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Socioeconomic Determinants of Expenditures on Fortified and Unfortified Fruit Juice

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SOCIOECONOMIC DETERMINANTS OF EXPENDITURES ON FORTIFIED AND

UNFORTIFIED FRUIT JUICE

BY

COLE SELLNOW

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SOCIOECONOMIC DETERMINANTS OF EXPENDITURES ON FORTIFIED AND

UNFORTIFIED FRUIT JUICE

COLE SELLNOW

This thesis is approved as a creditable and independent investigation by a candidate for

the Master of Science degree and is acceptable for meeting the thesis requirements for

this degree. Acceptance of this does not imply that the conclusions reached by the

candidate are necessarily the conclusions of the major department.

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ABBREVIATIONS

Body Mass Index (BMI)

Food and Nutrient Database for Dietary Studies (FNDDS)

National Household Food Acquisition and Purchase Survey (FoodAPS)

Supplemental Nutrition Assistance Program (SNAP)

United States Department of Agriculture (USDA)

Women, Infants, and Children (WIC)

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ABSTRACT

SOCIOECONOMIC DETERMINANTS OF EXPENDITURES ON FORTIFIED AND

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As of 2019, fruit beverages comprise an \$11 billion industry in the US (Juice Production
in the US 2019). There has been a recent push for fortification of fruit juices due to rising
consumer health concerns such as obesity and high sugar consumption. Additionally, the
2015-2020 Dietary Guidelines for Americans recommend limiting fruit beverage
consumption (Dietary Guidelines Advisory Committee 2020). While there is a rich set of
literature analyzing determinants of fruit beverage demand, there is a lack of research
analyzing which factors drive consumer expenditures on fortified and unfortified fruit
juices (Yen *et al.* 2004; Storey *et al.* 2006; Zheng and Kaiser 2008; Okrent and MacEwan
2014). In an evolving industry, an understanding of the determinants of fruit juice
expenditures by fortification status is essential to both the industry's ability to effectively
market their products and for policymakers to improve the health of US households.

The purpose of this study is to analyze the sociodemographic determinants of US
household expenditures on fruit juice by fortification status. Data analysis is conducted
using the National Household Food Acquisition and Purchase Survey (FoodAPS).
Analytical methods applied in this study include descriptive statistics and double hurdle
models. Descriptive statistics compare fortified and unfortified fruit beverage purchases

and expenditures across sociodemographic characteristics. Double hurdle models are estimated to determine how income, health, shopping, and sociodemographic characteristics affect households' decision to purchase, and given purchase, expenditures on each fruit juice category.

Findings from this research are applicable to both industry and policymakers. Identifying consumer profiles for each fruit beverage category provides industry with a deeper understanding of their target markets. Additionally, results provide policymakers with the insight needed to develop effective food and nutrition programs.

INTRODUCTION

The fruit juice market is a large market within the United States, coming in at over $16.6 billion in sales for 2018 (Harfmann 2018). However, fruit juice sales in the United States are declining year over year, forcing firms in the industry to diversify their offerings with healthier products such as fruit juice fortified with Omega-3, fiber, bioactive compounds, vitamins and/or probiotic bacteria (MarketWatch 2019).

Although the fruit juice market in the United States has been shrinking, the worldwide market is expecting steady future growth with a compound annual growth rate of 3.17 percent through 2024 (MarketWatch 2019). These worldwide growth trends establish the need for a better understanding of the sociodemographics of the fruit juice market for two main reasons. First, fruit juice firms in the United States need to stop the contraction of their market size. Second, firms outside of the United States market need to grasp the demographics of their customers in order to sustain their growth, as well as to ensure they are offering the optimal product mix. This study is conducted using United States data; the methods are globally applicable.

Supply and demand drivers exist in all industries and can be used to explain the changes the fruit juice market is experiencing. One of these changes is that consumers in the fruit juice industry are shifting their demand to products with less sugar content and more functional ingredients (Scott 2010). Another is that offering more functional fruit juice products allows some large firms in the industry, such as Coca-Cola and Nestle, to meet their social sustainability plans (Coca-Cola 2019; Nestle 2018).

There are a variety of studies and papers that focus on identifying customer demographics in the fortified food and fruit juice categories (Verbeke 2005; Hirvonen *et al*. 2012; Cirino *et al*. 2014; Bielemann *et al*. 2015; Leschewski and Weatherspoon 2016; Sicinska *et al*. 2018; Jahn 2019; Temesi *et al*. 2019). These studies indicate income, health shopping and sociodemographic characteristics are determinants of fortified food and/or fruit juice purchases and expenditures. However, no previous literature looks at fortified fruit juice in combination.

The purpose of this study is to analyze the sociodemographic determinants of US household expenditures on fruit beverages by fortification status. Bivariate and multivariate analyses are used to identify the sociodemographic factors that influence households' decision to purchase, and given purchase, the level of expenditure on fortified fruit juice, unfortified fruit juice, and all fruit juice. This study adds to the existing literature as the first analysis of fortified fruit juice, which is missing from both the fruit juice literature and the fortified food-and-beverage literature.

BACKGROUND

Food fortification is a differentiating factor that may sway whether a potential consumer purchases a good, and if so, what they are willing to pay for the good. While much research has been done on different types of fortified foods, current literature lacks in understanding the sociodemographic determinants of fortified fruit juice purchases versus those of unfortified fruit juice purchases.

History and Acceptance

It is vital to examine the history of how food fortification came to be and its current acceptance in order to understand its role as a differentiating factor of purchase. The first case of food fortification was an effort to prevent endemic goiter in schoolchildren with the use of iodine, which created the market for iodized salt in the early 1920s (Bishai 2002). The trend of holes in markets have led to food becoming fortified (Bishai 2002). Similar to the case of iodized salt, Bishai (2002) discusses how fortification of milk with vitamin D "was driven primarily by the awareness-raising efforts of the public sector and the medical professionals who were themselves spurred by food industry advertising" in the 1930s. The trend continued in the following decade as vitamin B and iron were added to flour and bread. However, major market entrances in food fortification then slowed until the 1980s and 1990s. During this period of the 1980s and 1990s there was yet again a spike in food fortification, which became a period that Bishai (2002) referred to as "the US Food Industry's Calcium Craze." During this period, governmental research drove market demand for increased intake of calcium. In his analysis of the history of food fortification, Bishai (2002) found that success of food fortification in the United States depended on the cooperation between advertising innovation within the industry, appropriate governmental action, private health care providers giving guidance on the topic, and public health departments deploying strategic campaigns.

Current acceptance of fortified foods plays an important role in a consumer's fortified and unfortified fruit juice purchase decisions. Psychological processes inherently play a

role in consumer's decision to purchase certain products and when acceptance of food fortification increases, the demand of fortified foods increases (Jahn 2019). When a large number of Danish consumers were surveyed, it was found that some of the psychological effects that impact a consumer's purchase decision for products fortified with vitamin D are perceived personal benefit, problem awareness, and appropriateness (Jahn 2019).

There are also sociodemographic and cognitive determinants of accepting fortified foods. In Verbeke's (2005) extensive literature review where the objective of his paper was to explore determinants of purchase for fortified foods, he found a higher likelihood of acceptance of functional foods among female and older consumers, especially when consumers were willing to trade off some taste benefits for the health benefits. Additionally, consumers who believed in the health benefits of fortified foods were more likely to accept these fortified foods (Verbeke 2005). Verbeke (2005) further finds that consumers most likely to accept functional foods can be classified as "benefit believers" who may have dealt with family illnesses.

Determinants of Fortified Food Purchase and Expenditures

Determinants of fortified food purchase and expenditures are a key group of variables in this study. When analyzing relevant income variables, average monthly household income was only a significant determinant in one study. Temesi *et al.* (2019) analyzed the perceived likeness of health effects as a new determinant for purchasing functional foods and found that for households with below average incomes, the only economic factor that matters was the perceived value of the combination between the original food being

fortified and the functional ingredient, which is thereby making the food fortified. In contrast, Verbeke (2005), Hirvonen *et al.* (2012), Cirino *et al.* (2014), Bielemann *et al.* (2015), Sicinska *et al.* (2018), found income has no significant impact on the purchase likelihood of or level of expenditure on fortified foods.

