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Sodium intake of special populations in the Healthy Aging in Neighborhoods of Diversity Across the Life Span (HANDLS) study

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ABSTRACT

Objective: The sodium intake of participants of the Healthy Aging in Neighborhoods of Diversity across the Life Span study who were in three of the special population groups identified by the *Dietary Guidelines for Americans, 2010* (those with hypertension, African Americans, and those ≥51 years) was analyzed to determine if they met sodium recommendations.

Methods: The sample included 2152 African American and White subjects, aged 30–64 years. Major dietary sources of sodium for each group were determined from two 24-hour dietary recalls, and dietary intakes were compared with sodium recommendations. Dietary potassium was also evaluated.

Results: The intakes of the groups studied exceeded 1500 mg of sodium while their potassium intakes were lower than the Adequate Intake of 4700 mg. The major contributors of sodium included "cold cuts, sausage, and franks," "protein foods," and yeast breads.

Conclusions: Excessive sodium intake characterized the diet of an urban, socioeconomically diverse population who are hypertensive or at risk for having hypertension. These findings have implications for health professionals and the food industry.

Sodium intake has been positively associated with blood pressure (Stamler, 1997; Vollmer et al., 2001). Even in young healthy adults with clinically normal blood pressure, those who consume more sodium and less potassium are more likely to have increased left ventricular mass, suggesting that excess dietary sodium sensitizes the heart, large arteries, and kidneys to hypertrophic and fibrotic stimuli (Whelton et al, 2012). There have been more than 50 randomized trials conducted on the effect of sodium increasing blood pressure (Appel et al., 2006). Thus to manage hypertension (HTN), limiting sodium consumption by reducing salt intake is an important intervention (He and MacGregor, 2007; Whelton et al., 2012). Dietary potassium supplementation can also lower blood pressure in some hypertensive patients (Haddy et al., 2006). Unlike sodium, potassium promotes vasodilation, resulting from hyperpolarization of the vascular smooth muscle. Americans typically consume 3400 mg of sodium daily, due to high intakes of processed foods, frequent eating outside the home, and consumption of packaged meals and salty snack foods (Mattes and Donnelly, 1991; U.S. Department of Health and Human Services (USDHHS) and U.S. Department of Agriculture (USDA), 2010). Seventy-seven percent of the American sodium intake is from food processing and restaurant foods (USDHHS and USDA, 2010). Foods consumed outside of the home provide 34% of the sodium intake of Americans (Lin et al., 1999). Many restaurant meals are very high in sodium. For example, double bacon cheeseburger with mayonnaise on a bun provides 2445 mg of sodium (U.S. Department of Agriculture National Nutrient Database for Standard Reference, Release 25, 2012).

One in three Americans has HTN. Keeping blood pressure in the normal range reduces an individual's risk of heart attack and stroke, which are complications of diabetes, as well as congestive heart failure, and kidney disease. With a goal of reducing HTN in the United States, the *Dietary Guidelines* (DG) *for Americans*, *2010* recommends limiting sodium to 2300 mg daily for the general population and limiting sodium to 1500 mg daily for special population groups. Individuals with hypertension, diabetes, or chronic renal disease, African Americans (AA), and those ≥51 years comprise these special groups and account for ~50% of the US population ≥2 years (USDHHS and USDA, 2010).

The prevalence of HTN tends to increase as people age due to physiological changes in the vascular system, including arterial stiffening and thickening and is also more prevalent among African Americans (National Heart Lung and Blood Institute (NHLBI), 2012). AAs tend to have a higher severity of HTN complications, develop high blood pressure at younger ages, and have greater salt sensitivity

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than other racial groups (Lloyd-Jones et al., 2010). Roughly half of heart disease can be attributed to hypertension in this population (Barnes et al., 1997).

Obesity is an independent risk factor for HTN (Thomas et al., 2005). An individual's risk for HTN can also be increased by other unhealthful lifestyle habits such as eating too much sodium (salt), not getting enough potassium in one's diet, drinking too much alcohol, lack of physical activity, and smoking (NHLBI, 2012). The Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) study consists of an urban population of both African American and White adults who display many of these unhealthful lifestyles (Fanelli-Kuczmarski et al., in press). Approximately half of the population are current smokers, and over half of the men and over 70% of the women are obese as determined by Dual X-ray Absorptiometry measures, putting them at high risk for cardiovascular diseases.

