Socioeconomic trends in household food expenditures: Comparing objective food shopping receipts vs. self-reports

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Abstract

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Studies on the association between socioeconomic factors and food purchasing behavior have tended to rely on food expenditure data obtained through participant self-reports[1]. However, self-reported expenditures have only rarely been compared to objective measures such as store and restaurant receipts collected over a given period of time[2-9]. In addition, few receipt-based studies have addressed the disparities in the purchases of healthy or unhealthy foods across different socioeconomic status (SES) groups[3; 8].

The Seattle Obesity Study II (SOS II) collected store and restaurant receipts for 449 households over a period of 2 weeks. Participants were asked to report their monthly food expenditures for foods at home and away from home at the household level. The purpose of the present analyses was to: a) compare household food expenditures obtained from self-report vs. food shopping receipt data, using a number of validation techniques such as Pearson correlation, quintile kappa coefficient, and Bland-Altman method; b) examine socioeconomic trends in food expenditures using data from both methods: food shopping receipts vs. self-reports; c) to further examine SES trends in household food expenditures at home vs. away from home, as well as food groups using food shopping receipt data.

The food expenditure data from two methods showed moderate agreement with a Pearson correlation of .62, Kappa coefficient of .48, and Bland-Altman agreement of $3±$162 (mean ± Standard Deviation). Self-reported food expenditures adequately reflected objective data obtained by collecting food shopping receipts. Similar associations were observed between SES and food expenditure data, obtained from both the methods. Self-reported and receipt data showed that participants with higher SES spent significantly more on food. However, the percentage of income spent on food decreased as income increased. Further analyses of receipt data on eating out showed that higher income households spent a significantly higher percentage of food expenditure on eating-out as compared to lower income households (30.3% versus 18.7%). Higher income households spent a lower percentage of the food dollar in grocery stores (69.2% vs. 80.0%), and a greater percentage in full service restaurants (17.2% versus 6.8%) compared to lower income households. Produce purchases as percent of total were linked to educational attainment (23.8% vs. 14.5%). Purchases of sweetened beverages were linked to lower incomes (7.2% vs.9.6%). This study showed that self-reported expenditure is a valuable and cost-effective way to measure food spending.

Introduction

Socioeconomic disparities in diet quality are well known[10]. Lower income and education groups have been consistently linked with poor dietary intakes, which ranged from individual nutrients (fats, added sugars, vitamins, and minerals) to food groups to composite measures of diet quality such as energy density and Mean Adequacy Ratio (MAR), to indices of overall dietary patterns such as Mediterranean dietary scores and Health Eating Index to dietary variety or dietary diversity[11-15]. Poor dietary intakes have been in turn linked to a higher risk of obesity and diet-related chronic diseases[16-18]. The USDA 2010 Dietary Guidelines[19] recommend increasing the consumption of vegetables, fruits, whole grains and low fat dairy products while reducing the consumption of sodium, saturated and trans fatty acids, and added sugars. However, the recommended nutrient-rich diets have been associated with higher per calorie diet costs. A recent meta-analysis showed that healthier foods overall cost $1.48 more per day or $1.54 per 2000 kcal compared with less healthy food options[20]. Socioeconomically disadvantaged groups may have more difficulty following these recommendations due to increased dietary costs[21; 22].

Several studies have shown that nutrient dense foods, including many fruits and vegetables, tend to cost more, whereas high energy density foods such as fats and oils usually cost less[16; 21-23]. Cost may be one reason why lower income households tend to have a lower dietary quality. Lower cost foods have a high energy density but low nutrient density[23]. However, most of this evidence is based on dietary intake data[24-27]. The disparity in food purchasing behaviors among different socioeconomic groups has not been well studied. There are a few studies that have linked SES with food purchasing behaviors[1; 8; 28; 29]. Turrell and colleagues[28] found that people with low SES tended to purchase fewer types of fruits and

vegetables compared to people with high SES. Using participant's occupation as a measurement of SES, Pechey and colleagues[29] found that SES was associated with sodium purchase. In addition, households with high SES tended to purchase higher percentage of energy from healthier foods (i.e., high fiber breads vs. low fiber breads)[29]. In most of these studies, food purchasing behaviors were assessed through self-report, which is subject to inaccuracies and measurement bias. In a few studies, food related shopping receipts have been used as an objective indicator of food purchasing patterns [2-9; 30]. Examining the association between food purchasing behaviors and SES could lead to a better understanding of the gap between health and dietary quality among different socioeconomic groups.

In addition to use food shopping receipts to analyze household food purchasing patterns, the evaluation of household's food purchasing locations have drawn researchers' attention[3]. Previous studies have linked away from home food consumption with increased energy intake and weight gain [31-34]. Kant and Graubard[33] found the frequency of eating out was positively associated with energy intake and percentage of energy from fat using 1987-2000 national level survey data. Powell and Nguyen[34] found food consumption at both fast food and full service restaurants was associated with higher energy intake and poor diet quality among children and adolescents using 24-hour dietary recall. However, limit research is available to measure eating-out food purchase among SES. Food purchase is an upstream of food consumption. Using objective food shopping receipts to measure food purchase at various locations will assist in explaining the purchasing behaviors of different socioeconomic groups.

In order to investigate the connection between consumer behavior and health, a Flexible Consumer Behavior Survey (FCBS) module was developed and added to the 2007-2008 National Health and Nutrition Examination Survey (NHANES)[35]. Family food expenditure behaviors

including self-reported spending at grocery stores and eating-out were collected using FCBS on a continuous basis since 2007. However, little is known about the validity of using self-reported data on household food expenditures in relation to actual expenditures based on food shopping receipts.

The present study has the following aims:

1. To compare household level food expenditures and food shopping behaviors using an objective tool (household food shopping receipts) with self-reports.

   Hypothesis 1: Self-reported food expenditures can adequately reflect actual food expenditures made by the household, as documented by food shopping receipts.

2. To examine socioeconomic trends in household food expenditures, and to compare findings across two methods: objective data based on food shopping receipts vs. subjective data based on self-reports.

   Hypothesis 2: Following Engel's law, we hypothesize that lower SES families tend to have lower household food expenditures but the percent of their annual household income spent on food is much higher. We speculate that the results would be similar across objective and subjective food expenditures data.

3. To further examine socioeconomic trends in household food expenditures at home vs. away from home, as well as by food groups (using food shopping receipt data).

   Hypothesis 3: Using food shopping receipt as an objective measure of food purchasing behavior, we hypothesize that low SES families spend a smaller percentage of total food cost at eating out places, specific full service restaurants, compare with high SES families. Secondarily, we hypothesize that low SES families spend a smaller percentage of grocery store food cost on nutritious foods such as fruits and vegetables, compared to

high SES families. Low SES families spend a larger percentage of grocery store food cost on less nutritious foods, compared to high SES families.

The data for the present study was obtained from the Seattle Obesity Study II (SOS II), a longitudinal study on socioeconomic disparities in diets and health based on a cohort of 516 male and female adult residents of King County, WA. SOS II collected detailed data on food purchasing behaviors, using both objective and subjective measures. Objective measure included collection of household food expenditure receipts on both food stores and restaurants for two weeks. Subjective data was obtained using self-reported question from FCBS[35]. In addition, a behavior survey was used to collect detailed data on socio-demographics, diets and health of the study sample.

Comparing the self-reported food expenditure with spending computed from the objective food shopping receipts would help testify the validity and accuracy of the FCBS[35]. Linking the food shopping receipt data with socioeconomic predictors can help us identify gaps in food purchasing behavior among different SES groups. Our results can provide evidence of disparities in food purchasing behavior, providing policy makers with evidence to implement public health interventions to address the high costs of nutritious foods and thus promote healthy eating for people from all SES groups.

Methods

Sampling frame and participant data

This project is a secondary data analysis of NIH funded SOS II study. SOS II was a longitudinal study of 516 male and female adult residents of King County, Washington. An address-based stratified random sampling scheme was used to ensure a representative sample by

lower income. Participants were randomly selected based on three strata of residential property values: ≤$199,999; $200,000 to $299,999; and ≥$300,000, as residential property value has been demonstrated as a novel and useful measurement of household wealth[36]. Sampled addresses were sent to commercial vendors to match with telephone numbers. Potential participants were informed by pre-notification letters stating that their household was randomly selected by the University of Washington Shopping for Health Study. Each of these potential respondents were then contacted over the phone to screen for eligibility and recruitment. Eligibility criteria were age between 18 to 55 years, English-speaking, primary food shoppers for the household, not incapacitated and without mobility or other issues that would prevent them from completing this study. The study consisted of two phases: baseline phase and a follow up phase after 1 year. The study protocols were approved by the institutional review board (IRB) at University of Washington.

Study instruments and variables of interest

SOS II study had several study instruments, ranging from behavior surveys to GPS and travel log to dietary data collection tools. However, only those instruments relevant for this project are described here briefly. A total of 516 participants were recruited from October 2011 to October 2012 and were followed up for a period of one year. During the first in-person meeting at baseline, participants were interviewed using a comprehensive behavioral survey. This 60-min survey collected self-reported data on participant's socio-demographics, household and individual-level food expenditures, food related attitudes, physical activity, food security, access to food and transportation, body weight, and other health outcomes. Similar behavior survey was conducted at the end of one year follow up.

Socioeconomic and demographic variables

Income and highest education completed were used as two measures of SES. Education was measured in 7 categories from "never attended school or only attended kindergarten" to "Master's professional or doctoral degree". Education variable was combined into 3 categories for analytical purpose: "high school or less", "some college", and "college degree or higher". Household annual income was measured in 6 categories from "<$25,000" to "≥$100,000". Income was also combined into 3 categories: "≤$50,000", "$50,000 - <$100,000" and "≥$100,000". Demographic variables of interest were age, race/ethnicity, gender, and household size.

