ARTICLE IN PRESS

Food Policy xxx (xxxx) xxxx

Contents lists available at ScienceDirect

Food Policy

journal homepage: www.elsevier.com/locate/foodpol

What is driving increases in dietary quality in the United States?

Travis A. Smith*, Pourya Valizadeh, Biing-Hwan Lin, Ellen Coats

Department of Agricultural and Applied Economics, University of Georgia, United States

ARTICLE INFO

Keywords:
Diet quality
Nutrition labels
Dietary information
Food characteristics
Socioeconomic status
Oaxaca-Blinder decomposition

ABSTRACT

Over 1994–2010, adult dietary quality in the United States increased by 10 percent. We find a shift in consumption between at-home and away-from-home food played a relatively minor role as compared to changes in demographics and educational attainment. The two largest contributors we identify include an increased usage of nutritional information and a shift away from relying heavily on price, taste, storability and ease of preparation when shopping for food. Our findings suggest nutrition policy discussions could focus on further shifting attitudes/preferences towards healthier diets while allowing consumers to better extract nutrition information when making food choices.

1. Introduction

Poorer diet quality is associated with increased risks of cardiovascular disease, diabetes (Chiuve et al., 2012; Nicklas et al., 2012), and several cancers (e.g., Shahril et al., 2013; Reedy et al., 2008; Bosire et al., 2013). The connection between diet and health is not lost on the public – the perception of what constitutes a healthy diet has improved over the last 25 years (Variyam and Smith, 2010), and consumers are more realistic about the quality of their own diets (Gregory et al., 2011). Not only do consumers appear to be acting on this realization by consuming healthier food (e.g., Beatty et al., 2014), producers also appear to be supplying healthier food options (Krebs-Smith et al., 2010). Nevertheless, there is substantial room for dietary improvement and understanding what factors do and do not contribute to such improvements can help better shape nutrition policy (Wilson et al., 2016).

This research explores the role of leading drivers influencing dietary quality over 1994–2010. We focus on factors that can be, and are influenced by nutrition policy in the United States: the use of nutritional information (e.g., nutrition facts panel and health claims), reasons for purchasing food while shopping (e.g., price, ease of preparation, storability, and tastiness), and food source choices (i.e., food at home versus away from home). By way of comparison, we also examine the role of changing demographics (e.g., age and race/ethnicity) and socioeconomic status (e.g., education, income and employment) on the quality of adult diets.

The United States has a long history of promoting nutritional transparency and dietary awareness through policymaking that continues to evolve today (Davis and Saltos, 1999). In terms of nutritional transparency, the 1990 Nutrition Labeling and Education Act (NLEA), officially in effect in 1994, was the first to require nutritional labeling on most foods (i.e., the nutrition facts label), as well as to regulate nutritional content claims (e.g., "high fiber"). By and large, these regulations have remained relatively static over our sample period 1994–2010. As we show, however, the usage of such nutritional information has been increasing over time, and we aim to estimate how this increased usage has affected changes in the quality of foods consumed by adults. These results are important for current policymaking as the FDA continues to use its authority under the NLEA to further regulate labeling, both on packaged foods and in food-away-from-home (FAFH) establishments. We further discuss these current policy changes in relation to our results below.

The U.S. government's primary source of disseminating nutritional awareness is the Dietary Guidelines for Americans (DGA). Since 1980, the DGA have been updated every five years to reflect advances in nutrition science and research. Importantly, the DGA form the basis for large-scale informational campaigns in the U.S. that not only target the general public (e.g., the 1992 Food Guide Pyramid and the 2010 MyPlate), but also directly impact federal food policy (e.g., updating the nutritional standards for school food programs CITE). The DGA clearly have overlapping targeted audiences and broad reach that percolates throughout society via various modes.[1] While we cannot directly estimate the impact of the DGA, we can explore how changes in consumer attitudes and preferences towards a healthful diet affect changes in dietary quality. Put simply, the DGA aim to shift

* Corresponding author.
E-mail address: tasmith@uga.edu (T.A. Smith).

[1] For example, Mancino et al. (2008) find that the 2005 DGA, which were the first to offer quantitative recommendations for whole grains, sparked a reformulation of products in the retail market that led to increased whole grain consumption.

https://doi.org/10.1016/j.foodpol.2019.05.003
Received 23 January 2018; Received in revised form 9 November 2018; Accepted 14 May 2019

consumption towards a healthier diet and the results of this research support the efforts of the U.S. federal government to further increase dietary awareness.

To answer some of these questions, some researchers have taken a one-at-a-time approach to analyzing particular nutrients. For example, Bowman et al. (2004) and Paeratakul et al. (2003) show negative correlations between eating away from home and a host of selected nutrients. We take a holistic view of diet quality using a widely-used and validated measure, the Healthy Eating Index (HEI) (Guenther et al., 2008a,b). The HEI has been used in previous research when analyzing trends in overall dietary quality in the United States (e.g., Beatty et al., 2014), or as an outcome in various policy evaluations (e.g., Mancino et al., 2009; Smith, 2017).

Methodologically, determining the role of exogenously changing characteristics (e.g., demographics) is straightforward. However, we recognize that unobservable characteristics of individuals pose a significant threat to credibly identifying the role of endogenous choices on diet quality. For food source choices, for example, we are able to use a fixed effects approach by utilizing two days of dietary intake available in each of the nationally representative U.S. Department of Agriculture (USDA) surveys. The idea being, within each cross-sectional survey the fixed, unobservable characteristics (e.g., the food environment and preferences) are "differenced out." The main objective of this research, however, is to identify how *changes* in food choices and other dietary determinants affect *changes* in the quality of the American diet. To do so, we use decomposition methods and the weaker assumption of *ignorability*, which states that the conditional distribution of unobservables and observables does not change over time (Fortin et al., 2011). This assumption is not without its critiques, which we discuss below in the empirical methods.

Consistent with previous results (e.g., Mancino et al., 2009; Smith, 2017), we find the effect of substituting restaurant and fast food for home-prepared food has a negative impact on dietary quality. A particular interesting new finding is that the negative impact of fast food, relative to home-prepared food, has fallen over 1994–2010. Specifically, when the percentage of calories consumed from fast food increased by ten percent at the expense of at-home consumption in 1994–96, dietary quality fell by about 0.75 HEI points; for the same shift in consumption in 2007–10, we estimate a 0.47 decrease. Using similar logic for a shift consumption from at-home to restaurants we estimate a 0.2 decrease in HEI in 1994–96 and a 0.58 decrease in 2007–10. To be clear, the quality of food consumed from all three sources has increased over the sample period, but our results show that fast food has increased at the highest rate behind home food with the quality of restaurant food increasing at the slowest rate.

We then use an Oaxaca-Blinder decomposition approach (Blinder, 1973; Oaxaca, 1973) to understand how changes in food choices and observable characteristics of individuals have impacted the trajectory of dietary improvements. Over 1994–2010, average adult diet quality in the U.S. increased from 50.46 to 55.57 out of a maximum 100 HEI points, or by 5.11 (about a 10% increase). We find that food source choices have played a very small role in explaining this change (less than 1% of the total increase) as compared to changes in demographics (e.g., race/ethnicity – about 6%) and socioeconomic status (e.g., education – about 3%). The overall largest contributors to increasing diet quality is (a) the increased usage of nutrition facts panel and health claims, which account for 6.8% and 2.7%, respectively, or 9.5% in aggregate, and (b) a shift away from a reliance on price, storability, ease of preparation and taste when grocery shopping (8% of the aggregate increase in HEI-2005). We attribute the substantial residual, or unexplained effect to changes in unobservable factors (e.g., other consumer preferences and the food environment).

The paper proceeds as follows: we first provide further background. We then describe our data and how we measure overall diet quality. Our data support the observation that both diet quality and drivers are changing. After describing our methodological approach, we present our findings. We conclude with a discussion of the implications of our results on the current state of nutrition policy in the United States.

2. Background

Perhaps one of the largest shifts in the U.S. diet in recent decades is the increased consumption of food away from home (FAFH), such as full-service restaurants, fast-food and other establishments that cook, prepare and serve meals on-site. The share of daily calorie intake progressively increased from about one-fifth of calorie consumption in the late-1970's, before reaching a peak of about one-third in the mid-1990's (Guthrie et al., 2002). Since the mid-1990's, the share of FAFH calorie intake has remained relatively stable, only decreasing slightly during the Great Recession before rebounding back since 2013 (c.f., Lin and Guthrie, 2012; Todd, 2017). The lower nutritional quality of FAFH relative to food prepared at home (Lin and Guthrie, 2012) has engendered calls to incentivize at-home consumption (e.g., a tax on fast food; Duffey et al., 2010) or lower FAFH consumption (e.g., quantity restrictions in New York).

Despite American's increasing appetite for FAFH, several researchers have documented an increase in the overall quality of the diet (Popkin et al., 2003; Beatty et al., 2014; Wang et al., 2014; Rehm et al., 2016) as well as the food supply (Krebs-Smith et al., 2010). If the *relative* quality between foods consumed at home and away from home is constant over time while overall quality is improving, this may imply policies that generally focus on increasing nutritional knowledge, and thus choices, impact markets unilaterally. Put differently, in equilibrium increasing nutritional knowledge leads to healthier choices by consumers, which in turn leads to suppliers striving to meet this increased demand: a "rising tide lifts all boats" type of effect.

