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Food costs, diet quality and energy balance in the United States ☆

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HIGHLIGHTS

- Healthy diets are affordable but that message needs to be promoted.
- Additional guidance is needed on how to switch to healthier diets.
- Most Americans consume diets that need improvement.
- The relationship between income and diet quality is weak.
- How the food price is measured affects whether healthy food considered expensive.
- How Americans allocate their food budget is not in line with healthy diets.
- At any food spending level households can purchase healthy or unhealthy diets.

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ABSTRACT

The high obesity rates and poor diet quality in the United States, particularly among low income populations, are often attributed to low income, low food access, and high food prices of healthy foods. This paper discusses these associations and questions some of the metrics used to measure food prices. The paper argues that 1. On average, Americans consume diets that need improvement and there is only a very limited relationship between income and diet quality; 2. The way the food price is measured makes a difference in the perception of how expensive healthy and less healthy food is; 3. The way Americans allocate their food budgets between healthy and less healthy foods is not in line with healthy diets; and 4. At any food spending level there are households that purchase healthy (and unhealthy) diets, including budgets at or below the maximum allotment for the Supplemental Nutrition Assistance Program (SNAP) which provides a means for low-income households to purchase food. Our key finding is that healthy foods and diets are affordable, but policy makers, nutrition educators, researchers and the media need to focus on promoting this message, and providing additional guidance on making the changes for Americans to switch to a healthy and affordable diet.

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1. Introduction

The United States offers a wide array of both healthy and less healthy food choices. Unfortunately most Americans choose diets that are not healthy and, not surprisingly, are overweight or obese. Some economists argue that the cost of over-consumption has gone down as shown by lower real (inflation-adjusted) food prices and medical advances to treat obesity complications, while the cost of being active has increased as evidenced by more sedentary high-paying jobs [1]. However, a common explanation for the unhealthy food choices is a general perception that the healthy options are more expensive, and that some cannot afford to purchase healthy foods. This answer is unfortunately too simplistic and could lead to policies that will not impact the obesity crisis in the United States.

In this paper we argue that: 1. Most Americans tend to consume diets that need improvement and the relationship between income and diet quality is very limited; 2. The metric used to measure food prices makes a difference in whether healthy foods appear more expensive than less-healthy foods. 3. The way Americans allocate their food budgets between healthy and less-healthy foods is not consistent with healthy diets; and 4. At any food spending level there are households that purchase healthy (and unhealthy) diets. The key finding is that healthy foods are affordable, but there is a considerable need for education and other mechanisms to make the healthy choice a more desirable option.

☆ The views expressed here are those of the author and should not be attributed to the Economic Research Service or the US Department of Agriculture.

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The paper reviews the literature on the relationship between income, food budget allocations, food prices and how these relate to obesity and diet quality in the United States. We supplement the literature with our own estimates using publicly-available data. We define healthy diets as diets that conform to the *Dietary Guidelines for Americans 2010* [2]—that is, diets high in fruits, vegetables, whole grains, lean proteins, low-fat dairy products (or other calcium sources), and low in saturated fat, added sugars and sodium. Similarly, we define healthy foods as being low in saturated fat, added sugars, and/or sodium, and containing at least a minimum amount of one of the five major food groups.

1.1. Data used to supplement the literature

Although most of the findings discussed in this article are drawn from the literature, we use the following four datasets to create charts which enhance our discussion.

1.1.1. NHANES (National Health and Nutrition Examination Survey)

NHANES, conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention (CDC), collects demographic, socioeconomic, dietary, and health-related information through a combination of interviews and physical exams. As part of the physical exam, an in-person interviewer collects a 24-hour dietary recall; a second day of dietary recall is collected by telephone within ten days of the first. The dietary recalls are reported in a multi-pass interview, whereby the interviewer reviews an initial list of foods generated by the participant and reminds him or her of commonly forgotten foods such as candy on a co-worker's desk, and foods and beverages consumed as secondary activities including sitting at a desk, driving, or watching TV. More information on the NHANES can be found elsewhere [3].

1.1.2. Consumer Expenditure Survey (CE)

The Bureau of Labor Statistics' Consumer Expenditure Survey collects detailed expenditure data covering all aspects of household purchases in the United States, including larger purchases such as property, automobiles, and other durable items as well as frequently-purchased smaller items such as food. Food expenditures are collected for both food purchased to prepare at home as well as foods purchased in restaurants or other away-from-home sources. Information on food and other frequently purchased items are collected in a two-week diary survey, while larger purchases are collected in a single interview. There are approximately 7000 households per quarter in this nationally representative sample. The data are used in a variety of economic studies and by policy makers. Additional details are available elsewhere [4].

1.1.3. Food Expenditure Series

The Economic Research Service (ERS) of the US Department of Agriculture produces the Food Expenditure Series. The annual series shows the total sales of all food by retailers, food-away-from home venues, as well as the value of food donated by the Federal government. Consumer expenditures are also broken down by household income. Total sales cover food purchased by consumers as well as government, businesses and non-profit organizations. While the full series begins in 1929, some data are available as far back as 1869 [5].

1.1.4. CNPP Food Prices Database

The CNPP Food Prices Database provides the cost of foods reported consumed by participants in NHANES. The prices assume that all food is purchased from stores, though many foods are assumed to be purchased as prepared or frozen foods, or make use of convenience items. For foods that NHANES participants report obtaining from a restaurant or other food-away-from home establishments, prices are estimated as if the ingredients or pre-prepared food was purchased at stores. Convenience items were assumed for any food that generally takes more than 30 min to prepare. It is created for the estimation of the USDA Food Plans [6,7]. The prices are in edible grams—that is the price of food after peels, skins, seeds, shells, and bones have been removed, and the food is cooked. Because of the labor intensive nature of preparing these data, the database is only updated periodically. The most recent update is 2004 [8,9].

2. How income relates to obesity, food expenditure and diet quality

National data on prevalence of obesity and overweight in the US show that about one-third of adults 20–74 years of age were overweight, and another third were obese in 2009–2010 [1] [10–12]. Whereas the prevalence of overweight has remained fairly stable since 1960–62, obesity rates more than doubled among adults ages 20–74 years, so that by 2005–06 obesity was more prevalent than overweight (Fig. 1). Similarly, the prevalence of extreme obesity (BMI equal to or greater than 40) increased more than seven-fold in the same period. However, there was very limited change in the prevalence of obesity among adults or children between 2003–04 and 2011–12 [78].

Among children ages 2–19, nearly one-third were overweight or obese in 2009–10, with significant differences observed by gender and by race/ethnicity [13]. Between 1980 and 2009–10 obesity more than doubled among 6–11 year-olds and tripled among adolescents (12–19 years) with most of the increases occurring in the 1980s and 1990s [13,14] Increasing rates of obesity among children are particularly troublesome, since obese children are more likely to grow into obese adults [15–17].

2.1. Relationship of income to obesity

Because the prevalence of obesity is higher among the low-income [12,14], a common perception is that obesity is a low-income problem. However, a number of facts make it clear that this is not true. For one, the obesity rate is significantly higher than the poverty rate, which fell during the 1960's and has fluctuated between ten and fifteen percent since then [18], while obesity rates have increased in the same time period.

Second, the relationship between obesity and income differs by gender and race and ethnicity [11,12,19]. Whereas obesity prevalence among women and children tends to increase as income decreases, there is little difference in obesity prevalence across income levels among men. Among women, the inverse relationship between income and obesity is observed among non-Hispanic white women but not among other groups; in contrast, among men, a positive relationship between income and obesity is observed among non-Hispanic black and Mexican–American men.

