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The Impact of Conventional Dietary Intake Data Coding Methods on Snacks Typically Consumed by Socioeconomically Diverse African American and White Urban Population: A Comparison of Coding Methods

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Abstract

This study assessed the significance of implementing combination codes generated by USDA's Automated Multiple Pass Method and the impact on the assessment of snacking using the Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) study. African American and White participants (n=2177) completed two 24-hour dietary recalls. All self-reported snacks were assigned a food group code, while snacks eaten in combination (e.g. cereal with milk) were additionally assigned a combination code and associated with a food group based on primary component (e.g. cereal). Combination codes produced significant variation in snack lists by race, providing a better depiction of snacking patterns.

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1. Introduction

There is limited knowledge of foods as typically consumed by urban African American and White populations[1-5]. Perhaps the health disparities that exist in the United States may be associated with not only the food choices, but also eating practices. For example, a baked potato could be consumed with no toppings or it could be eaten topped with butter, sour cream, and cheese. Analyses of dietary intake data that includes codes to identify foods consumed simultaneously as one item can reveal more insight into how populations eat. With a better understanding of eating practices of populations, nutrition educators, health professionals, and public health policymakers may be able to translate nutrition goals into practical, culturally relevant, and sex-specific diet recommendations[6,] 7.The public-use dietary datasets for the Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) study and the What We Eat in America, National Health and Nutrition Examination Surveys contain coded foods which

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are used to explore the relationships between diet and health[8-11]. The assignment of a code for each food and beverage reported in United States Department of Agriculture's (USDA) Automated Multiple-Pass Method (AMPM) is required to link that item to an appropriate nutrient profile within USDA's Food and Nutrient Database for Dietary Studies. The assignment of a food code is completed one of two ways: 1) automatically through the Post Interview Processing System, a computer program separate from the AMPM or 2) manually by a coder using Survey Net, a computer-assisted coding system. In addition to the food code assigned to food/beverage reported, foods or beverages may also be given combination codes to identify items consumed together as combinations. The AMPM assigns combination codes, and Survey Net as well provides the ability for a coder to assign combination codes.

A combination code identifies foods that were consumed simultaneously as one item such as coffee with milk and sugar, and foods with separate ingredients, such as salads and sandwiches. These combination codes allow researchers the ability to create a composite food and assign this item (such as a sandwich) one code. Use of the combination codes has been shown to be critical for accurate identification of beverages when estimating energy density[12] and when estimating the sodium from sandwiches[13].

To create a picture of how foods are actually consumed, the use of these combination codes in analyses is essential. Similar to the selection of a dietary intake collection method, the coding variables used in dietary data analysis must match the purpose of the study. Unfortunately, our review of the literature revealed either a lack of detailed description as to use of food combination codes[14] or exclusion of food combinations in analysis[15, 16] when researchers were determining food patterns. The main objective of this study was to compare two coding methods to illustrate the importance of using the combination codes to provide the best depiction of how foods were typically consumed as snacks by the participants in the HANDLS study.

Nomenclature

AMPM	Automated Multiple Pass Method
FNDDS	Food and Nutrient Database for Dietary Studies
HANDLS	Healthy Aging in Neighborhoods of Diversity across the Life Span
PIR	Poverty Income Ratio
USDA	United States Department of Agriculture

2. Methods

2.1. Background on HANDLS study

The HANDLS study, a community-based, prospective epidemiological study, was designed to examine whether race and socioeconomic status influence age-related health disparities independently or synergistically. Participants were drawn from 13 pre-determined neighborhoods in Baltimore City, yielding representative distributions of individuals between 30 and 64 years old who were African Americans and Whites, men and women, and lower (<125% 2003 United States Department of Health and Human Services poverty guidelines[17] [PIR]) and higher (>125%PIR) socioeconomic status. There were 2 phases in the baseline HANDLS study. The first phase was done in the participant's home. This phase consisted of an in-home interview that included questionnaires about the participant's health status, health service utilization, psychosocial factors, neighborhood characteristics, demographics, and the first dietary recall.

