

## Policy Forum



## Inaccuracy of Self-reported Low Sodium Diet among Chinese: Findings from Baseline Survey for Shandong & Ministry of Health Action on Salt and Hypertension (SMASH) Project\*

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**This study was aimed to evaluate the agreement between the self-reported sodium intake level and 24-h urine sodium excretion level in Chinese. The 24-h urine collection was conducted among 2112 adults aged 18-69 years randomly selected in Shandong Province, China. The subjects were asked whether their sodium intake was low, moderate, or high. The weighted kappa statistics was calculated to assess the agreement between 24-h urine sodium excretion level and self-reported sodium intake level. One third of the subjects reported low sodium intake level. About 70% of the subjects had mean 24-h sodium excretion >9 g/d, but reported low or moderate sodium intake. The agreement between self-reported sodium intake level and 24-h urine sodium excretion level was low in both normotensive subjects and hypertensive subjects. These findings suggested that many subjects who reported low sodium intake had actual urine sodium excretion >9 g/d. Sodium intake is often underestimated in both hypertensive and normotensive participants in China.**

Excessive sodium intake is known to be a risk factor of hypertension<sup>[1-3]</sup>. The Chinese diet is high in it, and about 80% of the Chinese food sodium intake level exceeded the upper level of sodium chloride intake (6 g/d) recommended by the Chinese Nutrition Society<sup>[4]</sup>. In 2010, the estimated average

salt intake of Chinese was 9.1 g/d in urban area and 11.5 g/d in rural area<sup>[4]</sup>. Unlike western countries, dietary sodium in China is mainly from salt added in home cooking<sup>[5]</sup>.

In 2011, the Chinese Ministry of Health (MoH) selected Shandong Province as a national pilot area for the reduction of sodium intake, and initiated Shandong & MoH Action on Salt and Hypertension (SMASH) Project. China's population is approximately 1.3 billion, and population in Shandong accounts for 7% of the total. Shandong is the second most populated province in China, and provincial representative data indicate that the average daily sodium intake in the residents in Shandong was 12.5 g/d<sup>[6]</sup>. Most dietary sodium (80.8%) is from condiments added while cooking, including salt, soy bean sauce, other high sodium sauces, and monosodium glutamate (MSG)<sup>[6]</sup>.

Accurate measurement of sodium intake is crucial for effective sodium reduction and hypertension management. Methods to evaluate salt intake, such as 24-h urine sodium excretion, 24-h dietary recall, and food frequency questionnaire are costly and time-consuming, so they are not applicable in large-scale surveys<sup>[7]</sup>. The widely used dietary recall questionnaire simply asks subject whether he or she has a low sodium intake and is easy to complete. For hypertension management

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and effective control of salt intake, it is important to examine whether self-reported sodium intake level reflects actual level of sodium intake or not and evaluate the agreement between self-reported sodium intake level and actual sodium intake level. Research results from U.S. and South Korea suggested that agreement between self-reported sodium intake level and actual urine sodium excretion level is low<sup>[7-8]</sup>. This study was aimed to evaluate the association between self-reported sodium intake level and actual sodium intake level among a representative sample of Chinese living in Shandong Province.

**Subjects** The data from the cross-sectional baseline survey of the Shandong and MoH Collaborative Action on Salt Reduction and Hypertension Project (SMASH, 2011-2015) were used. Details of the baseline survey of the SMASH project have been described previously<sup>[6,9]</sup>.

**24-h urine Collection and Measurements** A total of 2184 subjects were included in the survey, and 24-h urine sample collection was conducted among them. Finally 2112 urine samples were collected. The subjects were given instruction on how to collect standard 24-h urine sample and standard urine containers were provided. Details of the 24-h urine collection and measurements have been described previously<sup>[10]</sup>. The quality of urine sample collection was under control of trained health staff at each survey site.