The region in which a household lives, Northeast, Midwest, South, or West, does not appear to have a positive or negative significant effect on the purchase determinants or expenditures on fortified foods (Verbeke 2005, Hirvonen *et al.* 2012, Cirino *et al.* 2014, Bielemann *et al.* 2015, Sicinska *et al.* 2018, Temesi *et al.* 2019). While the region in which a household lives is not significant, being in either a rural versus urban area does have an impact of fortified food purchases. Temesi *et al.* (2019) analyzed the perceived correspondence of health effects as a new determinant for purchasing functional foods and found that living in a city, versus in a rural area leads to a higher awareness of fortified products and placement of higher importance on the health image of fortified foods.

A common determinant playing a role in the purchase of fortified foods is gender. In the studies conducted by Verbeke (2005), Cirino *et al.* (2014), Bielemann *et al.* (2015), Temesi *et al.* (2019), women were more likely to purchase fortified foods at varying levels, depending on each individual study. Women are more likely to accept and purchase fortified foods, even when they taste worse than other similar offerings (Verbeke 2005). In Cirino *et al.*'s (2014) In a Brazilian study on micronutrient fortification, women were more likely to purchase these types of fortified foods. Similar

to Temesi *et al*. (2019), Bielemann *et al*. (2015) found that 22 and 23-year-old women were more likely than their male counterparts to purchase "ultra-processed" foods, which in this study is any food that has been altered or fortified. The same results were found when Temesi *et al*. (2019) analyzed the perceived correspondence of health effects as a new determinant for purchasing functional foods. In these results, women were more likely to purchase fortified foods when they saw the health benefit of the functional ingredient.

Temesi *et al*. (2019) also analyzed educational levels and found that those who had a high-school education, or only some high-school education, placed significant importance on the perceived fit of the combination of the fortified carrier food, also known as the original food which became fortified, and the fortification ingredient. Likewise, Cirino *et al*. (2014) further found a positive association between education level and purchase of fortified foods. Bielemann *et al*. (2015) also found that the highest level of education, which was defined as equal to or greater than twelve years of education, had a significant impact on the consumption of processed foods. In young adults it was found that the higher the level of education, for instance a bachelor's or master's degree, significantly increased the consumption of fortified foods (Bielemann *et al*. 2015).

The majority of studies considered found age to be a significant predictor of the purchase decision or expenditure level for fortified foods (Verbeke 2005; Cirino *et al*. 2014; Hirvonen *et al*. 2012; Sicinska *et al*. 2018; Temesi *et al*. 2019). Verbeke (2005) found

that teens, adults, and seniors were all more likely to accept functional foods regardless of their taste (Verbeke 2005). Cirino *et al.* (2014) found that young, Brazilian adults are significantly more likely than other older age groups to purchase fortified foods. The same results were found when Temesi *et al.* (2019) analyzed the perceived correspondence of health effects as a new determinant for purchasing functional foods. In these results, 18-to-29 year olds were more likely to purchase fortified foods when they were aware of the fortified product versus not having that awareness (Temesi *et al.* 2019). Hirvonen *et al.* (2012) found that toddlers and children were more likely to consume fortified foods than their adult counterparts (Hirvonen *et al.* 2012). When toddlers, children and teens were grouped into the category of adolescents in Sickinska *et al.*'s (2018) study of Polish children and adults, they were more likely than the adult group to voluntarily consume fortified foods and beverages.

There were a large number of variables that had no significant impact on purchasing fortified foods or beverages in the studies which were analyzed. Being a WIC household, SNAP household, checking nutritional labels, a respondents' health status according to their BMI, shopping characteristics, race/ethnicity, region, marital status, and purchasing habits (as listed in Table 2) were not significantly associated with household purchases of fortified foods and beverages (Verbeke 2005, Hirvonen *et al.* 2012, Cirino *et al.* 2014, Bielemann *et al.* 2015, Sicinska *et al.* 2018, Temesi *et al.* 2019).

Most health characteristic determinants also did not have a significant effect on the purchase determinants or expenditures of fortified food, with Hirvonen *et al.*'s (2012)

research being the only study in which nutritional fact-checking, BMI, enrolling in nutritional education classes, searching for nutritional information online, or dieting contributed significantly. In Hirvonen's study of fortified foods among the adults of Finland, he interestingly found a link between higher BMIs and the purchase of fortified foods. This study was conducted in five regions of Finland and included men and women between the ages of 25 and 64 (Hirvonen *et al*. 2012).

Determinants of Fruit and Vegetable Juice Purchase and Expenditures

The literature is mixed on how income affects fruit and vegetable juice purchase and expenditures decisions. Drewnowski and Rehm (2015) found many positively correlated variables to both whole fruit consumption and the consumption of 100 percent fruit juice. An interesting finding from this study is that while total fruit and whole fruit consumption are generally at higher levels among those households with higher incomes relative to lower incomes, the purchase and consumption of 100 percent fruit juice was higher among lower income households. In an alternative literature, several studies on beverage demand report that fruit juice demand increases with income (Kinnucan *et al.* 2001; Yen *et al.* 2004; Zheng *et al.* 2008; Smith *et al.* 2010; Dharmasena & Capps 2012; Okrent & MacEwan 2014). Szathvary and Trestini (2014) found that in their hedonic analysis of health claims for fruit beverages, consumers are willing to pay more for health claims. Furthermore, Carol Byrd-Bredhenner (2017) found that households who have any member in the WIC program are less likely to meet their fruit intake and less likely to receive enough nutrients from the consumption of fruit juice. In contrast, Leschewski and Weatherspoon (2016) found that participating in WIC increases the likelihood of paying a

premium for fruit juice. Whether a household was in the SNAP program or not had not been included in prior studies.

Considering health characteristic determinants, a hedonic analysis of Australian consumers found that consumers are willing to pay a premium for nutritional information when purchasing fruit juice (Weemaes, Hans, and Riethmuller 2001). Other determinants, such as body mass index (BMI), searching for nutritional information online, and dieting did not significantly affect the purchase of or the level of expenditures on fruit juice (Weemaes, Hans, and Riethmuller 2001).

Multiple studies further found that when it comes to convenience, households are willing to pay a premium for fruit juice. Weemaes, Hans, and Riethmuller (2001) found a positive, significant effect of convenient locations and expenditure levels on fruit juice. Leschewski and Weatherspoon (2016) found similar results with conveniently located stores increasing the likelihood of paying premiums for fruit juice. This study also found that shopping at a discount store decreases the likelihood of paying premiums for fruit juice (Leschewski and Weatherspoon 2016). Volpe and Okernt (2012), Caspi *et al.* (2016), and Stern *et al.* (2016) all also looked the types of stores at which customers shopped, how frequently they did so, and the variances in food quality by store type. What was found is that there tends to be more nutritious foods, including juices, at traditional stores than at convenience stores (Volpe and Okernt 2012, Caspi *et al.* 2016, and Stern *et al.* 2016).