Self-reported data on food expenditures: using behavior survey

Food expenditure data on all grocery stores combined and at all eating out places was collected, as part of the baseline behavior survey. Each respondent was asked the following two questions: "Now think about how much money your household spends on shopping for food and beverage altogether in a typical month. It includes amount spent on groceries for foods and beverages at all stores combined.", "In a typical month, think about how much money your family spends on eating out altogether. Please include money spent at full service or fast food restaurants, cafeterias at work or school or on vending machines, for all family members." These questions were adapted from the Flexible Consumer Behavior Survey Module of NHANES[35].

Objective data on food expenditures: using food shopping receipts

At baseline phase, each respondent was asked to collect two weeks of household food shopping receipts from all grocery stores and restaurants. These receipts were received through mail within the 1st month of follow up, checked for accuracy and completeness, scanned and manually entered into the database.

Data obtained from each food shopping receipt was manually entered into the database. These included identification numbers for each food item, participant numbers, number of receipts received from each participant/household, food item purchased date, receipt/food source name, number of food items on each receipt, department of grocery stores (i.e., bakery, frozen, meat) if available, food item name, size of the food item, unit (i.e., oz, lbs), unit price (i.e., $1,99/lb, $2.99/lb), cost of each food item ($), and receipt total cost ($). Some of these data were used to create more variables - food source locations data from the receipt was categorized into two groups: receipts from grocery stores or from eating-out. Grocery store receipts are eating-at-home source receipts from supermarkets, super centers, grocery stores, wholesale stores, community supported agriculture deliveries, convenient stores/gas stations, meat shops, and farmers' markets. Eating-out receipts include restaurants, food courts, and cafeterias at work or school, vending machines, carry-outs, bakery, and movie theaters. Eating-out purchase were further categorized into full service restaurants (defined as "pay after eat") or fast food restaurants (defined as "pay before eat").

A small number food items were categorized as eating-out or grocery even though the food sources were missing (~261 food items). This categorization was based on best subjective assumption. Judgment was made based on available indicators including tips, sale taxes, and key words on the receipts (e.g., dining, takeout, window #). Non-food items, alcohol and tobacco products, nutrition supplements, tax and tips were excluded. It had been previously shown that

collection of two-week food shopping receipts is adequate to measure household food purchasing behavior[2]. Two week total food expenditure, food expenditures at grocery stores, fast food restaurants, and full service restaurants were computed separately.

Food items from grocery stores were further aggregated into food groups developed by the National Cancer Institute[37]. A revised version which include nine major food groups and 89 mutually exclusive subgroups was created and used to accommodate the simple description of food items on the receipts**.** For example, the food item from a grocery store receipt may be printed as "milk". There is no detailed information to specify whether this milk product is "whole milk", "reduced fat milk", or "skim milk". For accuracy purpose, a food group named "milk, not further specified" was created to categorize milk that could not be further specified. The nine major food groups were beverage, bakery/bread, dressing/spread, produce (fresh and canned), snack, ethnics, entree, and miscellaneous/other. Food items were categorized into subgroups under major groups. For example cake was coded as "grain-based desserts" under "bakery/bread". Please see appendix 1 for a detailed list of food groups and subgroups.

Food items from eating out sources were not categorized into food groups because many restaurant receipts were not as detailed as store receipts and the single entree price was usually missing when participants ordered multiple entrees. In addition, restaurants may sell bundled/combo meals, for instance buying one entree getting one free side dish. Therefore it is difficult to capture the cost for complimentary side dish items[38]. An inter-coder method was used to measure the objectivity and reliability of the coding of food groups. Kappa coefficient was used to measure the agreement among coders. Two independent coders were randomly assigned to code a certain number of food items into food groups using the same coding scheme.

The agreement among three independent coders was 79% with a chance corrected agreement (kappa) of 0.78.

Of the 516 participants recruited at baseline, 515 successfully completed the baseline behavioral survey and 487 mailed back food shopping receipts. After taking missing data into account, 449 participants were used for analysis in the present study.

Statistical Analysis

Comparison of self-reported data with objective food-receipts

In order to test the validity of self-reported survey data, estimated monthly household total food spending (including food expenditures at grocery stores and eating-out places) was converted to two week expenditures (monthly spending ÷ 30.4 × 14). These estimates were then compared to the food shopping receipt data. Simple descriptive analyses (mean ± standard deviation, median (IQR)) were used to study the distribution of the data obtained. Scatterplots were used to give a visual presentation of the association. Food expenditure data obtained from these two methods was first treated as continuous measures and Pearson correlation coefficient was used to measure the correlation between two measurements. The Bland-Altman method was used to present the agreement between self-reported expenditure and spending summed by food shopping receipts[39]. The detailed description of Bland-Altman method was discussed elsewhere [39; 40]. In brief, an "average" variable was created and defined as: (food expenditure based on self-report + food expenditure computed by receipts) ÷2. A "difference" variable was created and defined as: food expenditure computed by food shopping receipts minus food expenditure based on self-report. A scatterplot with variables of "average" and "difference" was generated to measure the agreement and variance between self-reported and receipt computed food

expenditures. In addition, food expenditures from self-report and food shopping receipts were further divided into quintiles and weighted kappa coefficient were performed to evaluate the agreement between these two measurements. Weights were defined as 1.0 for perfect match, 0.8 for discordant by one category, 0.5 for discordant by two categories, and 0 for discordant by more than two categories.

Socioeconomic trends in total household food expenditures

The total household food expenditures, obtained from receipts and self-report, were each adjusted for household size to compute average food expenditure per person for every household. Multivariate regressions with robust standard errors were used to examine the association of SES measures (annual household income and education each) with 2-week food expenditure per person for every household, based on food-shopping receipts. Both crude and adjusted means were calculated. The covariates included age, race/ethnicity, and gender. The model for income was adjusted for education and vice a versa. These analyses were then replicated for self-reported 2-week food expenditure per person for every household.

Additional analyses were conducted to examine if the SES trends in food expenditure in the present sample followed Engel's law and of the data from Bureau of Labor Statistics[41]. Since participant's household income data was collected using income category, medians of each income category were used as the denominator to calculate percentage of income spent on food (Engel's law). For example $25,000 was used as the denominator for families with annual household income <$50,000, $75,000 was used as the denominator for families with annual household income $50,000-<$100,000. $125,000 was chosen as the denominator for families with annual household income>$100,000

Household food expenditures by food purchasing locations and food groups

To assess food purchasing locations among different SES groups, spending on each food item was summed to total food expenditure using food shopping receipts. The percentage of total food expenditure at grocery stores and restaurants including fast food restaurants and full service restaurants were calculated (i.e., % grocery store spending = total dollars spent at grocery stores divided by total food spending). The percentages of food expenditure on various purchasing locations were compared by education and income levels.

For food items purchased at grocery stores, the percentage of food expenditure on each food group was calculated (i.e., % spending on produce=total dollars spent on produce divided by total spending at grocery stores). Using the proportion of food expenditure instead of the actual dollar amount spending on each food group will eliminate the effects of household size on food spending.

Multivariate regressions with robust standard errors were used to examine the association of SES and purchasing locations and food groups of every household. Both crude and adjusted means were calculated. The covariates included age, race/ethnicity, household size, and gender. The model for income was adjusted for education and vice a versa. All statistical analyses were conducted using Stata version 11.

Results

Participant characteristics

Participants' baseline characteristics are presented in **Table 1.1**. The participants were more likely to be females (68.4%) with an average age of 46 years. The sample was

predominately White (80%). Almost two-third of the sample was at least college graduates (61.7%), a characteristic of the Seattle population. Higher income participants also tended to have higher education background. Mean BMI of the sample was 28 kg/m^2. Participants with higher income tended to have lower BMI. The mean and median household food expenditures for 2-weeks based on receipts were $315 and $284, which were very comparable to the data obtained from self-reports ($312 and $290 respectively). Interesting trends were observed by income. Higher income households tended to have higher food expenditures, based on both receipts and self-reported data (p-value for trend <.001).