A 24-h urine collection was considered complete if creatinine excretion level was  $\geq 20$  mg/kg in men or  $\geq 15$  mg/kg in women, and incomplete if below those amounts<sup>[8]</sup>. Actual intake of sodium was calculated by multiplying the factor of 100/95 because sodium excretion through urine is on average 95% of the intake<sup>[11]</sup>. A 24-h urine sodium excretion level was classified as low  $\leq 6$  g/d, moderate 6-9 g/d, and high  $\geq 9$  g/d, which were consistent with the Chinese Dietary Recommendation for healthy persons (i.e. under 6 g/d)<sup>[10]</sup>, and the National Plan on Non-communicable Disease (NCD) Prevention and Control<sup>[12]</sup>, which set the goal of reducing sodium intake to  $\leq 9$  g/d.

**Self-reported Dietary Sodium Intake** The subjects also completed a self-administered questionnaire, which included the question whether they considered their sodium intake level to be low, moderate, or high. Closed-ended questionnaires were completed during face-to-face interviews by trained public health staff.

**Statistical Analysis** Statistical analyses were

performed with STATA 12.0 for Windows (Stata Corp, College Station, TX). The characteristics of the study subjects were described by using standard summary statistics. The weighted kappa statistic was calculated to evaluate agreement between the actual sodium intake level measured by 24-h urine sodium excretion and self-reported sodium intake level in all the subjects and in both hypertensive subjects and normotensive subjects. This study was approved by the Ethics Committee of Shandong Center for Disease Control and Prevention, and the subjects provided their written informed consent.

The characteristics of the study subjects are shown in Table 1. The majority (75.1%) of the subjects reported low education level (i.e. junior high school or below). Nearly one fourth (23.5%) of subjects were hypertensive, and the mean age of the hypertensive subjects were 49.5 years.

The hypertensive subjects were more likely to be less educated than normotensive subjects ( $\chi^2=81.4, P<0.01$ ). For all the subjects, mean 24-h urine sodium excretion was  $13.7\pm 5.3$  g/d; mean 24-h creatinine excretion was  $15.7\pm 6.2$  mg/kg; and mean 24-h urine volume was  $1531.2\pm 636.6$  mL. Approximately 60% of 24-h urine collection was considered complete. Overall, hypertensive subjects were more likely to report high sodium intake than normotensive subjects, the difference was statistical significant ( $\chi^2=17.5, P<0.01$ ).

Approximately one third (29.6%) of the subjects reported low sodium intake, 42.1% reporting a high sodium intake and 28.3% reporting moderate sodium intake (Table 2). The education level and age specific differences in self-reported sodium intake level were statistical significant ( $\chi^2=44.0, P<0.01$ ;  $\chi^2=62.9, P<0.01$ ). Overall, older subjects were more likely to report high sodium intake than younger subjects. The subjects with higher education level were less likely to report high sodium intake than the subjects with lower education level. No significant association was observed between self-reported sodium intake level and actual sodium intake measured by 24-h urine sodium excretion, which was classified as  $\leq 6$  g/d, 6-9 g/d, and  $\geq 9$  g/d ( $\chi^2=5.9, P=0.21$ ).

The average 24-h urine sodium excretion level was  $>9$  g/d in about 70% of the subjects (1258) who reported low or moderate sodium intake level (Table 3). The sex, age, education level, and blood pressure status specific comparisons were made between these subjects and the subjects who had average 24-hour urine sodium excretion  $>9$  g/d but

reported high sodium intake level, the results indicated that the differences were statistical significant among different age groups ( $\chi^2=37.7$ ,  $P<0.01$ ), among the subjects with different education level ( $\chi^2=31.3$ ,  $P<0.01$ ), and among the subjects with different blood pressure status ( $\chi^2=5.1$ ,  $P=0.02$ ).