When Lindstrom (2001) analyzed socioeconomic variance in the consumption of fruit, vegetables, and fruit juice he found that while men were no more likely to purchase fruit and vegetable juices when their socioeconomic status increased, women were more likely to do so. Also looking at gender as a determinant of purchase for fruit juice, Demydas (2011) found that women are more likely than men to purchase fruit juice. Demydas (2011) also found that single individuals are more likely to consume more fruit juice than individuals with other relationship statuses. Drewnowski and Rehm (2015) analyzed US children and adults to determine where the source of their fruit intake, considering whole fruits and 100% fruit juice. Drewnowski and Rehm (2015) found that the highest 100% fruit juice consumption was among racial and ethnic minorities. In this same study, they found that individuals with higher levels of education had higher total fruit and whole fruit consumption, which is consistent with results found for the determinants and expenditure levels of fortified foods and beverages (Drewnowski and Rehm (2015)

The majority of studies considered found age to be a significant predictor of the purchase decision or expenditure level for fruit juice with Weemaes Hans, and Riethmuller (2001), Demydas (2011), Drewnowski and Rehm (2015), Herrick *et al.* (2015), Byrd-Bredbenner *et al.* (2017), and Auerbach *et al.* (2018) all finding significant effects of age in their studies. Drewnowski and Rehm (2015) found that while 100 percent fruit juice is highest among US children of all the age groups, it declines sharply with age. It should be noted that their study did not include any children under four years old. When Byrd-Bredbenner *et al.* (2017) analyzed the fruit gap in the United States and found that children who are drinking fruit juice within the USDA recommended Dietary Guidelines come closer to

their recommended daily intake of nutrients. Herrick *et al.* (2015) conducted a unique

study in that they only looked at the youth in the United States. Their results showed that

34% of daily fruit intake for children between the ages of 2 and 19 comes from 100%

fruit juice. Lastly, Weemaes, Hans, and Riethmuller (2001) found that juices specifically

marketed towards children incur a 5.5 cent premium compared to standard labeled juices.

Some variables that did not have a significant impact on the purchase determinants or

expenditures for fortified foods, also did not have a significant impact on the purchase

determinants or expenditures of fruit and vegetable juices. These variables include: BMI,

taking nutritional-education classes, searching for nutritional information online, dieting,

the household's region of the United States (Northeast, Midwest, South, and West), the

number of trips a household takes to the store, marital status, and place of birth

(Weemaes, Hans, and Riethmuller 2001, Volpe and Okrent 2012, Drewnowski and Rehm

2015, Herrick *et al.* 2015, Leschewski and Weatherspoon 2016, Caspi *et al.* 2016, Stern

et al. 2016, Byrd-Bredbenner *et al.* 2017, and Auerbach *et al.* 2018).

CONCEPTUAL FRAMEWORK

Traditional consumer demand theory serves as the basis of the theoretical framework for

this analysis. However, in this study the household is categorized as a single unit, which

collectively makes food purchase and expenditure decisions. Following Davis (1983),

this study expands traditional consumer demand theory to include factors other than

income that may affect consumer demand such as age, gender, race, preferences,

education, and so forth. The demand function for fruit juice, whether fortified or unfortified, is generalized in the following equation,

$$Q_{fj} = F(I, H, S, D)$$

where: Q_{fj} is household expenditure on fruit juice, I represents household income, H represents household health characteristics, S is a vector of household shopping characteristics, and D represents household sociodemographic characteristics. These sets of variables are further expanded and defined in Table 1 below.

The income variables, including household income and food assistance program participation, are informed by traditional consumer demand theory. Other variables included in the food and beverage literature based upon adapted demand theory are number of trips to a store, store type, region, race, ethnicity, gender, education, marital status, household age composition, and place of birth (Patch *et al.* 2005, Verbeke 2005 , Hirvonen *et al.* 2012, Cirino *et al.* 2014, Özen *et al.* 2014, Bielemann *et al.* 2015, Drewnowski and Rehm 2015, Herrick *et al.* 2015, Mesirow and Welsh 2015, Leschewski and Weatherspoon 2016, Byrd-Bredbenner *et al.* 2017, Sicinska *et al.* 2018, Jahn 2019, Temesi *et al.* 2019).

Table 1. Description of Variables

	Description	Type	Base Variable
Income			
WIC Household	Anyone in the household is receiving benefits from WIC	Binary	Not a WIC Household
SNAP Participant	Anyone in the household is receiving SNAP Benefits, confirmed by administrative match	Binary	Not a SNAP Participant
Average Monthly Income	Household average monthly income	Continuous	N/A
Health Characteristics			
Nutritional Fact Checks	Respondent uses the Nuritional Facts Panel Sometimes, Most of the Time, or Always	Binary	No Nutritional Fact Check
Respondent is Overweight	Individual is overweight according to BMI measure	Binary	Respondent is Not Overweight
Respondent is Obese	Respondent is obese according to BMI measure	Binary	Respondent is Not Obese
Nutritional Education	In the past two months, respondent participated in a nutrition education event	Binary	No Nutritional Education
Nutriton Search	In the past two months, respondent searched interent for nutrition information	Binary	No Nutriton Search
Any Dieting	Anyone in th household is on any kind of food diet	Binary	Dieting
Shopping Characteristics			
Number of trips to store	Number of trips that the household took to a food store during the one week survey period	Continuous	N/A
Shop at a Traditional Store	Household primarily shops at a supermarket or superstore	Binary	Household primarily shops at other retailer type
Household Characteristics			
Northeast	Census region is Northeast	Binary	West
Midwest	Census region is Midwest	Binary	West
South	Census region is South	Binary	West
Rural	Household is in a rural census tract	Binary	Urban
Non-Hispanic African American	Respondent reported race as Non-Hispanic Black or African American	Binary	White
Non-Hispanic Asian	Respondent reported race as Non-Hispanic Asian	Binary	Non-Hispani Caucasian
Hispanic	Respondent is Spanish, Hispanic, or Latino	Binary	Non-hispanic
Other	Respondent reported race as Non-Hispanic American Indian, Native Hawaiian, or Other	Binary	White
Some High School Education	Highest Level of Education was that Respondent attended some high school, but did not graduate	Binary	Bachelor's Degree
High School Education	Highest Level of Education that Respondent received was a high school diploma, GED, or equivalent	Binary	Bachelor's Degree
Some College Education	Highest Level of Education was that Respondent attended some college, but did nto graduate	Binary	Bachelor's Degree
Master's Education	Highest Level of Education that Respondent received was a Master's degree or above	Binary	Bachelor's Degree
Widowed	Respondent's marital status is widowed	Binary	Married
Divorced	Respondent's marital status is divorced	Binary	Married
Seperated from Spouse	Respondent's marital status is seperated from spouse	Binary	Married
Never Married	Respondent's marital status is never married	Binary	Married
Respondent is Female	Respondent's sex is female	Binary	Respondent is Male
Toddler	The number of 0-4 years olds in the household	Continuous	N/A
Child	The number of 5-11 years olds in the household	Continuous	N/A
Teen	The number of 12-17 years olds in the household	Continuous	N/A
Adult	The number of 18-59 years olds in the household	Continuous	N/A
Senior	The number of 60+ year olds in the household	Continuous	N/A
US Born	Respondent was born in the United States	Binary	Not US Born
Purchasing Habits			
Buy Fruit Juice	The household purchased fruit juice	Binary	Do Not Buy Fruit Juice
Fruit Juice Expenditures	Level of expenditures on fruit juice, measured in Dollars	Continuous	N/A
Buy Unfortified Fruit Juice	The household purchased unfortified fruit juice	Binary	Do Not Buy Unfortified Fruit Juice
Unfortified Fruit Juice Expenditures	Level of expenditures on unfortfied fruit juice, measured in Dollars	Continuous	N/A
Buy Fortified Fruit Juice	The household purchased fortified fruit juice	Binary	Do Not Buy Fortified Fruit Juice
Fortified Fruit Juice Expenditures	Level of expenditures on fortified fruit juice, measured in Dollars	Continuous	N/A

Unique to this analysis is the consideration of this set of health characteristics as potential

drivers of fortified and unfortified fruit juice expenditures. Health characteristic variables,

including BMI, nutrition education and searching for nutrition information, were included

because households with individuals who relatively value their health are likely to also relatively value fruit juice products' health attributes. This has been seen in prior studies on general food expenditures including Cirino's (2014) Brazilian study of food purchase determinants and Temesi (2019) who found that individuals who view themselves as healthful purchase products that have a healthy connotation. While respondent weight has been included in previous literature, such as BMI in Patch's (2005) study on foods enriched with Omega-3 fatty acids, nutritional education and nutrition search have not been included in studies on the purchase of fruit juice (Patch *et al.*2005).