The second phase was completed 4 to 10 days later, on mobile medical research vehicles located in the preselected census tracts where participants resided. This phase included the second dietary recall, a medical history and physical examination, cognitive evaluation, physiology assessments including heart rate variability, arterial thickness, carotid ultrasound, assessments of muscle strength and bone density, and laboratory measurements.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures were approved by the Institutional Review Boards at MedStar Health Research Institute and University of Delaware. Written informed consent was obtained from all HANDLS participants, all of whom were compensated monetarily. Further detailed information on the study design, eligibility and subject recruitment, and data collected can be found elsewhere.[18, 19]

2.2. Study Sample

Baseline data collection began in August 2004 and ended March 2009, with a total of 3720 participants. The sample consisted of 2177 socioeconomically diverse African American and White individuals who completed two days of 24-hour dietary recalls. Participants who completed only one recall day (n=1543) were not included because two days of recall provides a better representation of usual intakes. There were no statistical differences in demographic data or energy and nutrient profiles of the participants who completed one or both days of dietary recall. Thus the study sample is considered representative of the entire HANDLS baseline sample.

Characteristics of the HANDLS study participants are provided in **Table 1**. For the overall sample the mean (±SE) age was 47.8 ± 0.2 years and approximately half (57%) was female. The racial composition was 58% African American. Self-reported socioeconomic status revealed 43% with a household income <125% PIR. About one-third of the sample had less than a high school education. Among the African Americans, 48% have less than an 8th grade literacy rate compared to 26% among the Whites. Over 40% of the study sample were current smokers. The mean usual energy intake of the women was about 1,800 kcal and 2,450 kcal for men.

Table1. Characteristics of HANDLS Participants by Race and Sex (n=2177)

Characteristics	AA Women (n-708)	AA Men (n=553)	W Women (n=524)	W Men (n=392)
	X or %± SE	X or %±SE	X or %±SE	X or %±SE
Age, yrs (X)	47.9±0.3	47.7±0.4	47.7±0.4	48.1±0.5
Education (% <High school)	31.5±1.7	35.8±2.0	30.9±2.0	32.1±2.4
WRAT Literacy (% ≤ 8th grade)	47.4±1.9	49.5±2.1	25.7±1.9	26.9±2.2
Poverty Status (% <125% DHHS 2003 PIR)	53.1±1.9	48.3±2.1	35.7±2.1	26.5±2.2
Employed in last month (% Unemployed)	48.9±1.9	43.0±2.1	45.0±2.2	30.9±2.3
Smoking (% Currently)	43.9±1.9	58.8±2.1	44.2±2.2	46.5±2.5
Energy Usual Intake, kcal (X)	1812±1.9	2442±130	1827±22	2564±39

2.3. Dietary Intake Collection Method

The USDA validated 5-step Automated Multiple-Pass Method dietary recall survey software was used to collect both dietary recalls.[20, 21] The survey was supplemented by measurement aids such as measuring cups, spoons, ruler, and an illustrated Food Model Booklet to assist participants in estimating accurate quantities of foods and beverages consumed. Trained interviewers administered both 24-hour dietary recalls. Eating occasions were self-reported and included snack as one of the eight eating occasions. Snacks were foods and beverages not consumed with main meals – breakfast, lunch, or dinner.

Foods and beverages reported in the dietary recalls were coded with their own unique food codes using the Food and Nutrient Database for Dietary Studies (FNDDS) version 3.0 in the Survey Net coding software.[22, 23] Combination codes assigned initially by AMPM were reviewed in Survey Net, providing the coder the ability to change, remove or add new codes to ensure that foods eaten together were correctly linked.[23, 24] Combinations were defined using two separate variables – a combination food number, which distinguishes foods as eaten in combination, and combination food type. Examples of combinations include cracker with such additions as cheese or peanut butter, toppings added to ice cream, bread/baked goods with additions such as jelly or chocolate, and sandwiches. There were 14 combination types defined by USDA (beverage, cereal, bread/baked product, salad, sandwich, soup, frozen meal, ice cream, dried beans/vegetable, fruit, tortilla, meat/poultry/fish, lunchables, and chips), excluding a category of "99-other food mixtures".[23] For this study, the researchers created five additional combination types based on foods found in the "99" category (pasta dishes, rice dishes, Asian dishes, pizza, and dairy). A total of 19 unique combination types were used for analysis.