Younger subjects ( $\chi^2=37.7$ ,  $P<0.01$ ), subjects with lower education level ( $\chi^2=31.3$ ,  $P<0.01$ ), and hypertensive subjects ( $\chi^2=5.1$ ,  $P=0.02$ ) who had average 24-h urine sodium excretion  $>9$  g/d were more likely to report low or moderate sodium intake level than older, well educated and normotensive subjects.

**Table 1.** Characteristics of Study Subjects According to Hypertensive Status

| Characteristics                | n (%)          |                       |                      | P Value |
|--------------------------------|----------------|-----------------------|----------------------|---------|
|                                | Total (n=2110) | Normotensive (n=1615) | Hypertensive (n=495) |         |
| Age (y) <sup>a</sup>           | 41.1 (14.1)    | 38.6 (13.4)           | 49.5 (12.9)          | <0.01   |
| Age group (y)                  |                |                       |                      | <0.01   |
| 18-29                          | 558 (26.4)     | 516 (32.0)            | 42 (8.5)             |         |
| 30-39                          | 530 (25.1)     | 443 (27.4)            | 85 (17.2)            |         |
| 40-49                          | 397 (18.8)     | 289 (17.9)            | 108 (21.8)           |         |
| 50-59                          | 331 (15.7)     | 216 (13.4)            | 115 (23.2)           |         |
| 60-69                          | 296 (14.0)     | 151 (9.4)             | 145 (29.3)           |         |
| Sex                            |                |                       |                      | 0.15    |
| Male                           | 1104 (52.3)    | 831 (51.5)            | 273 (55.2)           |         |
| Female                         | 1006 (47.7)    | 784 (48.5)            | 222 (44.8)           |         |
| Education                      |                |                       |                      | <0.01   |
| illiteracy                     | 290 (13.8)     | 174 (10.8)            | 116 (23.4)           |         |
| Primary school                 | 405 (19.2)     | 282 (17.5)            | 123 (24.9)           |         |
| Junior high school             | 887 (42.1)     | 718 (44.5)            | 169 (34.1)           |         |
| Senior high school             | 320 (15.2)     | 259 (16.1)            | 61 (12.3)            |         |
| College and above              | 206 (9.8)      | 180 (11.2)            | 26 (5.3)             |         |
| Urban/rural                    |                |                       |                      | 0.04    |
| Urban                          | 668 (31.7)     | 530 (37.8)            | 138 (27.9)           |         |
| Rural                          | 1442 (68.3)    | 1085 (67.2)           | 357 (72.1)           |         |
| Urine volume <sup>a</sup>      | 1531.2 (636.6) | 1512.3 (630.1)        | 1593.9 (653.9)       |         |
| 24-h urine sodium <sup>a</sup> | 13.7 (5.3)     | 13.5 (5.3)            | 14.3 (5.3)           | <0.01   |
| Measured 24-h urine sodium     |                |                       |                      | <0.01   |
| <6 g/d                         | 95 (4.5)       | 84 (5.2)              | 11 (2.2)             |         |
| 6-9 g/d                        | 234 (11.1)     | 190 (11.8)            | 44 (8.9)             |         |
| ≥9 g/d                         | 1780 (84.4)    | 1340 (83.0)           | 440 (88.9)           |         |
| Salt perception                |                |                       |                      | <0.01   |
| Self-reported 'low'            | 622 (29.6)     | 462 (28.7)            | 160 (32.3)           |         |
| Self-reported 'average'        | 886 (42.1)     | 717 (44.5)            | 169 (34.1)           |         |
| Self-reported 'high'           | 597 (28.3)     | 431 (26.8)            | 166 (33.6)           |         |

**Note.** <sup>a</sup>Data were means (standard deviations) or proportions(%). *P* values were obtained by using *t* test, chi-squared test, or Wilcoxon's rank sum test as appropriate.