MATERIALS AND METHODS

Data

This study uses the National Household Food Acquisition and Purchase Survey (FoodAPS) to examine sociodemographic determinants of the purchase of fruit juice by fortification status. FoodAPS was a data collection project sponsored by the U.S. Department of Agriculture from 2012 to 2013. The data were collected from 4,826 U.S. households, which are defined by the U.S. Department of Agriculture's User's Guide as "all persons who live together and share food and who expect to be present at the sampled address during at least part of the data collection week." The head of each household completed an initial survey; thereafter, each household that passed a screening process was trained how to report and scan all of their food purchases, both consumed at the home and away from the home, for the seven-day period. In addition to the food purchase data, extensive data were collected about the sociodemographic characteristics of each individual in the household. Researchers also conducted an interview following

the seven-day period. This final interview included the collection of the family's eating habits in the past seven days, whether any household members had participated in various health education classes or research, how the household ranks their individual health statuses, income data, transportation data, housing situation data, and so forth.

Fortification status was determined by merging FoodAPS with the Food and Nutrient Database for Dietary Studies (FNDDS) for the period from 2013 to 2014. These datasets were linked using food code variables, which are included in the FoodAPS nutrient files and the FNDDS data. In the FNDDS dataset, the food code variables are associated with a fortification identifier code, that identified the fortification status of each item and allowed for the FoodAPS items to thereby be identified by fortification status as well. The fortification statuses in the FNDDS are either fortified, unfortified, contain fortified ingredients, or contain fortified ingredients including margarine/milk/flour. Fortified beverages were those that were classified as fortified themselves in the dataset. Unfortified beverages were those that were classified as unfortified, contained fortified ingredients, or contain fortified ingredients including margarine, milk, or flour.

After identifying fruit juice item fortification status, aggregate expenditures for fruit juice, fortified fruit juice, and unfortified fruit juice were created. The FoodAPS dataset included a total expenditure variable for each item the household purchased. Aggregate fruit juice, fortified fruit juice, and unfortified fruit juice expenditures were then estimated by calculating the sum of the total expenditures on each item by the associated household number.

Corresponding to this study's objective, households with no fruit juice purchases were excluded. Of the 4,826 households in the FoodAPS dataset, 983 households purchased fruit juice (20.37 percent of the sample), 531 households purchased unfortified fruit juice (11.00 percent of the sample), and 521 households purchased fortified fruit juice (10.80 percent of the sample).

Methods

Cragg's double hurdle model includes is a two-stages (or hurdles): model which involves modeling aa binary decision in the first hurdle and then models a continuous expenditure decision in the second hurdle. This method was selected because many households incurred had zero expenditures. In this study, the first hurdle considers a household's decision to purchase fruit juice. Given the purchase of fruit juice, the second hurdle examines the household's level of expenditures on fruit juice. In this analysis, Cragg's double hurdle model is estimated three times, once each: for fruit juice, unfortified fruit juice, and fortified fruit juice, respectively.

Cragg's double hurdle model is specified as follows.

$$y_i = y_i^* \quad \text{if} \quad y_i^* > 0$$

$$y_i = 0 \quad \text{if} \quad y_i^* < 0$$

and

$$y_i^* = \alpha + X_i\beta_i + \varepsilon i$$

where y_i^* is the latent variable, y_i is the observed expenditures on fruit juice, X_i is the vector of income, health characteristics, shopping characteristics, and sociodemographic independent variables, and β_i is the vector of coefficients associated with the purchasing probabilities and conditional expenditures of fruit juice, unfortified fruit juice, and fortified fruit juice, respectively.

The outcomes from Cragg's double hurdle model include the purchase probability, expected conditional expenditures, and expected unconditional expenditures.

The purchase probability coefficient, $P(y_i > 0 \mid x_{1i})$, is represented by the following equation.

$$P(y_i > 0 \mid x_{1i}) = \Phi(x_{1i}\gamma)$$

The expected conditional expenditure, $E(y_i \mid y_i > 0, x_{2i})$, is represented by the following equation.

$$E(y_i \mid y_i > 0, x_{2i}) = x_{2i}\beta + \sigma\left(\frac{x_{2i}\beta}{\sigma}\right)$$

The expected unconditional expenditure is represented by the following equation as:

$$E(y_i \,|x_{1i}, x_{2i}) \; = \; \Phi(x_{1i}\gamma) \left\{ x_{2i}\beta + \sigma \; \times \lambda \left(\frac{x_{2i}\beta}{\sigma} \right) \right\}$$

where λ is the inverse Mills ratio.

To interpret the results from Cragg's double hurdle model, average partial effects are calculated.

The partial effect of an independent variable, around the probability that $y_i > 0$ is:

$$\frac{\partial P(y_i > 0 \,| \, x_{1i})}{\partial x_j} = \; \gamma_j \phi(x_{1i}\gamma)$$

while the partial effect of an independent variable on the expected value of *y*, around the probability that $y_i > 0$ is:

$$\frac{\partial E(y_i | y_i > 0, x_{2i})}{\partial x_j} = \; \beta_j \left[1 - \lambda \left(\frac{x_{2i}\beta}{\sigma} \right) \left\{ \frac{x_{2i}\beta}{\sigma} + \lambda \left(\frac{x_{2i}\beta}{\sigma} \right) \right\} \right]$$

Cragg's double hurdle model was estimated using Stata version 12.1. Postestimation calculations of average partial effects were also estimated in accordance to Burke (2009). The Craggit code that was used was developed by Dr. William J. Burke and allows for estimation of the double hurdle model in STATA.

RESULTS

Descriptive Statistics

Descriptive statistics provided in Table 2 characterize the income, health, shopping habits, and sociodemographic characteristics for all households. Additionally, descriptive

statistics for the dependent variables (buying fruit juice, fruit juice expenditures, buying unfortified fruit juice, unfortified fruit juice expenditures, buying fortified fruit juice, and fortified fruit juice expenditures) have been included. Mean and standard deviations are provided for each variable.

Results are presented for three double-hurdle models in Tables 3 through 5: (1) fruit juice, (2) unfortified fruit juice, and (3) fortified fruit juice. Purchase and expenditure decisions are analyzed in each of these models. Results are further broken down into four categories of determinants of purchase and level of conditional expenditures. These four categories are income, health, shopping habits, and sociodemographic characteristics. Refer to Table 1 for detailed descriptions of these variables.