Furthermore, most obese individuals are not low-income: among obese adults in 2005–08, 20% had incomes below 130% of the poverty level, 39% had incomes between 130 and 350% of the poverty level, and 41% had incomes at or above 350% of the poverty level [11]. Among obese children, 38% lived in households with income below 130% of the poverty level [12]. Also, income disparities seem to be weakening with time, as the largest increase in obesity over the last few decades has occurred among individuals with household incomes at or above 200% of the poverty line [20].

Given the sheer size of the prevalence of obesity, and the more rapid rise in obesity among higher income groups, Ljungvall and Zimmerman [19] concluded that obesity is not limited to lower socioeconomic groups. Thus it is not clear what role income plays in obesity. One economic study found that low-income women experience an increased BMI when there was an exogenous change in income-earning potential such as an expansion of the Earned Income Tax Credit [21]. Careful

[1] Overweight is defined as BMI equal to or greater than 25 but less than 30; obesity is defined as BMI equal to or greater than 30, and extreme obesity is defined as BMI equal to or greater than 40.

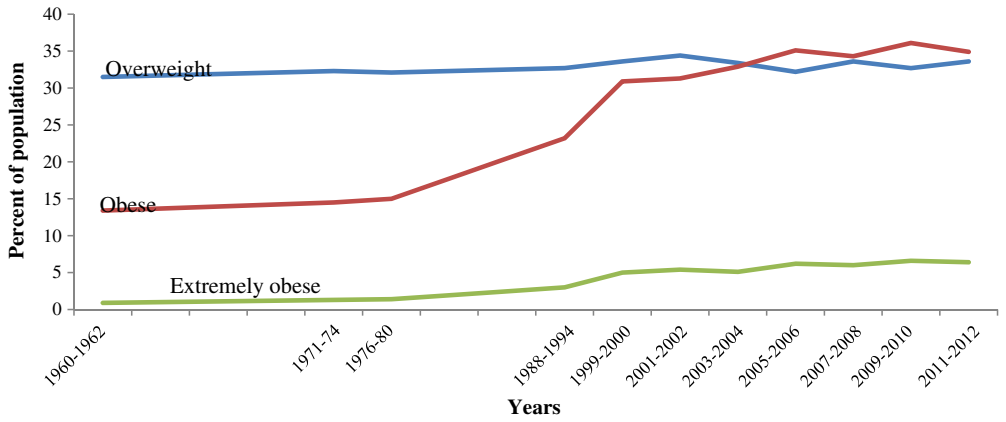

Fig. 1. Obesity rates are rising while overweight remains constant. Between the 1976-80 NHANES II and the 1988-94 NHANES III, obesity rates rose dramatically compared to overweight. Obesity has continued to rise through the 1990's and 2000's. Overweight refers to BMI >= 25.0 and < 30.0; obese refers to BMI => 30, and extremely obese refers to BMI =>40. Trends show adults ages 20-74, pregnant females excluded from these numbers. Source: Data from Fryar, Cheryl D., Margaret D. Carroll, and Cynthia L. Ogden. 2012. "Prevalence of overweight, obesity, and extreme obesity among adults: United States, trends 1960–1962 through 2009–2010." *Hyattsville, MD: National Center for Health Statistics*.; Ogden, C. L., M. D. Carroll, B. K. Kit, and K. M. Flegal. 2014. "Prevalence of childhood and adult obesity in the united states, 2011-2012." *JAMA* 311 (8):806-814.

economic studies where the models account for a variety of confounding factors also find little or no evidence of a relationship between BMI and income (for an overview, see [22]).

In summary, although the prevalence of obesity has increased considerably over the past 50 years, rates appear to have stabilized in more recent years. The largest increase in obesity rates have been among the non-poor. The relationship between obesity and income is not straightforward, which suggests that multiple factors are involved, and that relationships that might have been important in the past may have become less important. What is clear is that a growing majority of people in the United States need to make changes to both their diet and physical activity levels. Yet, concern is often raised that healthier diets will increase food costs, which is a burden for low-income consumers. In addition, it has been argued that low-income individuals do not have access to healthy foods. Section 2.2 examines the extent of the food access problem, while section 2.3 addresses the relationship between income and diet quality.

2.2. Limited access to affordable and nutritious foods

In recent years, increasing focus has been devoted to 'food deserts' with the objective of addressing the problem of limited access to affordable and nutritious foods as a barrier to the ability of low-income households to purchase and consume a healthy diet.

According to Walker et al. [23], the phrase 'food desert' was first used in the early 1990s in Scotland, and has been defined differently by different researchers. A 2009 report to Congress for the first time offered an official definition of 'limited access to affordable and nutritious foods' as living more than a mile from a supermarket or large grocery store and not having access to a vehicle [24]. Although the focus on supermarkets was driven by the availability of data, it is also based on perceptions that supermarkets and other large grocery stores are more likely to offer the large variety of foods needed for a healthy diet (such as fruits and vegetables, whole grains, and low-fat dairy products) at lower prices [25] and that individuals with limited access to supermarkets may be more reliant on small food retailers or fast food restaurants that offer mostly high-calorie foods and limited varieties of healthy foods [23].

The 2009 report to Congress provided an estimate of the magnitude of the problem in the US: 2.9 million households (2.2% of all households) had limited access to affordable and nutritious foods, and an additional 3.4 million households, or 3.2% of all households, lived between one-half to 1 mile and did not have access to a vehicle. The Report also noted that there were differences between rural and urban areas in terms of distance, travel patterns, and retail market coverage. Urban core areas with limited food access are characterized by higher levels of racial segregation and greater income inequality. In small-town and rural areas with limited food access, the lack of transportation infrastructure is the most defining characteristic [24]. A 2012 update to the report to Congress found that vehicle availability for households more than 1 mile from a supermarket had improved, so that fewer households (2.1 million households, or 1.8% of all US households) lived more than a mile from a supermarket and did not have a vehicle [26].

Although supermarkets and larger grocery stores tend to offer a greater variety of healthy foods than what small food stores can carry, recent policy changes suggest that focusing only on supermarkets and larger grocery stores may underestimate some households' access to healthy foods. In particular, research indicates that the implementation of the new WIC food package revisions in 2009—with the addition of new healthy foods such as fruits, vegetables, and whole grains, and the requirement that WIC-authorized food stores stock a minimum amount of healthy foods—has increased the availability and variety of healthy foods in WIC-authorized convenience and small grocery stores [27,28]. For example, Gleason et al. [28] found that whereas whole-wheat bread was available in 58% of small WIC stores prior to implementation of the WIC food package revisions, 87% of small WIC stores offered whole-wheat bread after implementation. Because WIC stores also sell to non-WIC customers, the increased availability and variety of healthy foods in these small stores affect both WIC and non-WIC households. Further, Andreyeva et al. [27] observed that the availability and variety of healthy foods also improved among non-WIC stores, albeit to a smaller degree. Interestingly, Andreyeva et al. [29] found that increasing distance from supermarkets predicted greater availability and variety of fruit and vegetables and whole grain products in small stores.

It is also important to note that research shows that while some of the very poorest households – those earning less than $8000 per year – may pay between 0.5% and 1.3% more for their groceries than households earning slightly more, households earning between $8000 and $30,000 tend to pay the lowest prices for groceries, whereas higher-income households pay significantly higher prices [79].