The main purpose of this study was to analyze the sodium and potassium intake of participants of the HANDLS study who were in three of the special population groups identified by the DGs (those with hypertension, African Americans, and those ≥51 years).

Methods

Participants were drawn from the baseline HANDLS study (n = 3720) a community-based, longitudinal epidemiological study, conducted in the city of Baltimore between August 2004 and March 2009. Study design for HANDLS has been reported elsewhere (Evans et al., 2010; National Institutes of Health-HANDLS website, 2004). This study sample included 2152 people who completed both diet recalls and had no missing hypertension data. In addition to the three non-overlapping special risk groups defined in the *Dietary Guidelines for Americans, 2010*, Whites 51–64 years without hypertension were examined for comparative purposes for nutrient intakes. The participants were identified as having HTN by an overall HTN dichotomous variable based on blood pressure readings (diastolic > 90 mmHg and/or systolic > 140 mmHg), prescriptions (diuretics, blockers, angiotensin inhibitors, and/or vasodilators), and self-report in medical history (asked if have high blood pressure and when first told of condition).

Nutrient information was obtained from two 24-hour recall dietary interviews. The 24-hour recalls were administered by trained interviewers utilizing the USDA's Automatic Multiple Pass Method, Versions 2.3–2.6, which included measurement illustrations to facilitate estimations of food quantity consumed. The AMPM was validated comparing reported energy intake to total energy expenditure using the doubly labeled water technique and shown to be an effective method for collecting accurate group energy intake of adults (Blanton et al., 2006; Moshfegh et al., 2008; Rumpler et al., 2008). The first dietary recall was obtained during the household interview, and the second was obtained in the mobile medical research vehicle. The dietary recalls were coded using Survey Net, matching codes to foods in the Food and Nutrient Database for Dietary Studies version 3.0 (Agricultural Research Service, 2008). Estimates of total energy and intakes of sodium and potassium per 1000 kcal were averaged over both recall days. Intakes were evaluated to determine if the population groups met the DG recommended intake levels for sodium and the Adequate Intakes (AI) for potassium.

In addition, foods were aggregated into food groups using the codes from the Food and Nutrient Database for Dietary Studies (Agricultural Research Service, 2008). These food groups reflect nine major food groups and subgroups within these groups to distinguish different nutrient compositions such as whole versus reduced fat dairy products. The food groups were then reviewed and aggregated where appropriate to match the groups studied in the National Cancer Institute study "Sources of Sodium Among the US Population (2005–2006)" (National Cancer Institute, 2010). The top 10 food groups were rank ordered by percentage of sodium contributed to dietary intakes.

Statistical analysis

Statistical analyses were carried out using the SAS statistical analysis computer package [9.2 (TS1M0), 2002–2008: SAS Institute Inc., Cary, NC] and STATA (1985–2011; Statacorp, College Station, TX). STATA procedure regress and cross-equation tests were performed to test whether there were any significant differences in mean energy, sodium, and potassium intakes between the first and second recalls. To allow for group comparisons without the influence of energy intake as well as evaluate the intakes with respect to the target nutrient goals of Dietary Approaches to Stop Hypertension (DASH) pattern (Mellen et al., 2008), mineral intakes were expressed per 1000 kcal. Means and medians for sodium and potassium milligrams (mg) per 1000 kcal, as well as the mean energy intake, were calculated for the special population groups. In addition to these groups, descriptive statistics were run for the White population less than 51 years of age. Since the HANDLS sample is stratified and clustered, sampling weights were applied (Evans et al., 2010).

The SAS SURVEYREG procedure was used to test for mean differences between AAs and Whites, between young (30–50 years) and old (51–64 years) and between those with and without HTN. Two sets of regressions (adjusted and unadjusted) were run with age, race and hypertension status as the independent variables and energy and nutrient intakes as the dependent variables. The reported unadjusted means indicate the results for one independent variable without controlling for the other two independent variables. Statistical tests reported as adjusted means were based on regression analyses of one category of an independent variable while controlling for the other two independent variables, as well as two additional variables indicating whether the first recall and second recall were done on the weekend day. A p-value of 0.05 was considered to be statistically significant.