The coders of HANDLS study participant dietary recalls completed a multiple day training workshop and were given a coder reference manual which provided general instructions for reviewing and coding food intakes. This manual also included a chapter dedicated to combination codes and outlined the protocol to be used when assigning food groups to combinations. Their supervisor, a nutritionist and Registered Dietitian, performed quality reviews of coded recalls to ensure consistency in coding and compliance with protocol. The coders also completed quarterly trainings on coding.

2.4. Statistical Analyses

Duplicate analysis methods were performed on two separate datasets, specifically the Dataset-Original and Dataset-Revised. Dataset-Original consisted of all foods reported as the eating occasion "snack".

Each food item retained its original respective USDA food code. This dataset includes snack foods that were reported consumed as individual items and selected composite (i.e. already coded as combinations) foods. Examples of composite snack foods include grilled cheese sandwiches and brand name fast food items (McDonald's hot fudge sundae).

The Dataset-Revised was derived exclusively from the Dataset-Original. First, foods reported consumed at a "snack" eating occasion in combination (i.e. containing combination codes) were isolated from those without combination codes. The dataset of snack foods with combinations codes was then modified to reflect their concurrent consumption as a single snack food item. Specifically, snack foods consumed simultaneously [as a distinct food item] were aggregated into one food record and given a new individual food code associated with a food group. The final step involved appending the newly aggregated foods with the remaining non-combination foods into the Dataset-Revised. Detailed description of the creation of these datasets is described by Mason et al.[1]

The frequency of reported intake over both days of dietary recalls was calculated and categorized into one of 58 food groups. The nine major food groups in the FNDDS, namely (1) milk and milk products, (2) meat, poultry, fish, and mixtures, (3) eggs, (4) legumes, nuts, and seeds, (5) grain products, (6) fruits, (7) vegetables, (8) fats, oils, and salad dressings, and (9) sugars, sweets, and beverages [22], were expanded for this study to separate groups by their fat, sugar, and sodium content. Since foods eaten simultaneously that were assigned combination codes represent multiple food groups, the main food component was used to define the appropriate food group in the Dataset-Revised. For example, chips with salsa were associated with salty snack group. Next, the frequency of reported intake was calculated for all foods consumed in Dataset-Original along with foods consumed in Dataset-Revised.

For this study, a frequency of consumption of snacks by race and by sex was generated. Snacking records accounted for 15.2% of the non-combined original dietary data. The most frequently consumed snacks from selected food groups were determined. For lack of a clear cut-point in the descriptive frequency analyses, the top 19 food groups from the Dataset-Original were selected as a representative majority of the snacks eaten (Tables 2 and 3). These 19 food groups represented a minimum of 80% of the top foods eaten as snacks. The total percent contributed by the top 19 food groups for snacks was always greater when using Dataset–Revised compared to Dataset-Original, accounting for approximately 99% of snacks (Tables 2 and 3). Statistical analyses were performed with SAS statistical software Version 9.3 (SAS Institute, Cary, NC, 2010).

Results

To our knowledge this is the first publication that compares snack intakes with and without using the combination codes. As shown in **Tables 2** and **3**, when foods eaten in combination were coded as an aggregate, not only did the percent contribution of snack food groups change, but also new snack food groups appeared. Food groups unique to a dataset were presented in bold font in Tables 2 and 3. For instance, refined breads and grains ranged from 4-5% with the Dataset-Original to 1.7-1.9% in the Dataset-Revised lists, reflecting the incorporation of breads into sandwiches. Food groups such as sugar and condiments, disappeared from the list because they were eaten as an addition to a snack food, namely beverages and sandwiches, respectively.

