POST-MILLENNIAL BEVERAGE TRENDS AND THE RELATIONSHIP BETWEEN PRICE AND FOOD/BEVERAGE INTAKES AND PURCHASES IN THE U.S. PRESCHOOLER

Christopher N. Ford

A dissertation submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Nutrition, with minor in Epidemiology, Gillings School of Global Public Health.

Chapel Hill
2015

Approved by:

Barry M. Popkin

Shu Wen Ng

David K. Guilkey

Anna Maria Siega-Riz

Penny Gordon-Larsen

ABSTRACT

Christopher N. Ford: Post-millennial preschool beverage trends and the relationship between beverage price and food/beverage intakes and purchases in the U.S. preschooler
(Under the direction of Barry M. Popkin)

Improving preschooler (ages 2-5y) diet has become an important strategy for preventing excess weight gain in children. However, there has been little focus on changes in the intakes of beverages among U.S. preschoolers during the past decade. Meanwhile, imposing taxes on beverages high in sugar and/or fat in an effort to discourage their intake among the general population has become a prominent strategy. Yet, how such taxes relate to food/beverage purchases and intakes among U.S. preschool children and their households is unclear.

We examined trends in beverage intakes among U.S. preschool children between 2003 and 2012 using data from the National Health and Nutrition Examination Survey (NHANES). Next, we used data from the Nielsen Homescan Panel (2009-2012) to examine the relationship between beverage prices and food/beverage purchases in U.S. households with a preschool child. We estimated a two-part marginal effects model (probit and ordinary least squares regression) to simulate 'taxes' on SSBs, or SSB and >1% fat/high-sugar milks of 10%, 15%, and 20%. We then extended our analysis to include years 2003-2012 of the Homescan data in order to estimate demand relationships for 10 years of data corresponding to survey years 2003-2012 in NHANES. Resulting demand relationships from Homescan were applied to dietary data from NHANES to predict changes in caloric intakes among U.S. preschool children with 10%, 15% and 20% increases in the prices of SSBs.

We found that between 2003-04 and 2011-12, among 2-5 year olds, total caloric intake from beverages decreased fell by 55 kcal/d, which was mostly due to decreased intakes of juice drinks, soft drinks, and >1% fat, low-sugar milk. In our analysis of 2009-2012 Homescan data, we found that price increase of 10%, 15%, and 20% on SSBs were predicted to decrease purchases of juice drinks, and increase purchases of low-fat, low-sugar milk and 100% juice among households with a preschool child. Lastly, our simulations using Homescan and NHANES years 2003-2012 showed that a 20% increase in the price of SSBs was predicted to decrease caloric intakes from total SSBs, and total beverages among U.S. preschool children.

Our findings show significant decreases in beverage intakes among U.S. preschoolers between 2003-04 and 2011-12, to which decreases in caloric intakes from SSBs were a major contributor. Our study also provides further evidence in support of a tax on SSBs, which may be associated with decreases purchases and intakes of beverages high in sugar and/or fat among U.S. preschool children and their households.

ACKNOWLEDGMENTS

Foremost, I would like to thank my advisor, Barry Popkin. Dr. Popkin has been most instrumental in pushing me to become a better researcher. Unlike many other students, I come from a broken family where neither of my parents attended college. And, unlike other students, my parents have not been a major part of my life since I was a child. So at times, Dr. Popkin was both a mentor and a father figure. During my first year with Dr. Popkin, he encouraged me to publish my first paper, and since then he's continued to push me to submit abstracts, publish papers, and enhance the quality of my academic writing. He is generous with his time, although he advises a number of students and young faculty. Even when I was busy, though not nearly as busy as Dr. Popkin, he would always check in with me at regular intervals to see how I was doing and take stock of my research progress.

Although there were times when I was undeserving, Dr. Popkin has always been my greatest champion. He was always been willing to offer superlative letters of recommendation and support, which have landed me a number of honors and awards. While I am thankful to Dr. Popkin for these and many other things, I am most thankful to him for second (and even third) chances. Dr. Popkin did not choose to have me as a student when I first came to Chapel Hill. After spending my first year with another advisor in a different department, Dr. Popkin gave me a chance to prove myself and become his advisee. For that, I am eternally grateful. And, even after I failed my comps during my second year, Dr. Popkin gave me yet another chance. While I had my doubts that I was smart enough, or deserving enough to earn my doctorate, Dr. Popkin convinced me that, with hard work, I could pass comps and eventually go on to confer my PhD. So, I owe a tremendous debt of gratitude to Dr. Popkin for being my advisor, teacher, mentor, and advocate.