The perception that low-income households have limited access to affordable and nutritious food implies that it is a supply (availability) rather than a demand problem, and that households would purchase those nutritious foods if they were available. However, Andreyeva et al. [29] and Gleason et al. [28] interviewed owners and managers of small food stores, and found that customer demand was the primary factor in retailers' stocking decisions. Despite some retailers' interest in offering healthy foods, they were unwilling to increase their offerings of healthy foods because of the perception that their customers did not like healthy foods. In fact, some managers interviewed shortly before

implementation of the WIC food package revisions expressed concerns that their customers might not respond well to the changes, since previous attempts to sell healthier foods (e.g., low-fat milk, produce, whole grain bread) in their store(s) had failed. Although some store managers recognized that changing eating behaviors might take time, they were concerned that, in the meantime, their sales might decline. Some of the store managers interviewed after implementation of the WIC food package changes reported that their sales had declined; however, the majority felt that the policy changes had resulted in greater demand for healthy foods, and that carrying the new healthy foods helped them compete with other stores in their areas.

Low-income households that face limited availability and opportunity to purchase affordable and nutritious foods deserve attention and assistance. However, the problem likely affects only a small share of low-income populations, and cannot explain the high prevalence of obesity, which, as we noted earlier, affects individuals across all income levels. Thus, we now focus our attention on the relationship between income, food expenditure, and diet quality.

2.3. Income, food expenditure and diet quality

Increasing food expenditures could be both beneficial and detrimental to improved diet quality. On the one hand, spending more on food allows the consumer to have a greater variety of options and convenience levels, allowing for a greater possibility that the consumer will be able to find healthy foods that taste good and can be obtained within the available time and budget constraints. On the other hand, greater variety means even more unhealthy options are available. This section reviews the literature on food prices, expenditure and the impact on diet quality. We continue to define healthy diets as diets that conform to the *Dietary Guidelines for Americans*.

Food expenditure data from the Consumer Expenditure Survey show that higher-income households spend considerably more on food than lower-income households (Fig. 2). In 2012, households in the highest-income quintile spent three times as much on food as households in the lowest-income quintile. The data also show that real food expenditures have remained fairly flat since 2000, and that during the 2007–09 recession, households in the United States economized on food purchases by decreasing inflation-adjusted expenditures by about five percent. The reduction in expenditures was most apparent in the middle-income quintile [30].

In order to understand whether the higher income households are purchasing healthier foods with their income, we can break down food expenditures by food-at-home and food-away-from-home.[2] As will be discussed below, food-away-from-home is generally less healthy than food-at-home.

Since the US government began collecting expenditure data in 1869, the share of the food budget allocated to food away-from home has steadily increased [5] (Fig. 3). During World War II, purchases of food away-from-home increased as women entered the labor force while men were serving overseas. Since 2000, the share of food away-from-home has leveled off at nearly half of total food expenditures, though households did reduce food away-from-home expenditures during the 2007–09 recession [30]. Analysis of NHANES data for 2005–10 confirms that the reduced expenditures on food away-from-home resulted in a reduced amount of food (measured in calories, share of calories and the number of meals and snacks) from away-from-home food sources. However, this reduction explained less than 20% of the small improvements in diet quality that are also noted during the recession [31].

Frazao et al. [32] examined how food spending patterns changed with income. To control for differences in spending patterns associated with differences in household size, they compared food spending for 4-person households across various income levels. We update their 2004–05 estimates using 2012 data from the Consumer Expenditure Survey [4]. Our findings are very similar. Almost all households, across all income levels, spend a significant share of their food budget on away-from-home food, although how much they allocate to food away-from-home varies by income (Fig. 4). Households with the lowest income allocate 25 cents of every dollar to food away-from-home, whereas households with the highest income allocate about 44 cents of every dollar to food away from home.

While expenditure data does not typically include information on nutrient intake, studies show that food away-from-home tends to be less healthy – higher in saturated fat, sodium and cholesterol, and lower in calcium and fiber – than food at-home [33,34], and that as the share of food expenditures spent on food away-from-home increases, so does the share of calories consumed from away-from-home sources [35]. Thus, higher spending on food away-from-home is associated with poorer-quality diets, particularly for those with limited knowledge of nutrition and health [35]. Given that higher-income households devote a higher share of their food budget to food-away-from-home, we now look at what research shows about the relationship between income and diet quality.

Because diet quality involves a number of attributes, the US Department of Agriculture developed the Healthy Eating Index, which measures compliance with the US government's *Dietary Guidelines for Americans*. The 100-point scale of the HEI-2005 measures both the total quantity and variety of vegetables, fruits, grains, protein foods, dairy and oils. The HEI also includes measures for foods where less consumption is desirable, including saturated fat, sodium, and calories from solid fat, alcohol and added sugars. The HEI-2005 has been updated by the HEI-2010, to reflect changes in the *Dietary Guidelines for Americans 2010*; however, research currently available on diet quality uses the HEI-2005. In both the HEI-2005 and the HEI-2010 a higher score always indicates better compliance and therefore better diet quality [36,37].

Several studies [38–40] have found that, among children and older adults, there is no improvement in diet quality with income level. Among adults ages 18–64 years, diet quality generally improved very slightly (if at all) with income level. However, whereas the difference between the highest and lowest income group in total HEI-2005 scores among adults 18–64 is statistically significant (55 vs. 58) [40], it is not clinically significant.[3] In general, individuals in families with incomes less than 300% of the federal poverty level tend to consume fewer total vegetables, dark green and orange vegetables and legumes, and whole grains, than individuals in higher-income families. On the other hand, individuals in these lower-income households also tend to consume less saturated fat and less sodium than individuals in higher-income families (Fig. 5). The net effect is only a marginal difference in total HEI-2005 scores.

Another way to look at the relationship between income and diet quality is to examine the impact of changes to income of individuals, such as a job loss. Unemployment can affect diet quality by increasing the available time for food preparation and exercise or by increasing stress and decreasing the ability to purchase a varied diet. Research into the relationship between business cycles and diet quality is mixed. Dave and Kelly [41] use the Behavior Risk Factor Surveillance System (BRFSS) data for the years 1990–2000 and find that an increase in the state unemployment rate increases individual consumption of less healthy food such as fast food, and decreases the consumption of fruits and vegetables. However, a similar analysis using BRFSS data for the years 1987–1995 finds that state unemployment rates increase

[2] Food-at-home expenditures are purchases made in grocery stores, regardless of whether the food is brought into the home or not. Food-away-from-home expenditures are purchases in eating and drinking places such as restaurants, fast food, bars and taverns, cafeterias, vending machines, and recreation facilities such as theaters and sports venues, regardless of whether the food is consumed there, taken out, or delivered to a home.

[3] In a 2000 kcal diet, a 1 point increase is equivalent to just over 1/2 more ounce equivalents of whole grains, 1/6 cup-equivalent of dark green and orange vegetables or legumes, or just under 1/2 cup-equivalent of milk.