The top snacks reported by both the African American and White adults examined in the HANDLS study were salty snacks, grain-based desserts and sweetened beverages. Salty snacks included chips, pretzels, and crackers. Grain-based desserts included cakes, cookies, doughnuts, and pies. Sweetened beverages included sweetened tea, sweetened coffee, fruit-flavored drinks, and soft drinks. These three groups contributed 40% of all snacks and the proportion contributed to snacks by race was not significantly different based on analyses with the Dataset-Revised. The next three food groups which contributed approximately 25% of all snacks were candy, non-citrus fruits, and diet beverages. Non-citrus fruits contributed less than 10% of all snacks. Diet beverages reported by African Americans contributed significantly less to snack foods compared to Whites (p=0.01). The use of the combination codes captured 65% of all snacks with six food groups compared to 11 food groups when no combination codes were utilized. Using the Dataset-Revised, the contribution of the sandwiches and meat/food groups was significantly greater for African Americans than White adults (p< 0.01 and p<0.0001, respectively). The reverse was observed for regular fat milk (p=0.0013), processed cheese (p=0.0002), ready-to-eat cereal (p=0.0024), diet beverages (p=0.0112), and bars (p=0.0043). Bars include such items as granola as well as fruit filled grain-based bars.

Table 2.Typical snacks of an African American urban population defined by frequency of reported consumption: A comparison of analyses using different coding approaches.

Dataset-Original		Dataset-Revised	
All coded foods entered analysis as individual items		Coded foods identified as combinations entered analysis as aggregates	
Food Groups	*%*	*Food Groups*	*%*
Grain-based desserts	11.8[a]	Salty snacks	15.9[b]
Salty snacks	11.6[a]	Grain-based desserts	15.5[b]
Sweetened beverages	7.6[a]	Sweetened beverages	11.7[b]
Candy	7.4[a]	Candy	8.9[b]
Fruit, excludes citrus	6.9[a]	Fruit, excludes citrus	8.8[b]
Refined breads and grains	5.0[a]	Diet beverages	7.5[b]
Dairy desserts	3.5[a]	Dairy desserts	5.2[b]
Coffee	3.5	**Sandwiches**	4.8
Diet beverages	3.3[a]	**Meat/Seafood**	4.8
Luncheon meats	3.1	**Pizza**	3.2
Vegetables, excludes green, orange, starchy	2.9	Nuts and nut butters	2.8
Sugar	2.7	**Starchy vegetables**	2.3
Nuts and nut butters	2.6	Refined breads and grains	1.9[b]
Citrus fruit	1.9	Regular fat milk	1.5
Poultry	1.8	**Alcoholic beverages**	1.4
Condiments	1.7	Ready-to-eat cereals	1.4
Ready-to-eat cereals	1.7	Processed cheese	0.8[b]
Processed cheese	1.5[a]	**Bars**	0.7
Alcoholic beverages	1.1	Dairy products	0.5
Total	*81.4*		*99.3*

Note: Different superscript letters for same food group indicates statistically different (p<0.01).Bolded font indicated food groups that only appear among the top 19 food groups. The proportion of snacks contributed by sandwiches, pizza, and bars from the Dataset-Revised was statistically greater than that of Dataset-Original (p<0.0001). There were no statistical difference for alcoholic beverages (p=0.22). No statistical comparisons were performed for the following bolded groups: coffee, luncheon meats, vegetables, sugar, poultry, condiments, (Dataset-Original) and meat/seafood (Dataset-Revised) due to lack of data.

When comparing the lists of snack foods reported by African American adults derived from the Dataset-Original to the Dataset-Revised, coffee, luncheon meats, sugar, poultry and condiments only appeared as snacks when the combination codes were not used (Table 2). When the combination codes were used, these 5 groups were replaced with sandwiches, meat/seafood, pizza, alcoholic beverages, and bars. The types of vegetables used as snacks changed when combination codes were used. Starchy vegetables, mostly French fried potatoes, were identified as a snack with the Dataset-Revised, whereas vegetables other than green, orange, or starchy type were seen in the list derived from the Dataset-

Original. Lettuce was typically the other vegetable and was most likely incorporated into sandwiches along with the luncheon meats or poultry, and the condiments. A comparison of the food groups presented in both datasets in Table 2 revealed significant differences for 9 food groups contributing snacks.

