            |            |            |            | 72.693(6)           | 0.000 |
| 19          | 0%(0)      | 0%(0)      | 66.70%(14) | 23%(14)    |                     |       |
| 18          | 0%(0)      | 7.70%(1)   | 28.60%(6)  | 11.50%(7)  |                     |       |
| 17          | 37%(10)    | 92.30%(12) | 0%(0)      | 36.10%(22) |                     |       |
| 16          | 63%(17)    | 0%(0)      | 4.80%(1)   | 29.50%(18) |                     |       |

Table I shows that the sample is randomly selected from all students in BNDS International Department, and the above data table shows that the proportions of male and female students in the sample are approximately even (freshmen: male: 59.3%, female: 40.7%; junior: male: 30.8%, female: 69.2%; senior:

male: 57.1%, female: 42.9%), so are the proportions of students from each grade (positively related with age). As for Body mass index (BMI), our sample mainly consists of students who is in normal range (15 to 23.9, inclusive). Therefore, sex and age does not affect the result of our study, but BMI may have effect.

Table II: Descriptive Statistics of each Variable and Correlation Coefficient Matrix

|   | Mean    | SD      | 1.    | 2.    | 3.     | 4.    | 5.    | 6.     | 7.     | 8.     | 9.     | 10.    |
|---|---------|---------|-------|-------|--------|-------|-------|--------|--------|--------|--------|--------|
| 1.Salt-Related Knowledge Score                            | 5.54    | 1.512   | 1.000 | 0.322 | 0.009  | 0.186 | 0.175 | 0.154  | 0.062  | 0.072  | 0.140  | -0.026 |
| 2.Attention to Nutrition Knowledge                        | 2.79    | 1.097   |       | 1.000 | -0.008 | 0.005 | 0.680 | 0.055  | 0.021  | 0.095  | 0.214  | -0.057 |
| 3.The Frequency of Dining in the Canteen                  | 9.89    | 4.758   |       |       | 1.000  | 0.112 | 0.160 | 0.158  | -0.099 | -0.241 | 0.002  | -0.522 |
| 4.BMI   | 21.5092 | 3.32572 |       |       |        | 1.000 | 0.064 | -0.066 | 0.333  | 0.257  | 0.296  | -0.060 |
| 5.Attention to Daily Salt Control                         | 2.49    | 1.059   |       |       |        |       | 1.000 | 0.214  | -0.092 | 0.044  | 0.305  | -0.162 |
| 6.Willingness on Salt Reduction in the Future             | 3.56    | 0.904   |       |       |        |       |       | 1.000  | -0.335 | -0.015 | -0.022 | -0.311 |
| 7.Self-reported Taste Preference                          | 3.08    | 0.759   |       |       |        |       |       |        | 1.000  | 0.023  | 0.156  | 0.137  |
| 8.Preference for Food in the Frequency Dining Place       | 3.28    | 0.581   |       |       |        |       |       |        |        | 1.000  | -0.088 | 0.175  |
| 9.The frequency of Reporting Problems to the Dining Place | 1.344   | 0.6024  |       |       |        |       |       |        |        |        | 1.000  | -0.041 |
| 10.Preference for Takeout                                 | 4.38    | 4.026   |       |       |        |       |       |        |        |        |        | 1.000  |

Self-reported taste preferences were recorded using a five-point scale (1= very light; 5= Very heavy). Data analysis shows that most students think their taste to be relatively light. Specifically, 68.9% of the total number of adolescents chose options such as "very light," "light," or "moderate" taste.

The adolescents' evaluation of the taste of food at their regular dining place was documented using a five-point scale (1=very light; 5=very heavy). Data analysis shows that most students find the taste of the food to be moderate. Specifically, 68.9% of the total number of students selected the option "moderate."