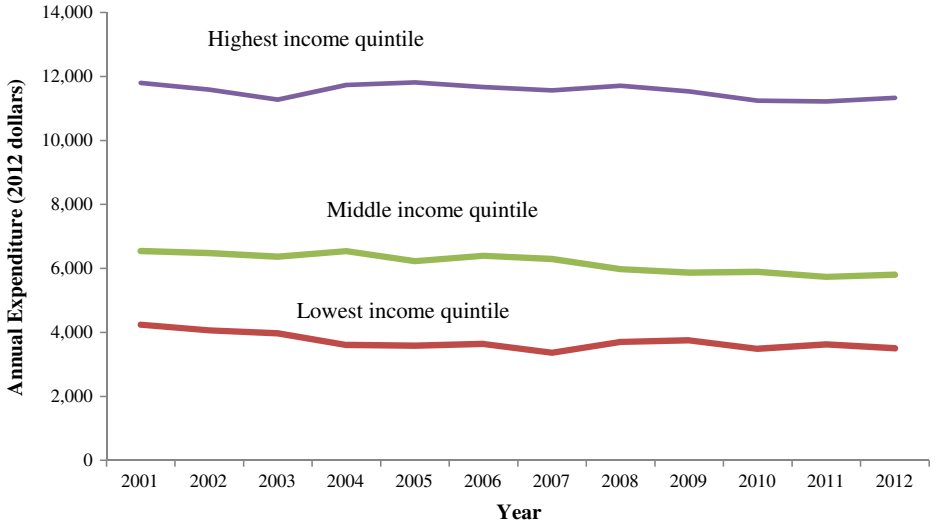

Fig. 2. Higher-income households spend significantly more on food than lower-income households. Expenditures on food in real (inflation adjusted) dollars has remained fairly constant 2000–2012. However, the highest income quintile spends about three times as much on food as the lowest income quintile. Source: Data from Consumer Expenditure Survey, multiple years.

physical activity and decrease BMI and fat consumption [42]. Interestingly enough, the unemployment covered by the later study [41] affected higher income individuals more than the recessions covered by the earlier study [42]. The reality is that Americans across all income groups consume diets that need significant improvements.

2.4. Interim summary

Taken together, this body of research shows that while higher-income individuals spend more on food, they are not purchasing or eating diets that are healthier than low-income individuals. In fact persons of all income levels need to improve their diets in order to combat obesity. Higher income individuals do spend more on food-away-from home, which is generally less healthy than food-at-home, but this may not completely explain the poor diet of higher-income individuals. Food access is raised as a potential barrier for low-income households to obtain a healthy diet; evidence suggests that this barrier affects a small percent of the population and may be partially solved by creating a demand for healthy foods in these low-access areas. The next section will examine another perceived barrier to eating a healthy diet—the prices of healthy foods.

3. Food prices and diet quality

Economic theory suggests that prices play an important role in consumers' choices, and that price changes can affect what and how much consumers purchase [43]. Consumers tend to purchase less of a good when its price increases, and to buy more of a good when its price goes down. Thus, some public health advocates and policymakers have pointed to the successful use of large taxes in reducing smoking in the US, and have proposed taxing unhealthy foods and/or subsidizing healthy foods – which effectively change their prices – to improve food choices and diet quality in the US [44]. Lin et al. [45] show that a tax on sugar sweetened beverages will encourage weight loss, but the study

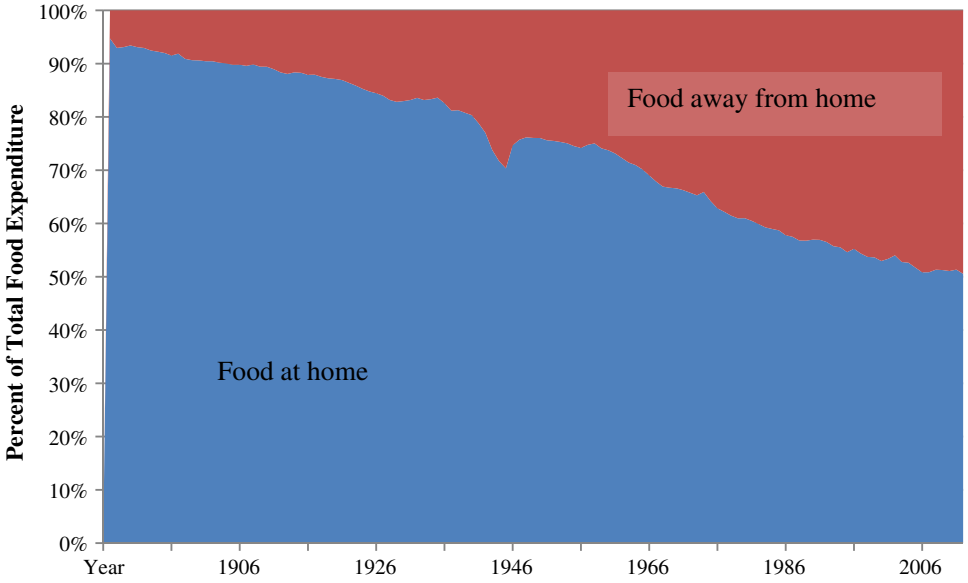

Fig. 3. Food-away-from-home is an increasingly larger share of the U.S. food budget. Since the US Department of Agriculture began collecting expenditure data, the share of the food budget dedicated to food-away-from-home purchases grew until about the year 2000. Since then the percentages have leveled off. Source: Data from ERS Food Expenditure Series.

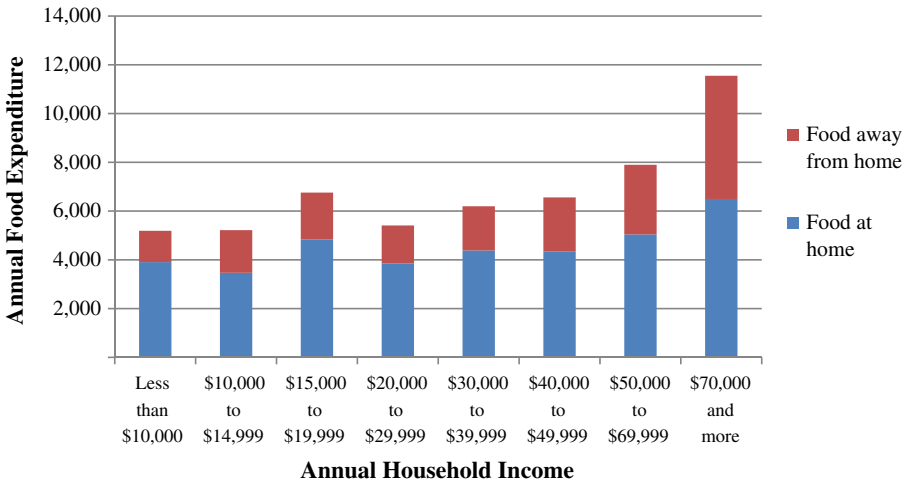

Fig. 4. Spending on food-away-from-home increases with income. All households allocate some of their food budget to food-away-from-home, but the share differs by income. This graph shows the expenditures on food for four person households at different income levels. Source: Data from Consumer Expenditure Survey, 2012.

points out that since many authors use a static weight reduction equivalency (3500 kcal reduced = 1 lb lost) rather than a dynamic one, the estimated weight loss from a tax on sugar sweetened beverages has been overestimated by other authors. Another way to lower prices is to use a subsidy or give coupons. Coupons may be more effective than a price discount at encouraging fruit and vegetable consumption because coupons play the dual role of advertising and a price break [46].

Although economic theory suggests that lowering the price will lead to more consumption, for most US consumers, price is only one factor in a complex decision that also considers tastes and other preferences such as convenience, interest in nutrition and health, familiarity of the food, cooking skills, and mental health [31,43]. In fact, for most consumers, price is secondary to tastes [31,47–50]. Economic models that predict consumer behavior assume that consumers use the resources they have (money and time) to purchase or create goods that will maximize their utility. If consumers do not value nutrition as highly as they value other benefits of food, then economic theory suggests that there may be a need to decrease the cost of healthier foods in order to reflect how consumers value nutrition. In the remainder of this section we address the actual prices of food, and discuss how consumers value the foods in Section 4.

3.1. Food prices and choices

Prices are relevant because they help consumers allocate their limited food budget. For example, a consumer with a budget of $20 can purchase ten $2-items, or four $5-items, or a combination of five $2-items and two $5-items. Consumers see and compare prices all the time—the price of houses, the price of cars, the price of milk, and so forth. At food stores, prices are typically specified per unit, although the unit can be a measure of weight or volume (such as a pound or gallon), or a physical unit (such as a loaf of bread, or a whole watermelon).