**Table 2.** Number (%) of Respondents in each Self-reported Category, by Demographic Characteristics

| Characteristics                | Self-reported Sodium Intake [n (%)] |            |            | P Value |
|--------------------------------|-------------------------------------|------------|------------|---------|
|                                | Low                                 | Average    | High       |         |
| Total                          | 622 (29.6)                          | 886 (42.1) | 597 (28.3) |         |
| Age                            |                                     |            |            | <0.01   |
| 18-29                          | 159 (28.6)                          | 290 (52.2) | 107 (19.2) |         |
| 30-39                          | 158 (29.9)                          | 231 (43.8) | 139 (26.3) |         |
| 40-49                          | 108 (27.2)                          | 138 (34.8) | 151 (38.0) |         |
| 50-59                          | 93 (28.2)                           | 131 (39.7) | 106 (32.1) |         |
| 60-69                          | 104 (35.1)                          | 97 (32.8)  | 95 (32.1)  |         |
| Sex                            |                                     |            |            | 0.11    |
| Male                           | 307 (27.9)                          | 464 (42.1) | 331 (30.0) |         |
| Female                         | 315 (31.3)                          | 423 (42.1) | 267 (26.6) |         |
| Education                      |                                     |            |            | <0.01   |
| Illiteracy                     | 90 (31.3)                           | 105 (36.5) | 93 (32.2)  |         |
| Primary school                 | 118 (29.0)                          | 147 (36.1) | 142 (34.9) |         |
| Junior high school             | 256 (28.9)                          | 365 (41.2) | 265 (29.9) |         |
| Senior high school             | 101 (31.6)                          | 158 (49.4) | 61 (19.0)  |         |
| Any college                    | 56 (27.5)                           | 111 (54.4) | 37 (18.1)  |         |
| Urban/rural                    |                                     |            |            | 0.03    |
| Urban                          | 176 (26.4)                          | 307 (46.1) | 183 (27.5) |         |
| Rural                          | 446 (31.0)                          | 580 (40.3) | 415 (28.8) |         |
| 24-h urine sodium <sup>a</sup> | 13.5 (5.1)                          | 13.3 (5.0) | 14.5 (5.9) | <0.01   |
| Measured 24-h urine sodium     |                                     |            |            | 0.21    |
| <6 g/d                         | 155 (25.0)                          | 288 (32.5) | 176 (29.4) |         |
| 6-9 g/d                        | 305 (49.0)                          | 393 (44.4) | 247 (41.4) |         |
| ≥9 g/d                         | 162 (26.0)                          | 205 (23.1) | 174 (29.2) |         |

**Note.** <sup>a</sup>Data were means (standard deviations).

**Table 3.** Comparison between Self-reported Sodium Intake and 24-h Sodium Excretion, by Demographics

| Characteristics    | Self-reported Low or Average (n=1258) (%) | Remainder of Subjects in Sample (n=519) (%) | $\chi^2$ | P Value |
|--------------------|---|---|----------|---------|
| Gender             |   |   | 1.49     | 0.22    |
| Male               | 52.7                                      | 55.9  |          |         |
| Female             | 47.3                                      | 44.1  |          |         |
| Age (y)            |   |   | 37.7     | <0.01   |
| 18-29              | 28.4                                      | 18.1  |          |         |
| 30-39              | 27.1                                      | 23.1  |          |         |
| 40-49              | 16.1                                      | 25.4  |          |         |
| 50-59              | 15.4                                      | 17.7  |          |         |
| 60-69              | 13.0                                      | 15.6  |          |         |
| Education          |   |   | 31.3     | <0.01   |
| Illiteracy         | 13.7                                      | 16.0  |          |         |
| Primary school     | 17.4                                      | 23.5  |          |         |
| Junior high school | 40.4                                      | 44.1  |          |         |
| Senior high school | 16.8                                      | 10.0  |          |         |
| Any college        | 11.7                                      | 6.4   |          |         |
| Residence          |   |   | 0.49     | 0.49    |
| Urban              | 32.2                                      | 29.5  |          |         |
| Rural              | 68.8                                      | 70.5  |          |         |
| Hypertension       |   |   | 5.10     | 0.02    |
| Yes                | 76.7                                      | 71.6  |          |         |
| No                 | 23.3                                      | 28.4  |          |         |