One way to test the aforementioned hypothesis is to estimate how changes in the usage of nutritional information have affected the trajectories of increasing dietary quality. A body of literature suggests there exists a correlation between the usage of nutritional information and the quality of food choices (e.g., Variyam, 2008; Barreiro-Hurlé et al., 2010; Ollberding et al., 2011). A separate set of literature finds those who have higher nutritional knowledge/literacy (i.e., nutritional capital) tend to utilize such dietary information to a larger degree (e.g., Drichoutis et al., 2005 Cowburn and Stockley, 2005). Thus, we aim to decompose changes in diet quality into changes in food-source choices and the usage of dietary information. Because nutritional knowledge and the usage of information translate into food choices, we also look at the importance of food characteristics when food shopping (i.e., nutrition, price, storability, ease of preparation and taste).

Demographically, the U.S. has become much older and ethnically diverse, two factors that are associated with higher quality diets (e.g., Popkin et al., 2003; Beatty et al., 2014). In terms of socioeconomic status, the U.S. has become more educated, although the distribution of income has become more polarized. Again, it has been shown that these factors are associated with dietary quality (e.g., Popkin et al., 2003; Beatty et al., 2014), and we decompose their role in changes in diet quality as a way of comparison.

3. Data

This study uses nationally representative data from two U.S. individual food intake surveys: the 1994–96 Continuing Survey of Food Intakes by Individuals (CSFII) conducted by the USDA (USDA, 2000) and the 2007–10 National Health and Nutrition Examination Survey (NHANES) conducted jointly by the USDA and U.S. Department of Health and Human Services (USDA, 2018). The dietary intake component in each survey used similar sampling methods, survey methodologies, and the dietary collection protocol was overseen by the USDA (USDA, 2000; Tippett and Cypel, 1998). Specifically, both sets of data used stratified random sampling, computer automated multi-pass methods, and the usage of three-dimensional measuring instruments (e.g., measuring cups).

Respondents reported two 24-h dietary intakes in all surveys, as well as detailed demographic information. Day-one dietary recalls were conducted in-person by trained interviewers in each survey. A second nonconsecutive day of intake was obtained in each survey 3–10 days after the initial interview in a follow-up telephone interview. Respondents did not know in advance when the second day of intake would be administered, nor did they know that the second day would occur on a different day of the week. Both surveys provide unique 2-day sampling weights to account for non-response. We restrict the sample to adults aged 20–79 with complete dietary intake and demographic information.

We define four food sources by where food was obtained, not where food was consumed. The exact coding is provided in the Appendix. Home food is obtained from a store (e.g., grocery or supermarket), mail order, or grown/caught. Restaurant food is obtained from a venue with table service, including bars, lounges, and taverns. Fast food is obtained from quick-service venues (e.g., pizza place, street vendor, or vending machines). All other venues are included in an “other” category (e.g., gifts, fundraising sales, residential dining facilities, and cafeterias).

In 2007, the USDA began fielding the Flexible Consumer Behavior Survey (FCBS) module as part of the NHANES survey (ERS, 2018). The FCBS allows new questions to be added replacing older ones to measure topical food attitudes and behaviors, as well as to re-administer questions from previous surveys. The particular survey questions pertaining to our research question originally appeared in the 1994–96 CSFII, Diet and Health and Knowledge Survey (DHKS) and were re-fielded during two waves of the NHANES over 2007–10, and subsequently dropped thereafter. These questions were administered in two blocks: the usage of dietary information (list of ingredients, nutrition panel, serving size, and health benefits) and factors influencing grocery choices (nutrition, price, storability, ease of preparation, and taste).

Both the FCBS-NHANES and DHKS-CSFII were conducted over the phone after the second day of dietary intake information was collected. Both surveys also provided cards with response categories to facilitate the phone interview. There were some differences. First, the questions differed in their language. For the questions about factors influencing grocery choices, the questions and responses were very similar (see Appendix). The main difference pertained to questions about the usage of dietary information when buying foods. NHANES respondents were provided with two additional hand cards: one that showed a nutrition facts panel and another that gave examples of health claims in food labels (see Appendix). The CSFII, on the other hand, described the information provided in the nutrition facts panel without a visual aid. To the extent that visual aids prompted NHANES respondents uniformly across the population, our results will not be biased. However, it seems more likely that respondents who typically eat better were less influenced by the visual prompts due to their familiarity with the panel and health claims. This implies that our decomposition estimates will be biased downwards, against rejecting the null, if the visual aids were more likely to prompt affirmatives from those who typically eat worse in the latter period.

3.1. Measuring dietary quality

We use the Healthy Eating Index-2005 (HEI-2005) as our measure of dietary quality. The HEI-2005 is a continuous, scalar measure calculated from the per-calorie consumption of twelve key foods and nutrients. Each component assigns a score ranging from 0 to 5 (total fruit, whole fruit, total vegetables, dark green/orange vegetables and legumes, total grains, whole grains), 0 to 10 (milk, meats and beans, oils, saturated fat, sodium), or 0 to 20 for the percentage of calories from solid fats, alcoholic beverages, and added sugars, creating a maximum score of 100. See Guenther et al. (2008a) for exact details on scoring. Thus, the HEI is designed to measure the relative quality of foods independent of quantity (i.e., calories).

The HEI-2005 was designed to measure compliance to the 2005 Dietary Guidelines for Americans (DGA), the U.S. Government’s official recommendations for healthful eating (Guenther et al., 2008a), and has been validated as a measure of overall dietary quality (Guenther et al., 2008b). While the HEI-2005 corresponds to the present-day recommendations during the 2007–10 survey period, they post-date the 1994–96 survey. The predecessor HEI-1995 measures compliance to the 1990 DGA, but is not available for the 2007–10 survey. Kirkpatrick et al. (2018) advice against using two different versions of the HEI and recommends using the most current version (which applies to the 2007–10 period in this study) when analyzing trends across years. Moreover, for comparability, note that previous studies by the USDA and other researchers have used the HEI-2005 when comparing the 1994–96 CSFII to the later NHANES survey (e.g., Guenther et al., 2008c; Mancino et al., 2009; and Beatty et al., 2014). The overall results of this study do not substantially change when using more recent versions of the HEI (e.g., the HEI-2010 or HEI-2015), but these versions of the HEI measure compliance to federal recommendations that post-date our study periods.

4. Summary statistics

4.1. Food consumption

Table 1 shows food consumption summary statistics by day of intake for each survey period. Average adult dietary quality has increased over 1994 to 2010 according to both the in-person (Day 1) interview and phone interview on Day 2 by about 9% and 11%, respectively. The share of kilocalories (kcals) attributed to food from home (FFH) remained stable according to Day 1, but increased when measured on Day 2. The observed shifts in food source consumption could be attributed

Table 1
Summary statistics: food consumption by interview day.

	Day 1			Day 2		
Variable	1994–96	2007–10	*p*-value	1994–96	2007–10	*p*-value
HEI-2015	50.45	54.93	< 0.000	50.47	56.20	< 0.000
	(0.37)	(0.41)		(0.37)	(0.31)	
Percent of daily kilocalories from:						
Home	69.47	70.42	0.327	69.31	74.59	< 0.000
	(0.67)	(0.68)		(0.64)	(0.67)	
Fast food	11.24	12.92	0.023	11.30	11.78	0.475
	(0.53)	(0.49)		(0.47)	(0.47)	
Restaurant	9.85	10.16	0.575	10.40	9.17	0.053
	(0.37)	(0.39)		(0.46)	(0.43)	
Other	9.44	6.51	< 0.000	8.98	4.45	< 0.000
	(0.56)	(0.23)		(0.40)	(0.17)	
Percent of individuals surveyed on:						
Sunday	13.54	13.50	0.967	14.33	27.50	< 0.000
	(0.55)	(0.75)		(0.56)	(0.88)	
Monday	15.29	13.98	0.239	14.20	19.45	< 0.000
	(0.79)	(0.77)		(0.56)	(0.62)	
Tuesday	14.43	13.86	0.613	14.30	15.58	0.160
	(0.58)	(0.96)		(0.69)	(0.58)	
Wednesday	14.30	14.62	0.806	14.31	14.05	0.733
	(0.80)	(1.02)		(0.52)	(0.55)	
Thursday	13.94	14.66	0.600	14.25	7.97	< 0.000
	(0.99)	(0.93)		(0.83)	(0.65)	
Friday	14.55	13.79	0.380	13.94	12.10	0.109
	(0.77)	(0.40)		(0.81)	(0.79)	
Saturday	13.94	15.60	0.163	14.66	3.35	< 0.000
	(0.97)	(0.66)		(0.84)	(0.35)	
Individuals	5058	7662		5058	7662	

Notes: Standard errors in parentheses. All calculations use survey weights. *p*-values represent a two-sample t-test of period 2007–10 versus period 1994–96.

to the effects of the economic recession present in the final years of the 2007–10 survey period, although it is not the goal of this paper to address the recession (for recessionary effects, see Todd, 2014). Moreover, since all individuals in the period 2007–10 experience the recession, we cannot separate the recessionary effects from any other effects associated with 2007–10.