Similar to the results for the African American adults, sandwiches, meat/seafood, pizza, alcoholic beverages, and bars appeared on the snack list for White adults when the combination codes were used in analysis (Table 3). Coffee, sugar, luncheon meat, and natural cheese were snacks that appeared on the list generated from the Dataset-Original but were not apparent in the list generated from the Dataset-Revised. Interestingly, the percentage of sweetened beverages increased from 5.7 % to 10.3% when combination codes were used. Once again, the type of vegetable in the snack list changed as previously described. Both racial groups consumed sweetened ready-to-eat cereals such as Lucky Charms®, Frosted Flakes®, and Cinnamon Toast Crunch® over unsweetened cereals like Corn Flakes® and Rice Krispies® as snacks.

Table 3. Typical snacks of a White urban population defined by frequency of reported consumption: A comparison of analyses using different coding approaches.

Dataset-Original All coded foods entered analysis as individual items		Dataset-Revised Coded foods identified as combinations entered analysis as aggregates	
Food Groups	*%*	*Food Groups*	*%*
Grain-based desserts	11.1[a]	Grain-based desserts	15.3[b]
Salty snacks	10.4[a]	Salty snacks	14.8[b]
Fruit, excludes citrus	7.0[a]	Sweetened beverages	10.3[b]
Candy	6.8[a]	Fruits, excludes citrus	9.3[b]
Sweetened beverages	5.7[a]	Diet beverages	9.2[b]
Coffee	5.4	Candy	8.8[b]
Dairy desserts	4.1[a]	Dairy desserts	6.1[b]
Refined breads and grains	4.0[a]	**Sandwiches**	3.5
Diet beverages	3.9[a]	Nuts and nut butters	3.4
Nuts and nut butters	3.5	**Starchy vegetables**	2.6
Sugar	3.1	**Pizza**	2.6
Ready-to-eat cereals	2.9	Regular fat milk	2.6[b]
Dairy products	2.7[a]	Ready-to-eat cereals	2.4
Vegetables, excludes green, orange, starchy	2.5	**Meat/seafood**	2.2
Reduced/non-fat milk	2.1	Processed cheese	1.8
Luncheon meats	1.8	Refined breads and grains	1.7[b]
Regular fat milk	1.6[a]	**Bars**	1.4
Natural cheese	1.4	**Alcoholic beverages**	1.2
Processed cheese	1.3	Dairy products	0.7[b]
Total	*81.2*		*99.7*

Note: Different superscript letters for same food group indicates statistically different ($p<0.01$). Bolded font indicated food groups that only appear among the top 19 food groups. The proportion of snacks contributed by sandwiches, starchy vegetables, and pizza from the Dataset-Revised was statistically greater than that of Dataset-Original ($p<0.0001$). There were no statistical difference for alcoholic beverages ($p=0.21$). No statistical comparisons were performed for the following bolded groups: coffee, luncheon meats, vegetables, sugar, and natural cheese (Dataset-Original), and bars and meat/seafood (Dataset-Revised) due to lack of data.

The impact of implementing combination codes on the assessment of snacking by men and women was also evaluated. The use of combination codes resulted in changes to the Dataset-Original list of snacks consumed by men and women (data not shown). Coffee, sugar, luncheon meats, and citrus fruits were included as snacks when the analysis used the Dataset-Original. These food groups were not found in the snack list generated from the Dataset-Revised. Sandwiches, pizza, bars, and alcoholic beverages appeared on that list. Most likely the sugar was added to coffee which increased the percentage of sweetened beverages, and luncheon meats were incorporated into sandwiches. Once again there was a change in the vegetable group. Vegetables, excluding green, orange and starchy seen on the Dataset-Original list was replaced by Starchy vegetables when the analysis was performed with the Dataset-Revised. The list of snacks consumed by men and women were similar regardless of the dataset used.