Kuchler and Stewart [51] find that real (inflation-adjusted) food prices declined between 1980 and 2006, particularly for dessert and

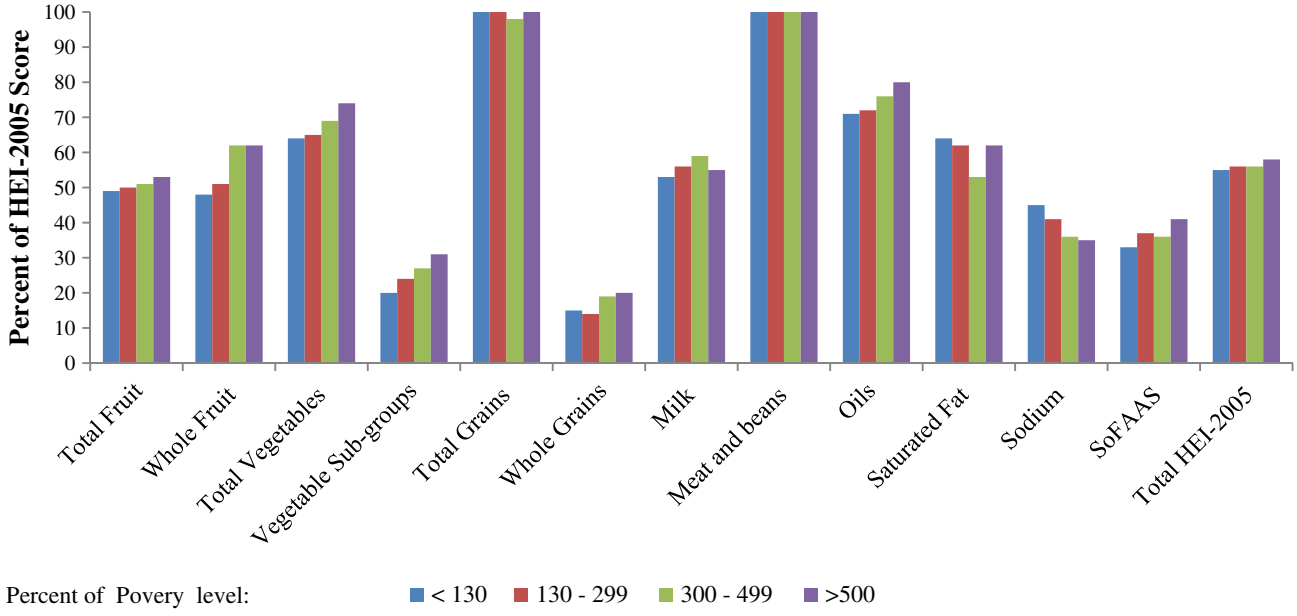

Fig. 5. HEI-2005 scores do not differ by income. Regardless of income, most Americans consume diets that need improvement. The Healthy Eating Index-2005 rates the quality of diet compared to the Dietary Guidelines for Americans. A higher score always means greater compliance. Scores are shown as percent of the possible total for each Healthy Eating Index component. Source: data from Hiza, Hazel B, Kellie O Casavale, Patricia M Guenther, and Carole A Davis. 2013. "Diet Quality of Americans Differs by Age, Gender, Race/Ethnicity, Income and Education Level." *Journal of the Academy of Nutrition and Dietetics* 113 (2):297-306.

snack foods, although the real price of fruits and vegetables increased. However, the authors point out that the increase in the real price of fruits and vegetables is due to the 'changes' in fruits and vegetables, such as the increased levels of convenience (for example, pre-washed and cut fresh vegetables, salad kits, and baby carrots), or fruits which are now available over a much longer season than in the past. Commonly-consumed fruits and vegetables for which quality remained fairly constant showed a real price decline similar to that of desserts and snack foods. These changes in food prices may have opened up more choices for more people, allowing greater opportunities to purchase both healthy and less healthy foods. Studies find a link between the reductions in the real food price of food – particularly prices at fast food restaurants – and the rise in young adult BMI, particularly the prices at fast food restaurants [22,52].

Studies also show that a consumer's response to a food price change can vary considerably, depending on household income, the magnitude of the price change, the availability of food substitutes and complements, how long they anticipate the price change will last, and other personal characteristics [45]. Further, how consumers respond to a food price will differ depending on whether the product is very specifically-defined (e.g., apples) or broadly-defined (e.g., fruit). For example, if the price of apples goes up, consumers can easily switch away from apples and purchase bananas, oranges or grapes. Similarly, if the price of apples goes down, consumers may purchase more apples and fewer grapes. In the end, purchases of apples may decrease or increase significantly but overall purchases of fruit may not change much [53].

Consumers' perception of the relative cost of food is influenced not only by the prices they see on the shelf or how much they are willing to spend on food, but also by what they hear in the media, among their social networks and from experts. Among researchers, consumers, and the media there is a wide-spread perception that 'healthy' foods cost more than 'less-healthy' foods. This perception is supported by a number of studies (for example see [54,55]). The problem is that these studies use a unique price metric for their comparisons—the price of food energy provided by the food. However, since this price metric does not reflect how much it actually costs to purchase foods [56], the finding that healthy food costs more under this metric is misleading. Yet, these studies have reinforced the perception that healthy foods – and therefore healthy diets – are expensive, and that low-income households, in particular, cannot afford to purchase and consume healthy diets. Other research finds that healthy foods are not necessarily more expensive *per serving* than less-healthy foods [57–59].

Fig. 6. Amounts of different foods providing 100 kcals vary considerable. Food energy is not a measure of satiety because the quantities of food needed to provide 100 kcals varies by the type of food. Photo Credit: Joseph Sanford.

3.2. Making appropriate price comparisons

The retail price (per package) is likely adequate for comparing the price of some foods—such as two brands of pasta, or whole- and refined-grain pasta in the same size box. However, a straightforward price comparison can be misleading for some foods, such as those that differ in their package sizes. In fact, stores often provide 'unit prices' to assist consumers in determining whether a larger package size is cheaper (per pound, or per count) than a smaller package size. But even the unit price can be misleading for some foods that differ in their formats—for example, vegetables can be purchased fresh, pre-cut, frozen or canned, and chicken is sold with and without the skin and bones, pre-cooked rotisserie, frozen, and raw. The relevant unit might be an *edible weight*, since the final objective is to compare the price of purchasing a pound of actual edible vegetables or meat.

This suggests that in order to use prices to explain, predict and possibly influence consumer behavior, it is important to use the same price metric that consumers use to make their decisions. Below we provide a brief description of three price metrics that have been, or could be used for comparing prices of healthy and less-healthy foods, and compare the prices of the same set of foods using the different metrics. For a more detailed discussion of the strengths and weaknesses of each price metric see [57].

3.2.1. Price of food energy

The price of food energy measures the price associated with providing a specified quantity of food energy, such as 100 kcal. However, the metric offers no guidance in terms of out-of-pocket costs, since a food that is a cheap source of calories may end up having a high out-of-pocket cost if a large number of calories are consumed from that food. Calories are not a good proxy for satiety; rather, studies indicate satiety primarily as a function of volume [60–64]. Both problems can be illustrated by comparing the amounts of different foods that provide 100 kcal (Fig. 6). Most consumers will likely consume more than 100 kcal of potato chips at a sitting (a typical 1.5-ounce bag of potato chips provides about 250 kcal) and considerably less than 100 kcal of broccoli (a typical half-cup serving of cooked broccoli is 27 kcal). (for additional discussion see [57,65–67]).