Finally, earlier studies have shown that dietary patterns differ by day of the week (e.g., An, 2016; Jahns et al., 2017). For instance, dietary quality is lower and energy intake is higher on weekends than weekdays. We can see a shift in dietary recalls towards the beginning of the week for Day 2 in 2007–10, which could also be driving the observed changes in food source selection. Therefore, it will be important to control for this pattern by including day of the week indicators. The CSFII and NHANES provide specific two-day dietary sample weights that account for nonresponse of dietary intake on Day 1 and for additional nonresponse on Day 2. The weights also account for the differential allocation by day of the week and for the proportion of weekend-weekday combinations of Day 1 and Day 2 recalls.

4.2. Demographics and socioeconomic status

Changes in demographic characteristics (Table 2) across time suggest that the United States is becoming more ethnically diverse and older. Greater ethnic variation is primarily driven by increases in Hispanic populations and those who belong to other race/ethnicities. An aging population is driven by a decrease in the 30–44 year age group, and a significant growth in the 45–64 age group. Household size has also increased over time, with a notable decrease in the share of single-person households and a large increase in households of five and more. To the extent that each of these characteristics have their own (partial) influence on the quality of diets, we should expect such changes to further influence the observed increase in diet quality.

Turning to socioeconomic status in Table 3, we can see education levels have increased over time, with more individuals completing one or more years of college and fewer not finishing high school or stopping at the high school level. With respect to the distribution of income, there exists evidence of polarization: there are more individuals below 130% and above 500% of the poverty guidelines in the latter period. Regarding the trends in employment we observe an increase in the population of full-time workers and a decrease in the population of part-time workers, retired individuals, and those reporting their occupation as “housekeeper” over time. As well, we observe an increase in the population of those reporting ”Not working” which could be attributed to the economic recession. Again, these factors will be important as control variables in the empirical estimation.

Table 2
Summary statistics: demographics.

Variable	1994–96	2007–10	*p*-value
Female	52.99	53.20	0.851
	(0.96)	(0.63)	
Non-hispanic white	76.19	70.51	0.067
	(1.96)	(2.34)	
Non-hispanic black	11.33	11.10	0.878
	(1.01)	(1.10)	
Hispanic	8.70	13.00	0.082
	(1.74)	(1.71)	
Other race/ethnicity	3.78	5.38	0.029
	(0.38)	(0.61)	
Age 20–29	17.96	19.73	0.160
	(0.84)	(0.93)	
Age 30–44	36.14	29.98	< 0.000
	(0.88)	(0.89)	
Age 45–64	31.22	37.77	< 0.000
	(0.83)	(0.83)	
Age 65+	14.68	12.52	0.023
	(0.71)	(0.60)	
Household size 1	20.22	12.46	< 0.000
	(1.18)	(0.62)	
Household size 2	32.67	33.93	0.436
	(0.78)	(1.41)	
Household size 3	19.14	18.53	0.594
	(0.81)	(0.80)	
Household size 4	16.39	18.56	0.043
	(0.78)	(0.71)	
Household size 5+	11.58	16.51	< 0.000
	(0.48)	(0.97)	
Individuals	5058	7662	

Notes: Standard errors are in parentheses. All calculations use survey weights. *p*-values represent a two-sample t-test of period 2007–10 versus period 1994–96.

Table 3
Summary statistics: socioeconomic status.

Variable	1994–96	2007–10	*p*-value
Less than high school	14.52	17.22	0.035
	(0.84)	(0.93)	
High school	34.08	22.92	< 0.000
	(1.37)	(0.88)	
Some college	23.91	30.60	< 0.000
	(0.72)	(0.78)	
4+ yrs college	27.49	29.26	0.392
	(1.53)	(1.36)	
Percent poverty (< 130)	16.63	20.93	0.007
	(0.99)	(1.18)	
Percent poverty (130–250)	22.07	21.33	0.495
	(0.66)	(0.86)	
Percent poverty (250–500)	45.05	39.30	< 0.000
	(0.89)	(1.18)	
Percent poverty (> 500)	25.01	26.56	0.439
	(1.26)	(1.56)	
Full-time worker	49.58	53.77	0.010
	(1.14)	(1.08)	
Part-time workter	12.13	11.06	0.200
	(0.56)	(0.61)	
Retired	14.89	11.78	0.003
	(0.84)	(0.58)	
Housekeeping	8.52	6.89	0.035
	(0.59)	(0.48)	
Not working, other	11.14	16.46	< 0.000
	(0.93)	(0.80)	
Individuals	5058	7662	

Notes: Standard errors are in parentheses. All calculations use survey weights. *p*-values represent a two-sample t-test of period 2007–10 versus period 1994–96.

4.3. Nutritional information and food characteristics

Both surveys asked how frequently individuals used nutritional information when making food purchases using a scale of often, sometimes, rarely, never, or never seen. In particular, the survey asked about the usage of the ingredient list, nutrition facts panel, serving size, and health claims/benefits (e.g., low fat). Fig. 1 shows the distribution of responses for each type of information. In our empirical work, we dichotomize the use of nutritional information as those reporting ”often” or not, which is reported in Table 4. We can see that the often usage of the nutrition facts panel, serving size, and health benefits all significantly increased over the sample period, while the often usage of the ingredient list remained relatively stable.

Both surveys also asked individuals about the importance of nutrition, price, storability (i.e., how well the food keeps), ease of preparation, and taste when buying foods. The scale here is: very important, somewhat important, not too important, or not at all important. Fig. 2 shows the distribution of responses over time. For the empirical work, we again dichotomize individuals by those who rely heavily on food characteristics (i.e., those reporting ”very important”) and all other individuals (Table 4). Here, we observe a significant shift away from relying on nutrition, food prices, storability, ease of preparation, and taste while buying food. To the extent that the latter four characteristics

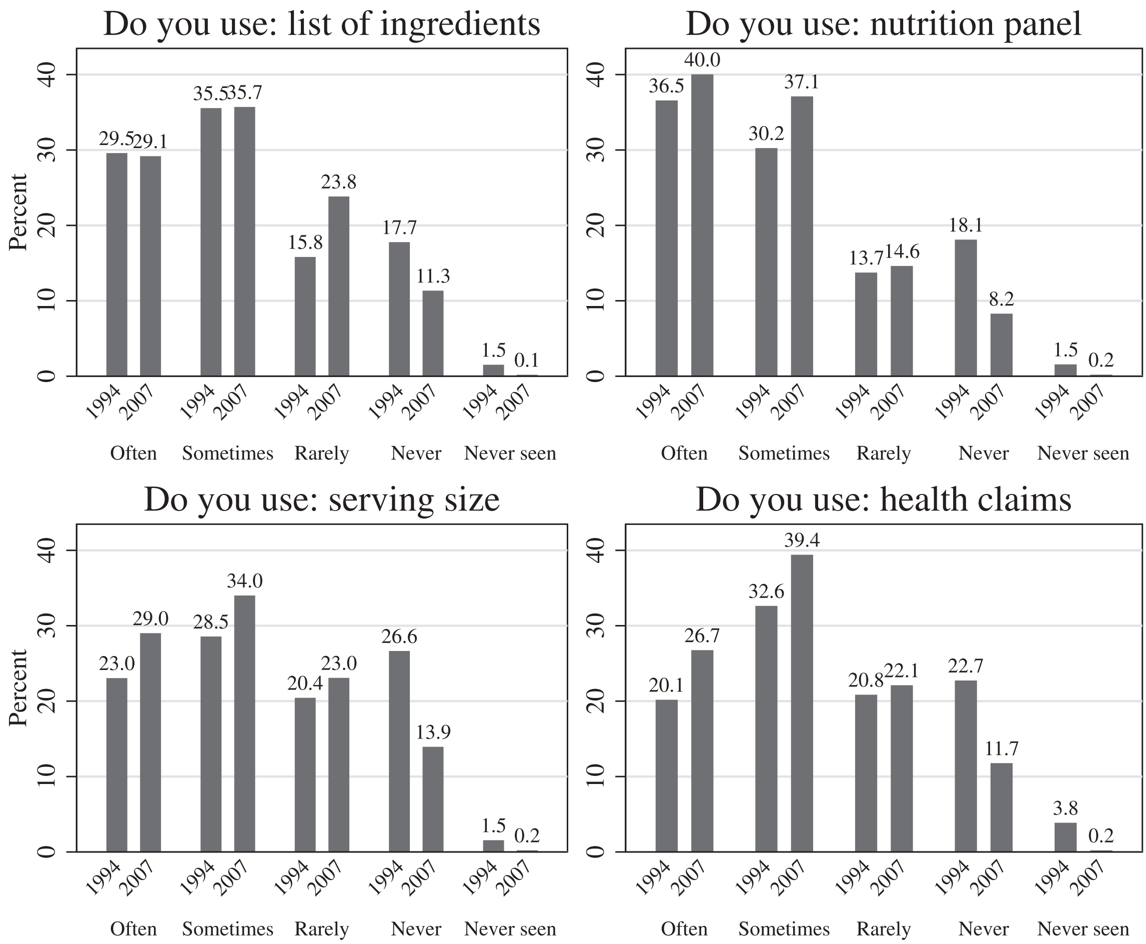


Fig. 1. Use of dietary information, 1994–2010. *Note:* Columns labeled "1994" use the 1994–96 CSFII and columns labeled "2007" use the 2007–10 NHANES.

Table 4
Summary statistics: nutritional information and food characteristics.