Results

Characteristics of the participants

The mean (±SEM) age of the sample was 47.8 ± 0.2 years. Approximately half (57%) of the sample was female, 58% African American, and 43% self-reported a household income <125% of the 2004 Health and Human Services poverty guidelines. It should be noted that many of the samples above the 125% poverty guidelines were close to this criteria partition. The participants assigned to the special groups comprised 82% of the total sample.

Energy and nutrient intakes

There were no significant differences in mean energy or mineral intakes between the first and second recall days. The median energy intake of the special population groups ranged from 1731 to 1960 kcal (Table 1). The "Whites <51 years with no HTN" reported consuming a median of 2035 kcal daily (Table 1). There were significant effects of some of the independent variables on the unadjusted and adjusted means for energy. The effect of age group on the unadjusted mean energy intake was significant ($Pr > F = 0.0002$) (Table 2). The effect of HTN status was also significant on unadjusted mean energy intake ($Pr > F = 0.0036$). When all of the independent variables were compared together in a regression, the adjusted mean energy for the age groups was still significant ($Pr > F = <0.0020$), with younger adults (30 to < 50 years) consuming more energy than the older age group (51–64 years).

Sodium

The mean sodium intake for the total population for the first dietary recall (3354 ± 93 mg) was similar to the second recall (3307 ± 80 mg). Approximately 13% of the African American population had sodium intakes less than 1500 mg, compared to 10% of the White population. No significant differences in sodium intakes were found among the HANDLS subpopulation groups studied (Table 1). The mean daily range for sodium intake was 1585–1607 mg/1000 kcal. Given that the mean energy intake ranged from 1968 to 2366 kcal, neither the total mean nor the median sodium daily intakes were below 1500 mg of sodium for any of the special population groups. The median sodium intake/1000 kcal for "Whites <51 years with no HTN" group was 1586 mg, also exceeding their DG recommendation of 2300 mg of sodium.

Table 1
Sodium, potassium, and energy intakes for HANDLS[a] study participants (n = 2152).

Group	N	Sodium, mg/1000 kcal X ± SE	Potassium, mg/1000 kcal X ± SE	Energy, kcal X ± SE	Median potassium, mg/1000 kcal	Median sodium, mg/1000 kcal	Median energy, kcal
All with HTN[b]	973	1589 ± 20.2	1169 ± 20.3	1976 ± 55	1555	1122	1759
All ≥51 years with no HTN[b]	317	1603 ± 38.2	1311 ± 35.5	1968 ± 93	1537	1225	1731
AAs <51 years with no HTN[b]	483	1586 ± 26.1	1035 ± 24.9	2366 ± 117	1524	1002	1960
Whites <51 years with no HTN[c]	379	1608 ± 25.3	1256 ± 29.7	2143 ± 80	1586	1239	2035

[a] HANDLS—Healthy Aging in Neighborhoods of Diversity across the Life Span.
[b] HTN—hypertension, AA—African Americans. Special population group defined by Dietary Guidelines for Americans, 2010, with a 1500 mg sodium intake limit. This group includes African Americans and Whites.
[c] General population group defined by Dietary Guidelines for Americans, 2010, with a 2300 mg sodium intake limit.

The top 10 foods contributing the greatest intake of sodium to the diets of HANDLS study participants were deli ham, beef hot dogs, pork bacon, deli chicken/turkey loaf, deli chicken/turkey breast, tuna salad, smoked ham, crab cakes, chili con carne with beans, and white bread. For the total sample, approximately 66% of sodium intake came from foods in the following 10 categories: "Cold cuts, sausage, and franks," "protein foods," yeast breads, pasta and pasta dishes, chicken and chicken dishes, salty snacks, sandwiches, regular cheeses, starchy vegetables, and egg and egg dishes (Table 3). Protein foods include red meat, meat and seafood dishes and frozen meals with meats or seafood as the main entrée. The three categories providing approximately one-third of daily sodium intake for all groups despite different rank order were "cold cuts, sausage, and franks," yeast breads, and "protein foods" (Table 3).

In general, for all subpopulation groups, the same food categories were present but in different rank orderings. There were a few exceptions. Starchy vegetables consisting mostly of French fried white potatoes, potato salad and corn were found in the list for only the "All with HTN" and "AAs <51 years with no HTN" groups. Grain-based desserts which included chocolate cake and cupcakes, doughnuts, cheesecake, and muffins, were major contributors of sodium for the "All with HTN" and "All ≥51 years with no HTN" groups. Pizza, namely, cheese pizza, pepperoni pizza, and pizza with meat and vegetables, and the Other vegetables groupings which included beans and tomatoes were top sources of sodium for only the "Whites <51 years with no HTN" group (Table 3).