Table1.1: Baseline Characteristics of Study Participants

Characteristics	**Overall**	**Annual Household Income**			
	n=449	**<$50,000 (n=131)**	**$50,000-<$100,000 (n=165)**	**≥$100,000 (n=153)**	**P-value trend**
Age, years (mean)	46	45	46	46	.568
Gender, n (%)					
Men	142 (31.6)	55 (42.0)	48 (29.1)	39 (25.5)	**.008**
Women	307 (68.4)	76 (58.0)	117 (71.0)	114 (74.5)	**.008**
Race/Ethnicity, n (%)					
White	359 (80.0)	100 (76.3)	133 (80.6)	126 (82.4)	.435
Non-White	90 (20.0)	31 (23.7)	32 (19.4)	27 (17.7)	.435
Highest Education, n (%)					
High School Graduates or Less	48 (10.7)	25 (19.1)	16 (9.7)	7 (4.6)	**<.001**
Some College	124 (27.6)	51 (38.9)	47 (28.5)	26 (17.0)	**<.001**
College Graduates	277 (61.7)	55 (42.0)	102 (61.8)	120 (78.4)	**<.001**
Household Size (mean)	2.8	2.2	2.7	3.4	**<.001**
Measured BMI (mean±SE)	28.1±.3	29.3±.7	28.4±.5	26.7±.5	**.004**
2-week Household Food Expenditure based on Receipt (mean±SD)	315±202	192±124	298±152	439±231	**<.001**
2-week Household Food Expenditure based on Self-report (mean±SD)	312±165	204±118	312±140	406±168	**<.001**
2-week Household Food Expenditure based on Receipt median, (IQR)	284 (171, 421)	163 (100, 270)	267 (195, 392)	393 (296, 530)	**<.001**
2-week Household Food Expenditure based on Self-report median, (IQR)	290 (184, 415)	175 (120, 276)	295 (207, 396)	391 (288, 484)	**<.001**

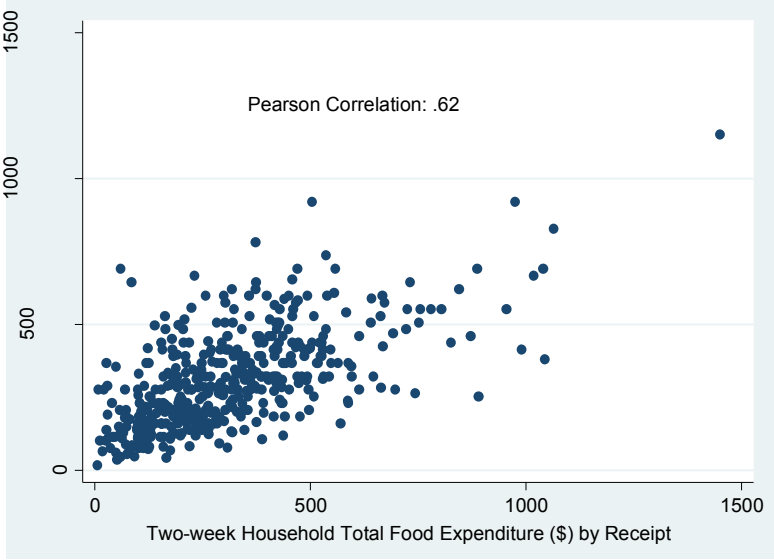
SECTION 1: Formal comparisons of household food expenditure data: based on receipts vs. Self-reports

Three methods were used to measure the concordance in data obtained from food shopping receipts and self-reports – Pearson correlation, Bland-Altman method and quintile kappa coefficient.

Overall household food expenditure for two weeks

The scatterplots of two weeks household food expenditures based on food shopping receipts and self-report were depicted in **Figure 1.1.1**. Moderate correlation was observed with scatterplots, and the Pearson correlation was .62.

Figure 1.1.1: Scatter Plots of Two-week Household Food Expenditure, Using Receipt and Self-report Data



Based on the Bland-Altman method (**Figure 1.1.2**), the mean difference of total food expenditures between food shopping receipts and self-report was $3 indicating that, on average, self-reported food expenditure was $3 less than food shopping receipt data. The standard

deviation of difference between food shopping receipts and self-reported total food expenditures was $162. The 95% limits of agreement (mean±2 SD) for total food expenditure was (-$322, $328).

Figure 1.1.2: Agreement of Two-week Household Food Exepditure between Receipt and Self-report by Bland-Altman Method

Total food expenditures were further categorized into quintile and treated as categorical variables. Using quintile method (**Table 1.2**), the observed agreement of two week household total food expenditures was 77.86% with a chance corrected kappa agreement of 0.48. A summary of the agreements between food shopping receipts and self-reported food expenditures were depicted in **Table 1.5**.

Table 1.2 Agreement of Two Week Household Food Expediture between Receipt and Self-report by Quintile

Quintile of Total Food Expenditure by Self-report	Quintile of Total Food Expenditure by Receipt				
	1	**2**	**3**	**4**	**5**
1	48	22	15	3	1
2	22	31	19	13	4
3	10	14	28	21	16
4	6	12	16	28	23
5	3	11	12	25	46

Household food expenditures at grocery stores

Total household food expenditures were further divided into food expenditures at grocery stores and eating-out places to conduct detailed comparison between data from food shopping receipts and self-report. The scatterplots of two week household food expenditure at grocery stores were depicted in **Figure 1.2.1**. A slightly lower correlation was observed for grocery stores food expenditures. The Pearson correlation between food shopping receipts and self-reported grocery store food expenditures was 0.57, slightly lower than the correlation of total spending.

Based on the Bland-Altman method (**Figure 1.2.2**), the mean difference of food expenditures at grocery stores between food shopping receipts and self-report was $14 indicating, on average, self-reported grocery stores food expenditure was $14 less than shopping receipts data. The standard deviation of difference of between receipt and self-reported grocery stores food expenditures was $131. The 95% limits of agreement (mean±2 SD) for total food expenditure was (-$249, $277).

Figure 1.2.1: Scatter Plots of Two-week Household Food Expenditures at Grocery Stores, Using Receipt and Self-report Data

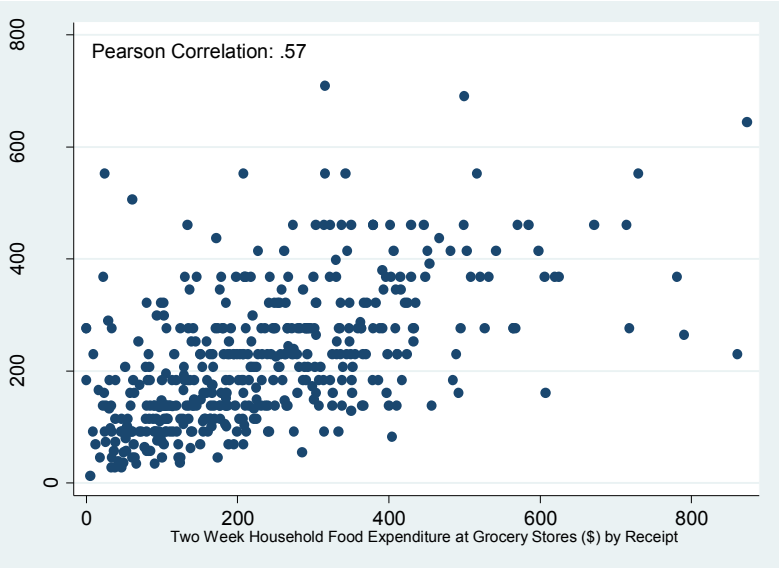


Figure 1.2.2: Agreement of Two-week Household Food Expeditures at Grocery Stores between Receipt and Self-report by Bland-Altman Method

Food expenditures at grocery stores were further treated as categorical variable and divided into quintile **(Table 1.3)**. The observed agreement between food shopping receipt and self-reported grocery stores expenditures was 77.84% with a chance corrected kappa agreement

of 0.48. In summary, moderate agreement was observed between receipts and self-reported food expenditures at grocery stores using three comparison methods.

Table 1.3 Agreement of Two Week Household Food Expeditures at Grocery Stores between Receipt and Self-report by Quintile

Quintile of Food Expenditure at Grocery Stores by Self-report	Quintile of Food Expenditure at grocery stores by Receipt				
	1	**2**	**3**	**4**	**5**
1	43	25	11	4	1
2	16	31	22	8	6
3	14	19	17	20	10
4	8	13	26	33	28
5	4	6	13	24	47

Household food expenditures on eating-out

For food expenditures at eating-out, the scatterplots of food shopping receipts and self-reported spending were demonstrated in **Figure 1.3.1**. Similar moderate correlation was observed for eating-out with the Pearson correlation of .59. Based on the Bland-Altman method **(Figure 1.3.2)**, the 95% limits of agreement (mean±2 SD) between food shopping receipts and self-reported eating-out food expenditures was (-$175, $148). The mean difference of eating-out food expenditure between food shopping receipts and self-report was $-13. On average, participants tended to overestimate their food expenditure at eating-out places by $13.

Figure 1.3.1: Scatter Plots of Two-week Household Food Expenditure at Eating-out, Using Receipt and Self-report Data

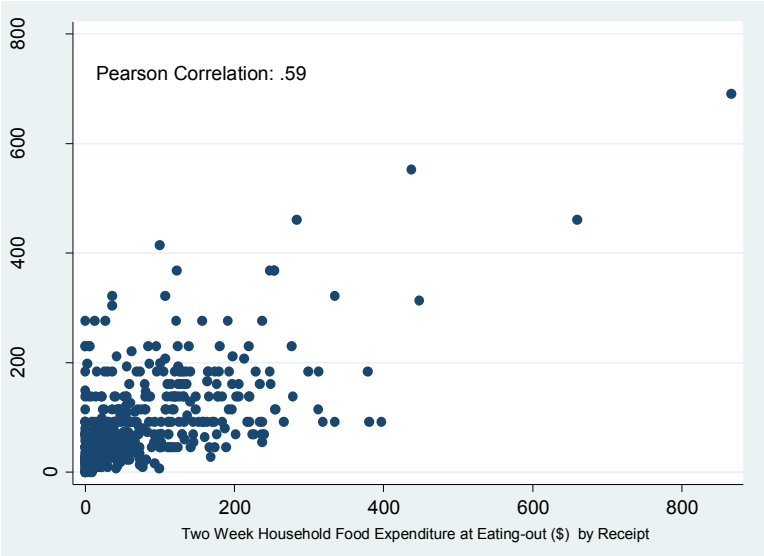
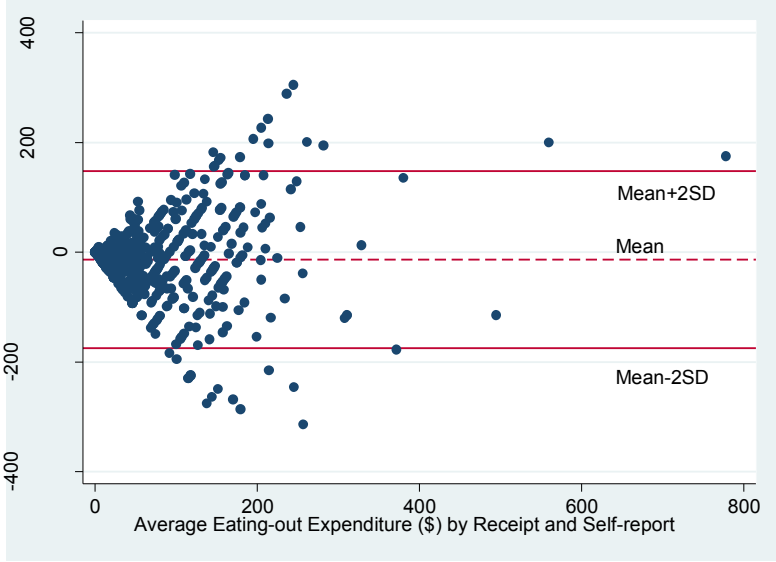