Variable	1994–96	2007–10	*p*-value
Percent who indicate they often use:			
Ingredient list	29.54	29.13	0.751
	(0.95)	(0.85)	
Nutrition facts panel	36.52	39.97	0.021
	(1.16)	(0.90)	
Serving size	23.00	28.96	< 0.000
	(0.90)	(0.92)	
Health claims	20.13	26.71	< 0.000
	(0.70)	(0.75)	
Very important characteristic when buying food:			
Nutrition	62.57	58.73	0.010
	(1.00)	(1.06)	
Price	44.33	39.97	0.008
	(1.31)	(0.91)	
Storability	57.18	49.18	< 0.000
	(1.23)	(1.10)	
Ease of preparation	38.56	29.10	< 0.000
	(1.14)	(0.91)	
Taste	84.38	76.50	< 0.000
	(0.71)	(0.77)	
Individuals	5058	7662	

Notes: Standard errors are in parentheses. All calculations use survey weights. *p*-values represent a two-sample t-test of period 2007–10 versus period 1994–96.

are related to poorer diet quality, the observed changes suggest that individuals in 2007–10 period were more concerned about their diet than in 1994–96 period, an observation noted in Gregory et al. (2011). Less reliance on nutrition should work in the opposite direction.

5. Empirical methods

We begin by considering a simple reduced-form equation that includes only variables that change from Day 1 to Day 2 within each survey period (i.e., variables in Table 1),

$$HEI_{it} = \beta_0 + D_{it}'\beta + \varepsilon_{it} \tag{1}$$

where HEI_{it} is a measure of diet quality on day $t = \{1, 2\}$ for individual i. Thus, D_{it} contains food source choices (measured by the share of calories consumed at each source), indicators for each day of the week, and an indicator for the first day of intake (i.e., the face-to-face interview). We will first estimate Eq. (1) separately for each survey to determine if the impact of food source choices on dietary quality has changed over time.

Naturally, we are concerned that omitted variables in ε_{it} are correlated with both HEI_{it} and D_{it}, yielding inconsistent and biased estimates of β. For example, *observable* characteristics such as age influence both food choices and overall dietary quality. Moreover, *unobservable* characteristics such as culinary skills and nutritional knowledge are also a likely source of endogeneity. As will be apparent shortly, we expand the error term ε_{it} to include these components so that Eq. (1) can be written,

$$HEI_{it} = \beta_0 + D_{it}'\beta + X_i'\delta + u_i + \nu_{it}. \tag{2}$$

where X_i are observable characteristics: demographics (Table 2), socioeconomic status (Table 3), the use of dietary information (Table 4), and the importance of food characteristics when grocery shopping (Table 4). Notice that variables in X_i are stable within each survey period (i.e., they don't change from Day 1 to Day 2), but they do change cross-sectionally from 1994–96 to 2007–11. The composite error term

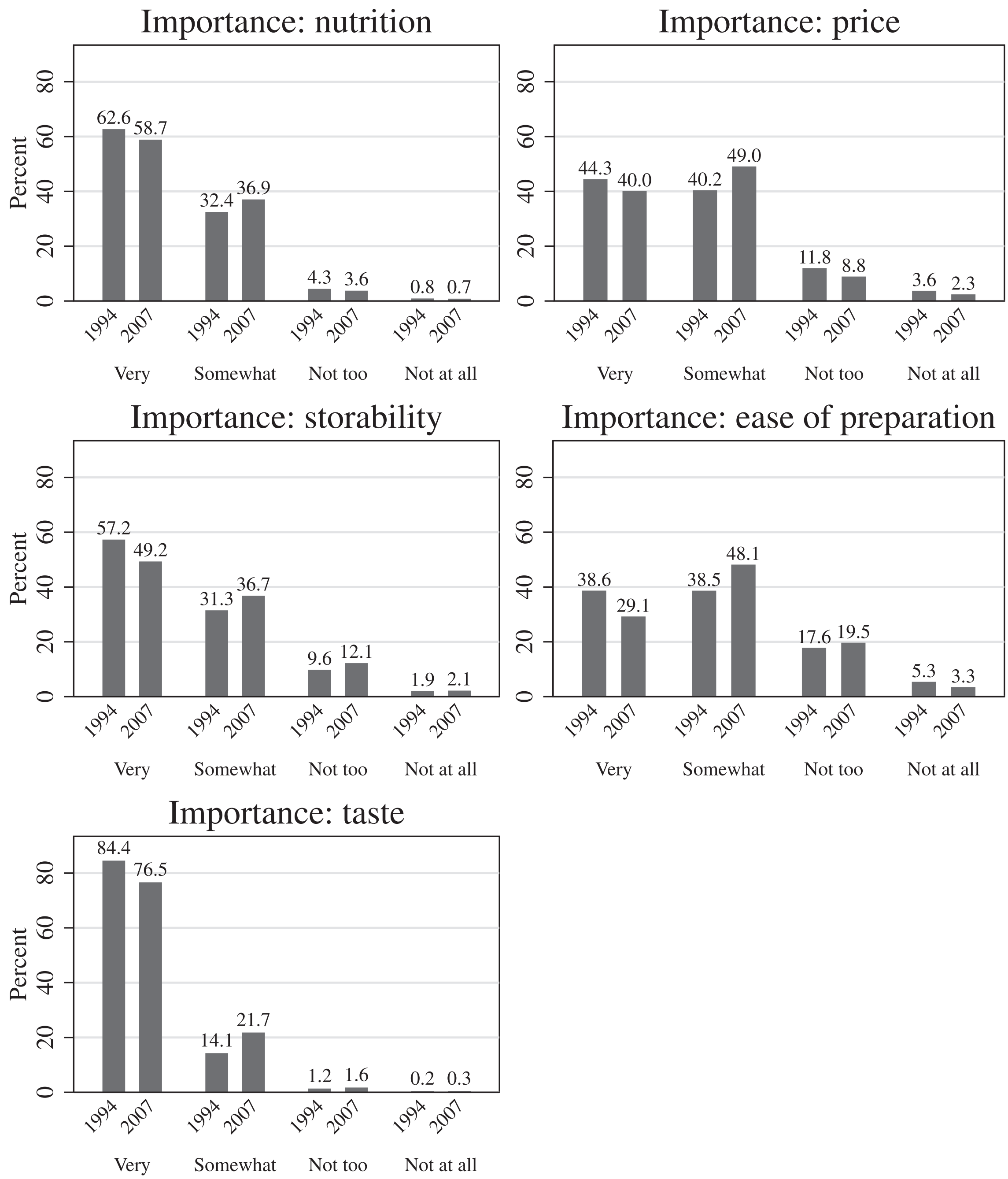


Fig. 2. Importance of food characteristics when grocery shoppings, 1994–2010. *Note:* Columns labeled "1994" use the 1994–96 CSFII and columns labeled "2007" use the 2007–10 NHANES.

$(u_i + \nu_{it})$ contains unobservable characteristics u_i that still introduce endogeneity and an idiosyncratic term ν_{it} assumed to be uncorrelated with all covariates. This model allows us to estimate the (potentially biased) impact of observable fixed factors by running a pooled OLS regression.

5.1. Fixed effects

With more than one day of intake, within-individual variation can be used to net out observable and unobservable characteristics by estimating an individual fixed effects model for each survey period, an identification strategy previously used with dietary intake data (Mancino et al., 2009; Smith, 2017)

$$HEI_{it} = \beta_0 + D_{it}'\beta + \alpha_i + \nu_{it} \quad \text{s. t.} \sum_i \alpha_i = 0 \tag{3}$$

where the individual fixed effect α_i controls for both observable and unobservable characteristics (i.e., $\alpha_i = X_i'\delta + u_i$), and we maintain that ν_{it} is random error. The constraint is without loss of generality and is necessary in the decomposition analysis below. Under the strict exogeneity assumption, $E[\nu_{it}|D_{it}, \alpha_i] = 0$, the model yields an unbiased and consistent estimate of β within each survey period. This assumption, while untestable, seems appropriate given that each day of intake within a survey is 3–10 days apart, which implies unobservable characteristics are stable over this short period of time. In other words, Eq. (3) allows us to identify the within-period effect of food source choices on dietary quality. The next step is to account for changes in observable characteristics between periods.

5.2. Decomposing changes in diet quality

We begin with the well-known Oaxaca-Blinder decomposition to decompose the over-time increase in diet quality (Blinder, 1973; Oaxaca, 1973),

$$\underbrace{HEI^{2007} - HEI^{1994}}_{\text{observed change}} = \underbrace{(D^{2007} - D^{1994})'\hat{\beta}^{1994}}_{\text{food choices}} + \underbrace{D^{2007'}(\hat{\beta}^{2007} - \hat{\beta}^{1994})}_{\text{returns to food choices}} + \underbrace{\left(\hat{\beta}_0^{2007} - \hat{\beta}_0^{1994}\right)}_{\text{reference group}} \tag{4}$$

where the superscripts $k = 1994, 2007$ represent the grand mean in periods 1994–96 and 2007–10, respectively.[2] The parameter estimates $\hat{\beta}^k$ are obtained from one of the three specifications above in Eqs. (1)–(3). The first component "food choices" tells us how much of the observed change (i.e., unconditional improvement) in dietary quality can be attributed to changes in the share of calories consumed at each food source (sometimes called the "explained" portion). The second component "returns to food choices" measures the expected change in dietary quality in period 1994–96 if the returns to calories where held at the levels observed in 2007–10. Changes in the "returns to food choices" plus the "reference group" represent the "unexplained" portion. It is well-known that estimates of the unexplained portion are subjective depending on the reference group (Fortin et al., 2011), therefore we focus on and only report the "explained" portion.