I would also like to thank Dr. Shu Wen Ng, Dr. David Guilkey, Dr. Anna-Maria Siega-Riz, and Dr. Penny Gordon-Larsen for graciously offering their support and feedback as members of my dissertation committee. I would also like to thank Dr. Linda Adair, and Dr. Michelle Mendez, who lent additional support throughout this process.

I would like to thank family, including my wife Cassandra, my mother- and father-in-law Linda and Doug Miller, and my brother Matthew.

Additionally, I wish to thank the members of my research team, which includes Bridget Hollingsworth, Jessica Davis, Phil Bardsley, Donna Miles, Greg Bricker. Kuo-Ping Li, Frances Dancy, and Emily Ford-Yoon. Their diligence behind the scenes is what made any of my research possible. In addition, Bridget and Jessica were most helpful in offering up their expertise as dietitians at a moment's notice whenever it was needed. They played an instrumental role in the development of the food/beverage groups used throughout this work.

I also want to thank current and former students, foremost among them Jennifer Poti, to whom I am deeply indebted for providing a recommendation that undoubtedly swayed Dr. Barry Popkin to take me on as a student. I also thank Lindsey Smith, Kevin Mathias, Dalia Stern, Carmen Piernas, and Carolina Batis, who were my greatest resources in the pursuit of my PhD.

Of course these simple words cannot fully express my gratitude to the individuals named above. Thus, in honor of all those who supported me during this process, I aim to achieve many great things on their behalf during the course of my research career.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND SYMBOLS

CPG	Consumer-packaged goods
FNDDS	Food and Nutrient Database for Dietary Studies
FPL	Federal Poverty Level
FPI	Food Price Index
NHANES	What We Eat In America, National Health and Nutrition Examination Survey
RTE	Ready-to-eat
SSB	Sugar-sweetened beverage
SNAP	Supplemental Nutrition Assistance Program
US	The United States
USDA	The United States Department of Agriculture
WIC	The Special Supplemental Nutrition Program for Women, Infants and Children

CHAPTER 1. INTRODUCTION

Background

In response to an epidemic of childhood obesity in the United States, beverages have risen to the top of the list of dietary factors to which the current dilemma is attributed. Beverages, such as sugar-sweetened beverages (SSB) and whole-fat milk consistently rank among the leading sources of calories from solid fats and added sugars (empty calories) in the diets of U.S. children (1, 2). Though certain *foods* also rank among the top sources of empty calories in children's diets (2), consuming too many calories from beverages may promote overeating in ways that foods do not. Under optimal conditions, hunger and satiety are tightly controlled to ensure that caloric intake does not exceed caloric demand. However, relative to the calories they provide, satiety from consuming beverages may be less than that from foods (3-8). Consequently, consuming too many empty calories from beverages may promote weight gain (9, 10).

In recent years, preschooler diet has been seen as a major focus for preventing excess weight gain in children. Not only is the prevalence of obesity lower among preschoolers (11), but this developmental period is marked by the formation of dietary preferences and behaviors that may track into later stages in life (12, 13). Thus, obesity-related dietary interventions may be especially effective among preschool children. Total energy intake among U.S. preschool children (ages 2-5y) decreased between 2003-04 and 2009-10. However, no work has examined how intakes of beverages among U.S. preschoolers (ages 2-5y) changed from 2003-04 through 2011-12. Furthermore, how eating location (at home vs. away from home) and source of calories (e.g. stores, restaurants, cafeterias, etc.) may have contributed to dietary changes over this period is unclear.

U.S. preschooler diets are high in beverages like high-fat (>1% fat) milk and sugar-sweetened beverages (SSBs) (14), which has prompted calls for taxing these beverages from a number childhood obesity researchers and health advocates to limit their consumption in the general population (15-21). Yet, how taxes on beverages high in sugar and/or fat might influence purchases of foods and beverage among households with preschool children is unclear. While a number of studies have used household purchases data to examine these relationships among a general sample of U.S. households, none to our knowledge have focused on households with a preschool child. Furthermore, it is unclear whether taxes on beverage high in sugar and/or fat may have unintended consequences (22), such as increasing purchases or other beverages or foods high in sugar and/or fat. In the majority of previous studies, the relationship between beverage taxes and only foods was examined, thus making it unclear – particularly among households with young children – how targeted beverage taxes might influence purchases of foods.