Figure 1.3.2: Agreement of Two-week Household Food Expeditures at Eating-out between Receipt and Self-report by Bland-Altman Method



When treating food expenditures at eating-out as categorical variables, the observed agreement by quintile was 74.81% (**Table 1.4**). The chance corrected kappa agreement was 0.42. Slightly lower but overall similar kappa coefficient was observed for eating out expenditures versus total expenditures.

Table 1.4 Agreement of Two Week Household Food Expeditures at Eating-out between Receipt and Self-report by Quintile

Quintile of Food Expenditure at Eating-out by Self-report	Quintile of Food Expenditure at Eating-out by Receipt				
	1	**2**	**3**	**4**	**5**
1	36	26	9	10	0
2	16	31	24	16	5
3	15	17	20	15	12
4	6	9	23	16	26
5	11	8	12	36	50

A summary of study findings for aim 1 were showed in **Table 1.5**. Moderate agreements were observed between food shopping receipts and self-reported total food expenditures using three comparison methods. The agreement remained the same even after stratifying by the type of food source - grocery stores vs. eating-out.

Table 1.5: Two-week Household Food Expenditures: Agreement between Receipt and Self-report Data

	Pearson Correlation	**Kappa Coefficient: Observed Agreement**	**Kappa**	**Bland-Altman: mean diff±SD[a]**
Total Food Expenditure	.62	77.86%	0.48	3±162
Food Expenditure at Grocery Stores	.57	77.84%	0.48	14±131
Food Expenditure at Eating-out	.59	74.81%	0.42	-13±81

[a]mean diff=mean difference of two measures (food expenditure($) based on receipt-food expenditure($) based on self-report)

SECTION 2: Socioeconomic trends in household food expenditures: comparisons across receipts and self-report

Socioeconomic trends in household food expenditures were examined using data from each: food shopping receipts and self-report. Income and education were each used as indicators of SES.

Food expenditure data in relation to income

Based on food shopping receipts (**Table 2.1**), higher income households were associated with higher per person expenditure on food. The mean household expenditure per person for two-weeks was $147 among highest income strata (≥$100,000), as compared to $110 among lower income strata (<$50,000). The association slightly attenuated but remained statistically significant even after adjusting for age, gender, race/ethnicity and education.

Self-reported food expenditures also showed overall increase with income (**Table 2.2**). As compared to lower income strata (<50,000), those with income $50,000-100,000 had significantly higher self-reported food expenditures per person ($115 vs. $143 respectively). However, the self-reported food expenditures dropped among those in highest income strata (≥$100,000). After adjusting for education, age, race/ethnicity, and gender, only medium income households reported significantly more food spending than low income households. These findings suggest that higher income households may tend to underestimate their self-reported food expenditure.

Table 2.1: Bivariate and Multivariate Regression Analysis to Test the Association between Annual Household Income and 2-week Household Food Expenditure, based on Food Shopping Receipts

Annual Household Income	Unadjusted Food Expenditure per Person			Adjusted Food Expenditure per Person[a]		
	Mean±SE	(95% CI)	P	Mean±SE	(95% CI)	P
<$50,000 (n=131)	110±7	Reference	Reference	115±7	Reference	Reference
$50,000 - <$100,000 (n=165)	136±6	(9, 44)	**.004**	136±6	(4, 40)	**.014**
≥$100,000 (n=153)	147±8	(18, 58)	**<.001**	143±8	(8, 50)	**.008**

[a]Adjusted mean after adjusting for age, education, race/ethnicity, and gender

Table 2.2: Bivariate and Multivariate Regression to Test the Association between Income and Two-week Household Food Expenditure per Person, Based on Self-report

Annual Household Income	Unadjusted Food Expenditure per Person			Adjusted Food Expenditure per Person[a]		
	Mean±SE	(95% CI)	P	Mean±SE	(95% CI)	P
<$50,000 (n=131)	115±6	Reference	Reference	120±6	Reference	Reference
$50,000 - <$100,000 (n=165)	143±6	(11, 46)	**.001**	144±6	(7, 41)	**.006**
≥$100,000 (n=153)	136±6	(3, 38)	**.020**	131±6	(-7, 30)	.219

[a]Adjusted mean after adjusting for age, education, race/ethnicity, and gender

Food expenditure data in relation to education

Food expenditures based on food shopping receipts showed similar results with education. Participants with higher education spent significantly more on food ($105 vs. $146 per person for two-weeks respectively) (**Table 2.3**). The association remained significant after adjusting for income, age, race/ethnicity, and gender.

Table 2.3: Bivariate and Multivariate Regression to Test the Association between Education and Two-week Household Food Expenditure per Person, Based on Food Shopping Receipts

Education	Unadjusted Food Expenditure, per Person			Adjusted Food Expenditure, per Person[a]		
	Mean±SE	(95% CI)	P	Mean±SE	(95% CI)	P
High school graduates or less (n=48)	105±11	Reference	Reference	112±11	Reference	Reference
Some college (n=124)	113±7	(-17, 34)	.500	117±7	(-20, 30)	.689
College graduates or higher (n=277)	146±5	(18 65)	**.001**	143±5	(6, 55)	**.015**

[a]Adjusted mean after adjusting for age, race/ethnicity, income, and gender

Similar trend was observed with the self-reported expenditure data (**Table 2.4**). Participants with the highest education degrees reported an average spending of $144 per person on food which was significantly higher than participants in the least education category who reported $102 food expenditure per person in two weeks. The association remained significant even after adjusting for key covariates.

Table 2.4: Bivariate and Multivariate Regression to Test the Association between Education and Two-week Household Food Expenditure per Person, Based on Self-report

	Unadjusted Food Expenditure, per Person			Adjusted Food Expenditure, per Person[a]		
Education	**Mean±SE**	**(95% CI)**	**P**	**Mean±SE**	**(95% CI)**	**P**
High school graduates or less (n=48)	102±8	Reference	Reference	106±9	Reference	Reference
Some college (n=124)	118±6	(-3, 36)	.098	120±6	(-6, 34)	.177
College graduates or higher (n=277)	144±5	(24, 61)	**<.001**	143±5	(17, 56)	**<.001**

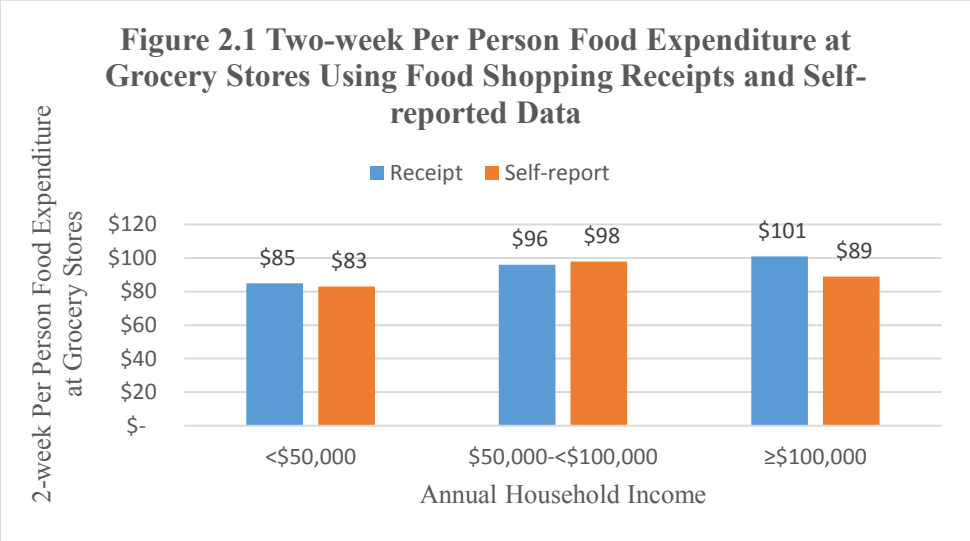
[a]Adjusted mean after adjusting for age, race/ethnicity, income, and gender

