Urinary Excretion of Sodium, Potassium, and Chloride, but not Iodine, Varies by Timing of Collection in a 24-Hour Calibration Study

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Online Supporting Material

Supplemental Methods 1

Screener Questionnaire for the Urine Calibration Study

Screening Date and Time: _____

Name: _____ Phone: _____

Script for Recruiting Persons Responded to Flyers

Hello, this is _____. I am working for Westat (a research company in Rockville) to find volunteers for a research study on sodium intake and excretion being conducted for the National Center for Health Statistics. Participants will be asked to collect urine samples over a 24-hour period and to answer questions on their diet. We are paying people $150 for participating.

In order to find out if you are eligible to participate in this study, I need to ask you a few questions.

Script for Recruiting Persons from Westat Volunteers Database

Hello, this is _____ calling from Westat. You may recall that you requested to be included in our database of research study volunteers. We are looking for people willing to meet with us for a study on sodium intake and excretion being conducted for the National Center for Health Statistics. Participants will be asked to collect urine samples over a 24-hour period and to answer questions on their diet. We are paying people $150 for participating.

In order to find out if you are eligible to participate in this study, I need to ask you a few questions.

1. What is your age?

:_____: [IF UNDER 18 or OVER 39 YEARS OLD, TERMINATE]

2. RECORD GENDER. IF NOT OBVIOUS, ASK: Are you male or female?

MALE :___: [IF MALE, SKIP TO QUESTION 4]
FEMALE :___:

Recruit 200 participants for each gender, if the respondent's gender group is less than 200 at this time, continue; Otherwise, terminate.

3. Are you currently pregnant or trying to get pregnant?

YES :___: [IF YES, TERMINATE]
NO :___:
DK :___: [IF DK, TERMINATE]
Refused :___: [IF REFUSED, TERMINATE]

4. Do you consider yourself to be Black or African American?

YES :___:
NO :___:

Recruit 200 Black or African American participants, and 200 participants in other races. If the respondent's race group is less than 200 at this time, continue; Otherwise, terminate.

5. Are you currently taking any prescription medication?

YES :___:
NO :___: [IF NO, SKIP TO QUESTION 7]

6. What is the name of the medication?

:_____: [IF THE DRUG NAME IS FOUND IN THE LIST OF “LOOP DIURETICS”, TERMINATE]

7. Have you ever been told by a doctor or other health professional that you have any chronic kidney diseases?

YES :___: [IF YES, TERMINATE]
NO :___:

8. Have you ever been told by a doctor or other health professional that you had hypertension, also called high blood pressure?

YES :___:
NO :___: [IF NO, SKIP TO QUESTION 10]

9. In the past two weeks, did you receive any new treatment or changes in treatment for hypertension?

YES :___: [IF YES, TERMINATE]
NO :___:

10. **Over the past 12 months**, how often did you eat pizza? Would you say never, 1 to 6 times a year, more than 6 times a year but less than once a week, or once a week or more?

NEVER 1

1-6 TIMES A YEAR 2

MORE THAN 6 TIMES A YEAR BUT LESS THAN ONCE A WEEK 3

ONCE A WEEK OR MORE 4

REFUSED 7

DON'T KNOW 9

11. **During the past 30 days**, have you ever eaten frozen meals or frozen pizzas?

YES :___:
NO :___:

12. Next I’m going to ask you about meals. By meal, I mean **breakfast, lunch and dinner**. **During the past 7 days**, how many meals did you get that were prepared **away from home** in places such as restaurants, fast food places, food stands, grocery stores, or from vending machines?

:_____: meals

A. Recruit at least 50 participants (25 male and 25 female) who are likely to have low sodium diet. This is indicated by 1) had pizza less than 6 times in the last 12 months; or 2) never had frozen meals or frozen pizzas in the last 30 days AND never had meals prepared away from home in the last 7 days:

1. If respondent's answer is "1" or "2" for Q10, schedule the appointment.

2. If respondent's answers are "No" for Q11 **and** "0" for Q12, schedule the appointment.

B. Recruit at least 50 participants (25 male and 25 female) who are likely to have high sodium diet. This is indicated by 1) had pizza once a week or more in the last 12 months; or 2) had frozen meals or frozen pizzas in the last 30 days AND had 7 or more meals prepared away from home in the last 7 days:

1. If respondent's answer is "4" for Q10, schedule the appointment.

2. If respondent's answers are "Yes" for Q11 **and** "≥ 7" for Q12, schedule the appointment.

C. Else, if there are less than 300 participants (150 male and 150 female) recruited outside these dietary criteria, schedule the appointment.