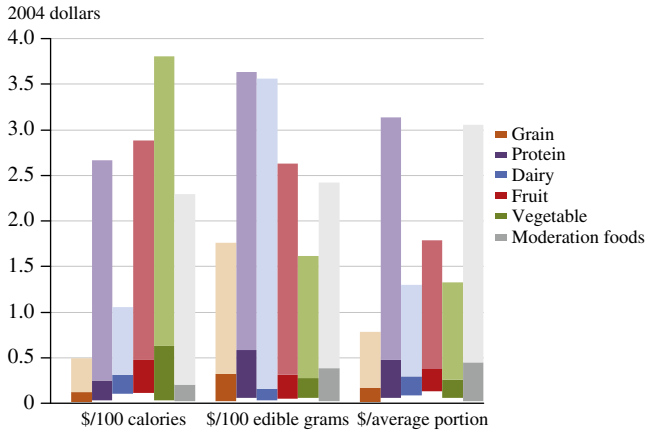

Fig. 7. Vegetables and fruits are cheaper than less-healthy foods when measured in dollars per edible gram or average portion. The metric used to measure the price of food could change the perception of the relative expense of healthy and less healthy foods. In this chart, the dark areas of each bar represent the price range for the cheaper half of the foods in the category, while the lighter areas are the price ranges for the higher-cost foods. White space at the bottom of the bars represents the start of the price range. Less healthy foods are foods that are high in sodium, added sugars or saturated fat, or did not contain foods from a food group. Source: Carlson, Andrea, and Elizabeth Frazão. 2012. Are Healthy Foods Really More Expensive? It depends on How You Measure the Price. *Economic Information Bulletin 96*. Washington, DC: Economic Research Service, USDA.

3.2.2. Price per edible weight of food

The price per edible weight of food reflects the price of putting the food on the plate—that is, after the peel, skin, seeds, shells, and bones have been removed, and the moisture and fat gain or loss due to cooking has been accounted for. For example, this metric would allow the consumer to compare the final cost of serving one pound of cooked chicken breast meat depending on whether it is purchased as raw boneless skinless chicken breast, raw chicken breast sold with the skin and bones, purchased as a pre-cooked rotisserie chicken, or some other forms. Although this metric is not currently used by consumers, this metric is used in the economic optimization model to estimate the types and quantities of foods in the USDA Food Plans [6,7] In addition, the edible weight forms the scientific basis of the food group recommendations in the *Dietary Guidelines for Americans*, and is translated into consumer-friendly cup- and ounce-equivalents in the USDA Food Patterns, found at www.ChooseMyPlate.gov. If this metric were more readily available to nutrition educators, purchasers of food for school meals, and policy makers, it would be significantly easier to estimate and compare the cost of meeting recommendations with different combinations of foods. If this metric were available to consumers in stores, it could provide a mechanism to compare prices of foods that are purchased in different forms.

3.2.3. Price per portion or unit of food

The price per portion, based on the amount typically consumed of each food, allows for the comparison of different foods. For example, parents can compare the cost of offering a cookie, pudding, fruit, or vegetable as a snack for their child [68]. When consumers make price comparisons of different items on a menu, they are also using this metric.

3.2.4. Comparing the cost of healthy and less-healthy foods using different price metrics

In this section we summarize recently-published research [57] that used all three price metrics to compare the prices of the same set of healthy and less-healthy foods. All foods reported consumed by adults in the 2003–04 National Health and Nutrition Examination Survey were priced using the CNPP Price Database, and then price distributions were estimated for various price metrics (Fig. 7). The sets of bars in Fig. 7 represent the distribution of prices using $ / 100 kcal, $ / 100 edible grams, and $ / average portion. The length of each bar represents the range of prices from the first to the 99th percentile; the 50th percentile is represented by the transition from the dark to the light-colored bars. The distribution of the less healthy foods (defined as foods high in saturated fat, added sugar and/or sodium, or foods that did not fit into a food group) is depicted by the gray bars, while the other colored bars represent grains, protein foods, dairy, fruits, and vegetables that are not high in saturated fat, added sugar and/or sodium.

For each food and each metric there is a wide range of prices, indicating that no matter how the price is measured, there are inexpensive and expensive options within each food group. Grains are consistently less expensive than the less-healthy foods regardless of the metric used. While the foods included in the grain group include some refined grains, the least expensive grains are cooked cereals, such as unsweetened oatmeal, which are a whole-grain.

Fig. 7 confirms that, when using price per calorie, fruits and vegetables are more expensive than less-healthy foods (that is, foods high in saturated fat, added sugars and/or sodium). However, those findings change when using the other metrics. Using the price per 100 edible grams, vegetables and grains are less expensive than less-healthy foods. When considering only the least-expensive foods within each group, low-fat dairy and fruits are also less expensive than the less-healthy foods. Using the price per average portion we find that vegetables, fruits, low-fat dairy, and grains cost considerably less than the less-healthy foods. There are also many protein foods, including plant-based protein foods that are less expensive than the less-healthy foods.

3.3. Interim summary

Prices of individual foods allow consumers to make decisions on which foods to purchase. Economic theory suggests that consumers will make decisions based on their budget, their familiarity with the food, their cooking skills, and how much they value the attributes of different foods, such as taste, nutrition, and convenience. Consumers are repeatedly told that healthy foods are more expensive, but evidence suggests that this perception is based on both the use of a misleading price metric as well as price increases associated with qualitative changes in fruits and vegetables, such as increased convenience and extended availability throughout the year—attributes that the market suggest consumers want. However, at a given point in time, healthy foods are not necessarily more expensive than less healthy foods. This suggests that the poor diet choices are being made either because consumers do not value healthy diets, or because they do not have adequate information to purchase and prepare healthy diets. Section 4 will look at how different food groups appear to be valued by consumers, while Section 5 will explore total expenditures and healthy diets as well as the importance of nutrition education to assist consumers in making dietary improvements.

4. Food budget shares and diet quality

An underlying principle of the economic modeling discussed in Section 3 is that consumers will allocate their scarce resource in a way that will maximize their utility (or satisfaction). This principle suggests that consumers will use the information available to them to choose foods that will satisfy their desires to not feel hungry, take pleasure in the consumption of the food, and derive the desired level of health benefits from the food, while simultaneously staying within their food budget. Thus, we can gain an understanding of how consumers value different types of foods by examining how they allocate their food budget. By comparing this allocation to the allocation associated with purchasing a healthy diet at the same budget level, we will show that consumers either do not have adequate information or do not place a high value on healthy foods.

A few studies use data from the Consumer Expenditure Survey to examine total expenditures on key categories of food such as fruits and vegetables. For example, Stewart, Blisard, and Jolliffe [69] find that the poor spend less on fruits and vegetables than the non-poor. As the authors of this study note, the limitation of these studies is that the actual quantities of fruits, vegetables, sweets or snack foods purchased or actually consumed are unknown. Thus, we cannot conclude whether income or total expenditure has a relationship with the actual consumption of food. Frazão et al. [32] and French et al. [70] also find that lower-income households spend less on fruits and vegetables, as well as on other foods such as sweets and snacks, than higher-income households. However, the ratio of the two categories is about the same for both income groups [70].