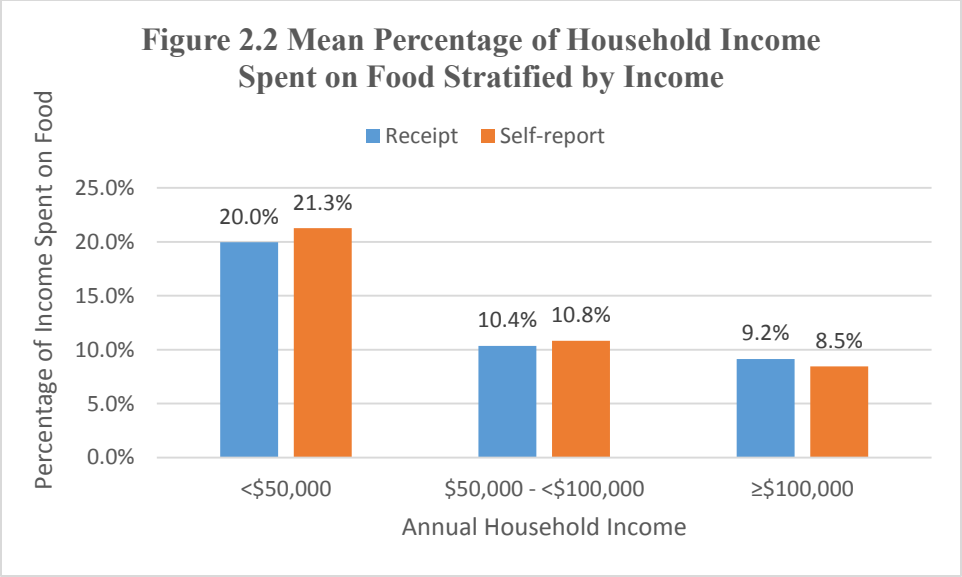
Engel's Law

The trends between income and food expenditures were also tested for Engel's Law in the present project. Engel's Law (1867) states that the proportion of income spent on food declines as incomes rise. Although higher income households spend more on food in absolute terms, food expenditures are a progressively lower proportion of their incomes. For the present study, household incomes were broken down into three categories (**Figure 2.1**). Overall, findings from the present study confirm Engel's Law. Higher income groups in the present sample spent significantly lower proportion on food, even though their per-person food expenditure in absolute terms was much higher. Two-week per person food expenditures increased from $85 to $96 to $101 as income increased based on receipt, but the proportion of income spent on food decreased from 20% to 10.4% to 9.2% (**Figure 2.2**). Overall, these trends were consistent for

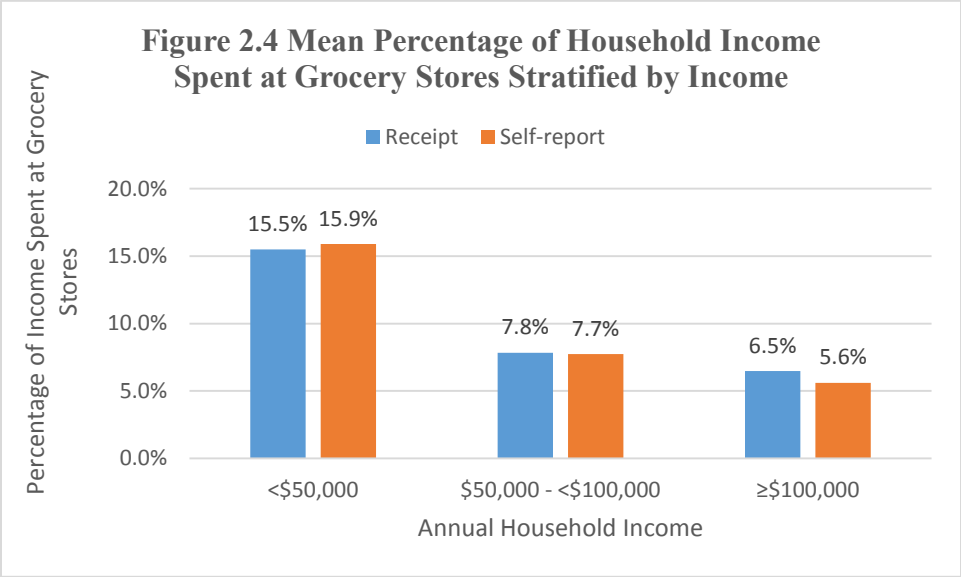
both receipts and self-reported data, however, a few differences were observed. In general, self-reported food expenditures were consistent with those based on food shopping receipts for most of the income categories, except for higher income category (>=100K) where people tend to underestimate their food expenditures.

The report of "Consumer Expenditures 2011"[41] from Bureau of Labor Statistics showed similar trend that highest income households spent lowest proportion of income on foods. Households in the lowest income quintile spent 36.2% of their income on foods versus households in the highest income quintile only spent 6.8% of their income on foods[41].



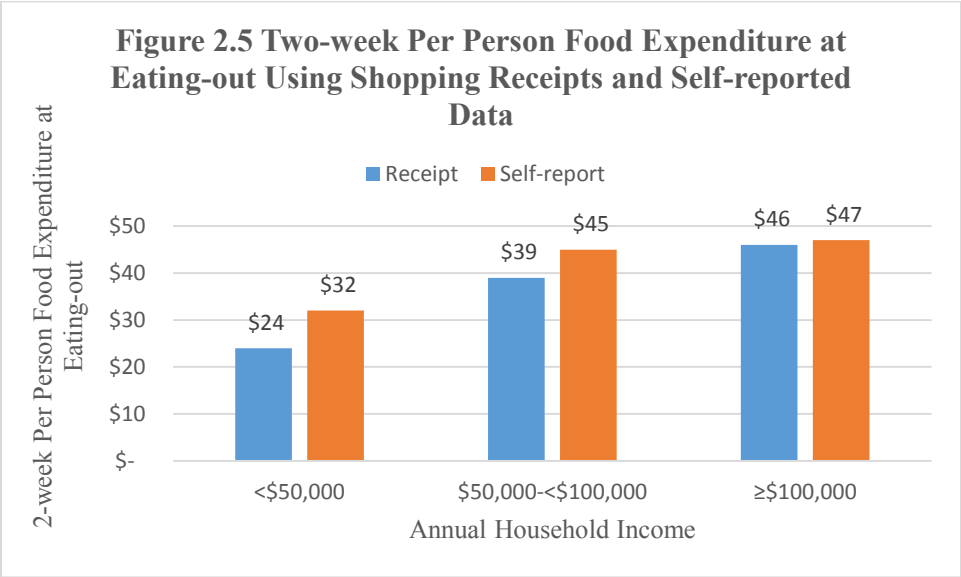


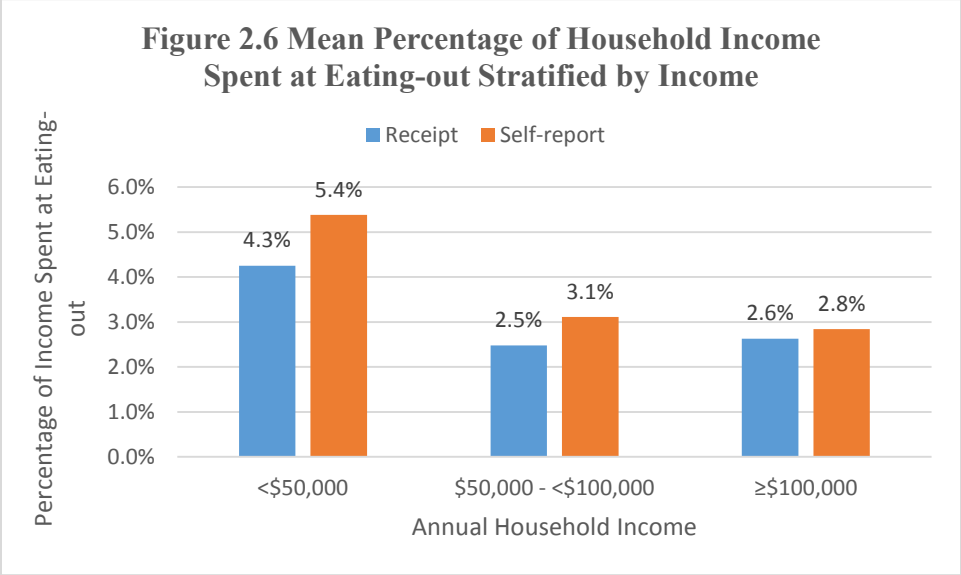
Validity with Engel's Law was also observed after stratifying by food expenditures at grocery stores vs. eating out. Two-week per person food expenditures at grocery stores were shown in **Figure 2.3**. According to food shopping receipt data, food expenditures at grocery stores were positively associated with income. Two-week per person food expenditures were $85 for low income households, $96 for middle income households, and $101 for high income households. Self-reported food expenditures showed similar trend. Again, high income households reported less spending at grocery stores than their actually spending based on food shopping receipts. The proportion of income spent at grocery stores followed Engel's law (**Figure 2.4**) that low income households spent higher proportion of income at grocery stores compared with high income households (15.5%/15.9% vs. 7.8%/7.7% vs. 6.5%/5.6%, receipt/self-report).



Two-week per person food expenditures at eating-out were shown in **Figure 2.5**. In general, households with higher income spent more on eating-out. Based on food shopping receipts data, households with high income roughly spent $22 more per capita in two-week, compared with households with low income. According to self-reported data, households with low income spent $32 per person at eating-out for two weeks compared with middle or high income households which spent $45 and $47, respectively. The percentages of income spent at

eating out generally decreased as income increasing (**Figure 2.6**). However the percentage differences between middle and high income households were small (2.5% vs. 2.6% based on receipt, 3.1% vs. 2.8% based on self-report) implying that high income households spent more at eating-out.