The data were analyzed for significance of the independent variables of age, race, and HTN status effect on the sodium intake. Regression analyses revealed that there was no significant effect of any of the independent variables on sodium intakes using either unadjusted or adjusted means (Table 2).

Potassium

The mean daily intake ranged from 1035 to 1169 mg of potassium/1000 kcal while the median daily intakes ranged from 1002 to 1239 mg of potassium/1000 kcal (Table 1). None of the HANDLS study groups met the Adequate Intake of 4700 mg of potassium per day. The top 10 foods contributing to potassium intakes were white potato chips, coffee, French fried white potatoes, orange juice, whole milk, banana, spaghetti with tomato sauce and meat, 2% fat milk, beer, and presweetened tea. African Americans consumed significantly less potassium, when controlling for age and hypertension status (Table 2). The effect of age and race on the unadjusted mean potassium intake/1000 kcal were also significant, with intakes higher for adults 51–64 years and for White participants (Table 2).

Discussion

The findings from this study increased our knowledge of sodium intake of a socioeconomically diverse but primarily low-income urban population. The findings are relevant in the current climate of proposed policy changes in regards to limiting sodium in food products by food manufacturers. None of the groups studied met the guidelines for intakes for sodium or potassium which could assist in improving blood pressure. Many of the foods consumed were relatively inexpensive processed foods which are known for being high in sodium. Thus, lowering the sodium in processed food and consuming less of these products would likely help lower sodium intakes.

The mean daily sodium consumption for the total HANDLS study sample is similar to a recent report by the Centers for Disease Control and Prevention (CDC). The mean daily sodium consumption of 7227 participants aged ≥2 years examined in the What We Eat in America, National Health and Nutrition Examination Survey, 2007–2008 was 3266 mg (Loria et al., 2012). Similar to our findings, the mean dietary potassium intake of the U.S. population aged two years and older is less than recommended. In 2009–2010 data it was 2640 mg per day (Hoy and Goldman, 2012). Hoy and Goldman also found that non-Hispanic black adults had significantly lower potassium intakes compared to non-Hispanic white adults.

In our study, the food group contributing the highest amount of sodium was "cold cuts, sausage, and franks" (12%). The "protein

Table 2
Comparisons of unadjusted and adjusted energy and nutrient means for age, race and hypertension (HTN) status.

	Energy, kcal				Mean Sodium, mg/1000 kcal				Mean Potassium, mg/1000 kcal			
	Unadjusted		Adjusted[a]		Unadjusted		Adjusted		Unadjusted		Adjusted	
Independent variables	Mean	Pr > |t|	Mean	Pr > |t|	Mean	Pr > |t|	Mean	Pr > |t|	Mean	Pr > |t|	Mean	Pr > |t|
Age												
30–50 years	2226	0.0002	2206	0.0020	1596	0.8872	1594	0.9184	1124	<0.0001	1122	<0.0001
51–64 years	1888		1934		1592		1591		1252		1255	
Race												
White	2108	0.9708	2107	0.9281	1615	0.2013	1611	0.2856	1290	<0.0001	1288	<0.0001
AA[a]	2111		2114		1583		1583		1101		1102	
HTN status												
HTN-yes	1976	0.0036	2038	0.1053	1586	0.7691	1591	0.9032	1169	0.9320	1164	0.8009
HTN-no	2206		2163		1596		1595		1167		1171	

[a] African Americans.

Table 3
Percentage contribution of sodium from the top ten food groups for HANDLS[a] study participants (n = 2152).