Table III: The Scoring Average of Sodium Knowledge Awareness in Different Dimensions

|                 | Harms of High Salt Diet | Salt Intake Standards and Current Status | The Use and Amount of Salt in Food | The Effect of Salt on the Human Body |
|-----------------|-------------------------|--|------------------------------------|--------------------------------------|
| Scoring Average | 47.5%                   | 53.3%                                    | 59.0%                              | 58.2%                                |

The results of ten tests (1-10) measuring knowledge about salt are used to determine the level of knowledge among adolescents. The higher the score, the greater the level of mastery of knowledge related to salt and its impact on health. The data indicates that the majority of students are able to answer approximately half of the questions about knowledge regarding salt, as shown by the mean=5.54,  $SD=1.512$  in Table II. Yet, only 13.12% of adolescents are able to score 7 points or higher, indicating a lack of knowledge about salt among the majority of respondents. This includes understanding the specific harms of a high-salt diet, the recommended daily intake of salt, how to use salt in a reasonable manner, and the effects of salt on the human body, as shown in the table III.

Adolescents' attention to daily salt control was recorded using a five-point scale (1= least attention; 5=most attention). However, only 21.31% of adolescents "often" (score of 4) and "always" (score of 5) pay attention to daily salt intake control, with mean=2.49,  $SD=1.059$ .

Similarly, the level of attention that adolescents paid to nutrition-related knowledge was recorded using a five-point scale (1= least attention; 5= most attention). The second term in Table II shows that most students do not pay much attention to nutrition-related knowledge in their daily lives. Specifically, 68.8% of the total number of students indicated that they either "pay no attention at all," "seldom pay attention," or "pay attention sometimes."

The sixth term in Table II summarizes the degree of willingness among adolescents to reduce their dietary salt intake, which was measured using a five-point scale (1= least willing; 5= most willing). Data analysis shows that most students agree that the consumption of dietary salt should be reduced. Specifically, 63.3% of the total number of students indicated that they were "more willing" or "most willing" to reduce their salt intake (mean=3.56,  $SD=0.759$ ).

The frequency at which adolescents reported on the taste of food at dining places was recorded using a five-point scale (1=never reported; 5=always reported). Data analysis shows that none of the students have reported the taste of food at dining places more than four times. The majority of students in the sample selected "never reported" (mean = 1.344,  $SD = 0.6024$ ).

Although most adolescents express a willingness to reduce the salt content in their food (with a mean score greater than 3), they often fail to pay attention to their daily salt intake and neglect to provide feedback to the dining place when their dishes are salty, implying a discrepancy between their intentions and their actual behavior. Therefore, it is crucial to implement measures that can motivate them to take the initiative in reducing their salt consumption.

Table II shows correlation coefficient between different variables. There is a weak positive correlation between the score of the salt-related knowledge test and knowledge of nutrition ( $r=0.322$ ,  $p\text{-value}<0.05$ ), so the test score can be regarded as a reflection of knowledge of nutrition.