Section 3: Household food expenditures for two weeks by food purchasing locations and food groups (Using Receipt Data)

Additional analyses were conducted to examine the SES trends in proportion of food expenditures by food purchasing locations and food groups, based on the objective tool: food shopping receipts. **Table 3.1** shows the average proportion of food expenditures at different food purchasing locations by education and income. Overall, higher education groups spent lower proportion of their two-week total food expenditure on grocery stores but higher on eating out sources (73.4% vs. 75% vs. 80.5%). However, within eating out sources, the proportion of total expenditure was much higher at full-service restaurants (13.9% vs. 9.8% vs.6.9%) but not at fast food restaurants (11.3% vs. 14.4% vs.12.3%). Similar but stronger association was observed with income. High income families spent significant less percentage of their two-week food budget at grocery stores as compared to middle and lower income groups (71.3% vs. 74.9% vs. 78.0% respectively), and higher percentage on eating-out (20.9% vs. 24.7% vs. 28.1%). However, after adjusting for covariates (**Table 3.2**), the trends remained statistically significant with income and not education suggesting that income had bigger influence on household food purchasing locations than education. The high percentage of spending on eating-out observed in higher income groups was mainly attributed by food expenditures at full service restaurants. The spending pattern on fast food restaurants was similar across all SES groups.

Table 3.1 Unadjusted Percentage of Household Food Expenditures for two Weeks, at Different Locations

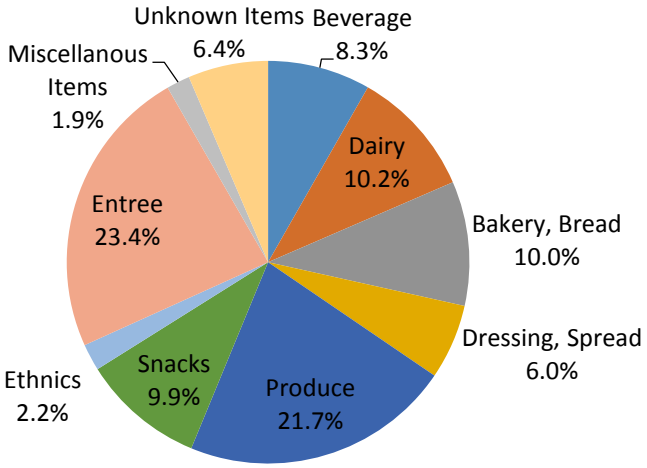
Socioeconomic Status	Grocery Stores		All Eating-out		Fast Food Restaurants		Full Service Restaurants	
Education	Mean±SE	P	Mean±SE	P	Mean±SE	P	Mean±SE	P
High school graduates or less	80.5±2.4	-	19.3±2.4	-	12.3±1.8	-	6.9±1.5	-
Some college	75.0±2.1	.086	24.4±2.1	.112	14.4±1.4	.356	9.8±1.5	.178
College graduates or higher	73.4±1.2	**.008**	25.9±1.2	**.016**	11.3±.6	.583	13.9±1.0	**<.001**
Income								
<$50,000	78.0±1.8	-	20.9±1.8	-	12.5±1.1	-	8.1±1.4	-
$50,000 - <$100,000	74.9±1.7	.209	24.7±1.7	.118	12.6±1.0	.911	11.6±1.1	**.049**
≥ $100,000	71.3±1.7	**.007**	28.1±1.7	**.004**	11.6±.9	.557	15.9±1.4	**<.001**

Table 3.2 Adjusted Percentage of Household Food Expenditures for Two Weeks, at Different Locations

Socioeconomic Status	Grocery Stores		All Eating-out		Fast Food Restaurants		Full Service Restaurants	
Education[a]	Mean±SE	P	Mean±SE	P	Mean±SE	P	Mean±SE	P
High school graduates or less	78.3±2.4	-	21.7±2.4	-	12.5±1.7	-	9.1±1.6	-
Some college	73.2±2.2	.102	26.3±2.2	.144	14.7±1.5	.344	11.4±1.5	.280
College graduates or higher	74.6±1.2	.166	24.6±1.2	.298	11.1±.6	.445	12.8±1.0	.053
Income[b]								
<$50,000	80.0±1.9	-	18.7±1.9	-	11.5±1.1	-	6.8±1.5	-
$50,000 - <$100,000	75.2±1.6	.057	24.4±1.6	**.022**	12.6±1.0	.502	11.4±1.0	**.011**
≥ $100,000	69.2±1.9	**<.001**	30.3±1.9	**<.001**	12.5±1.1	.527	17.2±1.5	**<.001**

[a]Multivariable regression after adjusting for household size, age, race/ethnicity, gender, and income.
[b]Multivariable regression after adjusting for household size, age, race/ethnicity, gender, and education.

Figure 3.1 Percentage of Grocery Store Food Expenditure on Different Food Groups



The proportion of grocery store food expenditure for each household by types of foods purchased (by food groups) were further examined (**Figure 3.1**). Only food items from grocery stores were categorized into food groups. The biggest source of food expenditure was from entrée purchase that accounted for 23.4% of total grocery store spending. Spending on produce was the second biggest source of food expenditure accounting for 21.7% of total grocery store spending. Approximately 10% of the food expenditure was spent on each of the following food groups including dairy, bakery/bread, and snacks. Participants on average spent 8.3% and 6.0% of grocery budget on beverage and dressing/spread. Ethnic foods including Asian mixed dishes and Mexican mixed dishes accounted for 2.2% of the grocery store food expenditure. 6.4% of the food items from grocery store were not coded due to missing or limited information on the receipts.

Table 3.3 Unadjusted Percentage of Food Expenditure on Different Food Groups

Food Groups	Income, mean % ±SE				Education, mean % ±SE			
	<$50,000	$50,000 - <$100,000	≥ $100,000	P	High school graduates or less	Some college	College graduates or higher	P
Beverage	9.6±.7	8.1±.6	7.1±.5	.117**; .005**	9.7±1.3	8.5±.6	7.9±.4	.364; .165
Bakery/Bread	10.7±.9	9.1±.5	10.5±.5	.108; .813	13.5±1.6	8.8±.6	9.9±.4	**.008; .039**
Dressing/spreads	6.0±.7	6.0±.4	6.0±.5	.961; .961	6.9±.9	6.7±.6	5.5±.3	.880; .134
Produce	19.±1.	22.8±1.0	22.2±.9	**.018; .031**	13.9±1.4	18.8±.9	24.0±.8	**.003; <.001**
Snack	10.6±.9	8.6±.5	10.3±.6	**.036**; .798	10.5±1.2	10.0±.7	9.5±.5	.722; .446
Ethnic Foods	1.9±.3	1.9±.2	2.6±.3	.956; .143	1.4±.4	2.0±.3	2.3±.2	.206; .057
Entree	23.0±1.3	24.0±.9	23.7±.9	.542; .677	25.9±2.0	26.2±1.2	22.1±.7	.905; .063
Dairy	9.9±.8	10.6±.6	10.5±.5	.502; .481	10.0±1.0	10.2±.7	10.5±.4	.924; .690
Miscellaneous	1.9±.4	1.8±.3	1.9±.3	.896; .977	1.1±.3	2.1±.4	1.9±.2	**.037; .020**

Table 3.4 Adjusted Percentage of Food Expenditure on Different Food Groups

Food Groups	Income[a], mean % ±SE				Education[b], mean % ±SE			
	<$50,000	$50,000 - <$100,000	≥ $100,000	P[a]	High school graduates or less	Some college	College graduates or higher	P[a]
Beverage	9.6±.8	8.1±.6	7.2±.5	.138; **.016**	9.4±1.2	8.2±.6	8.1±.5	.375; .314
Bakery/Bread	11.4±.8	9.2±.5	9.7±.5	**.029**; .079	13.0±1.6	8.5±.6	10.1±.5	**.009;** .085
Dressing/spreads	5.3±.7	5.9±.4	6.5±.6	.417; .196	7.0±.9	6.9±.7	5.4±.3	.917; .087
Produce	20.2±1.2	22.6±1.0	21.5±.9	.119; .415	14.5±1.3	19.0±1.0	23.8±.8	**.005; <.001**
Snack	10.6±.9	8.6±.5	10.3±.7	.047; .792	10.4±1.2	10.0±.7	9.5±.5	.761; .497
Ethnic Foods	1.8±.3	1.9±.2	2.7±.4	.921; .115	1.5±.4	2.2±.3	2.2±.2	.187; .135
Entree	21.6±1.3	24.0±.9	25.0±1.0	.131; **.044**	26.4±1.9	26.6±1.2	21.8±.7	.920; **.025**
Dairy	10.2±.8	10.6±.6	10.2±.6	.742; .998	10.2±1.1	10.1±.7	10.5±.5	.989; .784
Miscellaneous	2.0±.3	1.9±.3	1.8±.3	.760; .690	1.1±.3	2.1±.4	1.9±.2	**.038; .028**

[a]Multivariable regression after adjusting for household size, age, race/ethnicity, gender, and education.
[b]Multivariable regression after adjusting for household size, age, race/ethnicity, gender, and income.

The percentages of grocery store food expenditure on various food groups among different SES groups were showed in **Table 3.3 and 3.4**. Low income households (<$50,000) spent significantly high percentage of their food budget on beverage compared to high income households (≥$100,000). The association reminded significant after adjusting for education, age, gender, race/ethnicity, and household size. High income households on average spent 7.2% of their food budget on beverage compared to low income households who spent 9.6% on the same

food group. Compared to participants with low education background (high school graduate or less), participants with some college education spent significantly less on bakery and bread. Participants in the medium and high income category spent significantly higher percentage on produce. However, the association was not statistically significant after adjusting for education and other potential confounders. Education, on the other hand, tended to heavily affect the produce purchase. Participants with low level of education approximately spent 10% less of their food budgets on produce compared to participants with high level of education.