Table 4 compared self-reported sodium intake level and measured 24-h urine sodium excretion level in normotensive and hypertensive subjects. About 83.4% of the subjects who reported low or moderate sodium intake level had 24-h urine sodium excretion  $\geq 9$  g/d. Among normotensive subjects, 81.9% who reported a low or moderate sodium intake level had 24-h urine sodium excretion  $\geq 9$  g/d. In contrast, among hypertensive subjects, 89.1% who reported a low or moderate sodium intake level had 24-h urine sodium excretion  $\geq 9$  g/d. The agreement between the self-reported sodium intake level and actual urine sodium excretion level was low. The agreement rate was 63.2% and the weighted kappa statistic was 0.01 for all the subjects. The agreement rate was 63.7% and the kappa statistic was 0.011 for normotensive subjects. The agreement rate was 61.4% and the kappa statistic was 0.002 for hypertensive subjects. The pattern remains same for both complete urine collection and incomplete urine collection.

The average sodium intake of the subjects in this study was 13.7 g/d, twice higher than the recommendation of maximum sodium intake (6 g/d) in 2007. These results show that excessive salt intake is a problem among residents in Shandong, and self-reported sodium intake seemed to be inaccurate when compared with 24-h urine sodium excretion.

This study found that although nearly 90% of the subjects had average sodium intake  $>6$  g/d indicated by their 24-h urine sodium excretion, only 28.3% of the subjects reported a high sodium intake. Nearly

85% of the subjects who reported low or moderate sodium intake excreted sodium  $>9$  g/d. The findings suggested that the agreement between self-reported sodium intake level and actual urine sodium excretion level was low, similar to the findings from South Korea<sup>[7]</sup> and USA<sup>[8]</sup>. A previous study in South Korea reported that 74.1% of the subjects who reported less salty diet excreted salt  $>10$  g/d<sup>[7]</sup>. A study in the United States reported that 75% of the subjects who reported low sodium intake excreted sodium  $>100$  mEq/d, equivalent to 6 g/d<sup>[8]</sup>. Though consumer were aware of sodium in food<sup>[13-14]</sup>, the results indicate that, in practice, we should not assume that an individual who reports low sodium diet has actual sodium intake  $<6$  g/d unless a low sodium intake is confirmed with actual measurement, such as a 24-h urine collection or a spot urine sodium/creatinine ratio<sup>[8]</sup>. Therefore, self-reported sodium intake level should not be used as a reliable indicator to assess the actual sodium intake level in Chinese.

Sodium intake is a nutritional behavior influenced by multi factors<sup>[15]</sup>. High salt intake would gradually impair the taste perception to salt, and impaired taste perception would result in involuntary excess salt consumption<sup>[15]</sup>. Although 70% of the subjects in the present study had sodium intake  $>9$  g/d, their self-reported sodium intake level was lower than the actual intake level. This suggests that decreased taste perception to salt is common in Chinese. A previous Chinese study suggested that those who perceived their high sodium intake were more likely to reduce the sodium intake<sup>[9]</sup>. The fact