Following Frazão et al. [68] we use the Consumer Expenditure Survey's five food categories – bakery and cereal products, dairy, fruits and vegetables, animal-based protein, and miscellaneous foods – to look at the relationship between income and how households allocate their food-at-home budget between these five food categories. We control for differences due to household sizes by looking at 4-person households. Regardless of income, households tend to allocate their budgets in a similar manner. The smallest share of the food at-home budget, 8–11%, goes to dairy (Fig. 8). This is followed by bakery and cereal products (12–15%) and fruits and vegetables (fresh, frozen, canned, dried, or in the form of juice) (17–19%). Animal-based protein foods such as meat, poultry, fish, and eggs take up about 21–28% of the food at-home budget. The largest share of the food at-home budget (around 35%, regardless of income) is devoted to “miscellaneous foods”, which includes frozen meals and snacks; canned and packaged soups; potato chips, nuts and other snacks; condiments and seasonings such as olives,

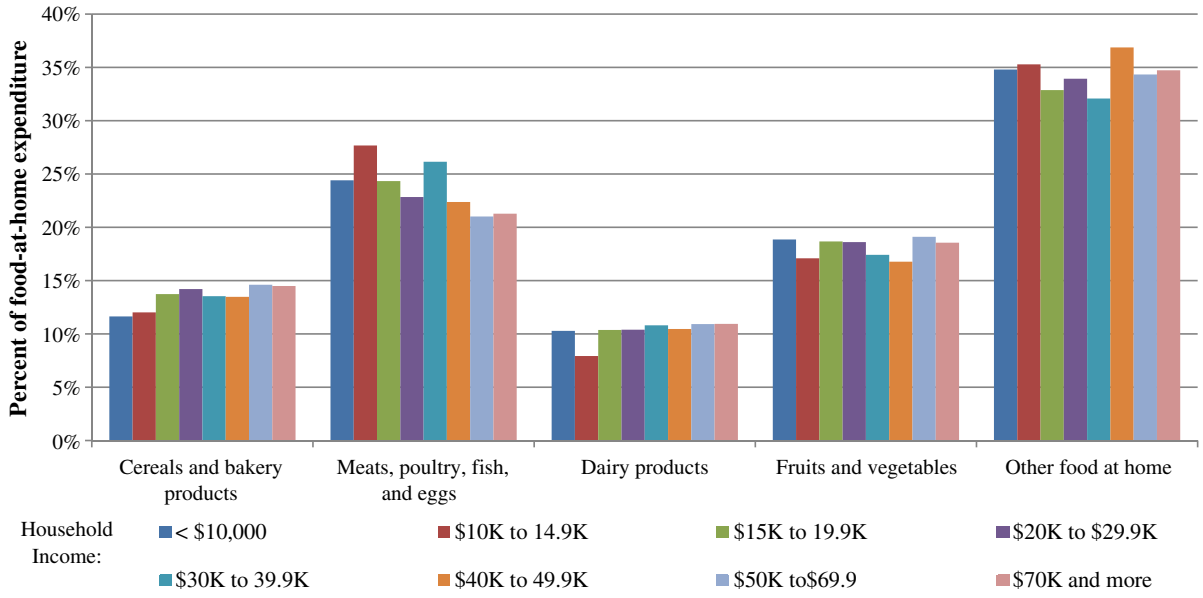

Fig. 8. Households allocate their food-at-home budget similarly regardless of income. Households spend more on "other food" than any other food group. Many of these foods are high in saturated fat, added sugars and/or sodium. All households spend less than 20 percent of their food budget on fruits and vegetables. Dietary guidance suggests that most Americans need to consume more fruits and vegetables and fewer foods represented in the "other foods". Source: data from Consumer Expenditure Survey.

pickles, relishes, sauces and gravies, and baking needs. These foods are often high in calories, fat, added sugars and/or sodium—food components and nutrients that the *Dietary Guidelines for Americans 2010* [2] recommends individuals should consume in lesser amounts.

That healthy diets need not cost much is demonstrated by the US Department of Agriculture Food Plans [6,7]. The Food Plans use an economic optimization model to define a diet that is as close as possible to current consumption yet meets the *Dietary Guidelines for Americans*, and are estimated at four expenditure levels. The lowest-cost Food Plan is the Thrifty Food Plan (TFP), which is used to set the maximum benefit in the Supplemental Nutrition Assistance Program (SNAP, formerly known as food stamps). All four budget allocations are similar, so we show the average budget allocation for the Low-Cost Food Plan in Fig. 9 (See appendix 4 of reference [6]). Also shown in Fig. 9 is an estimate of the actual food budget allocation using the same categories and prices as the food plans. Note that the food categories used in Fig. 9 are those used in the Food Plans and are slightly different than those shown in Fig. 8; the Food Plan budget share allocations include both food-at-home and food-away-from-home.[4]

The comparisons show that US consumers allocate their budget shares in a manner that is inconsistent with what would be needed in order to meet dietary recommendations. For example, the Food Plans allocate about 40% of the at-home food budget to fruits and vegetables, which is much more than the 26% consumers allocate. In contrast, the Food Plans allocate a considerably smaller share of the food budget to meat and meat alternatives and to fats and sweets, than consumers do (28% versus 48%). The budget shares allocated to grains and dairy products are consistent with the food plans, although dieticians argue that within these groups, Americans still need to shift to more whole grains and low-fat dairy products. Fig. 9 demonstrates that consumers can improve their diet quality by spending less on protein foods and fats and sweets, which might then allow them to spend more on fruits and vegetables without increasing overall food spending.

The studies discussed in this section demonstrate that no matter how much consumers spend on food, they allocate their food budgets in a similar way. These patterns deviate significantly from budget allocations that meet current dietary guidance. Economic theory would suggest that consumers do not place a high value on nutrition, given the way they choose to spend their money. However, this theory assumes that consumers have sufficient information to make an informed decision. In section 5 we return to the relationship between total food expenditure and diet quality from section 2, but focus more on the role of information in individual decision making.

5. Total food expenditure and diet quality

In Section 2 we demonstrated that higher-income households spend considerably more on food than lower income households, but their diets were not more nutritious. The explanation presented in Section 2 was that the higher-income households spend more on food-away-from home, which tends to be less nutritious than food at-home. Sections 3 and 4 demonstrated that even though healthy foods are not necessarily more expensive than less-healthy foods, consumers are not allocating their food budgets in a way that either demonstrates they value nutrition or that they have sufficient information to make an informed decision. In this final section we examine the relationship between total food expenditure and diet quality. We conclude that some Americans do purchase a healthy diet at the same expenditure level as others who purchase a poor diet.

We begin by examining a basic scatter plot of total food expenditure and diet quality (Fig. 10). This plot is generated by using the CNPP Food Prices Database to estimate the total daily food expenditure, based on the foods reported consumed by adult participants in NHANES 2003–04, the last year for which food prices are available. We also calculated the HEI-2005 scores for these same participants. Since the CNPP Food Prices Database prices all foods as if it were a food-at-home food, we follow Carlson et al. [71] and inflate the prices of foods that participants reported purchasing from away-from-home sources to more closely match the increased cost of purchasing food from these establishments.

[4] When estimating food prices, the food plans use the CNPP Food Prices Database and thus assume that all foods are purchased from retail food stores. However, the model (and thus the solution) covers the entire diet, including food-away-from home. Foods purchased from away-from-home sources are priced as if it were prepared at home, but the nutritional qualities and food group assignment are based on the food-away-from home foods. In other words, a salad purchased from a food away-from-home source is priced as if it had been purchased at a retail store, and its cost is included in the share of the budget allocated to fruits and vegetables. The data from the Consumer Expenditure Survey, however, covers only the foods purchased from stores (food-at-home), and completely ignores the salad purchase away from home.