Dietary Guidelines, 2010		General population, 2300 mg sodium		Special populations, 1500 mg sodium					
Populations defined by Dietary Guidelines		Whites, Asians, Hispanics 30–50 years without HTN		People with HTN		People aged 51 years and older without HTN		All African Americans without HTN	
HANDLS study population (n = 2152)		White, 30–50 years without HTN[b] (n = 379)		AA and W, 30–64 years with HTN[c] (n = 973)		AA and W 51–64 years, without HTN[c] (n = 317)		AA[d], 30–50 years, without HTN[c] (n = 483)	
Food groups	% of total sodium intake	Food groups	% of total sodium intake	Food groups	% of total sodium intake	Food groups	% of total sodium intake	Food groups	% of total sodium intake
Cold cuts, sausage, franks	12.38%	Protein foods	10.78%	Protein foods[e]	11.16%	Cold cuts, sausage, franks	15.35%	Cold cuts, sausage, franks	14.44%
Protein foods	10.80%	Yeast breads	10.43%	Cold cuts, sausage, franks	11.02%	Yeast breads	10.78%	Protein Foods	11.36%
Yeast breads	10.70%	Cold cuts, sausage, franks	9.79%	Yeast breads	10.99%	Protein foods	8.62%	Yeast breads	10.52%
Pasta and pasta dishes	6.11%	Pizza	6.40%	Pasta and pasta dishes	6.55%	Pasta and pasta dishes	5.13%	Chicken and chicken mixed dishes	6.57%
Chicken and chicken mixed dishes	5.52%	Pasta and pasta dishes	5.71%	Chicken and chicken mixed dishes	6.32%	Regular cheeses	4.54%	Pasta and pasta dishes	6.28%
Salty snacks	4.40%	Sandwiches	4.57%	Salty snacks	4.39%	Salty snacks	4.25%	Sandwiches	4.74%
Sandwiches	4.17%	Salty snacks	4.31%	Starchy vegetables	4.18%	Eggs and egg dishes	4.09%	Salty snacks	4.57%
Regular cheeses	4.06%	Regular cheeses	4.05%	Sandwiches	3.82%	Chicken and chicken mixed dishes	3.97%	Regular cheeses	4.50%
Starchy vegetables	3.81%	Other vegetables	3.52%	Eggs and egg dishes	3.76%	Grain-based desserts	3.85%	Eggs and egg dishes	4.45%
Eggs and egg dishes	3.74%	Chicken and chicken mixed dishes	3.18%	Grain-based desserts	3.70%	Sandwiches	3.32%	Starchy vegetables	4.06%

[a] HANDLS—Healthy Aging in Neighborhoods of Diversity across the Life Span.
[b] HTN—hypertension, general population as defined by Dietary Guidelines for Americans, 2010, with a 2300 mg sodium intake limit.
[c] HTN—hypertension, special populations as defined by Dietary Guidelines for Americans, 2010, with a 1500 mg sodium intake limit.
[d] AA—African Americans.
[e] Protein foods are defined as including red meats with fat, lean meats, meat dishes, seafood dishes, and frozen meals with meats or seafood as main entree.

foods" ranked second (10.8%), and the yeast breads ranked third in contributions (10.7%). Chicken and chicken mixed dishes group appears in all the listings for the groups from the HANDLS study. However pizza was only found as a top sodium contributor for White participants under 51 years of age with no hypertension. In the study conducted by CDC, the top contributor was bread and rolls (7.4%), followed by cold cuts/cured meats (5.1%), and pizza (4.9%). In another study conducted by the National Cancer Institute, the researchers also found that yeast breads were the top contributor (7%), followed by chicken and chicken mixed dishes (6.8%) and pizza (6.3%) (National Cancer Institute, 2010).

In our study, the food group contributing the highest amount of sodium was "cold cuts, sausage, and franks" (12%). This group was ranked second (5.1%) in a study conducted by CDC. "Protein foods" ranked second (10.8%) which is comparable to the ranking of chicken and chicken mixed dishes (6.8%) by the National Cancer Institute (National Cancer Institute, 2010). Yeast breads were the third highest contributor (10.7%) for the HANDLS study participants while these foods were the top contributors reported by both CDC (7.4%) and the National Cancer Institute (7%). While CDC and the National Cancer Institute reported pizza as the third highest contributor, pizza was only found as a top sodium contributor for White participants under 51 years of age with no hypertension.

Possible reasons for the differences in top contributor lists can reflect the differences in the socioeconomic status and the geographic location of the studies. The HANDLS study population consists of a greater portion of low-income participants compared to national nutrition surveys and was selected from census tracts within the city of Baltimore. Many of the foods consumed such as cold cuts, hotdogs, sandwiches, French fried potatoes, and salty snacks were obtained from local markets, corner stores and fast food restaurants.