4. Discussion

The findings of this study reveal that the use of combination codes provides a better picture of snacks consumed by the HANDLS study participants. Typically, researchers focus on the end result of dietary intake- the foods and nutrients a person is consuming and their effects on health. If instead researchers examine the way people are eating by utilizing combination codes, a more realistic picture of how food actually looks on a person's plate is created. This approach in analyses would allow for more specific recommendations and targeted nutrition programs for populations to improve overall dietary intakes.

The nutrition-related health outcomes of snacking most likely varies with different target populations and is influenced by many factors such as cultural diversity and food security.[25] Snacking can improve overall diet quality; however, the most frequently reported snacks for the HANDLS study participants were high in empty calories -salty snacks, grain-based desserts, sweetened beverages, and candy- results that are consistent with other reports in the literature.[25-27] Thus, the health-promoting qualities of foods and beverages consumed as snacks by the HANDLS study population are debatable.

Although there were no noteworthy differences in types of snacks consumed between the racial groups or between men and women, the analytical methods did produce differences in the list of snacks. These results differed from our previous study which reported differences by race using the combination codes at mealtimes, specifically breakfast, lunch, and dinner.[1] This difference might be attributed to the greater variety of foods consumed over these mealtimes.

A strength of this study is that it provides information on a socioeconomically diverse urban population of African American and White adults which are an understudied group. Another strength is that the list of snacks was based on two 24-hour dietary recalls which would provide a better representation of food intake. Even though these results describe a population that resided in Baltimore, Maryland, independent demographic analyses produced findings supporting this population was representative of urban populations from US cities with similar population densities and racial distribution. These cities include 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.[28]

In conclusion, the findings of this study are consistent with our previous research[1], indicating that the use of combination codes in dietary analyses does influence the results of dietary pattern investigations. Using combination codes may provide educators better insight to dietary practices which can be valuable when developing targeted nutrition-related messages. Accurate knowledge of how people choose and combine the foods they consume may also provide better insight to nutrition researchers and policy makers on the relationships between diet and health.

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References

1. Mason MA, Fanelli Kuczmarski M, Allegro D, Zonderman AB, Evans MK. The impact of conventional dietary intake data coding methods on foods typically consumed by a low-income African American and White urban population. *Public Health Nutrition* 2014 http://dx.doi.org/doi:10.1017/S1368980014002687.

2. Paeratakul S, Ferdinand DP, Champagne CM et al. Fast-food consumption among US adults and children: dietary and nutrient intake profile. *J Am Diet Assoc* 2003;103:332-1338.

3. Mullie P, Vansant G, Hulens M et al. Dietary patterns and socioeconomic position. *Euro J Clin Nutr* 2010:64:231-238.

4. Martikainen P, Brunner E, Marmot M. Socioeconomic differences in dietary patterns among middle-aged men and women. *Social Science and Medicine* 2003;56:1397-1410.

5. Kumanyika SK, Krebs-Smith SM. Chapter 19. Preventive nutrition issues in ethnic and socioeconomic groups in the United States. Preventive Nutrition, Volume II: Primary and Secondary Prevention, pp.325-356. Totowa NJ: Humana Press Inc.;2000.

6. Taylor CA, Gilmore AC & Keim KS. Impact of core and secondary foods on nutritional composition of diets in Native American women. *J Am Diet Assoc* 2005;105:413-409.

7. Sirot V, Volatier JL, Calamassi-Tran G *et al*. Core food of the French food supply: second Total Diet Study. *Food Addit Contam* 2006;26:623-639.

8. Kerver JM, Yang EJ, Bianchi L *et al.* Dietary patterns associated with risk factors for cardiovascular disease in healthy US adults. *Am J Clin Nutr* 2003;78:1103-1110.

9. Austin GL, Ogden LG & Hill JO. Trends in carbohydrate, fat, and protein intakes and association with energy intake in normal-weight, overweight, and obese individuals:1971-2006. *Am J Clin Nutr* 2011;93:836-843.