D. Otherwise, terminate.

13. When you use salt at home, is it iodized salt?

YES	:___:	
NO	:___:	
Refused	:___:	
Don't Know	:___:	[Flag the participant for data retrieval (DR) during the reminder call; at the end of scheduling, remind the participant to check the answer; DR result will be entered via back-end editing]

IF TERMINATED: I'm sorry, the system is showing that you are not eligible to participate so we cannot use you at this time. [Is it okay if we keep your information in our database so that we can contact you about future studies?] Thank you for your time.

SCHEDULING APPOINTMENT

Thank you for answering my questions. You are eligible to participate in this study. If you agree to take part in this study, we will ask you to collect all your urine in individual containers over a 24-hour period. You will need to come to Rockville for two in-person sessions. The first visit will take about 25 minutes to receive instructions and materials. We will measure your height and weight and give you a urine collection kit to take home. Once you complete the 24 hour urine collection, you will bring all the urine samples back to our office and receive your payment. This second visit will take about 45-60 minutes and you will be asked to answer some questions about your diet. Would you like to participate in the study?

If No: Thank the person and end the conversation.

If Yes:
Let's schedule your first visit. I'll read you some times I have available and you can choose the time that is best for you. *(Schedule the respondent)*

We will need you to be prepared to collection your urine within a few days of this first visit, and so at this first visit on _____we will be asking you to schedule your second visit to return with your urine. It will be helpful to bring your calendar with you for your first appointment.

If you have to cancel your appointment, please call back at 1-888-XXX-XXXX so that we can schedule someone in your place, OK?

Supplemental Methods 2

Compliance Questionnaire for the Urine Calibration Study

FQP1-FQP3 are completed based on Technician's observation. No need to read the questions to the participants.

FQP1. WAS THE TIME OF URINE COLLECTION RECORDED?

YES..... 1
NO ..... 2 (Go to REDO, FQR1)

FQP2. WAS THE LENGTH OF THE COLLECTION TIME WITHIN 22 TO 26 HOURS?

YES..... 1
NO ..... 2 (Go to REDO, FQR1)

FQP3. WAS THE TOTAL AMOUNT OF URINE COLLECTION MORE THAN 500 ML?

YES..... 1
NO ..... 2 (Go to REDO, FQR1)

We would like to ask you several questions about your experience in collecting the urine for a 24 hour period. Your answers to these questions will not affect your payment.

FQ1. (FOR FEMALES ONLY) Were you having your period at any time in the last 24 hours?

YES..... 1 (Go to REDO, FQR1)
NO 2
REFUSED ..... 7 (Go to REDO)
DON'T KNOW..... 9 (Go to REDO)

FQ2. During the 24-hour period, did you collect your urine every time you used the bathroom to urinate?

YES..... 1 (FQ4)
NO 2
REFUSED 7 (FQ4)
DON'T KNOW..... 9 (FQ4)

FQ3. How many times did you miss?

Interviewer instruction: Probe the amount of the void. Do not count as “miss” if the missed void was only a few drops.

|__|__| times

REFUSED 77
DON'T KNOW 99

FQ4. Is there any urine missing from the storage containers for any other reason such as spilling?

YES..... 1
NO 2 (FQ7)
REFUSED 7 (FQ7)
DON'T KNOW..... 9 (FQ7)

FQ5. Were more than a few drops of urine lost?

YES..... 1
NO 2 (FQ7)
REFUSED 7
DON'T KNOW..... 9

FQ6. How many times did this happen?

|__|__| times

REFUSED 77
DON'T KNOW 99

FQ7. Many people when having a bowel movement also urinate. Was there any time when you were not able to collect the complete urine sample because of a bowel movement?

Interviewer instruction: Probe the amount of the void. Do not count as “miss” if the missed void was only a few drops.

YES 1
NO..... 2 (FQ9)
REFUSED 7 (FQ9)
DON'T KNOW 9 (FQ9)

FQ8. How many times did this happen?

|__|__| times

REFUSED 77
DON'T KNOW 99

FQ9. Were you able to keep the storage containers cold in the cooler with ice packs or in the refrigerator until this appointment?

YES	1	(FQ11)
NO	2	
REFUSED	7	(FQ11)
DON'T KNOW	9	(FQ11)

FQ10. How long was the sample not kept cold?

|__|__| minutes/hour

REFUSED 7
DON'T KNOW 9

FQ11. Did you perform this collection on a day that you also went to work?