In addition to calls for taxing SSBs, some have suggested that other beverages high in fats and/or sugars also be taxed (20, 21), which would include >1% fat/high-sugar milks. There is, however, little empirical evidence on how imposing taxes on these beverages in addition to SSBs may influence food/beverage purchases among U.S. households with a preschool child. Moreover, those who've called for such taxes, as well as the majority of studies to explore such taxes, have focused on taxes of 20% or more (15-27). Thus, it remains unclear whether taxes of

10% or 15% on beverages high in sugars and/or fats may reduce purchases and/or intakes of these beverages.

Lastly, there is a particular need for studies examining how such taxes might influence food/beverage *intakes*, particularly in young children. Several prior studies have used household purchase data to examine these relationships with regards to food/beverage purchases (22-27), yet it these studies it is not clear how targeted beverage taxes relate to the dietary *intakes* of individuals within the household. Moreover, as individuals' dietary intake may be poorly reflected in total household purchases (28), there is a particular need for studies examining the relationships between targeted beverage taxes and food/beverage *intakes*. Furthermore, there is a need to examine these relationships at different household income levels, as it has been previously noted that a tax on SSBs might be more burdensome for low- vs. high-income households ('regressive') (25, 29).

To address these important gaps, this research examined trends in beverage intakes among U.S. preschool children between 2003 and 2012 using data from the National Health and Nutrition Examination Survey (NHANES). Next, data from the Nielsen Homescan Panel (2009-2012) were used to examine the relationship between beverage prices and food/beverage *purchases* in U.S. households with a preschool child. Lastly, this analysis was extended to include years 2003-2012 of the Homescan data in order to estimate demand relationships for 10 years of data corresponding to survey years 2003-2012 in NHANES. Resulting demand relationships from Homescan were applied to dietary data from NHANES to predict changes in caloric intakes among U.S. preschool children with 10%, 15% and 20% increases in the prices of SSBs.

Research Aims

Aim 1: Characterize beverage intake trends from 2003 to 2012 among U.S. preschoolers

1a. We examined the overall trends in intakes of 10 beverages, total milks, total sugar-sweetened beverages (SSBs), 100% juice, low/no-calorie beverages, and total foods among U.S. children ages 2-5 y from 2003 to 2012.

1b. We explored how eating location (at home vs. away from home) and source of calories (e.g., stores, restaurants, cafeterias, vending, etc.) contributed to trends in intakes of beverages and total foods in children ages 2-5 y between 2003 and 2012.

Aim 2: Examine how increases in the prices of selected beverages high in sugar and/or fat, by 10%, 15% and 20%, influence food and beverage purchases and intakes among U.S. preschool children and their households.

2a. We examined the relationship between 10%, 15% and 20% increases in the prices of SSBs, or SSBs *and* >1% fat/high-sugar milks, and food and beverage *purchases* among U.S. households with a single preschool child.

2b. We examined the relationship between 10%, 15% and 20% increases in the prices of SSB and *intakes* of 10 beverages, total SSBs, total >1% fat/high-sugar milks, selected foods, total foods, and total caloric intake among U.S. preschool children.

2c. We examined whether these relationships differed by level of household income using 0-185% Federal Poverty Level (FPL), >185-350% FPL, and >350% FPL.

CHAPTER 2. LITERATURE REVIEW

Beverages play an important role in child obesity

Beverages play a central role in child obesity risk. Milk (5), sugar-sweetened beverages (SSB) (6), and 100% fruit juice (7), have long been the focus of obesity prevention policies and interventions, and >1% fat milk and SSBs are leading sources of solid fats and added sugars in children (18). In addition, beverage calories are thought to contribute to excess caloric intake and weight gain by exerting a lesser effect on satiety than calories from food (19-23). As foods are consumed, children adjust their caloric intake to their caloric needs (24, 25). It may be more difficult, however, to compensate for calories from beverages, which may contribute to consuming more calories than are needed (26).

Preschool children are an important population for child obesity prevention

Preschool children (ages 2-5 years) are an ideal population for dietary interventions to prevent obesity. As eating behaviors and food preferences are formed during the first five years of life (2, 3), the preschool years encompass a critical period for developing beverage intake behaviors that may track into later stages of development. There may also be greater opportunity to prevent excess weight gain in preschoolers, among whom the prevalence of obesity is lower than that of older children (8.4% vs. 17.7% for 6-11y; 20.5% 12-19y) (1).