Discussion

The present study is one of the first few studies to compare self-reported household food expenditure data collected in national level survey (such as NHANES[35]) with an objective measure, food shopping receipts. There were several findings:

The first aim was to compare and validate overall household food expenditures for two weeks across the two methods of data collection. Three comparison methods – Pearson correlation, Bland-Altman agreement method, and kappa coefficient were used to measure the correlation and agreements between receipt and self-reported food expenditures. Similar moderate agreements were observed between receipt and self-reported food expenditures using all these methods [40; 42].

A number of previous studies have used store receipts to assess food purchases at the household level[4-9]. Fewer studies have compared self-reported food expenditures against receipt-generated data, in part because the collection of receipts over several weeks, followed by coding and analysis, is both time and labor intensive. Even though receipts may be the preferred

estimation method[38], they are unlikely to be incorporated in large national studies on diets and health.

The present analyses make a valuable contribution by showing that the answers to the new FCBS questions corresponded to reality. According to the Consumer Expenditure Survey of the U.S. Bureau of Labor Statistics (BLS), the national average for annual household food expenditures in 2011-12 was $6,529[43]. According to a recent BLS news release, annual household food expenditures for the Seattle-Tacoma-Bremerton area were $7,776 in 2011-2012[44]. The King County, WA area has higher median incomes than the national average. The present study, drawing on a sample of more affluent and educated King County adults estimated mean average annual household food expenditures at $8,142 using self-reports and $8,212 using store and restaurant receipts. It should be noted that the households of study respondents were also larger than the national norms (2.8 vs. 2.5).

The second aim of the present study was to examine socioeconomic trends in household food expenditures, and to compare these trends across two methods: objective data based on food shopping receipts vs. subjective data based on self-reports. The present study found that higher socioeconomic status was significantly associated with higher food expenditures, consistent with previous studies[3; 30]. The trend held for food expenditures at grocery stores and eating-out across SES strata defined by educational attainment and household incomes. French et al found that higher income households spent $163 per person per month on foods, significantly higher than lower income households who spent $100 per person per month[3]. The U.S. BLS report showed that households in the lowest income quintile spent $3,547 on foods, versus households in the highest income quintile who spent $10,991 in 2011[41].

One observation worth discussion was that receipt-based food expenditures showed a sharp linear increase with SES indicators consistent with BLS data[41], self-reported expenditures did not follow the same trend. The highest income households (≥$100,000) reported lower food expenditures than middle income households, which was supported by food shopping receipt data. It would appear that the highest-income participants underestimated what their households spent on food, whether knowingly or not. Future studies using self-reported data may take these into account when interpreting household food expenditures. The present study also sheds light on calibration of self-reported food expenditures. Future studies should consider developing mathematic model to calibrate self-reported food expenditures using food shopping receipt data as an objective reference.

The present sample also confirmed Engel's Law that higher income households had higher food expenditures in absolute amounts while the proportion of food expenditure was lower. These data were largely consistent for both self-reported and receipt data. Data from the national level shows the same trend[41]. In 2011, households in the 1st income quintile (mean income $9,805) spent 36.2% of their income on foods as compared to 6.8% among households in the 5th income quintile (mean income $161,292).

The third aim of this study was to further examine socioeconomic trends by household food purchasing locations and food groups using only the objective data – the food shopping receipts. Previous studies have linked food away from home with increased energy intake, poor diet quality, and higher BMI [31-34]. Todd et al[32] found that having one meal away from home on each week was associated with 2 pound weight gain each year. Similar association was observed with food consumption at fast food and full service restaurants [34; 45]. The present study found that high SES households, which tend to have lower BMIs in our sample, spent higher

percentage of total food cost on eating-out, specifically at full service restaurants. The proportion of total food spending at fast food restaurants was similar across all socioeconomic groups. Previous studies tend to focus on food intakes or frequency of food away from home consumption, whereas the present study focuses on food expenditures on eating-out and eating at home which is the upstream measurement of food consumption. In addition the results may be biased when using frequency of food consumption as a measurement of eating-out, because higher frequency of eating-out does not always equal to bigger food consumption or higher dollar amount of food purchase at eating out places. One potential explanation could be that high SES households obtain more resources than low SES households, for example access to parks and trails. They tend to have higher physical activity levels and less stress[46; 47], so even though eating-out may increase people's calories intake, but the impact on weight status and BMI would be different between high SES households and low SES households. Future study is needed to examine not only eating-out, but how physical activity, dietary pattern, and other factors synergistically affect people's weight status. Using food shopping receipt data, French, Wall and Mitchell[3] found similar trends that higher income households tend to spent higher percentage of their food budget on eating-out, compared to lower income households (37% vs. 27%). The expenditure differences at full service restaurants observed by household income could be explained by food cost and food related attitude, and may imply access barriers to healthy eating-out options. Future research should focus on examining the type of foods people purchase at fast food and full service restaurants between SES and the nutrient profile of each food item.

The present study found high SES households, specific with high education level, spent a higher percentage of grocery expenditure on produce including fruits and vegetables, compared to low SES households. Similar results were found in the previous studies that high SES groups

tended to consume more fruits and vegetables [3; 10; 26; 48]. A systematic review including 7 studies from the European Union showed that men with the highest level of education consumed 24.3 g/day and 17.0 g/day more fruits and vegetables than those with the lowest level of education. Same trend was observed for women. The estimate differences of fruit and vegetable consumption were 33.6 g/day and 13.4 g/day comparing women with highest education level to those with the lowest education level. French, Wall and Mitchell [3] found that high income households spent significantly more on fruits/vegetables ($21.5 versus $10.2) compared to those in the low income category. Food cost may play an important role in food purchase, given that high nutrient density foods such as fruit and vegetable typically cost more [21; 49]. Higher SES households spent more on foods, so food prices may not be a barrier for them to access nutritious foods. The present study also found that higher income households spent significantly less percentage of their food expenditures on beverages. Further analysis of subgroups showed a trend that high income households spent less on fruit drink, soda and energy/sport drinks. Although not statistical significant, this observation may help explain the variance of beverage expenditure on different SES groups.

Several limitations warrant discussion. First of all, food related shopping receipts provide information on household food purchasing behavior rather than food consumption. No individual level information was obtained to reflect food consumption among each household member. We also cannot distinguish food consumption of household members and occasional family visitors who ate inside the household. Secondly, food related shopping receipts only reflect household food expenditure instead of nutrient intake. For measuring nutrient intake using shopping receipts, additional information including edible portion, cooking methods, and food waste may be needed. However, food purchasing is an important and valuable measurement of household

food and nutrient availability. Using shopping receipt as an objective measurement can also eliminate inaccuracy and recall bias. Finally, bulk food purchase could potentially skew the data. For example, a family may purchase a bulk of sugar sweetened beverages or a gallon of cooking oil at a wholesale store during the receipt collection period. This occasional purchase of bulk food may not reflect typical household food expenditure at various food groups. However, previous study has showed that collecting two week shopping receipts is adequate to capture usual household food purchasing behavior[2]. In addition, the effect of bulk food purchase on our sample should be minimal, given the large sample size.

Conclusion

Using three different methods, self-reported food expenditure were validate with respect to grocery store and restaurant receipts collected over a two-week period. High SES families spent significantly more on food compared with low SES families. Meanwhile, the percentage of income spent on food decreases as income increasing. Using food shopping receipts, the objective measure of food purchasing behavior, the present study found that low SES families spent a smaller percentage of total food cost on restaurants, specific full service restaurants, compare with high SES families. The food expenditures at fast food restaurants were similar across all SES groups. This study also found that low SES families tend to spend a smaller percentage of grocery store food cost on produce and a larger percentage of grocery store food cost on beverage. This study identified gaps in food purchasing behavior among different SES groups. Future public policy should address the high costs of nutritious foods and thus promote healthy eating for people from all SES groups.

References

1. Turrell G, Bentley R, Thomas LR *et al.* (2009) A multilevel study of area socio-economic status and food purchasing behaviour. *Public Health Nutr* **12**, 2074-2083.

2. French SA, Wall M, Mitchell NR *et al.* (2009) Annotated receipts capture household food purchases from a broad range of sources. *Int J Behav Nutr Phys Act* **6**, 37.

3. French SA, Wall M, Mitchell NR (2010) Household income differences in food sources and food items purchased. *Int J Behav Nutr Phys Act* **7**, 77.

4. Cullen K, Baranowski T, Watson K *et al.* (2007) Food category purchases vary by household education and race/ethnicity: results from grocery receipts. *J Am Diet Assoc* **107**, 1747-1752.

5. Martin SL, Howell T, Duan Y *et al.* (2006) The feasibility and utility of grocery receipt analyses for dietary assessment. *Nutr J* **5**, 10.

6. Ransley JK, Donnelly JK, Botham H *et al.* (2003) Use of supermarket receipts to estimate energy and fat content of food purchased by lean and overweight families. *Appetite* **41**, 141-148.

7. Ransley JK, Donnelly JK, Khara TN *et al.* (2001) The use of supermarket till receipts to determine the fat and energy intake in a UK population. *Public Health Nutr* **4**, 1279-1286.

8. Rankin JW, Winett RA, Anderson ES *et al.* (1998) Food purchase patterns at the supermarket and their relationship to family characteristics. *Journal of Nutrition Education* **30**, 81-88.

9. DeWalt KM, D'Angelo S, McFadden M *et al.* (1990) The use of itemized register tapes for analysis of household food acquisition patterns prompted by children. *J Am Diet Assoc* **90**, 559-562.