YES	1
NO	2
DO NOT WORK	3
REFUSED	7
DON'T KNOW	9

FQ12. When collecting the sample, did you have any difficulty in remembering or carrying out the instructions?

YES (specify_____)	1
NO	2
REFUSED	7
DON'T KNOW	9

FQ13. Did you have any other problem when collecting the 24 hr urine sample?

YES (specify_____)	1
NO	2
REFUSED	7
DON'T KNOW	9

BOX 1

If (FQ2=1 AND (FQ4=2 OR FQ5=2) AND FQ7=2), mark as 'CONTINUE' and proceed with dietary interview;

Otherwise, mark as 'REDO' and proceed with item FQR1.

FQR1-FQR2 are completed by Technician for all cases need re-do. No need to read the questions to the participants.

FQR1. DOES THE PARTICIPANT AGREE TO REDO THE COLLECTION?

YES ..... 1 (END OF SECTION, MARK STATUS AS "NOT DONE" WITH COMMENT "NEEDS REDO")
NO 2 (BOX2)

BOX 2

If FQP1=2, go to the end of section, mark status as "NOT DONE" with comment "FAILED TO FOLLOW PROTOCOL".

Else if FQP2=1, go to BOX3;

Else if FQP3=2, go to the end of section, mark status as "NOT DONE" with comment "FAILED TO FOLLOW PROTOCOL".

Else if FQ1 = (1, 7, or 9), go to the end of section, mark status as "NOT DONE" with comment "FAILED TO FOLLOW PROTOCOL".

Otherwise, continue.

FQR2. WAS THE LENGTH OF THE COLLECTION TIME MORE THAN 20 HOURS?

YES .....1 (IF FEMALE, GO BACK TO FQ1, IF MALE, GO BACK TO FQ2; COMPLETE F-U Q'NAIR)
NO .....2 (GO TO END OF SECTION; MARK STATUS AS "NOT DONE" WITH COMMENT "FAILED TO FOLLOW PROTOCOL")

BOX 3

If (FQ3+FQ6+FQ8)=1, mark as 'CONTINUE' and proceed with dietary interview;

Otherwise, go to the end of section, mark status as "NOT DONE" with comment "FAILED TO FOLLOW PROTOCOL".

Online Supporting Material

Supplemental Methods 3

Verification of the completeness for the 24-h urine collections using expected creatinine excretions criterion.

To further verify the completeness of the 24-h urine collections, we conducted additional sensitivity analysis based on expected creatinine excretions criterion.

Methods

Multiple equations have been published to derive the expected urine creatinine value (1-4) and used to evaluate completeness based on the ratio of expected to observed 24-h creatinine (1-8). However, information on the validity of these methods is limited. We used two separate algorithms to calculate expected creatinine values. The first algorithm was developed by Joossens and Geboers (1), where the expected 24-h creatinine excretion (mg/d) = G × body weight (kg), and G = 21 for females and 24 for males. The second algorithm was developed by Mage et al. (2-3), where for males, expected 24-h creatinine (mg/d) = 0.00179 × [140 - age (y)] × [weight (kg)$^{1.5}$ × height (cm)$^{0.5}$] × [1 + 0.18 × (black = 1, other races = 0)] × [1.366 - 0.0159 BMI (kg/m^2)], and for females, expected 24-h creatinine (mg/d) = 0.00163 × [140 - age (y)] × [weight (kg)$^{1.5}$ × height (cm)$^{0.5}$] × [1 + 0.18 × (black = 1, other races = 0)] × [1.429 - 0.0198 BMI (kg/m^2)]. Participants with a ratio of observed to expected 24-h creatinine excretion equal or larger than 0.6 were identified as meeting the expected creatinine excretion criterion (1). The proportion of urine collections identified as meeting the expected creatinine excretion criterion by each algorithm were compared among subgroups and tested for significance using the Fisher's exact test. Differences in total urine volume, 24-h analyte excretions, and dietary intake estimates from 24-h recall between participants who met and who didn't meet the expected creatinine excretion criterion were compared using t tests at the $p < 0.05$ level.