Preschoolers' beverage trends since 2003 are examined in limited detail

After decades of rapid increases in the prevalence of child obesity, which more than doubled between 1977 and 2003 (28), the rate of preschoolers' obesity was unchanged between 2003 and 2010 (1). The unexpected leveling off of preschoolers' obesity in recent years may be due, in part, to changes in beverage intake (29). However, little is known of how beverage intakes have changed in U.S. preschoolers since 2003. While a few studies have examined trends in preschoolers' dietary intake for portions of this time period, beverage intake were examined in only limited detail. Broad beverage groupings were used in a 2013 study examining trends in sources of solid fats and added sugars among U.S. children from 1994 to 2010 (18), and in a 2013 study examining dietary intake trends in U.S. children ages 2-6 years from 1989-2008 (18, 30), the use of broad beverage groups in these studies may mask important trends within beverage categories. 'Milk', for example, was identified in a 2013 study as a key source of solid fats in the diets of U.S. children (31). 'Milk', however, comprises both high- and low-fat varieties, and grouping these milks together conceals this important difference. Sugar-sweetened beverages (SSBs) is another beverage group that frequently comprises several heterogeneous beverage subgroups, such as caloric sodas, fruit drinks, and sport drinks, that is both heterogeneous, and inconsistently defined in prior studies (18, 30, 32, 33). As a result, trends in beverages comprising these groups (e.g., caloric sodas, juice drinks and colas) among preschoolers are unclear. It is also unclear how trends how eating location (at home vs. away from home) and source of calories (stores, restaurants, cafeterias, etc.) may have contributed to changes in dietary intakes since 2003 among U.S. preschoolers.

The relationship between beverage price increases and food/beverage purchases among U.S. households with a preschool child is unclear

Preschoolers, owing to their young age and limited income, are unlikely to purchase beverages themselves. Rather, it is parents/guardians who purchase foods/beverages made available to preschoolers within the home, which is a critical determinant of food/beverage intake in children.(12) Yet, while parents/guardians are the implied targets of higher beverage taxes, no prior study (to our knowledge) has examined the effect of price increases on beverage purchases among households with preschool children.

It is unclear how taxing other beverages high in sugar and/or fats are taxed may influence

In addition to calls for taxes on SSBs, some have also suggested that other beverages high in sugar and/or fats also be taxed to discourage their consumption (1, 2). Such beverages might include milks containing >1% fat by volume, or >22 g of sugar per 8 oz serving (3, 4). However, as prior studies have focused only simulating 'taxes' on SSBs (5-9), it remains unclear how food/beverage purchases might change when SSBs *and* >1% fat/high-sugar milks are simultaneously taxed.

The relationship between beverage price increases and food/beverage intake among U.S. preschool children is unclear

The few studies to examine the relationship between higher beverage prices and beverage intake in young children have focused on SSBs, and reported no significant relationship between price and intake (13, 14). Nevertheless, these studies used state-level soda tax rates to model beverage price change (13, 14), which poses several major limitations. First, state-level soda taxes are relatively small, ranging from zero to seven percent of initial beverage price.

Therefore, state-level tax rates allow only a small magnitude of price change to be examined, whereas larger price increases may be needed in order to observe decreases in intake (47). A further limitation of state-level tax rates is their effects on beverage prices may be masked by market-level variation in prices. Within a state, beverage prices may vary substantially from market to market,(48) such that any effects of state-level tax rates on beverage prices may be subsumed or negated. Lastly, sales taxes, unlike excise taxes – which are reflected in shelf price, are not imposed until the point of purchases. Thus, whereas the opposite is true for excise taxes, sales taxes are unlikely to influence consumer behavior (10). Therefore, there is a need for examining the relationship between beverage prices, as a proxy for excise taxes, and food/beverage purchases and intakes among U.S. preschool children and their households.

It is unclear whether taxes of 10% and 15% may also significantly reduce intakes of beverages high in sugar and/or fat.

The predominance of previous studies to explore the relationships between beverage prices and food and/or beverage purchases have used taxes of 20% or more (5, 7-9, 11). It has been previously suggested that taxes less than 20% would not have an appreciable influence on consumer behavior (12-14). However, the few prior studies to examine how beverages taxes of less than 20% influence consumer behavior (13, 14), used state-level soft drink sales taxes – which tend to be small in magnitude – to explore this relationship. Moreover, because sales taxes are not typically reflected in shelf price, they are unlikely to influence consumer behavior (10). Thus, in light of recent voter opposition to policies proposing taxes of 20% or more on SSBs (15-19), there is cause to examine these relationships using taxes of 10% and 15%.

