Supplementary Online Content

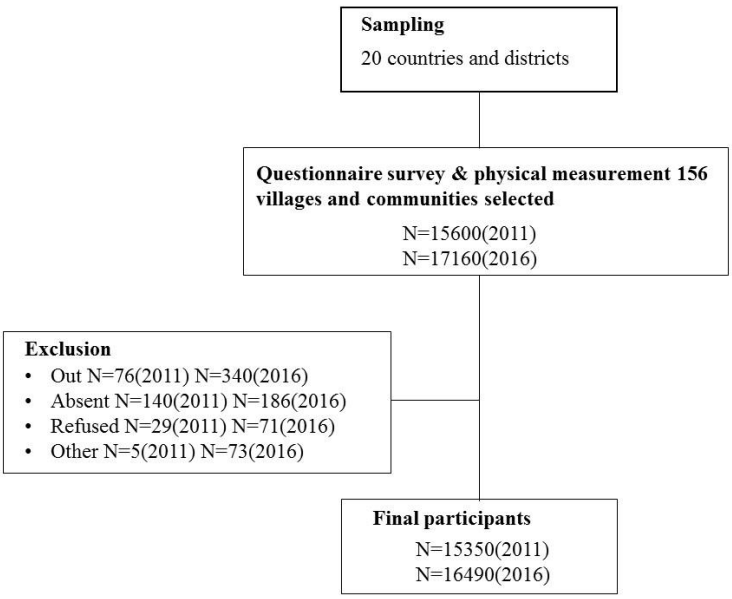
Xu A, Ma J, Guo X, et al. Association of a province-wide intervention on salt intake and hypertension in Shandong Province, China, 2011-2016. *JAMA Intern Med*. Published online April 27, 2020. doi:10.1001/jamainternmed.2020.0904

This supplementary material has been provided by the authors to give readers additional information about their work.

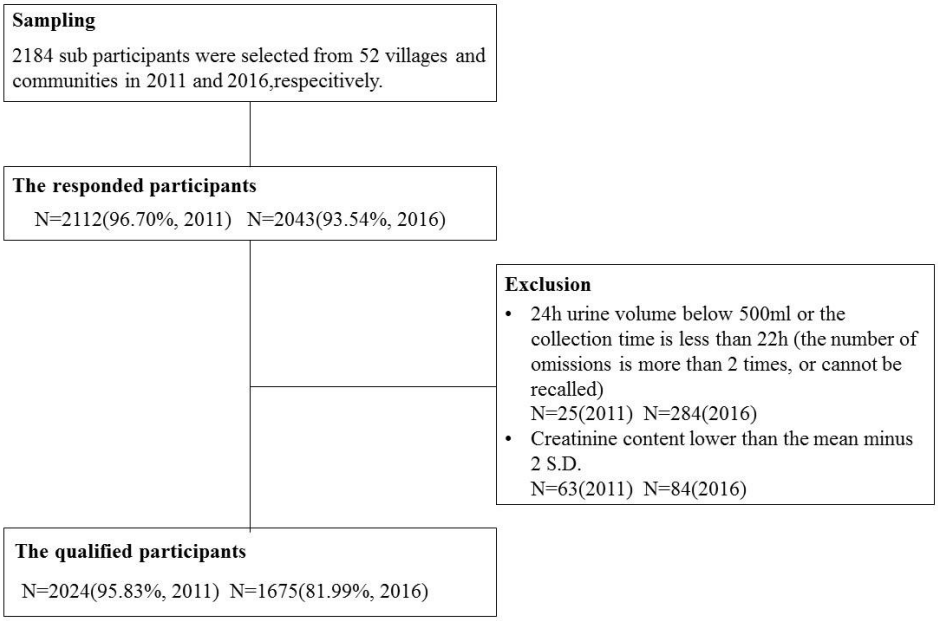
eTable 1. The SMASH Multi-sectoral Brief Roles Summary