Results

Among 407 participants who provided complete 24-h urine samples, 365 (173 blacks, 192 other races) had a ratio of observed to expected 24-h creatinine excretion equal to or larger than 0.6 in their day 1 collections, when the Joossens algorithm was used to calculate the expected creatinine excretion (**Supplemental Table 1**). The same criterion was met by 373 participants

using the Mage algorithm. Using the Joossens algorithm, 53 out of 66 (80%) black and 42 out of 52 (81%) non-black obese participants met the expected creatinine excretion criterion. These proportions were significantly lower than that of normal weight and overweight participants (92% among blacks, 94% among other races). With the algorithm developed by Mage et al. the proportions of participants meeting the expected creatinine excretion criterion were significantly different between blacks (87%) and other races (96%). While there were no differences among BMI categories within the same race group, the Mage algorithm identified a significantly lower proportion of normal weight participants among blacks than among other races as meeting the expected creatinine excretion criterion (88% vs. 99%).

As expected, there were significant differences in 24-h excretions for most of the analytes we observed between the participants who met and who did not meet the set creatinine criterion (**Supplemental Table 2**). Participants who met the expected creatinine criterion generally had higher sodium, potassium, chloride, creatinine, and iodine excretions. There was no significant difference observed in total urine volume between the two groups as identified by either algorithm among participants of other races. Participants who met and who failed to meet the expected creatinine criterion did not differ in their energy intake and dietary sodium and potassium estimates based on the 24-h dietary interview data (Supplemental Table 2). The only exceptions were among black participants for energy and potassium (identified by Mage algorithm only) intakes.

We conducted sensitivity analysis excluding individuals who failed to meet expected creatinine excretion criterion using either algorithm and found no effect on the reported mean urine volume or any of the analyte excretions (**Supplemental Tables 2 and 3**). Therefore, data from all 407 individuals are included in the analytic sample to produce estimates for this and subsequent reports from the study.

To assess whether the mean sodium and potassium intakes as determined by 24-h urine sodium excretion are similar to that expected, we also calculated the geometric mean for sodium and potassium intakes from 24-h dietary recall data and examined the patterns in these estimates (based on 24-h sodium excretion or 24-h dietary recall) by race and expected creatinine excretion criterion. Sodium and potassium intakes estimated from our day one 24-h dietary recall

interviews appeared to be higher than the excretion values measured from the 24-h urine collections (**Supplemental Table 2**). These observed differences remained after the exclusion of those who did not meet expected creatinine excretion criterion.

Discussion

Based on two of these equations, we found the number of participants who met the expected creatinine criterion were disproportionally lower among obese and black participants. The Joossens equation estimated 24-h creatinine based on gender and total body weight (1). Therefore, it may have overestimated the creatinine excretion among obese individuals, as creatinine excretion can vary by muscle mass and adipose tissue metabolism does not produce creatinine (9). Compared with the estimates from the Joossens equation, those based on the Mage equation (2-3) which adjusts for obesity and race are more homogeneous across BMI categories. However, using the Mage algorithm, a much smaller proportion of black participants met the expected creatinine criterion compared with other races (87% vs. 96%). When we compared the expected creatinine excretions using the Mage equation to the measured creatinine excretions; the ratio between expected and measured 24-h urine creatinine averaged 1.20 (95% CI = 1.15-1.26) for blacks, and 1.03 (95% CI = 1.03-1.10) for other races (**Supplemental Table 4**). Without the race adjustment, this ratio dropped to 1.02 (95% CI = 0.97-1.07) for blacks. The overestimation in 24-h urine creatinine among black adults observed in our data suggests the need to review this adjustment factor in the Mage algorithm. There is no single optimal method to ascertain completeness (4, 7-8), thus use of any of these methods should be interpreted with caution.

Online Supporting Material

Supplemental Table 1. Number of total participants with complete 24-h urine collection in day 1 and samples that met the expected creatinine excretion criterion[1] by race, gender and BMI categories[2,3]

		Total	Samples meeting expected creatinine excretion criterion	
			Joossens[4]	Mage[5]
Black	Total	196	173 (88.3)	170 (86.7)
	Gender			
	Male	89	77 (86.5)	73 (82.0)
	Female	107	96 (89.7)	97 (90.7)
	BMI categories			
	Normal weight	73	65 (89.0)[a,b]	64 (87.7)
	Overweight	57	55 (96.5)[a]	51 (89.5)
	Obese	66	53 (80.3)[b]	55 (83.3)
Other races	Total	211	192 (91.0)	203 (96.2)[*]
	Gender			
	Male	97	90 (92.8)	92 (94.8)[*]
	Female	114	102 (89.5)	111 (97.4)[*]
	BMI categories			
	Normal weight	90	87 (96.7)[a]	89 (98.9)[*]
	Overweight	64	58 (90.6)[a,b]	60 (93.8)
	Obese	52	42 (80.8)[b]	49 (94.2)

[1] Participants with a ratio of observed to expected 24-h creatinine excretion equal or larger than 0.6 were identified as meeting the expected creatinine excretion criterion.