10. Fanelli Kuczmarski M, Mason MA, Allegro D *et al*. Diet quality is inversely associated with C-Reactive Protein levels in urban, low-income African-American and White adults. *J Acad Nutr Diet* 2013;113:1620-1631.

11. Fanelli Kuczmarski M, Mason MA, Beydoun M *et al*. Dietary patterns and sarcopenia in an urban African American and White population in the United States. *J Nutr Geriatr & Geronotol* 2013;32(4):291-316.

12. Vernarelli JA, Mitchell DC, Rolls BJ, Hartman TJ. Methods for calculating dietary energy density in a nationally representative sample. *Procedia Food Science* 2013;2:68-74.

13. Sebastian RS, Wilkinson Enns C, Goldman JD, Hoy MK, Moshfegh AJ. Sandwiches are major contributors of sodium in the diets of American adults: Results from What We Eat in America, National Health and Nutrition Examination Survey 2009-2010 *J Acad Nutr Diet* 2014 http://dx.doi.org/10.1016/j.jand.2014.07.034

14. Han E, Powell LM. Consumption patterns of sugar-sweetened beverages in the United States. *J Acad Nutr Diet* 2013;113:43-53.

15. Fulgoni, III VL, Quann EE. National trends in beverage consumption in children from birth to 5 years: analysis of NHANES across three decades. *Nutr J* [serial online] 2012;11, e92. http://www.nutritionj.com/content/11/1/92 (accessed March 2015).

16. Kit BK, Fakhouri THI, Park S *et al*. Trends in sugar-sweetened beverage consumption among youth and adults in the United States: 1999-2010. *Am J Clin Nutr* 2013;98:180-188.

17. United States Department of Health and Human Services (2003) Poverty Guidelines.available at http://aspe.hhs.gov/poverty/03poverty.htm (accessed March 2015).

18. Evans MK, Lepkowski JM, Powell NR *et al*. Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS): overcoming barriers to implementing a longitudinal, epidemiologic, urban study of health, race, and socioeconomic status. *Ethn Dis* 2010;20:267-275.

19. Evans MK & Zonderman AB (2004) Healthy Aging in Neighborhoods of Diversity across the Life Span. HANDLS Research Protocol. Version No: 3. available at http://handls.nih.gov/pdf/HANDLS-2Protocol-2004-10-08-Protocol.pdf (accessed March 2015).

20. Moshfegh AJ, Rhodes DG, Baer DJ *et al*. The US Department of Agriculture automated multiple-pass method reduces bias in the collection of energy intakes. *Am J Clin Nutr* 2008;88:324-332.

21. Conway JM, Ingwerson LA, Moshfegh AJ. Accuracy of dietary recall using the USDA five-step multiple-pass method in men: an observational validation study. *J Am Diet Assoc* 2004;104:95-603.

22. Agricultural Research Service, Food Surveys Research Group. USDA Food and Nutrient Database for Dietary Studies, 3.0; available at http://www.ars.usda.gov/Services/docs.htm?docid=12089 (accessed March 2015).

23. NHANES dietary web tutorial. Resources for dietary data analysis. available at http://www.cdc.gov/nchs/tutorials/Dietary/SurveyOrientation/ResourceDietaryAnalysis/intro.htm (accessed March 2015).

24. Raper N, Perloff B, Ingwersen L *et al*. An overview of USDA's Dietary Intake Data System. *J Food Compost Anal* 2004;17:545-555.

25. Zizza CA. Healthy snacking recommendations: One size does not fit all. *Physiol Behav* 2014;134:32-37.

26. Nicklas TA, O'Neil CE, Fulongi VL. Snacking patterns, diet quality, and cardiovascular risk factors inadults. *BMC Public Health* 2014;14:388-402.

27. Bellisle F. Meals and snacking, diet quality and energy balance. Physiol Behav 2014;134:38-43.

28. Lepkowski J. HANDLS Generalizibility, 2010 and HANDLS Principle Cities Clusters Analysis. Unpublished internal National of Institutes on Aging documents; 2011.