It is unclear whether the relationship between SSB price increases and food/beverage intakes among U.S. preschool children differ by level of household income

Two prior studies have noted that the relationship between SSB price increases and food/beverage purchases differed between households earning 0-185% FPL, and those earning >185% FPL (7, 20). Moreover, findings from these studies suggested that a tax on SSBs might be more burdensome for low- vs. high-income households ('regressive') (7, 20). However, these relationships have yet to be examined among U.S. preschool children and their households. Moreover, no study has combined purchase and price data from Nielsen Homescan with dietary intake data from NHANES to explore these relationships.

CHAPTER 3. 10-YEAR BEVERAGE INTAKE TRENDS AMONG U.S. PRESCHOOL CHILDREN: RAPID DECLINES BETWEEN 2003 AND 2010, BUT STAGNANCY IN RECENT YEARS

Overview

It has been previously reported that total energy intake among U.S. preschool children (ages 2-5y) decreased between 2003-04 and 2009-10. However, little is known about how intakes of beverages among U.S. preschoolers (ages 2-5y) changed from 2003-04 through 2011-12. This paper examines changes in intakes of key beverages during this period, as well as how eating location (at home or away from home) and source (store vs others) may have contributed to these changes. Cross-sectional day one dietary data among children ages 2-5y from the National Health and Nutrition Examination Survey (NHANES) 2003-04, 2005-06, 2007-08, 2009-10 and 2011-12 were used. Survey-weighted mean intakes by survey year, eating location, and source, were computed for total sugar sweetened beverages (SSBs), milks, 100% juice, low/no-calorie beverages, 10 key beverages, total beverages and total foods. Means were compared using two-tailed z-tests with Bonferroni corrections (α<0.05). These findings suggest improvements in the diets of preschoolers between 2003-04 and 2009-10, of which stores were a major contributor.

Introduction

Beverages such as sugar-sweetened beverages (SSBs) and whole-fat milks are leading sources of added sugars and solid fats, respectively, in the diets of U.S. children (1), and contribute nearly one fifth of total caloric intake (2). Thought to have a smaller relative effect on satiety than foods (3, 4), beverages may promote overeating by making it difficult to adjust food intake as caloric needs are met (5). Thus, over-consuming calories from beverages can lead to excess weight gain (6), which is why beverages are the focus of a number of U.S. child obesity prevention initiatives (7-9). For promoting healthy beverage habits, preschool children (ages 2-5y) are an important population, as this stage encompasses the development of dietary behaviors that may track into later life stages (10).

While earlier studies have found total energy intake among U.S. preschoolers fell by 178 kcal between 2003-04 and 2009-10 (1), little is known of how intakes of beverages such as low-fat, low-sugar milk; 100% fruit juice; and caloric soft drinks may have contributed to this trend. A recent study showed decreases in intakes of SSBs and whole-fat milks, along with increases in intakes of low-fat milk between 2001-02 and 2009-10 (11). However, age group-specific findings were not reported. Slining and Popkin (2013) noted intake of total milks among U.S. preschoolers declined between 2003 and 2010. Yet, changes in intakes of major milk subgroups over this period are unclear, as milks were combined into a single category. The 2010 U.S. Dietary Guidelines for Americans distinguishes milks containing 1% or less fat by volume (low-fat) from those containing more than 1% fat (2% and whole-fat milks) (12). High- and low-fat milks can be further sub-grouped into high- (≥22 g sugar per 8 oz serving) and low-sugar varieties (<22 g sugar per 8 oz serving) (13). To determine how intakes of these subcategories of milk may have shifted since 2003 among U.S. preschoolers, further study is needed. Recent changes in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC), in particular, give cause to investigate these important milk subgroups. In 2009, WIC replaced whole milk with milks containing ≤2% fat content in packages for children ages two and older (14).

Similarly, there is cause for further investigation of trends in intakes of SSBs among U.S. preschoolers since 2003. Healthy People, directed by the U.S. Department of Health and Human Services, aims to improve the health of the U.S. population by setting goals every ten years to direct major public health initiatives. Reducing consumption of calories from added sugars among individuals ages two and older was an objective in Healthy People 2020 (15). SSBs are known to be a leading source of added sugars in the diets of U.S. preschoolers (16), and taxing these beverages has been a central controversy in the childhood obesity prevention discourse (17). Yet, while a 2013 study found total intake of SSBs among U.S. preschoolers also declined between 2003 and 2010 (18), intakes of key sugared beverages such as caloric soft drinks, juice drinks, and sport and energy drinks, were not reported separately, making it unclear how intakes of these beverages among U.S. preschoolers changed over this period.