Multi sector name	**Brief role**
Bureau of Health	Protocol development implementation and evaluation Technical support of salt reduction for other sectors
Bureau of Education	School teacher and children health education
Public Urban Department	Implement the health education campaign
Develop and Reform Committee	Engaging in policy and environment creation
Economy and Informatization Commission	Engaging food industry salt reduction
Bureau of Science and Technology	Research on salt reduction and hypertension control
Bureau of Finance	Financial support
Bureau of Human Resource and Social Security	Human resource support
Bureau of Commerce	Engaging in food industry salt reduction
Bureau of Industry and Commerce Administration	Engaging in food industry salt reduction
Bureau of Quality Inspection	Food labeling implementation
Tourist Administration	Engaging in the low salt advertising
Food and Drug Administration	Training and advertising in restaurants; Restaurant salt reduction
Bureau of Salt Administration	Salt sales monitoring and advertising
Women Federation	Engage in the house-cookers salt reduction

eFigure 1. Sampling Flowchart for SMASH Evaluation Survey in 2011 & 2016



eFigure 2. Sampling Flowchart for Urinary Excretion Collection in 2011 & 2016



eTable 2. Questions in Knowledge Attitude and Behaviors on Sodium-reduction between Baseline and Post-intervention Survey: Shandong–Ministry of Health Action on Salt and Hypertension (SMASH) Program 2011–2016

Questions in knowledge attitude and behaviors
Knowledge:
a. What is the limit on grams of salt that should be taken by an adult in a day?
Attitude:
a. Should processed food have sodium content on the label?
Behaviors:
a. Does your family ever use the scaled salt spoon?
b. Do you pay attention to sodium content of processed food labels?
c. Are you reducing salt in your diet?

eMethods 1. Methods for Sample Size Calculation

The sample size for the questionnaire survey and physical measurement component of the 2011 survey was calculated based on a hypertension prevalence estimate of 25.1% allowing a margin of error within 10% of the prevalence estimate (or +/-2.51%) with a 5% type I error 85% response rate stratification factor 6 and design effect 2. Based on these parameters it is estimated each stratum requires a sample size of 2699 for a total sample size of 16194 in the 2011 survey and 15350 participants completed the survey with participation rate of 98.4% in 2011. In the 2016 the sample size was estimated based on the same parameters except the hypertension prevalence was changed to 23.4% and response rate to 90% which led to a sample size estimate of 2796 in each stratum and total sample size of 16773 and 16490 participants complete the survey with a participation rate 96.1%.

The sample size for the 24h urinary sodium sample in 2011 was based on an estimated population mean sodium excretion of 4480 mg/day standard deviation of 1354 mg/day allowing a margin of error of 299 mg/day with a 5% type I error 50% successful sample collection rate stratification factor 6 and design effect 2. The estimated sample size in each stratum was 316 for a total sample size of 1896 and 2112 participants completed the 24h urine sample with a participation rate 96.7% in 2011. In the 2016 survey the estimated population mean sodium excretion was changed to 5347 mg/day (based on the mean urinary sodium excretion from the 2011 survey) standard deviation 1955 mg/day allowing a margin of error of 391 mg/day with a 5% type I error 60% successful sample collection rate stratification factor 6 and design effect 2. The estimated sample size in each stratum was 320 for a total sample size of 1920 and 2043 participants completed 24h urine sample with participation rate 93.5%. These sample sizes can detect a 15% sodium reduction with a power of 80% and 5% type I error. Among 2112 and 2043 participants completed 24h urine collection in 2011 and 2016 we excluded 88 and368 incomplete 24h urinary samples in 2011 and 2016 respectively. The final sample size for 24h urinary sodium and potassium excretion were 2024 and 1675 participants for 2011 and 2016 survey respectively.

eMethods 2. Methods for Physical Measurement, 24-hour Urine Collection and Quality Control