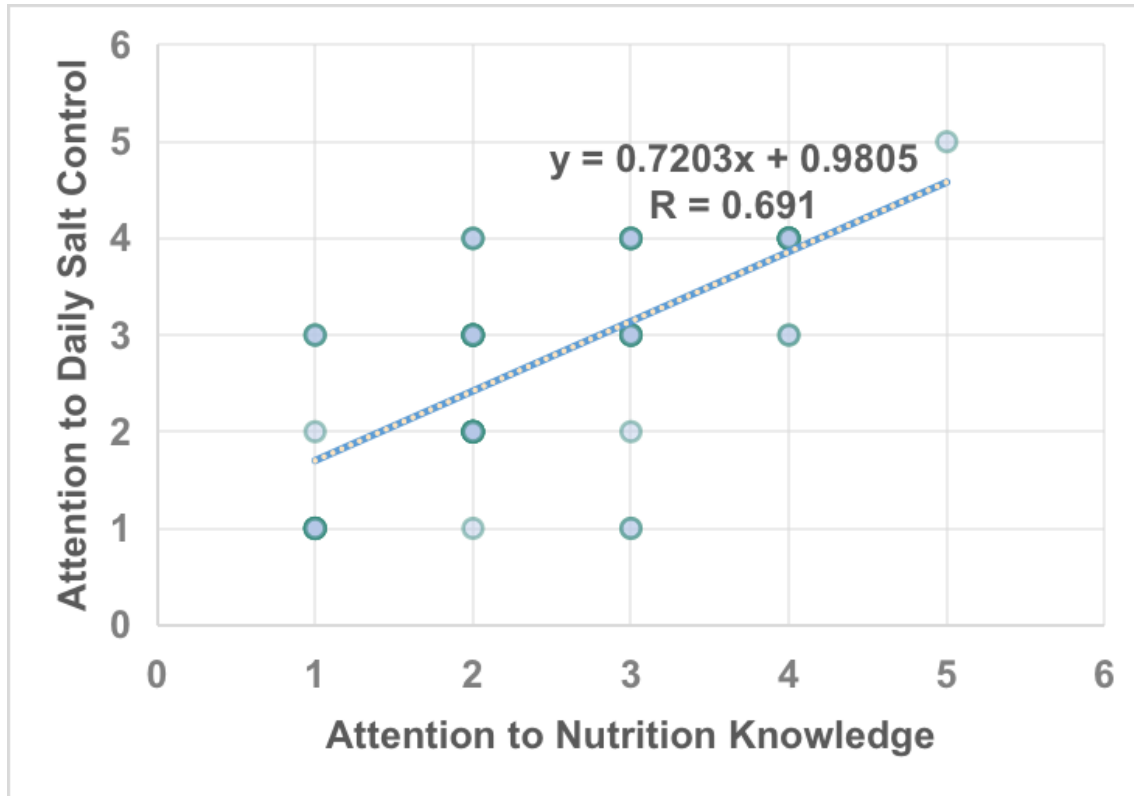


Figure 1: The linear Regression Line between Attention to Daily Salt Control and Attention to Nutrition Knowledge

Table IV: Computer Output for Linear Regression Line on Attention to Daily Salt Control and Attention to Nutrition Knowledge

| Model                            | Unstandardized Coefficients |            | Standardized Coefficients |       | Sig.  | 95.0% Confidence Interval for B |             |
|----------------------------------|-----------------------------|------------|---------------------------|-------|-------|---------------------------------|-------------|
|                                  | B                           | Std. Error | Beta                      | t     |       | Lower                           | Upper Bound |
| 1 (Constant)                     | 0.663                       | 0.276      |                           | 2.407 | 0.019 | 0.112                           | 1.215       |
| Attention to Nutrition Knowledge | 0.656                       | 0.092      | 0.68                      | 7.124 | 0     | 0.472                           | 0.84        |

Table IV and figure 1 show a moderately strong linear correlation between attention to dietary salt and knowledge of nutrition ( $r=0.680$ ,  $b=0.720$ ,  $p\text{-value}<0.01$ ), which indicates that students who have more knowledge of nutrition are likely to pay more attention to salt intake in diet, and are more inclined to give feedback to school restaurants about the taste of food provided ( $r=0.305$ ,  $p\text{-value}<0.05$ ).

Table II also indicates that Students' personal tastes also influence their tendency toward giving feedback to school restaurants. The data shows that there is a moderate correlation between the index of taste and BMI ( $r=0.361$ ,  $p\text{-value}<0.05$ ), and BMI is moderately correlated with tendency to give feedback to school restaurants about the taste of food provided ( $r=0.303$ ,  $p\text{-value}<0.05$ ). Students with higher BMI tend to prefer heavy-taste food, and are more likely to give feedback. However, these students

who prefer heavy-taste food or eat takeaway food more often do not tend to reducing dietary salt; the linear correlation between taste and index of opinion of dietary salt is weak ( $r=0.261$ ,  $p\text{-value}<0.05$ ). We speculate that these adolescents tended to report taste issues to dining place, but not always about the salt content in the food. It is possible that more than half of the feedback were unrelated to salt content.