Table 2. Descriptive Statistics

	All Households		Purchase Fruit Juice		Purchase Unfortified Fruit Juice		Purchase Fortified Fruit Juice	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Income								
WIC Household	0.10	0.00	0.14	0.01	0.10	0.01	0.19	0.02
SNAP Participant	0.33	0.01	0.30	0.01	0.27	0.02	0.32	0.02
Average Monthly Income	3756.50	53.16	4389.82	127.66	4479.42	177.75	4411.90	173.83
Health Characteristics								
Nutritional Fact Checks	0.64	0.01	0.68	0.01	0.72	0.02	0.68	0.02
Respondent is Overweight	0.32	0.01	0.31	0.01	0.31	0.02	0.31	0.02
Respondent is Obese	0.36	0.01	0.34	0.02	0.34	0.02	0.34	0.02
Nutritional Education	0.06	0.00	0.07	0.01	0.08	0.01	0.07	0.01
Nutriton Search	0.27	0.01	0.32	0.01	0.35	0.02	0.31	0.02
Any Dieting	0.31	0.01	0.34	0.02	0.36	0.02	0.32	0.02
Shopping Characteristics								
Number of trips to store	3.31	0.04	4.21	0.08	4.20	0.11	4.29	0.11
Shop at a traditional Store	0.93	0.00	0.91	0.01	0.89	0.01	0.92	0.01
Household Characteristics								
Northeast	0.17	0.01	0.19	0.01	0.20	0.02	0.19	0.02
Midwest	0.24	0.01	0.25	0.01	0.25	0.02	0.25	0.02
South	0.37	0.01	0.33	0.01	0.31	0.02	0.34	0.02
Rural	0.27	0.01	0.25	0.01	0.27	0.02	0.24	0.02
African American	0.14	0.01	0.10	0.01	0.10	0.01	0.11	0.01
Asian	0.04	0.00	0.05	0.01	0.06	0.01	0.03	0.01
Other	0.03	0.00	0.03	0.01	0.05	0.01	0.02	0.01
Hispanic	0.20	0.01	0.21	0.01	0.19	0.02	0.23	0.02
Some High School Education	0.17	0.01	0.14	0.01	0.13	0.01	0.14	0.02
High School Education	0.29	0.01	0.26	0.01	0.24	0.02	0.27	0.02
Some College Education	0.33	0.01	0.33	0.01	0.32	0.02	0.33	0.02
Master's Education	0.07	0.00	0.10	0.01	0.12	0.01	0.09	0.01
Widowed	0.07	0.00	0.06	0.01	0.07	0.01	0.04	0.01
Divorced	0.19	0.01	0.16	0.01	0.16	0.02	0.17	0.02
Seperated from Spouse	0.05	0.00	0.05	0.01	0.04	0.01	0.06	0.01
Never Married	0.27	0.01	0.24	0.01	0.24	0.02	0.21	0.02
Respondant is Female	0.74	0.01	0.76	0.01	0.74	0.02	0.78	0.02
Toddler	0.26	0.01	0.35	0.02	0.24	0.02	0.47	0.03
Child	0.36	0.01	0.42	0.03	0.39	0.03	0.44	0.04
Teen	0.29	0.01	0.30	0.02	0.30	0.03	0.32	0.03
Adult	1.66	0.02	1.76	0.04	1.69	0.05	1.83	0.05
Senior	0.40	0.01	0.43	0.02	0.46	0.03	0.38	0.03
US Born	0.82	0.01	0.79	0.01	0.77	0.02	0.82	0.02
Purchasing Habits								
Buy Fruit Juice	0.20	0.01	1.00	0.00	1.00	0.00	1.00	0.00
Fruit Juice Expenditures	0.88	0.03	4.31	0.11	4.81	0.15	4.91	0.16
Buy Unfortified Fruit Juice	0.11	0.00	0.54	0.02	1.00	0.00	0.19	0.02
Unfortified Fruit Juice Expenditures	0.43	0.02	2.13	0.09	3.94	0.12	0.79	0.09
Buy Fortified Fruit Juice	0.11	0.00	0.53	0.02	0.19	0.02	1.00	0.00
Fortified Fruit Juice Expenditures	0.44	0.02	2.18	0.09	0.86	0.10	4.11	0.13

Fruit Juice Purchase Decision and Conditional Expenditure Levels

First, income's effect on the probability of purchasing fruit juice and conditional expenditures are examined. Participating in WIC in the past six months increases the likelihood of purchasing fruit juice by 7 percent ($p<0.01$) but has no significant effect on the level of expenditures given purchase. Monthly income is significant for the purchase decision of fruit juice at the 99 percent confidence level, but the coefficient is so minimal that it does not have a meaningful impact. Participating in SNAP does not significantly affect whether a household purchases fruit juice nor does SNAP participation have any significant effect on a household's level of fruit juice expenditures given purchase.

Table 3. Cragg's Double-Hurdle Model and Average Partial Effects Estimates for Purchase of Fruit Juice

	Purchase Fruit Juice				
	Purchase Coefficient	**Expenditure Coefficient**	**Purchase Probability**	**Conditional Expenditure Level**	**Unconditional Expenditure Level**
Income					
WIC Household	0.28***	0.39	0.07***	0.20	0.26
SNAP Participant	0.30	0.66	0.01	0.34	-0.03
Average Monthly Income	1.96e-05***	0.00	5.09e-06***	0.00	-0.06
Health Characteristics					
Nutritional Fact Checks	0.05	0.19	0.01	0.10	-0.01
Respondent is Overweight	-0.03	-0.86*	-0.01	-0.44*	-0.10*
Respondent is Obese	-0.05	-0.72	-0.01	-0.37	-0.12
Nutritional Education	0.08	-0.27	0.02	-0.14	0.03
Nutriton Search	0.07	0.32	0.02	0.16	0.01
Any Dieting	0.06	0.02	0.02	0.01	0.01
Shopping Characteristics					
Number of trips to store	0.08***	0.10	0.02***	0.05	0.03
Shop at a traditional Store	-0.10	-1.58**	-0.03	-0.80**	-0.17**
Sociodemographic Characteristics					
Northeast	0.11	0.55	0.03	0.28	0.18
Midwest	0.10	-0.94	0.03	-0.48	0.02
South	0.02	-0.60	0.01	-0.31	-0.04
Rural	-0.05	-0.13	-0.01	-0.07	-0.12
Non-Hispanic African American	-0.17**	0.88	-0.04**	0.45	-0.26
Non-Hispanic Asian	-0.16	0.48	-0.04	0.24	-0.25
Non-Hispanic Other	0.00	-0.64	0.00	-0.33	-0.07
Hispanic	0.04	0.59	0.01	0.30	-0.02
Some High School Education	-0.29***	-1.38*	-0.08***	-0.70*	-0.40*
High School Education	-0.16**	-1.08*	-0.04**	-0.55*	-0.25*
Some College Education	-0.08	-1.50***	-0.02	-0.77***	-0.16***
Master's Degree or Above	0.20**	-0.59	0.05**	-0.29	0.17
Widowed	-0.08	-2.28**	-0.02	-1.16**	-0.16**
Divorced	-0.02	-0.41	-0.01	-0.21	-0.09
Seperated from Spouse	-0.01	-0.83	0.00	-0.42	-0.08
Never Married	-0.03	-1.22**	-0.01	-0.62**	-0.09**
Female	-0.01	-0.43	0.00	-0.22	-0.07
Toddler	0.04	0.09	0.01	0.05	-0.02
Child	0.05	0.53**	0.01	0.27**	-4.35e-03**
Teen	0.00	0.34	0.00	0.18	-0.07
Adult	-0.01	0.04	0.00	0.02	-0.08
Senior	0.07	-0.08	0.02	-0.04	0.01
US Born	-0.04	-0.18	-0.01	-0.09	-0.11
Constant	-1.11***	5.40***	---	---	---

*, **, *** represent 90%, 95%, and 99% signifigance, respectively.

Both shopping habit characteristics considered have significant effects on purchasing

fruit juice and conditional expenditures. The number of trips to the store that a household

takes increases the purchase probability of fruit juice by 2 percent (p<0.01), while not

having a significant effect on conditional expenditures. A household shopping at a

traditional store does not have a significant effect on the probability of purchasing fruit juice but does decrease the expenditures by $0.80 given purchase ($p<0.05$).

Next, the health characteristics and their effects on the probability of purchasing fruit juice and conditional expenditures are examined. Results indicate that health determinants have an impact on the decision to purchase fruit juice, specifically if the primary survey respondent in overweight. If a respondent is overweight, they will spend $0.44 less on fruit juice at the 90 percent significance level, given purchase.

Sociodemographic characteristics are the final category of variables that are examined. Being a rural household, the gender of the primary survey respondent, the primary respondent being born in the United States, and the household's region do not have a significant effect on purchasing fruit juice or the associated conditional expenditure levels ($p<0.10$). Of the four race categories, the only race that has a significant impact on the purchase of fruit juice is non-Hispanic African Americans. Non-Hispanic African American households are 4 percent less likely ($p<0.05$) to purchase fruit juice compared to non-Hispanic Caucasian households. Race has no significant impact on expenditure levels given the decision to purchase.