1. Blood pressure measurement: HEM-7071 Omron electronic blood pressure monitors were used for blood pressure measurement. The participants were resting in a seated position then measured 3 times every 5 minutes by trained technicians.
2. Body weight, height, and waist circumference measurement**:** the participants wore light indoor clothing without shoes during clinical examination. Waist circumference was measured by soft plastic tape at 1 cm above the navel at minimal respiration.
3. 24 hour urine collection: the first urine of the day was discarded and all urine over the following 24-hour period was collected in a plastic bottle with cap. The urine from one participant was carefully stirred and volume was measured. A 20mL aliquot of urine was immediately frozen at -20℃ and sent to Jinan ADICON Clinical Laboratory for analysis. Trained staff were responsible for quality control at each field site and they recorded both the beginning and ending time of urine collection for each participant. The eligibility of the 24h urine samples was judged with reference to US NIH GenSalt's salt sensitivity-related standards. If the collection time was less than 22h, or more than two urine samples were not collected, or participant recall regarding timing or missed collections was uncertain, or urine volume was <500 ml, or urinary creatinine was not within ±2 standard deviation of the gender-specific mean, then 24h urine samples were deemed as ineligible.

Quality control

4. Quality control in the field

4.1 Survey preparation:

4.1.1 Random principle: Samplings in all stages were centrally controlled by Shandong Center for Disease Control and Prevention and strictly implemented according to the random sampling plan.

4.1.2 Material preparation: Survey materials included questionnaire tools (laptops, tablet PCs, routers, code scanners, printers, blood pressure meters, weight scales, body fat scales, tapes, consumables required in glucose tolerance test, and consumables required in collection of urine samples) and souvenirs to survey respondents.

4.1.3 Organizational coordination: County/district health departments (CDCs) cooperated in the local survey and city/neighborhood committee staff and village doctors assisted in assembling local survey resources and sites.

4.2 Investigator competence and training

Training textbooks were prepared, along with site survey manuals. Investigators participated in survey training. Only those who successfully passed training examinations could perform survey assessments.

4.3 Data collection on survey sites

4.3.1 Investigator self-examination: After completing one questionnaire the investigator checked if there were any missing items.

4.3.2 Site inspection of provincial inspectors: At least one CDC staff was appointed to each survey site as an inspector to observe if site survey procedures strictly followed operational regulations. 5% of

surveys were sampled for physical examination review and review of core questions every day and judged if the physical examination conformed to standards and if the core questions were accurate. A regular meeting was held on the first day of survey for each village (neighborhood committee) to address any issues found on-site.

4.3.4 Questionnaire: A provincial inspector randomly checked 5% of questionnaires each day through listening to audio recordings after survey completion to ensure completeness and logical correctness of questionnaires.

5. Quality control of lab test

5.1 Lab quality control: Urine potassium and sodium tests were performed with the ion selective electrode method and urine creatinine was tested with the enzyme method. Before testing urine samples it was necessary to maintain the instruments and calibrate them, and to evaluate the reliability (including accuracy, precision, and range) of the measuring system. Internal variation was controlled within the established tolerance (mean +/- 2 standard deviations).

5.2 Quality control of standard samples: QC thresholds were established and QC samples of urine were tested during analysis of each lot of investigative samples so as to monitor test quality. A pair of QC samples was set for every 100 urine samples and each pair consisted of one high-concentration QC sample and one low-concentration QC sample.

5.3 Blind sample analysis: For each village/neighborhood surveyed, samples were classified into three subgroups in accordance with low medium and high urine concentrations. One blind sample was selected from each subgroup, and was re-processed with a separate patient code, hiding from the lab that this was a repeat sample. After the lab produced the test results, researchers compared consistency between the blind (repeat) sample and the corresponding original sample to judge the precision of tests. If technical error > 5%， it was considered a meaningful difference, suggesting that the blind sample and the original sample were not consistent.

5.4 Recheck of abnormal samples: Samples with abnormal urinary test values was tested again in labs. Definition for abnormal samples: K>100mmol Na>250mmol.

