Estimating Food Prices for NHANES and the USDA Food Plans

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Selected Paper prepared for presentation at the 2019 Agricultural & Applied Economics Association Annual Meeting, Atlanta, GA, July 21 – July 23

The Findings and Conclusions in This Preliminary Publication Have Not Been Formally Disseminated by the U. S. Department of Agriculture and Should Not Be Construed to Represent Any Agency Determination or Policy. This research was supported by the intramural research program of the U.S. Department of Agriculture, Economic Research Service.

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Background: The 2018 farm bill states that ‘‘... by 2022, and at 5-year intervals thereafter, the Secretary [of Agriculture] shall reevaluate and publish the market baskets of the Thrifty Food Plan based on *current food prices*, food composition data, consumption patterns, and dietary guidance.’’ (Italics added). In preparation for the Food Plan estimation, USDA plans to make the Purchase to Plate Food Price Tool (PPFPT) available to USDA IRI users to calculate food prices for the What We Eat in American/National Health and Nutrition Examination Survey (WWEIA/NHANES) using scanner data.

Understanding how and why consumers choose the foods they do is key to understanding why some choose healthy foods, and others choose less healthy options. Consumers use many factors to select food including how it tastes, how hungry they feel and how satisfied the food will make them feel. Consumers also factor in the price of the food, and the total amount they spend on food. Americans spend about half of their total food budget (Kuhns, 2018) to purchase about 70 percent of their food by weight and energy (calories) from retail stores. Since this is such a large portion of American’s food consumption, understanding the decision-making process of consumers in the retail setting is key to understanding the food choices Americans make.

To study the relationship between prices and food choices, economists use a variety of data sources including the ERS Food Expenditure Series (Okrent, et al., 2018), retail and household scanner data, and the Quarterly Food at Home Prices Database (QFAHPD) (Todd, et al., 2011, Todd, et al., 2010). In addition to these sources, researchers use dietary recall data such as What We Eat in America/National Health and Nutrition Examination Survey (WWEIA/NHANES) to study issues such as what Americans eat, what nutrients the food provides, how closely the total intake aligns with dietary guidance, and, the relationship between health behaviors and chronic diseases. Combined with the Flexible Consumer Behavior Survey (FCBS) (Restrepo, 2019), researchers can examine the relationship between what Americans know about food and nutrition, and how they use the information to make their food choices.

Data that combines the 24-hour dietary recall (food intake) with food prices or expenditures are limited. The Food Purchase and Acquisition Survey (FoodAPS) (Page, et al., 2018) contains all foods purchased or acquired by study participants and the price paid, but not food intake by individuals. The Center for Nutrition Policy and Promotion (CNPP) Food Prices Database (Carlson, et al., 2008, Center for Nutrition Policy and Promotion USDA, 2009) is a list of prices for the foods reported consumed in a 24 hour period by NHANES participants in the 2003-4 wave. These data are no longer current and do not allow researchers to use subsets of the scanner data to meet individual research needs.

The Purchase to Plate Food Price Tool (PPFPT) is the first method which allows researchers to estimate retail food prices for foods reported consumed by NHANES participants, using all or any subset of the IRI scanner data. To conduct research and inform policymakers about the costs of consuming a healthy diet, we need data that contains both prices and detailed nutrition information. The PPFPT is the first research tool that provides this essential information.

Data: To estimate prices we relied on three data sources: What We Eat in America/National Health and Nutrition Examination Survey (WWEIA/NHANES) (Centers for Disease Control and Prevention (CDC), et al., 2011-12) 2011-12, the USDA Food and Nutrient Database for Dietary Studies (FNDDS) (Martin, et al., 2014) 2011-12, and IRI InfoScan 2013 (Levin, et al., 2018, Muth, et al., 2016). We used the WWEIA/NHANES data to develop a list of foods consumed by Americans in a 24 hour period, the FNDDS to develop the types and quantities of purchasable ingredients required to prepare the foods, and the IRI InfoScan data as the basis for prices. The FNDDS is a system of tables, including recipes, created by USDA to estimate the nutrient content of foods reported consumed by WWEIA/NHANES participants. We used the Purchase to Plate Crosswalk (PPC) (Carlson, et al., 2019) to transition between the FNDDS and the IRI InfoScan data. The PPC includes a link between the FNDDS and the food items (identified at the UPC level) in the IRI data as well as conversion factors to convert the purchased weight of each food item in the IRI data to the consumed weight in the FNDDS.

Methods: Methods for the price tool involve four steps: (1) identify foods that require a price, (2) choose a price calculation method, (3) calculate the price of ingredients using the IRI scanner data, and (4) calculate the price of the food.

1. Identify foods: We identified 3,518 foods that were reported consumed more than ten times by all NHANES participants, using both the 1 and 2 day samples. Since a few other foods are simply modifications of these foods, the total number of foods covered by the price tool is 3,542 foods. This list covers 98 percent of the foods reported consumed by NHANES participants.

2. Choose a price calculation method: Since USDA primarily developed the FNDDS recipes in order to calculate the nutrient content, rather than prices of food, we modified most recipes for price estimation. Many foods, such as fresh fruit, crackers, bread, milk, frozen seafood, and condiments did not require a modified recipe, while others required us to adapt the recipe to make use of convenience items such as bottled sauces, packaged mixes, and prepared foods. Each recipe is scaled to make 100 grams of the food.

3. Calculate the ingredient price: The ingredient price is the average price per gram of all UPCs linked to the ingredient in the PPC. Researchers have the option to use a subset of the IRI data, or all of the data to develop national average prices.