Results indicate that education significantly impacts both the decision to purchase fruit juice and conditional expenditures. All variables are compared to the base variable of a household whose primary respondent has a bachelor's degree. A household with a respondent who has some high school education is 8 percent less likely to purchase fruit

juice (p<0.01) and conditional on that purchase will spend $0.70 less on fruit juice (p<0.10). Households whose primary survey respondent has a high school education are 4 percent less likely to buy fruit juice (p<0.05), and these households spend $0.55 less on fruit juice (p<0.10) than their degree-holding counterparts. Primary survey respondents who attended some college, but did not receive their degrees, have no difference in purchase probability but conditional purchase spend $0.77 less on fruit juice (p<0.01). When a household has a primary survey respondent who holds a master's degree or higher, the household is 5% more likely to purchase fruit juice than individuals who hold an associate's or bachelor's degree (p<0.05), with no difference in expenditure level given purchase.

Five categories of marital status were considered in this analysis: married (default), widowed, divorced, separated from their spouse, and never married. Marital status does not appear to have a significant effect on the probability of a household purchasing fruit juice. However, households whose primary survey respondent is widowed or never married spend less on fruit juice given purchase, $1.16 and $0.62 respectively, than households whose primary survey respondent is married (both p<0.05). Additionally, the household's age composition does not have a large effect on purchasing fruit juice, as seen in the age variables of toddler, teen, adult, and senior having no significance on purchasing decisions or conditional expenditure levels of fruit juice. Having more children in the household is the only age composition variable that has a significant effect on the conditional level of expenditures, with households spending $0.27 more (p<0.05).

Unfortified Fruit Juice Purchase Decision and Conditional Expenditure Levels

As shown in Table 4, results for unfortified fruit juice are presented in the following order of potential determinants: income, health, shopping habits, and sociodemographic characteristics. Participating in WIC in the past six months increases a household's likelihood of purchasing unfortified fruit juice by 4 percent ($p<0.05$) but has no significant effect on the level of expenditures given purchase. Monthly income is significant for the expenditure level when given purchase of unfortified fruit juice, but the coefficients are so minimal that it has no meaningful economic effect. Monthly income has no significant effect on purchasing probability. Participating in SNAP does not significantly affect whether a household purchases unfortified fruit juice, but it does decrease their level of unfortified fruit juice expenditures given purchase by $0.10 ($p<0.05$).

The only health characteristic that significantly affects a household's probability of purchasing unfortified fruit juice is if the primary survey respondent searched the internet for nutrition information, which increases the purchase probability by 2 percent ($p<0.10$). The only health characteristic variable that has a significant effect on a household's level of expenditure given the purchase of unfortified fruit juice is if there is anyone in the household on a food diet, which decreases spending by $0.01 ($p<0.05$). All other health characteristic variables have no significant effect on the household's decision to purchase unfortified fruit juice or their conditional expenditure levels.

Both shopping habit characteristics have a significant effect on purchasing unfortified

fruit juice, while neither have a significant effect on conditional expenditures. The

Table 4. Cragg's Double-Hurdle Model and Average Partial Effects Estimates for Purchase of Unfortified Fruit Juice

	Purchase Unfortified Fruit Juice				
	Purchase Coefficient	**Expenditure Coefficient**	**Purchase Probability**	**Conditional Expenditure Level**	**Unconditional Expenditure Level**
Income					
WIC Household	0.22**	-0.60	0.04**	-0.35	0.11
SNAP Participant	-0.08	1.19**	-0.01	0.69**	-0.10**
Average Monthly Income	1.3e-05*	0.00	2.34e-06*	0.00	-0.04
Health Characteristics					
Nutritional Fact Checks	0.08	0.40	0.02	0.23	0.02
Respondent is Overweight	-0.03	-0.65	-0.01	-0.38	-0.06
Respondent is Obese	-0.02	-0.61	0.00	-0.36	-0.06
Nutritional Education	0.10	-0.63	0.02	-0.37	0.03
Nutriton Search	0.10*	-0.11	0.02*	-0.06	0.03
Any Dieting	0.05	0.86**	0.01	0.50**	-0.01**
Shopping Characteristics					
Number of trips to store	0.07***	0.07	0.01***	0.04	0.01
Shop at a traditional Store	-0.18**	-0.45	-0.03**	-0.26	-0.17
Sociodemographic Characteristics					
Northeast	0.07	0.21	0.01	0.12	0.07
Midwest	0.01	-0.54	0.00	-0.31	-0.03
South	-0.04	-0.63	-0.01	-0.36	-0.07
Rural	0.04	0.48	0.01	0.28	-0.02
Non-Hispanic African American	0.04	1.09*	-0.01	0.63*	-0.06*
Non-Hispanic Asian	-0.04	-0.71	-0.01	-0.41	-0.07
Non-Hispanic Other	0.28**	-1.49	0.05**	-0.87	0.16
Hispanic	-0.01	0.74	0.00	0.43	-0.05
Some High School Education	-0.22**	-1.51**	-0.04**	-0.88**	-0.20**
High School Education	-0.12	-0.92	-0.02	-0.53	-0.13
Some College Education	-0.06	-1.12**	-0.01	-0.65**	-0.08**
Master's Degree or Above	0.21**	0.41	0.04**	0.24	0.10
Widowed	0.01	-1.09	0.00	-0.63	-0.05
Divorced	-0.07	0.04	-0.01	0.02	-0.09
Seperated from Spouse	-0.12	0.65	-0.02	0.38	-0.13
Never Married	-0.03	0.30	0.00	0.17	-0.06
Female	-0.05	-0.48	-0.01	-0.28	-0.08
Toddler	-0.12**	0.20	-0.02**	0.11	-0.13
Child	-0.04	0.79***	0.01	0.46***	-0.11***
Teen	0.00	0.35	0.00	0.21	-0.44
Adult	-0.01	-0.43*	0.00	-0.25*	-0.05*
Senior	0.05	-0.19	0.01	-0.11	-0.01
US Born	0.01*	-0.54	-0.03*	-0.19	-0.15
Constant	-1.20***	3.92***	---	---	---

*, **, *** represent 90%, 95%, and 99% signifigance, respectively.

number of trips to the store that a household takes increases the purchase probability of unfortified fruit juice by 1 percent ($p<0.01$) and a household shopping at a traditional store decreases the probability of purchasing unfortified fruit juice by 3 percent ($p<0.01$).

Sociodemographic characteristics are the final category of variables that are examined. Being a rural household, the gender of the primary survey respondent, and the household's region do not have a significant effect on households purchasing fruit juice or the associated expenditure levels. The marital status of the primary survey respondent does not have a significant effect on purchasing unfortified fruit juice. Of the four race categories, non-Hispanic others are 5 percent more likely to purchase unfortified fruit juice ($p<0.10$). Non-Hispanic African Americans have a significant value of expenditures given purchase of unfortified fruit juice, conditionally spending $0.63 more than non-Hispanic Caucasian households ($p<0.05$). Being Hispanic or a non-Hispanic Asian household has no significant effect on either purchase probability or expenditure level given purchase.

Results indicate that education significantly impacts both the decision to purchase unfortified fruit juice and expenditures given purchase. The only education level of the primary survey respondent that does not have a significant effect on the household's purchase probability or expenditure level is high school. A household with a respondent who has some high school education is 4 percent less likely to purchase unfortified fruit juice ($p<0.05$) and will spend $0.20 less on unfortified fruit juice given purchase ($p<0.05$). A household with a primary survey respondent who attended some college, but

did not receive their degrees, has no difference in purchase probability, but given purchase spends $0.08 less on unfortified fruit juice (p<0.05). When the household has a primary survey respondent who holds a master's degree or higher, the household is 4% more likely to purchase unfortified fruit juice than households with respondents who hold an associate's or bachelor's degree (p<0.05), with no difference in expenditure level given purchase.