The strength of the Oaxaca-Blinder decomposition is contingent on unbiased estimates of $\hat{\beta}^k$. Using the standard Oaxaca-type of decomposition found in Eq. (4) and excluding fixed factors will in most cases yield biased results. The intuition behind such a result appeals to the standard omitted variable case. Only in the special case where observable characteristics remain unchanged over time will decomposition results be unbiased (Heitmueller, 2005). To this end, Heitmueller (2005) shows how to reduce the bias in (4) by including within-period time-invariant characteristics. Fully written out, we have

$$\begin{aligned} \underbrace{HEI^{2007} - HEI^{1994}}_{\text{observed change}} &= \underbrace{(D^{2007} - D^{1994})'\hat{\beta}^{1994}}_{\text{food choices}} + \underbrace{D^{2007'}(\hat{\beta}^{2007} - \hat{\beta}^{1994})}_{\text{returns to food choices}} \\ &+ \underbrace{(X^{2007} - X^{1994})'\hat{\delta}^{1994}}_{\text{characteristics}} + \underbrace{X^{2007'}(\hat{\delta}^{2007} - \hat{\delta}^{1994})}_{\text{returns to characteristics}} \\ &+ \underbrace{(\hat{\beta}_0^{2007} - \hat{\beta}_0^{1994})}_{\text{reference group}} \end{aligned} \tag{5}$$

From a policy perspective the "food choices" component allows one to understand how changes in the consumption of FAFH has impacted the trajectory of dietary quality since 1994. Similarly, the "characteristics" portion tells us how changes in demographics, socioeconomic status, the usage of nutritional information, and the importance of food characteristics when grocery shopping have impacted changes in diet quality.

Several of the included time-invariant characteristics are almost surely positively correlated to omitted factors that affect healthy eating, and thus we cannot make the conditional independence assumption $E(\nu_{it}|X_i) = 0$. We therefore make the weaker assumption of *ignorability* (also called unconfoundedness or selection on observables) to compute the aggregate compositional effects (Fortin et al., 2011). In short, the ignorability assumption means the correlation between X and the error term is the same in both periods. If we believe this assumption does not hold, then we can sign the bias. For example, if we believe that more highly educated individuals use their stock of knowledge more efficiently in 2007–10 than in 1994–96, then we have a positive bias. However, there is no *a priori* evidence to suggest a change in the correlation of education and the error term, let alone as to its direction. As a second example, consider the nutritional facts panel: if the information content has changed (which it hasn't) or if individuals leverage the information differently (which is unlikely but perhaps possible), then we could again sign the bias.[3] Therefore, we clearly state this caveat in the form of the weaker assumption of ignorability.

6. Results

6.1. Pooled OLS results

Estimation results from Eq. (1) are presented in the first two columns of Table 5. In this specification, only time-varying characteristics are included (i.e., food source choices, the day of the week that the intake was recorded, and a dummy variable for the first day of intake). In this manner, the specification mirrors the individual effects model of Eq. (3) and provides a basis for comparison. Keeping in mind that food source shares fall between 0 and 1, with food from home (FFH) as the reference category, the parameter estimates are interpreted as substituting FFH for another food source, all else constant. For example, in 1994–96 (column 1) the OLS model estimates that for a 10-percent shift in the average share of kcals consumed at home to fast food, we should expect average HEI scores to fall by 1.54 points. As expected, fast food has the largest negative impact on diet quality followed by restaurants and other away-from-home food sources. In 2007–10 (column 2), the negative effect of fast-food consumption on diet quality becomes smaller, while the effects from restaurant food becomes more negative.

Columns (3) and (4), summarize estimation results from Eq. (2). As a reminder, this specification additionally includes time-invariant demographics (i.e., gender, age, race/ethnicity and household size), socioeconomic status (i.e., education, percent above the poverty line and employment), the use of dietary information (i.e., ingredient list, nutrition facts panel, serving size and health claims), and the importance of food characteristics (i.e., nutrition, price, storability, ease of preparation and taste). While the trend in the impact of food sources largely reflect those in the first two columns, we observe that the parameter estimates for fast food are attenuated, implying that observable fixed characteristics included in the model are positively correlated with fast-food consumption.

With respect to the use of dietary information, only the use of nutrition facts panel has a positive effect on diet quality in 1994–96 (column 3). However, in 2007–10 period (column 4), we see that ingredient list usage and health claims also have significant positive impacts on dietary quality. The estimated effect of the importance of nutrition, price, storability, ease of preparation, and taste all have the expected sign. Additionally, we observe an attenuation in the effects of the importance of food characteristics on diet quality over time.

6.2. Fixed effects results

Table 6 reports the estimation results from Eq. (3). This model controls for time-invariant observable and unobservable characteristics within each period. As compared to the previous OLS results (Table 5) parameter estimates are mostly attenuated. Again, this implies that fixed characteristics of individuals are positively correlated with food source choices. Such correlation causes no bias in estimation since

[2] For example, the grand mean for D_{it} in period 1994 is $D^{1994} = (NT)^{-1}\sum_i \sum_t D_{it}$, where N is the number of individuals and T is the number of time periods.

[3] To be clear, by leveraging information, we mean how one might interpret or use nutritional information in making food choices: are people better at synthesizing the information on the panel in 2007–10 than in 1994–96, such as converting the serving size? We argue, most likely not. Note our argument does not change due to the fact that more people acknowledge seeing or using the panel; rather they use it in the same manner.

Table 5
Effects of food source choices and fixed characteristics on diet quality: Pooled OLS specification.

	Eq. (1)		Eq. (2)	
Variable	1994–96	2007–10	1994–96	2007–10
Fast food (share of daily kilocalories)	−15.40***	−11.60***	−11.01***	−8.47***
	(0.85)	(0.71)	(0.80)	(0.70)
Restaurant (share of daily kilocalories)	−4.18***	−7.56***	−4.68***	−7.62***
	(0.76)	(0.82)	(0.76)	(0.77)
Other (share of daily kilocalories)	−4.50***	−3.71***	−3.74***	−4.13***
	(0.79)	(1.10)	(0.77)	(1.03)
Ingredient list usage			0.78	2.22***
			(0.48)	(0.46)
Nutrition facts panel usage			2.82***	2.23***
			(0.47)	(0.45)
Health claims usage			0.44	1.37***
			(0.50)	(0.45)
Serving size usage			0.26	−0.06
			(0.49)	(0.47)
Importance: nutrition			3.54***	3.00***
			(0.41)	(0.41)
Importance: price			−0.56	−0.60
			(0.41)	(0.39)
Importance: storability			−1.46***	−1.11***
			(0.40)	(0.40)
Importance: ease of preparation			−0.85**	0.34
			(0.39)	(0.40)
Importance: taste			−1.77***	−1.25***
			(0.53)	(0.43)
Constant	51.43***	54.51***	51.45***	52.49***
	(0.58)	(0.62)	(1.42)	(1.21)
Demographics	No	No	Yes	Yes
Socioeconomic status	No	No	Yes	Yes
Observations	10116	15324	10116	15324

Notes: Standard errors in parentheses and clustered at the individual level. All regressions include indicators for the first day of intake and days of the week. See Tables 2 and 3 for demographic and socioeconomic status variables, respectively.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Table 6
Effects of food source choices on diet quality: individual fixed-effects specification.

Variable	1994–96	2007–10
Fast food (share of daily kilocalories)	−7.54***	−4.68***
	(1.01)	(0.87)
Restaurant (share of daily kilocalories)	−2.03**	−5.83***
	(1.03)	(0.99)
Other (share of daily kilocalories)	−2.91***	−5.26***
	(1.06)	(1.26)
Constant	50.69***	54.39***
	(0.60)	(0.58)
Observations	10116	15324

Notes: Standard errors in parentheses and clustered at the individual level. All regressions include indicators for the first day of intake and days of the week. The reference category is the share of daily kilocalories consumed at home. Coefficients are interpreted as substituting some share (between 0 and 1) of daily at-home kilocalories for another food source.
* $p < 0.1$
** $p < 0.05$
*** $p < 0.01$.

Table 7
Oaxaca-blinder decomposition corresponding to pooled OLS and fixed-effects regressions.