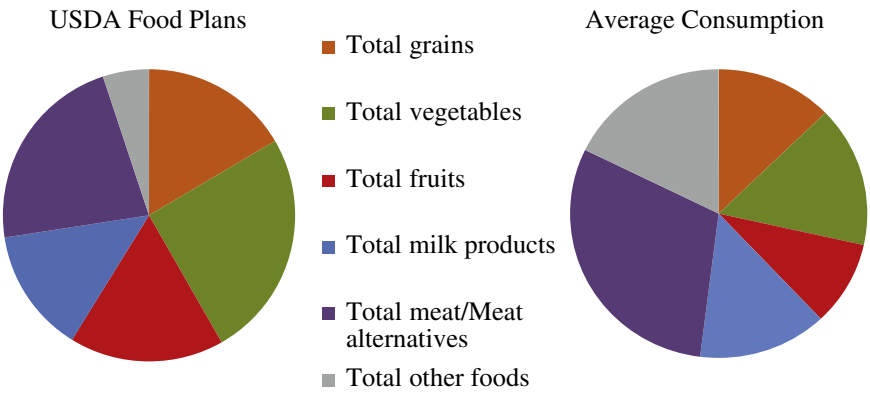

Fig. 9. Expenditure shares do not reflect current nutrition guidance. Americans who wish to consume a healthier diet could shift their food budget so that it is more in line with the USDA Food Plans. This means spending twice as much on fruits and vegetables, and less on "other foods", and protein foods. Source: Data from NHANES, CNPP Food Prices Database, and Carlson, Andrea, Mark Lino, and Thomas Fungwe. 2007. The Low-Cost, Moderate-Cost, and Liberal Food Plans, 2007. Alexandria, VA: U.S. Department of Agriculture, Center for Nutrition Policy and Promotion.

In the figure, note that there is no clear correlation between diet quality and daily food cost. Healthy diets are available at both the high and low end of the expenditure estimates. Similarly, poor diets can also cost a lot or a little. The scatter plot suggests that individuals who currently consume an unhealthy diet could choose a healthier diet at the same expenditure level as they currently spend on food. Other studies also find this [71,72].

While illustrative of the lack of correlation between diet quality and diet cost, Fig. 10 does not take into account the complex environment in which consumers make decisions. Carlson et al. [71] use the same data in an economic model to examine the relationship between diet cost and diet quality. They conclude that the relationship is limited, and there are more effective ways of improving diet quality than simply increasing expenditure. These include balancing energy intake throughout the day by eating more calories at breakfast and less at dinner, choosing low-calorie snacks such as fruits and vegetables, and eating the same way during the work week as on the weekend, and making healthier choices when eating out. They also find that consumers who exhibit other behaviors associated with improved health, such as regular exercise and not smoking, tend to have healthier diets, but spend more on food.

Similar behavior changes as well as other recommendations have been used in case studies where nutrition educators work with households to improve their diets and control the cost. One of the first studies was by Mitchell et al. [73] who worked with higher-income families who needed to switch to a low-fat diet. Since cost was not a barrier for these families, the education study simply tracked weekly grocery expenditures, without providing guidance on budget-friendly foods. While the children's fat intakes decreased in the treatment group, there was no difference in costs between the control and treatment groups. In another study of 31 families with obese children receiving a behavior modification intervention, daily food costs dropped after a year while consumption of nutrient dense foods increased [74]. Adopting a Mediterranean diet did not change the total diet cost among Canadian women who had previously consumed a less-healthy diet [75]. In a focus group study of 92 women, Wiig and Smith [76]

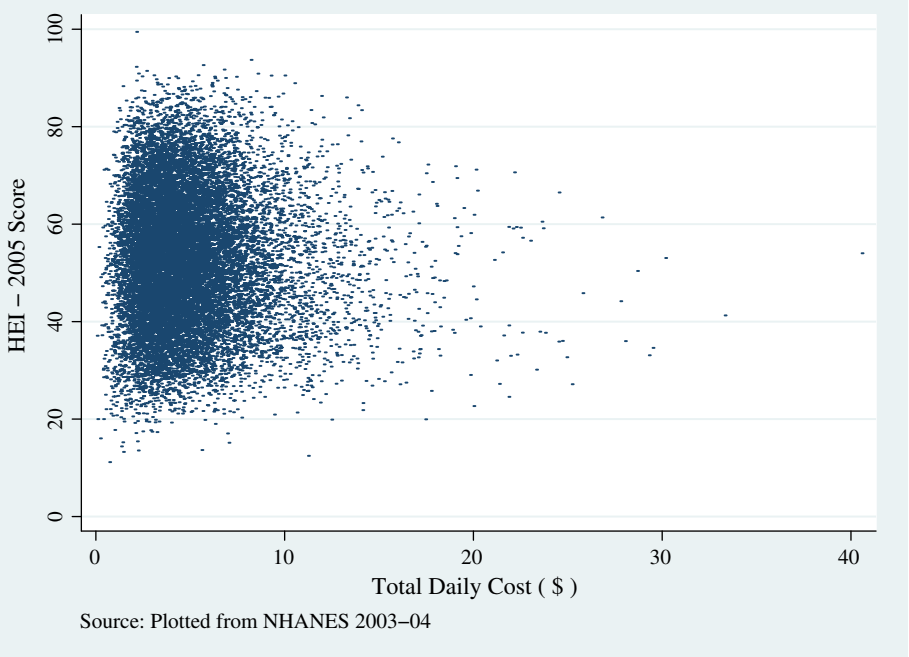

Fig. 10. Relationship between HEI-2005 and daily food expenditure is limited. Each point represents one adult participant in NHANES. Some individuals spend a lot on food and still fail to purchase a healthy diet. Others spend well below the mean and obtain a healthy diet (high HEI-2005 score).

confirm that meat has a higher priority for low-income women than fruits and vegetables, and these women lacked skills in food budgeting and meal preparation as well as nutrition knowledge. Cortés et al. [77] worked with 20 low-income Hispanic families where each household received 3–5 home visits and a grocery store tour. After this intensive education, study participants were able to lower their food costs and make improvements to their diets. Part of this study was to learn which budget-friendly healthy foods would be most appealing to this population. These studies show that households in the United States and Canada are able to improve their diet quality without increasing their food costs, but intervention from nutrition educators and dieticians was required.

This final section demonstrates that spending more on food does not necessarily lead to healthier diets, and that healthy diets are purchased at a variety of expenditure levels. Studies involving educational programs focusing on improving the overall diet quality of individuals or families appear to simultaneously lower food costs. This is likely because consumers reduce the spending on foods that offer little nutritional value, and fill the gap with healthier foods. For low-income consumers there is likely a need for specific education aimed at identifying low-cost foods that are both nutritious and satisfy the other qualities that food offers such as taste.

6. Conclusions

This paper has examined the possible linkages between food prices, diet quality and energy balance. The evidence shows that while higher-income households spend considerably more on food than lower income households, their diet quality is not improved in a meaningful manner. On average, Americans consume diets that need improvement. Economic theory suggests that either consumers do not value the nutrient quality or they lack sufficient information to make healthy choices at the same expenditure level as their current food budget. Consumers believe that healthy food is more expensive than less-healthy food, but this may be because of what they are told by experts, the media, their own experiences, and their social networks. In fact, healthy foods are not necessarily more expensive than less-healthy foods, but the way the price metric makes a difference in this perception. Americans who wish to consume a healthier diet need to reallocate their current food budget by spending less on protein foods and foods of limited nutritional value and more on fruits and vegetables. Budget allocations on grains and dairy foods are adequate, but consumers need to shift towards low-fat dairy (and calcium fortified dairy substitutes) and whole grain food choices. Finally, small scale studies indicate that Americans can make changes to their diets without increasing their expenditures, but they may need more guidance to make these changes. The key finding is that healthy foods are affordable, but there is a considerable need for education and other mechanisms such as making different price metrics available to consumers, and promoting healthy eating as a way to save money.

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