The age composition of the household is found to have a significant impact on purchase probability and expenditure levels. Households with more toddlers present are 2 percent less likely to purchase unfortified fruit juice (p<0.05), with no significant difference in expenditures given purchase. Having more children in the household does not have a significant effect on purchase probability, but it does significantly increase the level of expenditures on unfortified fruit juice given purchase by $0.46 (p<0.01). Households with more adults have no significant difference in purchase probability, but given purchase have $0.25 less expenditures on unfortified fruit juice (p<0.10). Households with more seniors are the only ones to have neither a significant impact on purchase probability nor expenditure level given purchase. Finally, the primary respondent being born in the United States leads to a 3 percent decrease in probability of the household purchasing unfortified fruit juice, with no significant effect on expenditure levels given purchase.

Fortified Fruit Juice Purchase Decision and Conditional Expenditure Levels

Fortified fruit juice results are presented in Table 5. Participating in WIC in the past six months increases the likelihood of purchasing fortified fruit juice by 5 percent (p<0.01) but has no significant effect on the level of expenditures given purchase. Monthly income is significant for the fortified fruit juice purchase decision, but the coefficients are so minimal that it is determined not to have a meaningful economic impact. Monthly income has no significant effect on the level of expenditure given purchase. Participating in SNAP does have a significant effect on whether a household purchases fortified fruit juice; SNAP participation increases the probability of purchase by 2 percent (p<0.10), but participation does have a significant effect on the household's level of fortified fruit juice expenditures given purchase.

No health characteristic variables have a significant effect on a household's probability of purchasing fortified fruit juice or on the level of expenditures given purchase.

Both shopping habit characteristics, number of trips to the store and shopping at a traditional store, have significant effects on purchasing fruit juice and conditional expenditures. The number of trips to the store that a household takes increases the purchase probability of fortified fruit juice by 1 percent (p<0.01), while not having a significant effect on conditional expenditures. A household shopping at a traditional store does not have a significant effect on the probability of purchasing fortified fruit juice but does decrease the conditional expenditures on fortified fruit juice by $1.31 (p<0.05).

The primary survey respondent's gender, place of birth, and region do not have a significant effect on the household purchasing fortified fruit juice or the associated expenditure levels given purchase. Being a rural household decreases the purchase probability of fortified fruit juice by 2 percent ($p<0.05$) but does not have a significant effect on the level of expenditure on fortified fruit juice given purchase.

Results indicate that the race of the primary survey respondent significantly impacts both the decision to purchase fortified fruit juice and expenditure levels given purchase. The primary survey respondent being non-Hispanic African American decreases the household's purchase probability of fortified fruit juice by 4 percent relative to non-Hispanic Caucasians ($p<0.05$) but does not have a significant effect on the conditional level of expenditure on fortified fruit juice. The primary survey respondent being non-Hispanic Asian does not have a significant effect on the household's purchase probability, but given the decision to purchase fortified fruit juice, this increases the level of conditional expenditure by $1.46 ($p<0.05$). The primary survey respondent classified as non-Hispanic other decreases the probability of purchasing fortified fruit juice by 5 percent ($p<0.10$) but does not have a significant effect on the level of expenditure for fortified fruit juice. Lastly, the primary survey respondent being Hispanic has no significant effect on the household's probability of purchasing fortified fruit juice or the level of expenditure on fortified fruit juice.

Results indicate that the education level of a household's primary survey respondent impacts fortified fruit juice purchase decisions and conditional expenditures. Households

with a primary survey respondent who has some high school education are 5 percent less likely to purchase fortified fruit juice ($p<0.01$) but have a similar level of expenditures on fortified fruit juice. Households with primary survey respondents who attended some college, but did not receive a degree, have no difference in purchase probability but given purchase, spend $0.75 less on fortified fruit juice ($p<0.05$). When households have a primary survey respondent with a high school degree or a primary respondent who holds a master's degree or higher, there is no difference in purchase probability of fortified fruit juice, or the associated level of expenditures given purchase.

There is no significant impact on the probability of a household purchasing fortified fruit juice or the associated conditional expenditures if the marital status of the primary survey respondent is divorced or separated from their spouse. When the respondent is widowed, the household is 5 percent less likely to purchase fortified fruit juice ($p<0.05$) than married respondents, with no significant effect on the level of expenditure given purchase. Households whose respondents who have never been married are 2 percent less likely to purchase fortified fruit juice ($p<0.10$) and spend $0.58 less on fortified fruit juice than households with married respondents ($p<0.10$).

The age composition of the household has a significant impact on fruit juice purchases in two age groups. Households with more toddlers present are 3 percent more likely to purchase fortified fruit juice ($p<0.01$), with no significant difference in expenditures given purchase. Having more adults in the household does not have a significant effect on purchase probability, but it does significantly increase the level of expenditures on

fortified fruit juice given purchase by $0.21 (p<0.01). The number of children, teens, and seniors in the household does not have a significant impact on the probability of purchasing fortified fruit juice, nor the level of expenditure given purchase.

Table 5. Cragg's Double-Hurdle Model and Average Partial Effects Estimates for Purchase of Fortified Fruit Juice

	Purchase Fortified Fruit Juice				
	Purchase Coefficient	Expenditure Coefficient	Purchase Probability	Conditional Expenditure Level	Unconditional Expenditure Level
Income					
WIC Household	0.28***	0.75	0.05***	0.46	0.18
SNAP Participant	0.12*	0.02	0.02*	0.00	0.01
Average Monthly Income	1.86e-05**	0.00	3.16e-06**	0.00	-0.02
Health Characteristics					
Nutritional Fact Checks	0.02	-0.31	0.00	-0.19	-0.01
Respondent is Overweight	-0.03	-0.79	-0.01	-0.48	-0.04
Respondent is Obese	-0.05	-0.72	-0.01	-0.44	-0.05
Nutritional Education	0.01	0.47	0.00	0.29	-0.01
Nutriton Search	0.04	0.39	0.01	0.24	0.01
Any Dieting	0.01	-0.34	0.00	-0.21	-0.01
Shopping Characteristics					
Number of trips to store	0.06***	0.00	0.01***	0.00	0.02
Shop at a traditional Store	0.01	-2.14***	0.00	-1.31***	-0.01***
Sociodemographic Characteristics					
Northeast	0.11	0.27	0.02	0.17	0.10
Midwest	0.12	-0.45	0.02	-0.28	0.06
South	0.06	-0.29	0.01	-0.17	0.03
Rural	-0.13**	-0.54	-0.02**	-0.33	-0.11
Non-Hispanic African American	-0.21**	0.39	-0.04**	0.24	-0.17
Non-Hispanic Asian	-0.26	2.39**	-0.04	1.46**	-0.21**
Non-Hispanic Other	-0.29*	0.05	-0.05*	0.03	-0.23
Hispanic	0.09	-0.18	0.01	-0.11	0.04
Some High School Education	-0.27***	-0.51	-0.05***	-0.31	-0.21
High School Education	-0.11	-0.86	-0.02	-0.53	-0.09
Some College Education	-0.06	-1.23**	-0.01	-0.75**	-0.06**
Master's Degree or Above	0.02	-1.05	0.00	-0.64	-0.01
Widowed	-0.25**	-1.97	-0.04**	-1.21	-0.20
Divorced	-0.03	0.07	-0.01	0.04	-0.04
Seperated from Spouse	0.04	-0.98	0.01	-0.60	0.01
Never Married	-0.14*	-0.95*	-0.02*	-0.58*	-0.12*
Female	0.01	-0.19	0.00	-0.11	-0.01
Toddler	0.15***	-0.09	0.03***	-0.05	0.09
Child	0.02	0.12	0.00	0.07	0.00
Teen	0.01	0.12	0.00	0.07	-0.01
Adult	0.00	0.35*	0.00	0.21*	-0.02*
Senior	0.06	-0.18	0.01	-0.11	0.02
US Born	0.07	-0.02	0.01	-0.01	0.03
Constant	-1.66***	6.71***	---	---	---

*, **, *** represent 90%, 95%, and 99% signifigance, respectively.