	Pooled[1]	Pooled[2]	FE[3]
Panel A: Differential			
$\overline{HEI}^{2007}$	55.57***	55.57***	55.57***
	(0.21)	(0.21)	(0.21)
$\overline{HEI}^{1994}$	50.46***	50.46***	50.46***
	(0.18)	(0.20)	(0.20)
Difference	5.11***	5.11***	5.11***
	(0.28)	(0.29)	(0.29)
Total Explained	−0.05	1.00***	1.05***
	(0.08)	(0.21)	(0.21)
Total Unexplained	5.16***	4.11***	4.06***
	(0.27)	(0.28)	(0.29)
Panel B: Explained			
Food source choices	0.02	0.05	0.04
	(0.08)	(0.06)	(0.05)
Day of week	−0.07*	−0.06*	−0.03
	(0.04)	(0.03)	(0.04)
Female		0.00	0.00
		(0.01)	(0.02)
Race/ethnicity		0.30***	0.30***
		(0.06)	(0.06)
Age		−0.00	0.00
		(0.05)	(0.05)
Household size		−0.05	−0.04
		(0.04)	(0.05)
Education		0.16***	0.16**
		(0.05)	(0.06)
Income		−0.07*	−0.06*
		(0.04)	(0.04)
Employment		−0.05	−0.04
		(0.05)	(0.06)
Ingredient list usage		0.01	0.01
		(0.06)	(0.07)
Nutrition facts panel usage		0.35***	0.35***
		(0.08)	(0.09)
Serving size usage		−0.07	−0.06
		(0.08)	(0.10)
Health claims usage		0.15**	0.14*
		(0.07)	(0.09)
Importance: nutrition		−0.12***	−0.13***
		(0.04)	(0.05)
Importance: price		0.11***	0.11***
		(0.03)	(0.04)
Importance: storability		0.12***	0.12***
		(0.03)	(0.02)
Importance: ease of preparation		0.06	0.06*
		(0.04)	(0.04)
Importance: taste		0.12***	0.12***
		(0.04)	(0.05)
Reference group	3.09***	7.71***	6.26***
	(0.84)	(1.55)	(1.69)
Observations	25440	25440	25440

Notes: Standard errors in parentheses and clustered at the individual level. Standard errors from the fixed-effects decomposition (column 3) are bootstrapped.
[1] Using parameter estimates from Eq. (1).
[2] Using parameter estimates from Eq. (2).
[3] Using parameter estimates from Eq. (3).
* $p < 0.1$
** $p < 0.05$
*** $p < 0.01$.

arbitrary correlation between individual fixed effects and covariates is allowed in fixed effect models (Wooldridge, 2010, p. 300).

For the purpose of comparison with the previously reported results, we will once again consider interpreting the estimated effect of a 10 percent shift, on average, in kcals consumed at home toward fast food. According to the fixed effects model, this shift would result in a 0.75 point decrease in mean HEI-2005 score during the 1994–96 period, a considerably smaller effect than those estimated via pooled OLS. Similar trends, however, are observed between the estimates from the pooled OLS and fixed effects model: similar to the results from pooled OLS, fixed-effects estimates indicate that in 1994–96 fast food consumption has the largest negative effect on diet quality followed by food from other sources; we also observe a decrease in the negative impact of fast food and an increase in the negative effect of restaurant food on diet quality over time.

6.3. Decomposition results

The estimates from the Oaxaca-Blinder decomposition analysis from Eqs. (4) and (5) are presented in Table 7. The first column shows the results from Eq. (4) using the pooled OLS coefficient estimates from Eq. (1). Columns (2) and (3) report the results from Eq. (5) using pooled OLS and fixed-effects estimates from Eqs. (2) and (3), respectively.

Panel A reports the mean predictions of dietary quality for each time period k, $\overline{HEI}^k$, as well as the their over-time difference. Overall, the results show that dietary quality is quite different between the two periods. The average HEI-2015 scores in 1994–96 and 2007–10 were 50.46 and 55.57, resulting in an observed 5.11 point increase (about 10%). Importantly, the fixed effects model in panel A shows that 20.5% of this change (or 1.05 HEI points) can be "explained" by changes in observables, which we discuss below. The remaining 79.5% (or 4.06 HEI points) is unexplained.

In describing the specific contributions of explanatory variables to the explained portion of the change in dietary quality, there are two important details to keep in mind. First, a positive coefficient implies the corresponding *change* in the variable's mean contributed to increasing dietary quality over 1994–2010. For example, the decrease in the importance of price when shopping for food contributed positively to the increase in HEI scores over time; presumably because higher priced items are of higher quality, and as individuals become less price-sensitive they are more likely to substitute to higher quality foods. Second, for groups of variables that are categorical (e.g., educational attainments) or scalable (e.g., percentage of calories from each food source), the reference category is arbitrary but its choice affects the decomposition analysis. We therefore follow the advice of Fortin et al. (2011) and analyze the impact in aggregate (e.g., how a shift in the distribution of educational attainment impacts dietary quality), which does not alter the interpretation of the explained portion.

As can be seen, pooled OLS and fixed-effects models in columns 2 and 3 yield similar results although there are exceptions. Using results from the pooled OLS in the decomposition analysis overestimates the explained part of the increase in diet quality related to several factors, and inferences from the fixed effect model are more conservative. Thus, we focus on the decomposition results corresponding to fixed-effects estimates found in column 3, which are summarized in Fig. 3 as the percentage of the total increase.

The explained part of the increase in dietary quality attributed to food source choices is positive on aggregate but insignificant: the shift in food choices towards more food at home (possibly due to the recession, as noted in Todd (2017)) contributed to a 0.04 point increase, or about 0.8% of the total 5.11 improvement in HEI-2005. As expected, day of the week has no significant contribution.

In terms of demographics, only the change in the race/ethnicity has a significant effect: the shift towards a more ethnically diverse country accounted for a 0.30 point increase in HEI-2005 score or about 6% of the total increase in dietary quality. In total, changes in all demographics explained about 5% of the total increase in HEI-2005 score.

Socioeconomic measures have mixed impacts on explaining increases in diet quality, but the results are intuitive. The shift towards higher educational attainment accounts for a 0.16 point increase (just over 3% of the total increase in the HEI-2005). This makes sense if education is positively correlated with more healthful dietary choices. The effect of a more polarized income distribution has had a negative impact contributing to a 0.06 point decrease in HEI-2005. While this contribution may appear small (but significant), it is of similar magnitude to the changes in food source choices.

Importantly, we can see that a relatively larger portion of the observed change is due to the increased usage of nutritional information and the importance of various food characteristics. In particular, the increased usage of nutrition facts panel and health claims account for about 6.8% (0.35/5.11) and 2.7% (0.14/5.11), respectively, or 9.5% in aggregate of total increase in HEI-2005. In other words, the increased usage of information content had a larger contribution than any other observable characteristic.

Another large part of the observed increase in dietary quality can be attributed to changes in the importance of food characteristics. In particular, the shift away from a reliance on price, storability, ease of preparation and taste contributed to 8% (0.41/5.11) of the aggregate increase in HEI-2005. Again, these are food characteristics typically associated with poorer quality foods. Thus, as consumers' attitudes shift towards healthier foods and the demand for hedonic characteristics associated with higher quality foods, we should expect this to manifest itself in the overall quality of foods consumed.

7. Implications for nutrition policy

Our results broadly support federal initiatives to increase dietary awareness and promote nutritional transparency. We explicitly state we cannot credibly ascribe a causal relationship to any one particular policy due to the sheer number of overlapping nutrition policies in the United States. For example, we show that consumers rely less on characteristics related to lower-quality foods (price, storability, ease of preparation, and taste) when making food purchases, and this implies a shift in attitudes/preferences that are potentially rooted in a variety of informational campaigns. The Dietary Guidelines for Americans, published every five years by the U.S. government since 1980, has an overarching influence on numerous national and localized initiatives, such as school food programs and publicly-disseminated informational campaigns, which in turn influence dietary choices through a variety of mechanisms.

Moreover, the United States has a long history of promoting nutritional transparency dating back to the Federal Food, Drug, and Cosmetic Act of 1938. The 1990 Nutrition Labeling and Education Act (NLEA), officially in effect in 1994, was the first to require nutritional labeling on most foods, as well as to regulate nutritional content claims (e.g., "high fiber"). Under the authority of the NLEA, the Food and Drug Administration (FDA) announced new labeling rules on May 20, 2016 with an underlying goal of increased transparency. Indeed, the FDA states, "The new label will make it easier for consumers to make better informed food choices." Specifically, the new label makes the serving size and corresponding calories, as well as servings per container, more prominent via increased font size. The current law already dictates that the posted serving size reflect the amounts people are actually consuming rather than the recommended amounts. The new law requires these serving sizes to be updated from their 1993 values (e.g., a serving a soda will increase from 8 to 12 oz). With regards to advances in nutrition science, the new label will include added sugars in grams and as a percent of recommended daily value. The idea here is to help consumers meet their recommended daily calorie intake by monitoring added sugar intake.

The new labeling rule was originally planned to take effect on July 26, 2018 for large manufactures (i.e., $10 million or more in annual sales) and July 26, 2019 for smaller manufactures. However in October of 2017, the FDA extended the compliance dates to January 1, 2020 and to January 1, 2021, respectively. The cited reasons for the extension were to allow manufacturers more time to (1) receive answers from the FDA concerning some technicalities of the rule change, and (2) finalize and print the updated labels.