4. Calculate the food price: The food price is the sum of all ingredient prices multiplied by the amount of each ingredient in the recipe. For single ingredient foods such as milk, the price is the price of 100 grams of the ingredient.

Results Using sales data from over 350,000 products in the 2013 IRI retail scanner data, InfoScan, the Purchase to Plate Food Price Tool (PPFPT) calculates a price for 3,542 foods of the 5,734 foods reported eaten by WWEIA/NHANES participants. Foods with prices represent 97 percent of the food and beverages (measured in grams) reported eaten by participants in the WWEIA/NHANES 2011-12 wave. The foods and beverages without prices are those that were reported less than 10 times by study participants.

The PPFPT also allows researchers to use a subset of the InfoScan Data, and The IRI Consumer Network (Sweitzer, et al., 2017). Prices are only calculated for foods when there is enough information in the subset to calculate a price for each ingredient in the food recipe. As a result, when researchers use a subset of the data, the tool estimates fewer prices. For example, we used the PPFPT to calculate prices using The Consumer Network, and prices by the type of store where the food was purchased. Table 1 shows the coverage in terms of the number of foods reported consumed in WWEIA/NHANES, the number of eating occasions for each food in WWEIA/NHANES, and the total grams of food and beverages reported eaten by WWEIA/NHANES participants.

Table 1: Coverage of the Purchase to Plate Food Price Tool

	Number of Foods (Percent)	Eating Occasions (Percent)	Grams of Food (Percent)
Transaction Source			
InfoScan	60	96	97
The Consumer Network	57	94	96
Type of Store			
Grocery	60	96	97
Club and Mass Market Stores	56	94	96
Defense Commissary	55	93	96
Convenience, Drug and Dollar stores	50	91	93

Source: Calculated by the authors using What We Eat in America/ National Health and Nutrition Examination Survey (WWEIA/NHANES) 2011-12 and the Purchase to Plate Food Price Tool. All calculations control for the complex sample design and use the dietary recall weights for the 2 day sample.

We also used the food prices to estimate the annual per capita food-at-home expenditure of WWEIA/NHANES participants, and compared it to the ERS Food Expenditure Series. Following the USDA Food Plans (Carlson, et al., 2007), we assumed that 15 percent of the food purchased is not eaten. In addition we applied an average sales tax of 2.2 percent for food and non-alcoholic beverages, and 7.1 percent for alcoholic beverages, following the ERS Food Expenditure Series. Despite using completely different methods and data sources, the annual average estimate using the PPFPT is only $192.04 lower than the ERS Food Expenditure Series (Table 2).

Table J: Estimated annual per capita food at home expenditures

	Mean	std error	95% Confidence Interval	
			Low	High
ERS Food Expenditure Series ($)	2139.45	0.00	2139.45	2139.45
Purchase to Plate Food Price Tool ($)	1947.41	46.34	1849.63	2045.19
Difference				
Amount ($)	192.04		289.81	94.26

Note: Purchase to Plate Price Tool (PPFPT) estimates assume 15 percent of food purchased is not eaten. Both PPFPT and ERS Food Expenditure Series estimates assume average sales tax of 2.2 percent for food and non-alcoholic beverages, and 7.1 percent for alcoholic beverages. Source: PPFPT estimate is based on WWEIA/NHANES 2011-12, IRI InfoScan 2013. Estimate accounts for complex survey weights and applies 2 day sample weights, as well as the same average sales tax applied in the ERS Food Expenditure Series: "Normalized food expenditures by all purchasers and household final users" (Elitzak, et al., 2019)

Conclusion. The Purchase to Plate Food Price Tool (PPFPT) will be available to researchers using USDA's purchased IRI scanner data. The tool allows researchers to estimate prices for foods reported consumed by participants in the 2011-12 WWEIA/NHANES survey. Researchers have the option to use any subset of the IRI data, as long as the subset includes at least one UPC for each ingredient used to prepare the food.

Researchers need to be aware of the limitations with both the price tool and the underlying data. First, the price tool estimates average prices, which are not the prices that consumers face in the grocery store. Prices are based on the type of store, package size and brands that consumers choose. Taken individually, prices may not make sense and researchers are advised not to draw conclusions based on the prices of individual food items (e.g. different flavors of yogurt) but examine groups of foods (e.g. yogurt). In addition, both InfoScan and The Consumer Network have limitations that impact price estimation. For example, when using the PPFPT with InfoScan data, some private label data are not included because not all stores release their private label data at the UPC level. While researchers have access to expenditures for these private label items, the quantity is not available and a price cannot be calculated. When using the tool with The Consumer Network, researchers should note that the 2013 PPC and PPFPT are designed for InfoScan, rather than The Consumer Network. As a result not all UPCs in the Consumer Network are included, and the random weight purchases made by consumer network participants are not included. Finally, since the 2013 PPFPT's creation, there have been some changes to the IRI data that may impact price calculations. Statistics in this report reflect these changes as of April, 2019. Researchers should consult the three IRI reports (Levin, et al., 2018, Muth, et al.,

2016, Sweitzer, et al., 2017) and the previous PPC report (Carlson, et al., 2019) to determine the suitability of the data for price estimates for the individual research question.

The PPFPT will allow researchers to examine the relationship between food choices, nutrition knowledge, and food prices because it ties the extensive data in WWEIA/NHANES and the FCBS to food prices. In addition the Purchase to Plate Food Price Tool allows researchers to estimate the cost of a healthy diet using updated food prices. Future updates to the tool will draw from more of the IRI data.

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