5.5 Recheck method: Diluted with distilled water

5.6 Data input and cleaning: The input data quality was checked by the data management team. In cases of questionable data, the investigator contacted survey subjects to verify the data in order to ensure their accuracy.

eTable 3. Unweighted Differences in 24h Urinary Sodium, Potassium and Urinary Sodium-to-potassium Molar Ratio

Group	Difference in 24h urinary sodium excretion (mg/day 95 CI)					Difference in 24h urinary potassium excretion (mg/day 95 CI)					Difference in 24h urinary sodium-potassium molar ratio (95 CI)			
	Pre-intervention	Post-intervention	Difference	*P*		Pre	Post	Difference	*P*		Pre	Post	Difference	*P*
Total	5347 (5260 to 5435)	4056 (3969 to 4143)	-1291 (-1415 to -1168)	<.001		1591 (1558 to 1624)	1843 (1803 to 1884)	252 (201 to 305)	<.001		6.7 (6.6 to 6.9)	4.3 (4.2 to 4.4)	-2.4 (-2.6 to -2.2)	<.001
Gender														
Male	5561 (5431 to 5690)	4378 (4244 to 4512)	-1183 (-1369 to -997)	<.001		1556 (1513 to 1600)	1833 (1772 to 1894)	277 (204 to 350)	<.001		7.1 (6.8 to 7.3)	4.7 (4.5 to 4.8)	-2.4 (-2.7 to -2.1)	<.001
Female	5113 (4998 to 5228)	3735 (3628 to 3843)	-1378 (-1535 to -1220)	<.001		1628 (1578 to 1679)	1853 (1800 to 1907)	225 (151 to 299)	<.001		6.3 (6.1 to 6.6)	3.9 (3.7 to 4.0)	-2.4 (-2.7 to -2.2)	<.001
Age Range y														
Youth (18-44)	5399 (5280 to 5517)	4157 (4031 to 4282)	-1242 (-1415 to -1069)	<.001		1572 (1530 to 1614)	1743 (1689 to 1796)	171 (104 to 238)	<.001		6.8 (6.6 to 7.1)	4.5 (4.4 to 4.7)	-2.3 (-2.6 to -2.0)	<.001

Middle aged (45-59)	5372 (5204 to 5540)	4105 (3965 to 4245)	-1267 (-1486 to -1048)	<.001		1650 (1581 to 1720)	1948 (1876 to 2020)	298 (197 to 398)	<.001		6.5 (6.2 to 6.8)	4.1 (4.0 to 4.3)	-2.4 (-2.7 to -2.0)	<.001
Aged (60-69)	5082 (4891 to 5273)	3512 (3286 to 3739)	-1570 (-1486 to -1048)	<.001		1561 (1479 to 1644)	1931 (1819 to 2043)	370 (197 to 398)	<.001		6.5 (6.0 to 6.9)	3.5 (3.3 to 3.8)	-3 (-2.7 to -2.0)	<.001
Urban/Rural														
Urban	5151 (5006 to 5295)	4176 (4022 to 4330)	-975 (-1187 to -762)	<.001		1563 (1502 to 1623)	1916 (1840 to 1991)	353 (256 to 450)	<.001		6.7 (6.4 to 7.0)	4.2 (4.0 to 4.3)	-2.5 (-2.9 to -2.2)	<.001
Rural	5438 (5329 to 5547)	4003 (3897 to 4108)	-1435 (-1587 to -1284)	<.001		1604 (1564 to 1643)	1811 (1763 to 1860)	207 (145 to 270)	<.001		6.7 (6.5 to 6.9)	4.3 (4.2 to 4.5)	-2.4 (-2.6 to -2.2)	<.001
BMI status														
Normal	5043 (4927 to 5159)	3673 (3553 to 3794)	-1370 (-1543 to -1197)	<.001		1530 (1484 to 1576)	1718 (1658 to 1778)	188 (113 to 262)	<.001		6.6 (6.3 to 6.8)	4.1 (4.0 to 4.3)	-2.5 (-2.7 to -2.1)	<.001
Overweight	5475 (5329 to 5621)	4118 (3973 to 4262)	-1357 (-1564 to -1151)	<.001		1636 (1578 to 1693)	1929 (1858 to 2000)	293 (202 to 385)	<.001		6.6 (6.4 to 6.9)	4.2 (4.0 to 4.4)	-2.4 (-2.8 to -2.1)	<.001