The FDA has also recently used its authority to require the display of

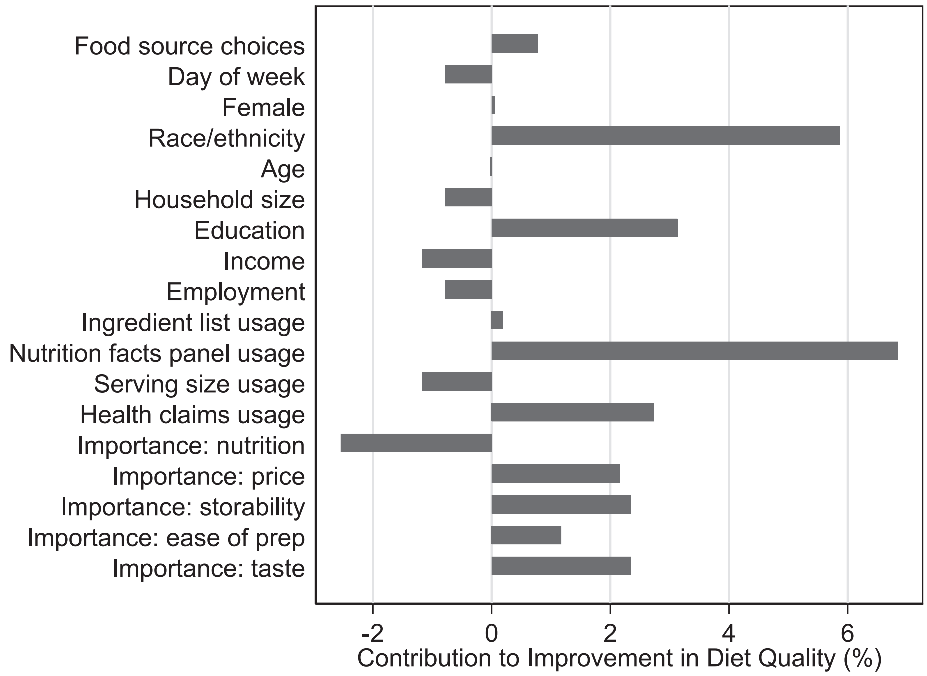


Fig. 3. Contribution to improvement in dietary quality over 1994–2010. *Note:* Percentages are calculated by dividing coefficient estimates found in column (3) of Table 7 by the total difference of 5.11.HEI-2005 points.

nutritional information in restaurants and food retail establishment with 20 or more locations, the so-called Menu Labeling Requirement. Prior to this requirement, food-away-from-home establishments voluntarily posted nutritional information. Again, the idea behind such a policy is to provide consumers with increased transparency. However, this requirement was also delayed from its original enforcement date of May, 2017 to May, 2018. Despite the implementation delays, the results of this study suggest that increased transparency should have positive affects on the quality of the American diet: the mechanism could be twofold via changes in consumer choice (e.g., Roberto et al., 2010) and/or changes in the formulation of foods (e.g., Bruemmer et al., 2012).

8. Conclusions

This study documents the rise in U.S. adult diet quality over 1994–2010: consistent with previous analyses (e.g., Beatty et al., 2014) we find a 10% increase from a baseline HEI score of 50.5/100 in 1994–96 to 55.6 in 2007–10. Of particular note is that the quality of food consumed at home, fast food and restaurants have all increased over the sample period, but our results show that fast food has increased at the highest rate behind home food with the quality of restaurant food increasing at the slowest rate. The relative ranking between the food sources remained unchanged with home food garnering the highest quality diets and fast food with the lowest quality.

We then document changes over 1994–2010 in other drivers correlated with increases in dietary quality that are relavent to food policymaking: demographics, socioeconomic status, dietary information, and food characteristics. In order to better understand each factors contribution to the observed changed, we use decomposition methods (Fortin et al., 2011). We find that changes in the amount of FAFH consumed has had a relatively small impact on dietary trends, accounting for less than 1% of the 5.11 increase in HEI-2005. Larger contributions to changes in diet quality are found for demographics (e.g., race/ethnicity – about 6%) and socioeconomic status (e.g., education – about 3%).

Of particular note is the affect of the increased usage of nutrition facts panel and health claims, which account for 6.8% and 2.7% of the total increase, respectively, or about 9.5% in aggregate. The increased usage of these two forms of communicating dietary information have had an aggregate affect on diets that is on par with demographics and socioeconomic status. In terms of food characteristics that influence consumer food choice, we find a shift away from relying heavily on nutrition, price, storability, ease of preparation and taste has had an aggregate impact on dietary quality similar to that of dietary information (about 0.41 HEI points, or about 8% of the total increase). Although a substantial portion of the increase goes unexplained via unobservables (a little over three-quarters), the relative magnitudes of what can be explained suggest nutrition policy discussions could focus on further shifting attitudes/preferences towards healthier diets while allowing consumers to better extract nutrition information when making food choices.

Acknowledgement and Disclaimer

This research was supported in part by the U.S. Department of Agriculture, Economic Research Service Cooperative Agreements No. 58-4000-5-0015 & 58-4000-3-0027. The findings and conclusions in this publication are those of the authors and should not be construed to represent any official USDA or U.S. Government determination or policy.

Appendix A

A.1. Language used in CSFII versus NHANES

- Importance of Food Characteristics when Grocery Shopping:

  1994-96 CSFII: "Now think about buying food. When you buy food, how important is: _________ – very important, somewhat important, not too important, not at all important, don't know?"

  1. nutrition
  2. price
  3. how well the food keeps
  4. how easy the food is to prepare
  5. taste

  2007-10 NHANES: "When you buy food from a grocery store or supermarket, how important is _________? Would you say very important, somewhat important, not too important, or not at all important, never buy from a grocery store or supermarket, don't know/refused?"

  1. nutrition
  2. price
  3. how well the food keeps after it's bought
  4. how easy the food is to prepare
  5. taste

- Use of Dietary Information:

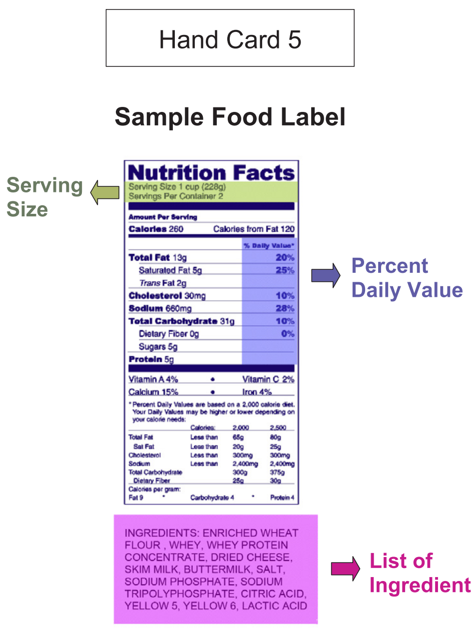
  1994-96 CSFII: "Now think about food labels. When you buy foods, do you use: _________ – often (always), sometimes, rarely, or never, never seen, don't know?"

  1. the list of ingredients
  2. the nutrition panel that tells the amount of calories, protein, fat, and such in a serving of the food
  3. the information about the size of a serving
  4. statements on the label that describe health benefits of nutrients or foods

2007-10 NHANES: “For the next few questions you’ll use hand card 6 to respond, but first please look at hand card 5 which shows an example of the food label. The “Nutrition Facts” panel of a food label is everything on this page except the list of ingredients in pink.

How often do you use the _________ when deciding to buy a food product? Would you say always, most of the time, sometimes, rarely, or never, never seen, don’t know/refused?

1. nutrition facts panel
2. list of ingredients
3. information on the size of a serving
4. Some food packages contain health claims about the benefits of nutrients or foods like the examples on hand card 8. How often do you use this kind of health claim when deciding to buy a product?



Appendix Table. Definition of food source

NHANES 2007-2010		CSFII 1994-96, 98		
Code	"Where did you get (this/most of the ingredients for this) {FOODNAME}?	Code	"Where the food item was obtained?"	Food source
1	Store	1	Store	Home
2	Restaurant with waiter/waitress	2	Restaurant with table service	Restaurant
3	Restaurant fast food/pizza	3	fast food place, pizza place	Fast food
4	Bar/tavern/lounge	4	Bar, tavern, lounge	Restaurant
5	Restaurant no additional information			Restaurant
6	Cafeteria not at school	6	Other cafeteria	Other
7	Cafeteria at school	5	School cafeteria	Other
8	Child care center	8	Children care center, family day care home, adult day care	Other
9	Family/adult day care center			Other
10	Soup kitchen/shelter/food pantry	9	Soup kitchen, shelter, food pantry	Home
11	Meals on Wheels	10	Meals on Wheels	Home
12	Community food program - other	11	Other community food program	Home
13	Community program no additional information			Home
14	Vending machine	7	Vending machine	Fast food
15	Common coffee pot or snack tray	15	Common coffee pot or snack tray	Other
16	From someone else/gift	13	Someone else/gift	Other
17	Mail order purchase	14	Mail order purchase	Home
18	Residential dining facility	16	Residential dining facility	Other
19	Grown or caught by you or someone you know	12	Grown by you or someone you know	Home
20	Fish caught by you or someone you know	71-74	Fish caught by you or someone you know	Home
24	Sport, recreation, or entertainment facility			Fast food
25	Street vendor, vending truck			Fast food
26	Fundraiser sales			Other
91	Other, specify	96	Other, specify	Other
99	Don't know	98	Don't know	Missing
.	Missing	99	Not ascertained	Missing

References

An, R., 2016. Weekend-weekday differences in diet among US adults, 2003–2012. Ann. Epidemiol. 26 (1), 57–65.

Barreiro-Hurlé, Jesús, et al., 2010. Does nutrition information on food products lead to healthier food choices? Food Policy 35 (3), 221–229.

Beatty, T.K.M., Lin, B.-H., Smith, T.A., 2014. Is diet quality improving? Distributional changes in the United States, 1989–2008. Am. J. Agricul. 96 (3), 769–789.

Blinder, A.S., 1973. Wage discrimination: reduced form and structural variables. J. Human Resourc. 8, 436–455.