**Table 4.** Self-reported Sodium Intake Versus Measured 24-h Sodium Excretion: Inaccuracy in Reporting Sodium Intake in Hypertensive and Non-Hypertensive Participants Residing in Shandong

| Characteristics       | Self-reported Na Intake |      | Overall Agreement (%) | Weighted Kappa (95% CI) |
|-----------------------|-------------------------|------|-----------------------|-------------------------|
|                       | Low or average          | High |                       |                         |
| Total sample (n=2107) | 1509                    | 598  | 63.2                  | 0.01 (-0.006, 0.031)    |
| <6 g/d                | 4.7                     | 4.2  |                       |                         |
| 6-9 g/d               | 11.9                    | 9.0  |                       |                         |
| $\geq 9$ g/d          | 83.4                    | 86.8 |                       |                         |
| Normotensive (n=1610) | 1179                    | 431  | 63.7                  | 0.011 (0.001, 0.029)    |
| <6 g/d                | 5.4                     | 4.6  |                       |                         |
| 6-9 g/d               | 12.7                    | 9.3  |                       |                         |
| $\geq 9$ g/d          | 81.9                    | 86.1 |                       |                         |
| Hypertensive (n=495)  | 329                     | 166  | 61.4                  | 0.002 (-0.018, 0.015)   |
| <6 g/d                | 1.8                     | 3.0  |                       |                         |
| 6-9 g/d               | 9.1                     | 8.4  |                       |                         |
| $\geq 9$ g/d          | 89.1                    | 88.6 |                       |                         |

that a large number of people with actual sodium intake >9 g/d fail to perceive their risk implies that they are unlikely to be involved in sodium reduction practices, indicating the need to help Chinese become better informed about the recommended dietary sodium intake level and the common underestimation of sodium intake. A previous study reported that only 29.3% of urban residents and 19.2% of rural residents in China were aware of the recommended dietary sodium intake level<sup>[12]</sup>. Therefore, health education is needed to increase the public's awareness of how actual sodium intake compares with the recommended upper limit.

Additionally, the sodium intake reduction is beneficial to both normotensive and hypertensive people. A review of randomized controlled trials, aimed at reducing dietary sodium with follow-up of 6 months or longer, found that systolic and diastolic blood pressure were reduced by an average of 1 mmHg in normotensive and by an average of 2-4 mmHg in hypertensive<sup>[17]</sup>. Although hypertensive subjects were more likely to report high sodium intake than normotensive subjects, 83.4% of hypertensive subjects who reported a low or moderate intake level had a urine sodium excretion level >9 g/d in the present study. Hypertensive subjects tended to underestimate their actual sodium intake. In response to the increased prevalence of non-communicable diseases, China's new health care reform (2009) invested 25 yuan (RMB) per capita or about US \$6.3 billion in total to deliver Essential Public Health Services (EPHS), including management of hypertension (i.e. providing advice on anti-hypertension medication and lifestyle coaching including dietary counseling for sodium reduction)<sup>[18]</sup>. The provision of dietary counseling was based on the self-reported saltiness of foods instead of 24-h urine collection. Studies found that only 17.1% of hypertensive participants managed by the primary health care providers replied 'eating salty foods' or 'eating very salty foods,' which might preclude the dietary counseling for sodium intake reduction and, in turn, lead to ineffective management of blood pressure<sup>[19]</sup>. A national survey conducted during 2011-2012 among Chinese aged ≥45 years reported that among the subjects with hypertension, about 80% were not controlling it well<sup>[18]</sup>. Hence, self-report of a low-sodium diet should not preclude dietary counseling in order to effectively manage hypertensi.

A limitation of the study was that only a single 24-h urine collection sample was obtained from each

subjects. A single collection will less accurately reflect 24-h sodium intake than multi collections. However, the day-to-day variation in sodium excretion can vary in both directions, so it is unlikely that the findings overstated the inaccuracy of reporting low sodium intake.

The agreement between self-reported sodium intake level and actual urine sodium excretion level among Chinese was low. The self-reported sodium level was lower than actual sodium intake level. Efforts should be made to increase the public's awareness of how actual sodium intake level compares with the recommended upper limit, which will help Chinese reduce sodium intake. Improving the awareness of the recommended limit of sodium intake is particularly important given the common high sodium intake, ineffective management of hypertension and increasing prevalence of hypertension among Chinese.

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**Conflict of Interest** There are no conflicts of interest relevant to this article.

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