Obese	5940 (5696 to 6183)	4559 (4362 to 4755)	-1381 (-1695 to -1068)	<.001		1671 (1587 to 1755)	1911 (1827 to 1995)	240 (121 to 360)	<.001		7.3 (6.8 to 7.7)	4.6 (4.4 to 4.9)	-2.7 (-3.2 to -2.2)	<.001
Education														
Primary middle school and under	5382 (5281 to 5484)	4041 (3943 to 4138)	-1341 (-1484 to -1199)	<.001		1600 (1560 to 1639)	1841 (1794 to 1888)	241 (180 to 303)	<.001		6.7 (6.5 to 6.9)	4.3 (4.2 to 4.4)	-2.4 (-2.7 to -2.2)	<.001
High school and above	5248 (5076 to 5420)	4104 (3913 to 4295)	-1144 (-1402 to -887)	<.001		1566 (1505 to 1627)	1850 (1769 to 1931)	284 (183 to 386)	<.001		6.6 (6.3 to 6.9)	4.2 (4.0 to 4.4)	-2.4 (-2.8 to -2.0)	<.001
Blood Pressure Status														
Normal	5208 (5084 to 5333)	3850 (3732 to 3967)	-1358 (-1532 to -1184)	<.001		1594 (1545 to 1644)	1811 (1752 to 1870)	217 (139 to 293)	<.001		6.4 (6.2 to 6.7)	4.1 (3.9 to 4.2)	-2.3 (-2.6 to -2.1)	<.001
Pre-hypertension	5405 (5241 to 5568)	4127 (3969 to 4284)	-1278 (-1505 to -1051)	<.001		1613 (1552 to 1675)	1889 (1818 to 1961)	276 (181 to 370)	<.001		6.7 (6.4 to 7.0)	4.2 (4.0 to 4.4)	-2.5 (-2.9 to -2.2)	<.001
Hypertension	5550 (5366 to 5733)	4347 (4147 to 4546)	-1203 (-1474 to -932)	<.001		1551 (1487 to 1616)	1848 (1760 to 1937)	297 (189 to 406)	<.001		7.2 (6.8 to 7.6)	4.7 (4.4 to 5.0)	-2.5 (-3.0 to -2.0)	<.001

Occupation														
(Hard physical work) Farmer/Peasant/Manual worker	5430 (5314 to 5545)	4120 (4004 to 4237)	-1310 (-1473 to -1145)	<.001		1617 (1573 to 1662)	1881 (1825 to 1938)	264 (192 to 336)	<.001		6.7 (6.5 to 6.9)	4.3 (4.2 to 4.5)	-2.4 (-2.6 to -2.1)	<.001
(Light physical work) Service/Administrative/Technical/Professionals/Others	5201 (5058 to 5343)	4002 (3858 to 4146)	-1199 (-1402 to -995)	<.001		1554 (1503 to 1605)	1749 (1690 to 1808)	195 (117 to 272)	<.001		6.6 (6.4 to 6.9)	4.3 (4.1 to 4.5)	-2.3 (-2.7 to -2.0)	<.001
Underemployment/Retired	5263 (4934 to 5592)	3765 (3458 to 4072)	-1498 (-1963 to -1033)	<.001		1463 (1295 to 1630)	2034 (1849 to 2220)	571 (318 to 824)	<.001		7.6 (6.6 to 8.7)	3.7 (3.3 to 4.1)	-3.9 (-4.9 to -2.9)	<.001
Frequencies of eating outside home														
0	5368 (5243 to 5494)	3958 (3837 to 4078)	-1410 (-1585 to -1236)	<.001		1653 (1605 to 1701)	1899 (1841 to 1956)	246 (171 to 320)	<.001		6.5 (6.2 to 6.7)	4.1 (3.9 to 4.2)	-2.4 (-2.7 to -2.1)	<.001
>0 ≤50%	5371 (5180 to 5563)	4277 (4051 to 4503)	-1094 (-1391 to -796)	<.001		1580 (1503 to 1657)	1806 (1707 to 1904)	226 (102 to 350)	<.001		6.8 (6.4 to 7.1)	4.5 (4.2 to 4.8)	-2.3 (-2.7 to -1.8)	<.001
>50% ≤100%	5304 (5139 to 5470)	4245 (4068 to 4422)	-1059 (-1302 to -817)	<.001		1503 (1446 to 1561)	1787 (1702 to 1872)	284 (181 to 386)	<.001		7.1 (6.8 to 7.4)	4.6 (4.4 to 4.8)	-2.5 (-2.9 to -2.0)	<.001