Bosire, C., Stampfer, M.J., Subar, A.F., Park, Y., Kirkpatrick, S.I., Chiuve, S.E., Hollenbeck, A.R., Reedy, J., 2013. Index-based dietary patterns and the risk of prostate cancer in the NIH-AARP diet and health study. Am. J. Epidemiol. 177 (6), 504–513.

Bowman, Shanthy A., Gortmaker, Steven L., Ebbeling, Cara B., Pereira, Mark A., Ludwig, David S., 2004. Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. Pediatrics 113 (1), 112–118.

Bruemmer, B., Krieger, J., Saelens, B.E., Chan, N., 2012. Energy, saturated fat, and sodium were lower in entrées at chain restaurants at 18 months compared with 6 months following the implementation of mandatory menu labeling regulation in King County, Washington. J. Acad. Nutrit. Dietet. 112 (8), 1169–1176.

Chiuve, S.E., Fung, T.T., Rimm, E.B., Hu, F.B., McCullough, M.L., Wang, M., Stampfer, M.J., Willett, W.C., 2012. Alternative dietary indices both strongly predict risk of chronic disease. J. Nutr. 142 (6), 1009–1018.

Cowburn, Gill, Stockley, Lynn, 2005. Consumer understanding and use of nutrition labeling: a systematic review. Public Health Nutrit. 8(1) 2005, 21-28.

Davis, C., Saltos, E., 1999. Dietary recommendations and how they have changed over time. In: Frazao, E. (Ed.), America's Eating Habits: Changes and Consequences. US Department of Agriculture, Economic Research Service, Food and Rural Economics Division, pp. 33–50.

Drichoutis, Andreas, et al., 2005. Nutrition knowledge and consumer use of nutritional food labels. Eur. Rev. Agric. Econ. 32 (1), 93–118.

Duffey, K.J., Gordon-Larsen, P., Shikany, J.M., Guilkey, D., Jacobs, D.R., Popkin, B.M., 2010. Food price and diet and health outcomes: 20 Years of the CARDIA study. Arch. Intern. Med. 170 (5), 420–426.

Economic Research Service (ERS, 2018). Flexible Consumer Behavior Survey, [cited 2018 Jan 23] https://www.ers.usda.gov/topics/food-choices-health/food-consumption-demand/flexible-consumer-behavior-survey/.

Fortin, N.M., Lemieux, T., Firpo, S., 2011. Decomposition methods in economics. In: In: Ashenfelter, O., Card, D. (Eds.), Handbook of Labor Economics, vol. IV.A. Amsterdam, North-Holland, pp. 1–102.

Gregory, C., Smith, T.A., Wendt, M., 2011. How Americans rate their diet quality: an increasingly realistic perspective. Economic Information Bulletin No. 83, ERS–USDA.

Guenther, P.M., Reedy, J., Krebs-Smith, S.M., 2008a. Development of the Healthy Eating Index-2005. J. Am. Diet. Assoc. 108 (11), 1896–1901.

Guenther, P.M., Reedy, J., Krebs-Smith, S.M., Reeve, B.B., 2008b. Evaluation of the Healthy Eating Index-2005. J. Am. Diet. Assoc. 108 (11), 1854–1864.

Guenther, P.M., Juan, W., Reedy, J., Britten, P., Lino, M., Carlson, A., Hiza, H.H., Krebs-Smith, S.M., 2008c. Diet quality of Americans in 1994–96 and 2001–02 as measured by the Healthy Eating Index-2005. Nutrition Insights.

Guthrie, J.F., Lin, B.H., Frazao, E., 2002. Role of food prepared away from home in the American diet, 1977–78 versus 1994–96: changes and consequences. J. Nutrit. Educat. Behav. 34 (3), 140–150.

Heitmueller, A, 2005. A Note on Decomposition in Fixed Effects Models in the Presence of Time-Invariant Characteristics. Institute for the Study of Labor (IZA) Discussion Paper 1886.

Jahns, L., Conrad, Z., Johnson, L.K., Scheett, A.J., Stote, K.S., Raatz, S.K., 2017. Diet quality is lower and energy intake is higher on weekends compared with weekdays in midlife women: A 1-year cohort study. J. Acad. Nutrit. Dietet.

Kirkpatrick, S.I., Reedy, J., Krebs-Smith, S.M., Pannucci, T.E., Subar, A.F., Wilson, M.M., Lerman, J.L., Tooze, J.A., 2018. Applications of the Healthy Eating Index for Surveillance, Epidemiology, and Intervention Research: Considerations and Caveats. J. Acad. Nutrit. Dietet. 118 (9), 1603–1621.

Krebs-Smith, S., Reedy, J., Bosire, C., 2010. Healthfulness of the U.S. Food supply: little improvement despite decades of dietary guidance. Am. J. Prevent. Med. 38 (5), 472–477.

Lin, B-H., Guthrie, J., 2012. Nutritional quality of food prepared at home and away from home, 1977-2008.' EIB-105, USDA-Economic Research Service.

Mancino, L., Kuchler, F., Leibtag, E., 2008. Getting consumers to eat more whole-grains: the role of policy, information, and food manufacturers. Food Policy 33 (6), 489–496.

Mancino, L., Todd, J., Lin, B.-H., 2009. Separating what we eat from where: measuring the effect of food away from home on diet quality. Food Policy 34 (6), 557–562.

Nicklas, T.A., O'Neil, C.E., Fulgoni III, V.L., 2012. Diet quality is inversely related to cardiovascular risk factors in adults. J. Nutr. 142 (12), 2112–2118.

Oaxaca, Ronald, 1973. Male-female wage differentials in urban labor markets. Int. Econ. Rev. 693–709.

Ollberding, Nicholas Jay, et al., 2011. Food label use and its relation to dietary intake among US adults. J. Am. Diet. Assoc. 111 (5 Supplement), S47–S51.

Paeratakul, S., Ferdinand, D., Champagne, C., Ryan, D., Bray, G., 2003. Fast-food consumption among US adults and children: dietary and nutrient intake profile. J. Am. Diet. Assoc. 103 (10), 1332–1338.

Popkin, B.M., Zizza, C., Siega-Riz, A.M., 2003. Who is leading the change?: US dietary quality comparison between 1965 and 1996. Am. J. Prev. Med. 25 (1), 1–8.

Reedy, J., Mitrou, P.N., Krebs-Smith, S.M., Wirfält, E., Flood, A., Kipnis, V., Leitzmann, M., Mouw, T., Hollenbeck, A., Schatzkin, A., Subar, A.F., 2008. Index-based dietary patterns and risk of colorectal cancer: the NIH-AARP Diet and Health Study. Am. J. Epidemiol. 168 (1), 38–48.

Rehm, C.D., Peñalvo, J.L., Afshin, A., Mozaffarian, D., 2016. Dietary intake among US adults, 1999–2012. JAMA 315 (23), 2542–2553.

Roberto, Christina A., Larsen, Peter D., Agnew, Henry, Baik, Jenny, Brownell, Kelly D.,

2010. Evaluating the impact of menu labeling on food choices and intake. Am. J. Public Health 100 (2), 312–318.
Shahril, M.R., Sulaiman, S., Shaharudin, S.H., Akmal, S.N., 2013. Healthy eating index and breast cancer risk among Malaysian women. Eur. J. Cancer Prev. 22 (4), 342–347.
Smith, T.A., 2017. do School Food Programs Improve Child Dietary Quality? Am. J. Agric. Econ. 99 (2), 339–356.
Tippett, K.S., Cypel, Y.S., 1998. Design and Operation: the Continuing Survey of Food Intakes by Individuals and the Diet and Health Knowledge Survey, 1994–96. United States Department of Agriculture, Agricultural Research Service.
Todd, J.E., 2014. Changes in Eating Patterns and Diet Quality Among Working-Age Adults, 2005-2010. Economic Research Report, 161, ERS–USDA.
Todd, J.E., 2017. Changes in consumption of food away from home and intakes of energy and other nutrients among US working-age adults, 2005–2014. Public Health Nutrit. 20 (18), 3238–3246.
U.S. Department of Agriculture (USDA, 2000), Human Nutrition Research Center. Continuing Survey of Food Intakes by Individuals 1994–96, 1998, Beltsville, MD. [cited 2018 Oct 25] http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/csfii9498_documentationupdated.pdf.
U.S. Department of Agriculture (USDA, 2018) NHANES Survey Methods and Analytic Guidelines. [cited 2018 Oct 25]. Available from: https://wwwn.cdc.gov/nchs/nhanes/analyticguidelines.aspx.
Variyam, J.N., 2008. Do nutrition labels improve dietary outcomes? Health Econ. 17 (6), 695–708.
Variyam, J.D., Smith, T.A., 2010. Americans are more Realistic About the Quality of Their Diets. Amber Waves March 2010, 7.
Wang, D.D., Leung, C.W., Li, Y., Ding, E.L., Chiuve, S.E., Hu, F.B., Willett, W.C., 2014. Trends in dietary quality among adults in the United States, 1999 through 2010. JAMA Int. Med. 174 (10), 1587–1595.
Wilson, M.M., Reedy, J., Krebs-Smith, S.M., 2016. American diet quality: Where It Is, Where It Is Heading, and What It Could Be. J. Acad. Nutrit. Dietet. 116 (2), 302–310.
Wooldridge, J.M., 2010. Econometric Analysis of Cross Section and Panel data. MIT Press.