10. Darmon N, Drewnowski A (2008) Does social class predict diet quality? *Am J Clin Nutr* **87**, 1107-1117.

11. Kushi LH, Folsom AR, Jacobs DR, Jr. *et al.* (1988) Educational attainment and nutrient consumption patterns: the Minnesota Heart Survey. *J Am Diet Assoc* **88**, 1230-1236.

12. Galobardes B, Morabia A, Bernstein MS (2001) Diet and socioeconomic position: does the use of different indicators matter? *Int J Epidemiol* **30**, 334-340.

13. Groth MV, Fagt S, Brondsted L (2001) Social determinants of dietary habits in Denmark. *Eur J Clin Nutr* **55**, 959-966.

14. Mullie P, Clarys P, Hulens M *et al.* (2010) Dietary patterns and socioeconomic position. *Eur J Clin Nutr* **64**, 231-238.

15. Kant AK, Graubard BI (2007) Secular trends in the association of socio-economic position with self-reported dietary attributes and biomarkers in the US population: National Health and

Nutrition Examination Survey (NHANES) 1971-1975 to NHANES 1999-2002. *Public Health Nutr* **10**, 158-167.

16. Drewnowski A, Specter SE (2004) Poverty and obesity: the role of energy density and energy costs. *Am J Clin Nutr* **79**, 6-16.

17. Wolongevicz DM, Zhu L, Pencina MJ *et al.* (2010) Diet quality and obesity in women: the Framingham Nutrition Studies. *Br J Nutr* **103**, 1223-1229.

18. Slawson DL, Fitzgerald N, Morgan KT (2013) Position of the Academy of Nutrition and Dietetics: the role of nutrition in health promotion and chronic disease prevention. *J Acad Nutr Diet* **113**, 972-979.

19. U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2010., 7th ed. Washington, DC: U.S. Government Printing Office.

20. Rao M, Afshin A, Singh G *et al.* (2013) Do healthier foods and diet patterns cost more than less healthy options? A systematic review and meta-analysis. *BMJ Open* **3**, e004277.

21. Drewnowski A, Darmon N (2005) The economics of obesity: dietary energy density and energy cost. *Am J Clin Nutr* **82**, 265s-273s.

22. Maillot M, Darmon N, Vieux F *et al.* (2007) Low energy density and high nutritional quality are each associated with higher diet costs in French adults. *Am J Clin Nutr* **86**, 690-696.

23. Aggarwal A, Monsivais P, Drewnowski A (2012) Nutrient intakes linked to better health outcomes are associated with higher diet costs in the US. *PLoS One* **7**, e37533.

24. Metcalf P, Scragg R, Davis P (2006) Dietary intakes by different markers of socioeconomic status: results of a New Zealand workforce survey. *N Z Med J* **119**, U2127.

25. Shahar D, Shai I, Vardi H *et al.* (2005) Diet and eating habits in high and low socioeconomic groups. *Nutrition* **21**, 559-566.

26. Irala-Estevez JD, Groth M, Johansson L *et al.* (2000) A systematic review of socio-economic differences in food habits in Europe: consumption of fruit and vegetables. *Eur J Clin Nutr* **54**, 706-714.

27. Hulshof KF, Brussaard JH, Kruizinga AG *et al.* (2003) Socio-economic status, dietary intake and 10 y trends: the Dutch National Food Consumption Survey. *Eur J Clin Nutr* **57**, 128-137.

28. Turrell G, Hewitt B, Patterson C *et al.* (2002) Socioeconomic differences in food purchasing behaviour and suggested implications for diet-related health promotion. *J Hum Nutr Diet* **15**, 355-364.

29. Pechey R, Jebb SA, Kelly MP *et al.* (2013) Socioeconomic differences in purchases of more vs. less healthy foods and beverages: analysis of over 25,000 British households in 2010. *Soc Sci Med* **92**, 22-26.

30. Monsivais P, Perrigue MM, Adams SL *et al.* (2013) Measuring diet cost at the individual level: a comparison of three methods. *Eur J Clin Nutr*.

31. McCrory MA, Fuss PJ, Hays NP *et al.* (1999) Overeating in America: association between restaurant food consumption and body fatness in healthy adult men and women ages 19 to 80. *Obes Res* **7**, 564-571.

32. Todd JE, Mancino L, Lin B-H (February 2010) The Impact of Food Away From Home on Adult Diet Quality: ERR-90, U.S. Department of Agriculture, Economic Research Services.

33. Kant AK, Graubard BI (2004) Eating out in America, 1987-2000: trends and nutritional correlates. *Prev Med* **38**, 243-249.

34. Powell LM, Nguyen BT (2013) Fast-food and full-service restaurant consumption among children and adolescents: effect on energy, beverage, and nutrient intake. *JAMA Pediatr* **167**, 14-20.

35. Centers for Disease Control and Prevention. National Center for Health Statistics. Flexible Consumer Behavior Survey. Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. Available at http://www.cdc.gov/nchs/data/nhanes/nhanes_09_10/FCBS_f.pdf. Accessed 10 December 2013.

36. Rehm CD, Moudon AV, Hurvitz PM *et al.* (2012) Residential property values are associated with obesity among women in King County, WA, USA. *Soc Sci Med* **75**, 491-495.

37. National Cancer Institute, U.S. National Institutes of Health: List of Specific Foods: Result of Grouping Like Foods Reported in 2003-2006 NHANES. Available at http://appliedresearch.cancer.gov/diet/foodsources/sodium/figure1.html#f_a. Access 17 March 2014.

38. French SA, Shimotsu ST, Wall M *et al.* (2008) Capturing the spectrum of household food and beverage purchasing behavior: a review. *J Am Diet Assoc* **108**, 2051-2058.

39. Bland JM, Altman DG (1986) Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* **1**, 307-310.

40. Bland JM, Altman DG (1999) Measuring agreement in method comparison studies. *Stat Methods Med Res* **8**, 135-160.

41. United States Department of Labor. Bureau of Labor Statistics (April 2013). Consumer Expenditures in 2011. Available at: http://www.bls.gov/cex/csxann11.pdf. Accessed March 17 2014.

42. Viera AJ, Garrett JM (2005) Understanding interobserver agreement: the kappa statistic. *Fam Med* **37**, 360-363.

43. United States Department of Labor. Bureau of Labor Statistics (September 2013). Consumer Expenditures--2012. Available at: http://www.bls.gov/news.release/cesan.nr0.htm. Accessed March 17 2014.

44. United States Department of Labor. Bureau of Labor Statistics (January 2014). Consumer Expenditures for the Seattle Area: 2011-2012. Available at: http://www.bls.gov/ro9/cexseat.pdf. Accessed 22 January 2014.

45. Bowman SA, Vinyard BT (2004) Fast food consumption of U.S. adults: impact on energy and nutrient intakes and overweight status. *J Am Coll Nutr* **23**, 163-168.

46. Ford ES, Merritt RK, Heath GW *et al.* (1991) Physical activity behaviors in lower and higher socioeconomic status populations. *Am J Epidemiol* **133**, 1246-1256.

47. Baum A, Garofalo JP, Yali AM (1999) Socioeconomic status and chronic stress. Does stress account for SES effects on health? *Ann N Y Acad Sci* **896**, 131-144.

48. Ricciuto LE, Tarasuk VS (2007) An examination of income-related disparities in the nutritional quality of food selections among Canadian households from 1986-2001. *Soc Sci Med* **64**, 186-198.

49. Darmon N, Briend A, Drewnowski A (2004) Energy-dense diets are associated with lower diet costs: a community study of French adults. *Public Health Nutr* **7**, 21-27.

Appendix 1 Major Food Groups and Subgroups

Major Food Groups	Subgroups
Beverages	vegetable juice; 100% fruit juice; fruit drinks, soda, energy and sports drinks; milk substitute and evaporated milk; coffee, tea; other beverage; low-calorie/no-calorie soda, energy and sports drinks
Bakery/Breads	hot cereal; pancakes/waffles/French toast; quickbreads; ready-to-eat cereals; grain-based desserts; yeast breads
Dressings, spreads	fat (butter, cream margarine, mayonnaise, nondairy creamer/cream substitutes, oils, sour cream, miscellaneous solid fats); savory (salad dressing, sauces, condiments); sweet (jams and jelly, sugars/honey, syrups/toppings gelatins)
Produce	broccoli; carrots; coleslaw; corn; fried white potatoes; lettuces; onions; other cruciferous; other white potatoes; peas; string beans; sweet potatoes; tomatoes; tomatoes sauces; celery; peppers; mushrooms, cucumbers, squash, asparagus; vegetable medleys and other vegetables; vegetable mixed dishes; apple and pears; avocado; bananas; citrus fruits; dried fruit; grapes; melon; peaches/plums/apricots/nectarines; strawberries; other fruits and fruit dishes; vegetable salad; salad with protein
Snacks	salty snacks (potato/corn/other chips, popcorn, pretzels); nuts/seeds and nut/seed mixed dishes; candy; miscellaneous snacks
Ethnics	Asian mixed dishes; Mexican mixed dishes
Entrees	Pizza, soups; meal replacements; pasta and pasta dishes; rice and rice mixed dishes; dried/canned beans; burgers; egg and egg mixed dishes; meat and poultry dishes; processed meat; seafood dishes; tofu and meat substitutes/veggie sandwiches
Dairy	whole milk**;** reduced fat milk**;** skim milk; milk, not further specified; yogurt; cheese; dairy desserts
Miscellaneous/Other	flour; grain, not further specified; baking soda/baking powder; spices; water