eTable 4. Unweighted Differences in SBP and DBP

Group	SBP (mmHg 95 CI)					DBP (mmHg 95 CI)			
	Pre-intervention	**Post-intervention**	**Difference**	***P***		**Pre**	**Post**	**Difference**	***P***
Total	121.5 (121.3 to 121.8)	120.7 (120.5 to 121.0)	-0.8 (-1.2 to -0.4)	<.001		79.2 (79.0 to 79.3)	77 (76.8 to 77.1)	-2.2 (-2.5 to -2.0)	<.001
Gender									
Male	124.7 (124.4 to 125.1)	124.3 (123.9 to 124.6)	-0.4 (-1.0 to 0.0)	.07		80.7 (80.5 to 81.0)	78.7 (78.4 to 78.9)	-2 (-2.4 to -1.7)	<.001
Female	118.3 (117.9 to 118.8)	117.3 (117.0 to 117.7)	-1 (-1.6 to -0.4)	.001		77.6 (77.3 to 77.9)	75.3 (75.1 to 75.6)	-2.3 (-2.6 to -1.9)	<.001
Age Range y									
Youth (18-44)	116.1 (115.8 to 116.4)	115.8 (115.5 to 116.1)	-0.3 (-0.8 to 0.1)	.12		76.9 (76.7 to 77.2)	74.4 (74.2 to 74.7)	-2.5 (-2.8 to -2.2)	<.001
Middle aged (45-59)	126.9 (126.3 to 127.5)	125.1 (124.7 to 125.6)	-1.8 (-2.5 to -1.0)	<.001		82.5 (82.1 to 82.9)	80.2 (79.9 to 80.5)	-2.3 (-2.8 to -1.9)	<.001
Aged (60-69)	134.3 (133.5 to 135.2)	130.2 (129.4 to 131.1)	-4.1 (-2.5 to -1.0)	<.001		82.4 (81.9 to 82.9)	78.8 (78.4 to 79.3)	-3.6 (-2.8 to -1.9)	<.001
Urban/Rural									
Urban	119.4 (118.8 to 119.9)	119.3 (118.8 to 119.7)	-0.1 (-0.8 to 0.6)	.77		78.4 (78.0 to 78.7)	76.8 (76.5 to 77.1)	-1.6 (-2.0 to -1.1)	<.001
Rural	122.5 (122.2 to 122.9)	121.4 (121.1 to 121.7)	-1.1 (-1.6 to -0.7)	<.001		79.5 (79.3 to 79.7)	77 (76.8 to 77.2)	-2.5 (-2.8 to -2.2)	<.001
BMI status									
Normal	116.8 (116.4 to 117.1)	115.1 (114.8 to 115.5)	-1.7 (-2.2 to -1.1)	<.001		75.1 (74.8 to 75.3)	72.3 (72.1 to 72.5)	-2.8 (-3.1 to -2.4)	<.001
Overweight	124.1 (123.6 to 124.6)	122.2 (121.8 to 122.6)	-1.9 (-2.6 to -1.3)	<.001		81.2 (80.9 to 81.5)	78 (77.7 to 78.2)	-3.2 (-3.6 to -2.8)	<.001
Obese	130.3 (129.5 to 131.0)	128.6 (128.0 to 129.1)	-1.7 (-2.6 to -0.8)	<.001		87 (86.6 to 87.5)	83.7 (83.3 to 84.1)	-3.3 (-3.9 to -2.7)	<.001
Education									
Primary middle school and under	122.8 (122.5 to 123.2)	121.9 (121.6 to 122.3)	-0.9 (-1.4 to -0.4)	<.001		79.7 (79.5 to 79.9)	77.6 (77.4 to 77.8)	-2.1 (-2.3 to -1.8)	<.001
High school and above	117.3 (116.8 to 117.8)	117.5 (117.0 to 118.0)	0.2 (-0.5 to 0.9)	.58		77.5 (77.1 to 77.8)	75.2 (74.8 to 75.5)	-2.3 (-2.8 to -1.8)	<.001
Blood Pressure Status									
Normal	107.1 (106.9 to 107.3)	107.5 (107.3 to 107.6)	0.4 (0.1 to 0.6)	.002		70.1 (69.9 to 70.2)	68.8 (68.7 to 68.9)	-1.3 (-1.5 to -1.1)	<.001
Pre-hypertension	124.3 (124.1 to 124.5)	125.8 (125.6 to 126.0)	1.5 (1.2 to 1.7)	<.001		81.3 (81.2 to 81.4)	79.7 (79.5 to 79.9)	-1.6 (-1.8 to -1.4)	<.001