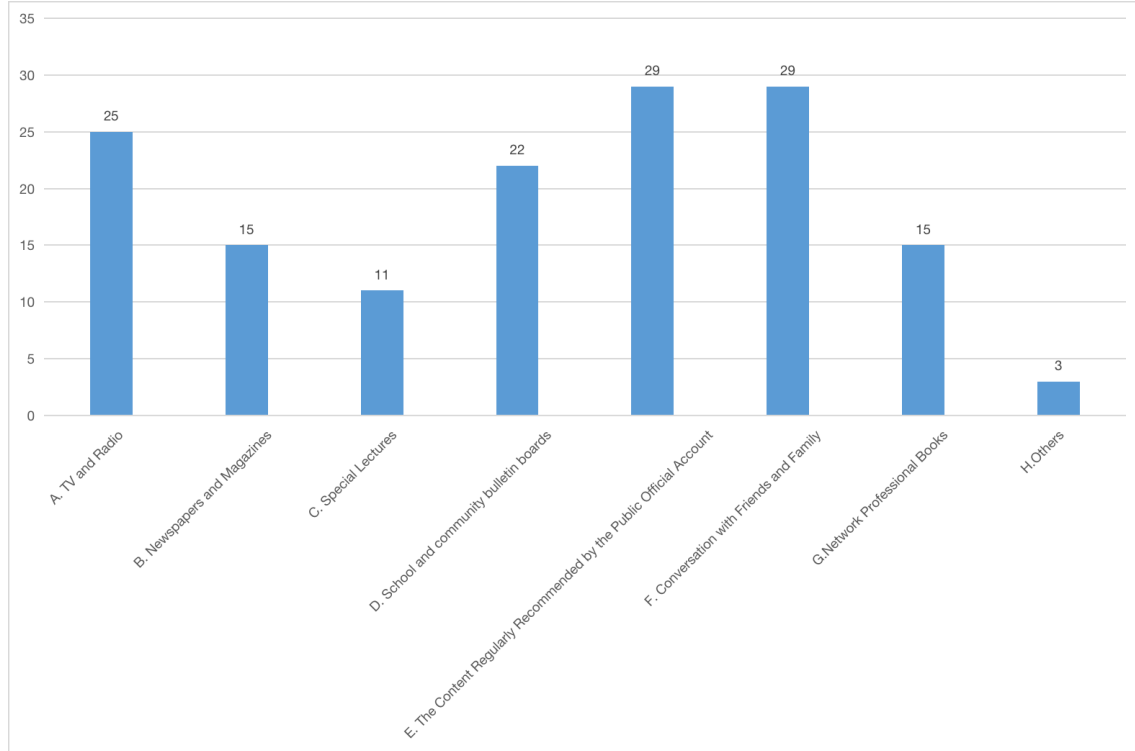


Figure 2: The Sources of Nutrition Knowledge among Adolescents

Figure 2 illustrates that the main sources for adolescents to acquire nutrition knowledge is to talk with their relatives and friends and content recommended by public official account as well as TV and radio, which suggests that the improvement of students' salt control awareness can be started from home and the places where adolescents spend most of their time with their friends to promote cooperative education and popularization of science on the network platform

## V. LIMITATION AND SUGGESTIONS

As there are only a few reference papers involving salt-related assessment, the test questions used in this study are few. Additionally, the construct validity appears to be relatively low, as indicated by the Kaiser-Meyer-Olkin (KMO) value of approximately 0.461, which is about 0.461,  $<0.5$ , which may be attributed to the unclear partitioning of test dimensions. Limited by objective factors (such as time and geographical location), the sample size of questionnaires collected in this study is small, which may affect the generalizability of the questionnaire results to all adolescents in Beijing. At the same time, it is difficult for us to define the strength of "salt reduction awareness" due to a lack of clarity on what constitutes "low salt" for individuals. This is evident from the results of the test, where only a small number of participants correctly identified the recommended daily limit for salt intake, despite China's dietary guidelines having clear standards. Applying a model related to continuous variables to our data is challenging. Therefore, in the future, we can consider referring to or making up the salt reduction scenario simulation test questions to quantify respondents' identification with certain salt-related behaviors. For example, people rate behaviors on a scale of 1 to 5, with 1 being the most disapproving and 5 being the most approving. There are multiple scenarios, and the scores are totaled. In addition, if an opportunity arises, we can measure the 24-hour urine sodium level of participants to calculate their daily salt intake, and then compare it with the Food Frequency Questionnaire [7], which can more accurately assess whether the participants are truly engaging in "salt control behavior." If there is additional time to study this topic, we will investigate the impact of other factors, such as family dynamics, on adolescents' awareness of salt reduction. Additionally, we will examine the direction of dining place construction from a policy perspective.