Comparison of the Models

The results across the three models provide insight into the determinants of purchasing

fruit juice by fortification status. In this section, similarities and differences amongst the

determinants of purchasing fortified fruit juice and unfortified fruit juice are analyzed.

Food assistance programs generally have a significant positive impact on a household's

probability of purchasing fruit juice. A household participating in the WIC program is

more likely to purchase fruit juice, regardless of the fortification status. WIC households

are anywhere from 4 to 7 percent more likely than non-WIC households to buy both

types of fruit juice. Similar to WIC, SNAP participation also has a positive significant

effect on both unfortified and fortified fruit juice purchases and conditional expenditures.

The household age composition gives some of the most statistically significant results,

with different patterns being observed in the different age groups that compose a

household. Households with more toddlers are less likely to purchase unfortified fruit

juice but are more likely to purchase fortified fruit juice. This is the only age group where

this result occurs. When there are more children present in the household, there are

generally higher expenditures on the various fruit juices, while having teenagers in the

house does not significantly impact any of the probabilities or conditional expenditure

levels.

Education variables also have meaningful impacts on the various purchase probabilities

and expenditure levels. Households whose primary respondent has less than a bachelor's

degree are generally less likely to purchase any type of fruit juice and conditionally spend less on any fruit juice, regardless of fortification status. Having a master's degree or higher, however, never significantly impacts the level of expenditure given purchase, but is a positive significant factor in the purchase probability of fruit juice and unfortified fruit juice.

In contrast, health determinants do not appear to broadly impact fruit juice purchases or expenditures. Only two of the health determinants, dieting and nutrition search, have positive significant impacts on unfortified fruit juice only.

All significant marital statuses have negative effects on either purchasing or spending more given purchase of fortified fruit juice. The two most impactful marital statuses are never married and widowed.

Households who make more frequent trips to the store have a higher probability of purchasing fruit juice, regardless of fortification status. Fruit juice expenditures, especially for fortified fruit juice, are lower when a household shops at a traditional store.

The various race variables do impact both unfortified and fortified fruit juice purchases, but there is no identifiable pattern in the correlation between race and purchasing fruit juice with a particular fortification status. Other determinants that occasionally have a significant impact on purchase probability or expenditures given purchase are area type, rural versus urban, and the birth country of the primary respondent.

Households with higher incomes are more likely to purchase all types of fruit juice, but changes in income must be exponentially high to see an impact on the amount purchased. Collectively, results also indicate that the gender of the primary respondent, the primary respondent checking nutritional fact panels, or being obese, as well as the region of the household, never have a significant impact on the purchasing probability or conditional expenditure for fruit juice, regardless of fortification status.

DISCUSSION

Health concerns are continuously growing in the US, which creates demand for everything from increased healthcare awareness to innovation in food products. These concerns in American culture drive food fortification and US food policy. This study fills a gap in the literature by analyzing the determinants of US household expenditures on fortified fruit juice. Variables analyzed in this study include income, health characteristics, shopping habits, and sociodemographic characteristics. Unique results from this study compared to previous studies on fortified foods include the effects of food assistance benefits, rural/urban status, age composition of the household, marital status and the region in which the household resides. Results for other covariates, including income, health characteristics, and shopping characteristics are similar to previous studies on fortified foods and fruit juice, in that higher incomes lead to higher demand for fortified foods (Caspi *et al*. 2016; Leschewski and Weatherspoon 2016; Stern *et al*. 2016; Okrent & MacEwan 2014; Dharmasena & Capps 2012; Volpe and Okernt 2012; Smith *et al*. 2010; Zheng *et al*. 2008; Yen *et al*. 2004; Kinnucan *et al*. 2001;Weemaes, *et al*. 2001).

There are two categories of implications from this study: one at the industry level and one at the policy level. The results of this study provide industry players with profiles of fortified and unfortified fruit juice consumers. Results indicate that fortified fruit juice companies should target households participating in food assistance programs and households with toddlers. The results from this study were similar to that of Hirvonen *et al*. (2012), in that this study found that having more toddlers in the household increases the likelihood that the household purchases fortified foods. While previous results have shown both positive and negative correlations between being a WIC household and increasing household purchases of fruit juice, this study shows that WIC households are more likely to purchase fruit juice, both fortified and unfortified. Households who searched online for nutritional information were also more likely to purchase fortified fruit juice.

Understanding the education levels of a household benefit industry producers immensely, as they are highly significant in the household's decision to purchase fortified fruit juice. Households that do not include an individual who has graduated college are less likely to purchase fruit juice, while those with individuals who hold master's degrees and above are more likely to purchase fruit juice. Having these profiles will allow companies within the fruit juice industry to better target potential customers with specific marketing campaigns, varying pricing tactics based upon location or store type, and adjusting their placement strategies for fortified fruit juice products. While this directly benefits companies in the fruit juice industry, it also could indirectly benefit consumers at large.

This would occur as a byproduct of companies knowing their customers more thoroughly and therefore increasing access to fortified fruit juice products to customers who are more likely to purchase these products, thus increasing convenience of purchasing for the consumer.

This analysis also allows companies selling fortified fruit juice to know who they should not target, or potentially target with another product. Results indicate that rural and minority-headed households are currently purchasing fewer fortified fruit juice products and would fall into this category. These results are similar to the negatively correlated relationship between rural households and fortified fruit juice that Temesi *et al.* also found (2019). This study also showed the positive correlation between minority-headed households and purchasing of fruit juice that found by Drewnowski and Rehm (2015).

Results indicate that a variety of variables had a significant impact on the purchase of unfortified fruit juice; these variable include being a WIC household, having higher monthly income, searching for nutrition facts, the number of trips a household takes to the store, as well as race and ethnicity. Results also indicate that a variety of variables had a significant impact on unfortified fruit juice expenditure levels given purchase including being in a governmental food program, the dieting of the household and the age composition of the household.

The other major implication from this study is at the policy level. Policymakers have goals and objectives of implementing programs that increase the overall food security and

diet quality of US citizens, or specific subsets of this population. Two programs that could potentially use fortified and unfortified fruit juice consumer profiles are the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and the Supplemental Nutrition Assistance Program (SNAP). Results indicate that households who have at least one individual in the SNAP program are more likely than non-SNAP households to purchase fortified fruit juice. This result suggests that either the aspects of the SNAP program encourage households to make healthier purchasing decisions but does not specifically indicate which aspect of SNAP influences this decision, or the household is taking action to improve the wellbeing of its members.

This study shows that WIC households are more likely to purchase fruit juice, both fortified and unfortified. Policymakers could use these results to shift their goal from decreasing fruit juice intake to shifting consumption to fortified fruit juice. This shift would require efforts in nutrition education on the importance of food fortification as well as ensured ease of accessibility. This shift to fortified fruit juice could also come as a programmatic change that removes unfortified fruit juice from WIC food packages.

Results also indicate that rural households, who tend to lack convenient access to competitively priced, healthy food products are less likely to purchase fortified fruit juice (Temesi *et al.* 2019). This is indicative of the need for continued policy efforts to increase the ability of rural households to gain access to affordable healthy food and beverage options. There have been efforts in this regard such as public-private partnerships and

grassroots health campaigns, which studies show have been successful but have not been commercialized (Walker, Keane and Burke 2010).

Limitations

While this analysis contributes to the literature at large, it has room for improvement. This study is constrained by cross-sectional data, therefore indicating associations between household characteristics and fortified fruit juice expenditures, rather than the causal relationship between the two. Other limitations of this study stem from the data source on which it is based, FoodAPS. The FoodAPS data lack potential determinants of fruit juice demand such as advertising expenditures, product prices, and the subcategorization of what type of fruit juice that the fruit juice is. The data also have the potential for being skewed by self-reporting bias, misclassification of food purchases, and missing food item-level information. These shortcomings have also been analyzed and described in research completed by Wilde and Ismail (2018).

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