The DG recommendations of maximum intake of 1500 mg of sodium daily for the special population groups may not be feasible as our study and other studies have shown participants' mean sodium intakes of >3000 mg daily (Loria et al., 2012). A feasibility study by Maillot and Drewnowski (2012) indicated that in order to meet the maximum intake of 1500 mg of sodium daily then it would difficult to adequately meet standards for 27 nutrients (vitamins, minerals, macronutrients, and fiber) without making large changes in the typical American diet. That study suggested that the low guidelines should be viewed as "aspirational" because a large change in diet would be necessary to meet the 1500 mg sodium limit as processed foods provide 77% of sodium in diet and that eating out has increased 200% from 1977 to 1995 (Lin et al., 1999; Maillot and Drewnowski, 2012). The only way individuals in the United States will be able to reduce sodium intake is with the cooperation of the food and restaurant industry. This approach is possible as evidenced by the United Kingdom salt reduction campaign where they have reduced sodium intake by 10% population-wide (Appel et al., 2011). It is of interest to note that a 2013 report from the Institute of Medicine is now questioning whether lowering sodium intake to below 2300 mg per day is even advisable for anyone and has called for more research into low-sodium levels between 1500 and 2300 mg/day (IOM, 2013). It should be noted however that the American Heart Association disagrees with the IOM conclusions (AHA, 2013).

Strengths and limitations

Strengths of the study include the large sample size of an understudied population which are typically difficult to recruit, the 2-day food recalls, and having trained interviewers utilizing standardized measuring tools for food measurements during the recalls. Additionally, our findings could reflect similar results in the population of other selected cities. Baltimore has the same selected characteristics of cities with similar population densities and racial distribution. Baltimore was most similar to cities in the Northeast, South, and West, for example: Atlanta, GA; Bridgeport, CT; Bridgeton, NJ; Buffalo, NY; Camden, NJ;

Carson, CA; Chicago, IL; Cleveland, OH; Detroit, MI; Harrisburg, PA; Hartford, CT; Oakland, CA; Springfield, MS; and Trenton, NJ. Except for Atlanta and Chicago, these cities are mostly mid-sized.

This study has a few limitations. Diet intakes were self-reported which can lead to over- or under-estimation of nutrients (Moshfegh et al., 2008). The recall intakes do not reflect the sodium from salt added at the table or sodium from dietary supplements or antacids which can underestimate intake by 6% (Loria et al., 2012). In addition, potassium intakes do not include nutritional supplements, and sodium intakes were not validated with 24-hour urinary sodium values.

Conclusion

A high-sodium diet can contribute to hypertension leading to cardiovascular disease. This study provides the first available estimates of sodium intake and the major foods contributing to sodium intake among participants of the HANDLS study who represent a socioeconomically diverse urban African American and White population. The sodium intake of this vulnerable population is excessive in light of current recommendations. Inadequate intakes of potassium were also documented. It is not just the *Dietary Guidelines for Americans, 2010* that recommend a maximum daily intake of 1500 mg of sodium for those at risk of HTN. The American Heart Association recommends this maximum level of sodium intake for all Americans (American Heart Association, 2010) and continues to do so despite the 2013 IOM report questioning sodium reduction below the 2300 mg/day level (AHA, 2013). Sodium intakes above these levels may increase risk for cardiovascular disease.

These results demonstrate the need for strategies to improve this population's diet. It is not feasible to simply educate or counsel individuals to limit their sodium intake to 1500 mg daily in the face of the abundance of prepared foods and with fast food restaurants plentifully available, especially in urban areas. Cooperation from the food industry to begin to reduce the sodium content of the food supply will be needed and has begun to occur. As HTN is rising in younger aged populations given the epidemic of obesity, health professionals can play a key role in educating families on the importance of monitoring the sodium in daily intakes and making healthful dietary choices that lead to disease prevention and control.

Ethical approval

The study protocol was approved by the human investigation review boards at both MedStar Health Research Institute and University of Delaware. All HANDLS participants were provided written informed consent and compensated monetarily.

Conflict of interest statement

None.

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Corrigendum

Corrigendum for "Sodium intake of special populations in the Healthy Aging Neighborhoods of Diversity Across the Life Span (HANDLS) study" [Prev. Med. 57 (2013) 334–338]

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The authors regret that the name of Dr. Marie Fanelli-Kuczmarski was misspelled in the above-referenced article. The correct author line appears above.

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