## VI. CONCLUSION

This study found that the main factors influencing adolescents' salt reduction behavior are their attention to and mastery of nutrition knowledge, as reflected by their salt-related test scores, though there is no direct relationship between test scores and salt reduction behavior. This study highlights the discrepancy between individuals' willingness to reduce their salt consumption and their actual behavior in controlling their salt intake. This means that adolescents are willing to reduce their salt intake, but they do not actually follow through with this intention. The study also identifies the characteristics of individuals who have relatively low willingnesses to decrease their salt consumption. These individuals include adolescents with a higher body mass index (BMI) and a stronger preference for salty foods. This may be caused by an increased salt sensitivity threshold resulting from repeated stimulation of salt taste receptors when frequently exposed to salty foods. Although it is generally believed that taste is innate and difficult to alter, some researchers argue that acquired intervention can modify one's taste preferences [3]. However, there are still ways to help adolescents control their salt consumption. One effective method is to promote salt-related health education and campaigns in the community where adolescents spend most of their time, such as in schools.

## REFERENCES

- [1] *Chinese Dietary Guidelines for Residents (2022)*. People's Medical Publishing House, Beijing, 2022.
- [2] J. S. Bao, Y. Y. Cheng, Y. X. Yang, and Z. Wang. Assessment of salt reduction knowledge and barriers to behavior change among chinese residents. *Acta Nutrimenta Sinica*, 36(5):421–425, 2014.
- [3] Gary K Beauchamp and Karl Engelman. High salt intake. sensory and behavioral factors. *Hypertension*, 17(1\_supplement):I176, 1991.
- [4] S. Chen, L. Shan, W. Tao, T. Lu, Á. Regan, H. Han, and P. ... Wall. A survey of chinese consumers' knowledge, beliefs and behavioral intentions regarding salt intake and salt reduction. *Public Health Nutrition*, 23(8):1450–1459, 2020.
- [5] Q. Jiang, G. Y. Ji, X. M. Hong, and Z. H. Chen. Salt and health. *South China Journal of Preventive Medicine*, (1):79–82, 2018.
- [6] D. M. Lenda and M. A. Boegehold. Effect of a high-salt diet on oxidant enzyme activity in skeletal muscle microcirculation. *American Journal of Physiology-Heart and Circulatory Physiology*, 282(2):H395–H402, 2002.
- [7] J. H. Li, Z. L. Lu, L. X. Yan, J. Y. Zhang, J. L. Tang, X. N. Cai, and A. Q. ... Xu. A comparison of the weight method, frequency method, and 24-hour urinary sodium excretion method for assessing salt intake in the population. *Chinese Journal of Preventive Medicine*, (12):1093–1097, 2014.
- [8] T.Y. Shen, Y. H. Ma, P. H. Zhang, L. X. Lu, and X. Gao. Oil and salt knowledge and eating behavior of primary and secondary school students in xicheng district, beijing. *School Hygiene in China*, 34(8):932–933, 2013.
- [9] C. L. Xiao, K. You, W. L. Cheng, Y. Zhang, S. W. Zhang, H. Y. Zhao, and C. Q. Li. Investigation of salt-related knowledge, beliefs, and behaviors among primary and middle school students in shunyi district, beijing. *Occupational and Health*, 33(8):1114–1116, 2017.
- [10] J. Xu. *Research on the strategies for implementing salt reduction in China*. PhD thesis, Chinese Center for Disease Control and Prevention, Beijing, 2014.
- [11] Y. F. Zhao, J. Ren, M. Liu, J. Chu, Z. J. Xu, L. X. Yan, and ... Analysis of the current status of salt-related knowledge, attitudes, and practices among 6-17-year-old students in shandong province in 2016. *Chinese Journal of Health Education*, (2):171–174, 2019.