[2] Participants were classified based on their BMI as: normal weight (18.5 $kg/m^2 \leq$ BMI < 25 kg/m^2), overweight (25 $kg/m^2 \leq$ BMI < 30 kg/m^2), or obese (BMI $\geq$ 30 kg/m^2).

[3] Data presented as *n* (% participants with complete day 1 collections). Within a race and BMI category, labeled *n* without a common letter differ, $P < 0.05$ (with Bonferroni adjustment)

[*] Different from blacks within the same gender or BMI category, $P < 0.05$.

[4] Expected 24-h creatinine excretion (mg/d) = G × body weight (kg), G = 21 for females and 24 for males.

[5] For males: expected 24-h creatinine (mg/d) = $0.00179 \times [140 - \text{age (y)}] \times [\text{weight (kg)}^{1.5} \times \text{height (cm)}^{0.5}] \times [1 + 0.18 \times (\text{black} = 1, \text{other races} = 0)] \times [1.366 - 0.0159 \times \text{BMI (kg/m}^2)]$;
For females: expected 24-h creatinine (mg/d) = $0.00163 \times [140 - \text{age (y)}] \times [\text{weight (kg)}^{1.5} \times \text{height (cm)}^{0.5}] \times [1 + 0.18 \times (\text{black} = 1, \text{other races} = 0)] \times [1.429 - 0.0198 \times \text{BMI (kg/m}^2)]$

Supplemental Table 2. Total urine volume, 24-h analyte excretions, and dietary intake estimates from 24-h recalls in the day 1 collection: Total sample and by expected creatinine criterion[1,2]

	Total		Joossens[3]				Mage[4]			
			Criterion met		Criterion not met		Criterion met		Criterion not met	
	n	Mean or Geometric mean	*n*	Mean or Geometric mean	*n*	Mean or Geometric mean	*n*	Mean or Geometric mean	*n*	Mean or Geometric mean
Urine excretion										
Volume, *mL*										
Black	196	1261 ± 562	173	1298 ± 556	23	985 ± 543*	170	1309 ± 556	26	945 ± 509*
Other races	211	1523 ± 695	192	1530 ± 687	19	1453 ± 781	203	1517 ± 682	8	1683 ± 1015
Sodium, *g*										
Black	196	3.34 ± 1.46	173	3.46 ± 1.40	23	2.37 ± 1.62*	170	3.53 ± 1.43	26	2.07 ± 0.97*
Other races	211	3.26 ± 1.34	192	3.34 ± 1.35	19	2.43 ± 0.96*	203	3.28 ± 1.35	8	2.79 ± 0.93
Potassium, *g*										
Black	196	1.79 ± 0.70	173	1.86 ± 0.69	23	1.22 ± 0.43*	170	1.86 ± 0.69	26	1.30 ± 0.49*
Other races	211	2.15 ± 0.89	192	2.20 ± 0.88	19	1.62 ± 0.77*	203	2.18 ± 0.89	8	1.43 ± 0.52*
Chloride, *g*										
Black	196	4.84 ± 2.14	173	5.03 ± 2.07	23	3.43 ± 2.21*	170	5.11 ± 2.10	26	3.11 ± 1.55*
Other races	211	4.80 ± 2.00	192	4.92 ± 2.01	19	3.62 ± 1.47*	203	4.83 ± 2.02	8	4.08 ± 1.32
Creatinine, *g*										
Black	196	1.73 ± 0.57	173	1.81 ± 0.53	23	1.10 ± 0.49*	170	1.83 ± 0.53	26	1.09 ± 0.38*
Other races	211	1.50 ± 0.49	192	1.54 ± 0.49	19	1.09 ± 0.26*	203	1.51 ± 0.49	8	1.14 ± 0.35*
Iodine, *μg*										
Black	195	237 ± 236	172	251 ± 242	23	131 ± 161*	169	251 ± 242	26	142 ± 170*
Other races	205	282 ± 278	188	295 ± 286	17	137 ± 75*	197	288 ± 281	8	117 ± 56*