Hypertension	144.9 (144.4 to 145.5)	142.5 (142.0 to 143.1)	-2.4 (-3.2 to -1.6)	<.001		93.4 (93.1 to 93.7)	90.8 (90.5 to 91.2)	-2.6 (-3.0 to -2.1)	<.001
Occupation									
(Hard physical work) Farmer/Peasant/Manual worker	122.9 (122.5 to 123.3)	122.6 (122.3 to 123.0)	-0.3 (-0.8 to 0.2)	.26		79.7 (79.5 to 79.9)	78 (77.7 to 78.2)	-1.7 (-2.1 to -1.4)	<.001
(Light physical work) Service/Administrative/Technical/Professionals/Others	118.5 (118.0 to 119.0)	117.7 (117.3 to 118.1)	-0.8 (-1.4 to -0.2)	.01		78 (77.7 to 78.3)	75.2 (75.0 to 75.5)	-2.8 (-3.2 to -2.3)	<.001
Underemployment/Retired	125.3 (123.7 to 127.0)	121.8 (120.6 to 123.0)	-3.5 (-5.5 to -1.5)	.001		80.5 (79.6 to 81.5)	78.1 (77.3 to 78.9)	-2.4 (-3.7 to -1.2)	<.001

eTable 5. Unweighted Differences in Knowledge Attitude and Behavior

Group	**Pre-intervention (%)**	**Post-intervention (%)**	**Difference**	***P***
Knowledge				
Chinese nutrition guidelines recommended salt intake (6g/d)	22.9(22.3 to 23.6)	47.3(46.6 to 48.1)	24.4(23.4 to 25.4)	<.001
Attitude				
Processed food should have its label with sodium content	79.3(78.6 to 79.9)	83.2(82.7 to 83.8)	4.0(3.1 to 4.8)	<.001
Behaviors				
Use salt spoon	7.4(7.0 to 7.8)	27.5(26.8 to 28.1)	20.0(19.2 to 20.8)	<.001
Pay attention to sodium content of processed food labels	10.8(10.3 to 11.3)	24.4(23.8 to 25.1)	13.6(12.8 to 14.4)	<.001
Self-assessment reducing salt in diet	38.4(37.6 to 39.2)	63.4(62.7 to 64.2)	25.0(24.0 to 26.1)	<.001