Dietary recall data										
Energy, *kcal*										
Black	196	2670 ± 1296	173	2589 ± 1170	23	3276 ± 1933	170	2547 ± 1135	26	3475 ± 1902*
Other races	207	2424 ± 987	189	2437 ± 1002	18	2289 ± 823	199	2435 ± 994	8	2167 ± 775
Sodium, *g*										
Black	196	3.81 (1.53, 9.50)	173	3.78 (1.51, 9.43)	23	4.09 (1.57, 10.68)	170	3.75 (1.52, 9.27)	26	4.27 (1.58, 11.56)
Other races	207	3.77 (1.51, 9.40)	189	3.82 (1.55, 9.42)	18	3.20 (1.08, 9.51)	199	3.80 (1.52, 9.48)	8	3.04 (1.07, 8.59)
Potassium, *g*										
Black	196	2.59 (1.02, 6.62)	173	2.55 (1.03, 6.32)	23	2.93 (0.89, 9.64)	170	2.52 (1.03, 6.22)	26	3.08 (0.97, 9.82)*
Other races	207	2.70 (1.17, 6.25)	189	2.74 (1.17, 6.41)	18	2.29 (1.13, 4.66)	199	2.72 (1.18, 6.29)	8	2.17 (0.79, 5.95)

[1] Participants with a ratio of observed to expected 24-h creatinine excretion equal to or larger than 0.6 were identified as meeting expected creatinine excretion criterion.

[2] Values are mean ± SD or geometric mean (95% CI) unless otherwise noted

[3] Expected 24-h creatinine excretion (mg/d) = G × body weight (kg), G = 21 for females and 24 for males.

[4] For males: expected 24-h creatinine (mg/d) = $0.00179 \times [140 - \text{age (y)}] \times [\text{weight (kg)}^{1.5} \times \text{height (cm)}^{0.5}] \times [1 + 0.18 \times (\text{black} = 1, \text{other races} = 0)] \times [1.366 - 0.0159 \times \text{BMI (kg/m}^2)]$; For females: expected 24-h creatinine (mg/d) = $0.00163 \times [140 - \text{age (y)}] \times [\text{weight (kg)}^{1.5} \times \text{height (cm)}^{0.5}] \times [1 + 0.18 \times (\text{black} = 1, \text{other races} = 0)] \times [1.429 - 0.0198 \times \text{BMI (kg/m}^2)]$

* Within an analyte, different from cases met expected creatinine criteria using the same method, $P < 0.05$.

Supplemental Table 3. Distributions of total urine volume and 24-h excretion of sodium, potassium, chloride, creatinine and iodine in the day 1 collection: Samples met expected creatinine excretion criterion[1]

		Joossens[2]				Mage[3]			
		Mean ± SD	Percentile			Mean ± SD	Percentile		
			25th	50th	75th		25th	50th	75th
Volume, *mL*									
Black	Male	1316 ± 538	921	1172	1580	1349 ± 536	937	1264	1616
	Female	1284 ± 573	860	1197	1546	1279 ± 571	843	1197	1533
Other races	Male	1610 ± 797*	1026	1307	2062	1600 ± 798*	966	1307	2057
	Female	1459 ± 568*	991	1368	1774	1448 ± 562*	987	1342	1774
Sodium, *g*									
Black	Male	3.71 ± 1.47	2.60	3.51	4.65	3.88 ± 1.52	2.78	3.67	4.77
	Female	3.27 ± 1.31†	2.39	2.94	4.00	3.26 ± 1.30†	2.39	2.94	3.96
Other races	Male	3.63 ± 1.43	2.73	3.24	4.23	3.58 ± 1.45	2.66	3.21	4.18
	Female	3.08 ± 1.21†	2.23	2.92	3.79	3.03 ± 1.22†	2.12	2.89	3.79
Potassium, *g*									
Black	Male	1.98 ± 0.77	1.47	1.85	2.23	2.00 ± 0.78	1.55	1.85	2.23
	Female	1.76 ± 0.60†	1.36	1.69	2.07	1.76 ± 0.60†	1.36	1.69	2.07
Other races	Male	2.42 ± 1.04*	1.73	2.10	2.87	2.39 ± 1.06*	1.72	2.10	2.83
	Female	2.02 ± 0.66*†	1.55	1.89	2.46	2.01 ± 0.67*†	1.54	1.89	2.46
Chloride, *g*									
Black	Male	5.34 ± 2.12	3.62	5.24	6.67	5.55 ± 2.16	3.69	5.42	7.07
	Female	4.78 ± 2.00	3.47	4.31	5.63	4.77 ± 1.99	3.48	4.28	5.63
Other races	Male	5.37 ± 2.19	3.95	5.11	6.24	5.29 ± 2.21	3.88	4.98	6.16
	Female	4.51 ± 1.76†	3.22	4.38	5.43	4.45 ± 1.78†	3.17	4.36	5.43
Creatinine, *g*									
Black	Male	2.17 ± 0.52	1.79	2.16	2.46	2.22 ± 0.50	1.87	2.20	2.48
	Female	1.53 ± 0.32†	1.29	1.50	1.69	1.53 ± 0.32†	1.31	1.49	1.68
Other races	Male	1.86 ± 0.45*	1.52	1.83	2.10	1.84 ± 0.47*	1.51	1.81	2.09
	Female	1.25 ± 0.31*†	1.06	1.25	1.41	1.24 ± 0.31*†	1.05	1.25	1.40
Iodine, *µg*									
Black	Male	276 ± 233	127	175	345	280 ± 235	132	188	345
	Female	230 ± 247	110	155	242	229 ± 246	110	154	242
Other races	Male	319 ± 298	146	229	393	318 ± 296	143	231	393
	Female	272 ± 275	134	199	314	263 ± 267	133	187	312

[1] Participants with a ratio of observed to expected 24-h creatinine excretion equal or larger than 0.6 were identified as meeting the expected creatinine excretion criterion.

[2] Expected 24-h creatinine excretion (mg/d) = G × body weight (kg), G = 21 for females and 24 for males.

[3] For males: expected 24-h creatinine (mg/d) = $0.00179 \times [140 - \text{age (y)}] \times [\text{weight (kg)}^{1.5} \times \text{height (cm)}^{0.5}] \times [1 + 0.18 \times (\text{black} = 1, \text{other races} = 0)] \times [1.366 - 0.0159 \times \text{BMI (kg/m}^2)]$; For females: expected 24-h creatinine (mg/d) = $0.00163 \times [140 - \text{age (y)}] \times [\text{weight (kg)}^{1.5} \times \text{height (cm)}^{0.5}] \times [1 + 0.18 \times (\text{black} = 1, \text{other races} = 0)] \times [1.429 - 0.0198 \times \text{BMI (kg/m}^2)]$.

[*] Within an analyte, different from blacks within the same gender, $P < 0.05$.

[†] Within an analyte, different from males within the same race category, $P < 0.05$.

Supplemental Table 4. Ratios of expected to measured 24-h urinary creatinines by race-adjustment for total sample and samples that met the expected creatinine excretion criterion as defined by the Mage algorism[1,2,3,4]

	Total		Samples met creatinine criterion	
	n	Ratio (Expected/Measured)	*n*	Ratio (Expected/Measured)
Black				
Total				
Race adjusted	196	1.20 ± 0.41 (1.15 - 1.26)	170	1.08 ± 0.23 (1.04 - 1.11)
Not race adjusted	196	1.02 ± 0.35 (0.97 - 1.07)	182	0.95 ± 0.24 (0.92 - 0.98)
Male				
Race adjusted	89	1.25 ± 0.41 (1.16 - 1.33)	73	1.09 ± 0.24 (1.03 - 1.15)
Not race adjusted	89	1.06 ± 0.35 (0.98 - 1.13)	81	0.98 ± 0.26 (0.92 - 1.04)
Female				
Race adjusted	107	1.17 ± 0.41 (1.09 - 1.25)	97	1.07 ± 0.22 (1.02 - 1.11)
Not race adjusted	107	0.99 ± 0.35 (0.92 - 1.06)	101	0.93 ± 0.22 (0.88 - 0.97)
Other races				
Total				
Race adjusted	211	1.07 ± 0.27 (1.03 - 1.10)	203	1.04 ± 0.23 (1.01 - 1.07)
Not race adjusted	211	1.07 ± 0.27 (1.03 - 1.10)	203	1.04 ± 0.23 (1.01 - 1.07)
Male				
Race adjusted	97	1.09 ± 0.28 (1.03 - 1.15)	92	1.05 ± 0.23 (1.00 - 1.10)
Not race adjusted	97	1.09 ± 0.28 (1.03 - 1.15)	92	1.05 ± 0.23 (1.00 - 1.10)
Female				
Race adjusted	114	1.05 ± 0.26 (1.00 - 1.10)	111	1.03 ± 0.23 (0.99 - 1.07)
Not race adjusted	114	1.05 ± 0.26 (1.00 - 1.10)	111	1.03 ± 0.23 (0.99 - 1.07)

[1] For males: expected 24-h creatinine (mg/d) = $0.00179 \times [140 - \text{age (y)}] \times [\text{weight (kg)}^{1.5} \times \text{height (cm)}^{0.5}] \times [1 + 0.18 \times (\text{black} = 1, \text{other races} = 0)] \times [1.366 - 0.0159 \times \text{BMI (kg/m}^2)]$;
For females: expected 24-h creatinine (mg/d) = $0.00163 \times [140 - \text{age (y)}] \times [\text{weight (kg)}^{1.5} \times \text{height (cm)}^{0.5}] \times [1 + 0.18 \times (\text{black} = 1, \text{other races} = 0)] \times [1.429 - 0.0198 \times \text{BMI (kg/m}^2)]$.

[2] Measured 24-h creatinine values was obtained from 24-h urine samples collected in the study

[3] Participants with a ratio of observed to expected 24-h creatinine excretion equal or larger than 0.6 were identified as meeting the expected creatinine excretion criterion.

[4] Values are mean ± SD (95% CI)

Online Supporting Material

Supplemental Literature Cited

1. Joossens JV, Geboers J. Monitoring salt intake of the population: methodological considerations. In De Backer GG, Pedoe HT, Ducimetiere P, ed. Surveillance of the dietary habits of the population with regard to cardiovascular diseases, EURONUT Report 2. Wageningen: Department of Human Nutrition, Agricultural University, 1984;61-73.
2. Mage DT, Allen RH, and Kdali A. Creatinine corrections for estimating children's and adult's pesticide intake doses in equilibrium with urinary pesticide and creatinine concentrations. J Expo Anal Environ Epidemiol. 2008;18(4):360-8.
3. Huber DR, Blount BC, Mage DT, Letkiewicz FJ, Kumar A, Allen RH. Estimating perchlorate exposure from food and tap water based on US biomonitoring and occurrence data. J Expo Sci Environ Epidemiol. 2011;21(4):395-407.
4. Murakami K, Sasaki S, Takahashi Y, Uenishi K, Watanabe T, Kohri T, Yamasaki M, Watanabe R, Baba K, Shibata K, et al. Sensitivity and specificity of published strategies using urinary creatinine to identify incomplete 24-h urine collection. Nutrition. 2008;24: 16-22.
5. Kawamura M, Ohmoto A, Hashimoto T, Yagami F, Owada M, Sugawara T. Second morning urine method is superior to the casual urine method for estimating daily salt intake in patients with hypertension. Hypertens Res. 2012;35(6):611-6.
6. Kawasaki T, Itoh K, Uezono K, Sasaki H. A simple method for estimating 24 h urinary sodium and potassium excretion from second morning voiding urine specimen in adults. Clin Exp Pharmacol Physiol. 1993;20: 7–14.
7. Knuiman JT, Hautvast JG, van der Heijden L, Geboers J, Joossens JV, Tornqvist H, Isaksson B, Pietinen P, Tuomilehto J, Flynn A, et al. A multi-centre study on within-person variability in the urinary excretion of sodium, potassium, calcium, magnesium and creatinine in 8 European centres. Hum Nutr Clin Nutr. 1986;40(5):343-8.
8. De Keyzer W, Huybrechts I, Dekkers AL, Geelen A, Crispim S, Hulshof PJ, Andersen LF, Rehůřková I, Ruprich J, Volatier JL, et al. Predicting urinary creatinine excretion and its usefulness to identify incomplete 24 h urine collections. Br J Nutr. 2011;5:1-8.
9. Edwards KDG, Whyte HM. Creatinine excretion and body composition. Clin Sci. 1959;18:361–6.

Supplemental Table 5. Number of observations in timed-spot urine specimens

			Timing of spot urine collections			
			Morning	Afternoon	Evening	Overnight
Day 1	For sodium, potassium, chloride, and creatinine					
	Black	Male	76	85	88	89
		Female	90	102	107	107
	Other races	Male	77	90	94	97
		Female	96	112	113	113
	For iodine					
	Black	Male	75	85	88	89
		Female	89	101	106	106
	Other races	Male	76	90	93	96
		Female	92	107	108	108
Day 2	For sodium, potassium, chloride, and creatinine					
	Black	Male	31	33	35	36
		Female	30	29	32	31
	Other races	Male	22	25	25	25
		Female	33	39	40	39
	For iodine					
	Black	Male	31	33	35	36
		Female	29	28	31	30
	Other races	Male	22	25	25	25
		Female	31	37	38	37