By source (where the food/beverage is purchased/obtained), preschool children consume more calories from stores than from all other sources combined, and the majority of these foods/beverages are consumed at home (19). Despite the significance of these food/beverage intake domains, there have been no studies to examine how beverage intake by eating location (at home or away from home) and source have changed since 2003. Moreover, as several major retailers and food manufacturers pledged to make healthier products and sell fewer calories during this period (20), there is particular cause to investigate trends in preschooler beverage intakes from stores.

To address these important gaps, we used the What We Eat in America dietary intake data from the National Health and Nutrition Examination Survey (NHANES) 2003-2004; 2005-2006; 2002-2008; 2009-2010; and 2011-2012. We aimed first to determine whether there were significant changes in intakes of total calories, total beverages, total milks, SSBs, 100% fruit juice, and low/no-calorie beverages among U.S. preschool children between 2003 and 2012. Next, we sought to characterize trends in intakes of important beverages comprising these larger groups. Lastly, we looked at how eating location (at home or away from home) and source (stores, dine-in restaurants, fast food restaurants, school cafeteria or child care center, and all other sources) contributed to changes in intakes of these beverages over time.

Methods

Data and subjects

We used data from NHANES, a survey of foods consumed by the U.S. population administered jointly by the U.S. Department of Health and Human Services and the U.S. Department of Agriculture (USDA). NHANES uses a complex multi-stage sampling design in order to optimally reflect the demographic composition of the U.S. population during each 2-year survey cycle (21). Diet is ascertained using interviewer-administered 24-hour dietary recall surveys and a 5-step automated multiple pass procedure to enhance the accuracy of reported data (22). Parents/caregivers, who completed dietary recall interviews by proxy for children younger than six, were asked to report whether foods/beverages were consumed at or away from home, as well as the source of each food reported. Respondents could select from 22 possible food/beverage sources, which we grouped into the following larger categories: 1) stores; 2) dine-in restaurants; 3) fast-food restaurants; 4) school cafeterias or child care centers; and 5) all other sources.

Nutrient information on foods/beverages reported consumed in the dietary data were derived using the USDA Food and Nutrient Database for Dietary Studies (FNDDS). Demographic and dietary intake data were included for children ages 2-5 years who participated in NHANES during survey years 2003-04, 2005-06, 2007-08, 2009-10, and 2011-12. These survey years were selected in order to examine a 10-year period, during which NHANES surveys used consistent methodology (21). Our focus on this 10-year period was also motivated by the apparent shift in the trend of U.S. child obesity that occurred between 2003-04 and 2011-12 (23). Five versions of the FNDDS were used: version 2.0 was applied to NHANES 2003-2004; version 3.0 was applied to NHANES 2005-2006; version 4.1 was applied to NHANES 2007-2008; version 5.0 was applied to NHANES 2009-2010, and FNDDS 2011-2012 was applied NHANES 2011-2012. Per person beverage intake was computed using data from a single 24-hour recall collected on the first of two days of recall.

Food grouping system

Beverages consumed by respondents were partitioned into categories with the goal of creating beverage groups with public health significance (24). Thus, we sought to separate total milks by fat and sugar content, disaggregate sugar-sweetened beverages into important subgroups, and to discern 100% fruit juice from juice-containing drinks consisting of less than 100% juice. NHANES foods/beverages are characterized by a USDA food code, corresponding food description, and nutrient profile. Using these data, we created six major beverage groups: 1) total beverages; 2) total milks; 3) SSBs; 4) 100% fruit juice; 5) low/no-calorie beverages; and 6) all other beverages. The intake of total milks was computed by summing intakes of all USDA food codes corresponding to liquid milks, then further separating them into four categories using nutrient values from FNDDS and sugar and fat content guidelines specified by the Institute of

Medicine (24). Milks containing ≥22 grams of sugar per 8-ounce serving were classified as 'high-sugar', while milks containing ≤1% fat by volume were classified as 'low-fat', resulting in a total of four groups: 1) low-fat, low-sugar milk; 2) low-fat, high-sugar milk; 3) >1% fat, low-sugar milk; and 4) >1% fat, high-sugar milk. 'Sugar-sweetened beverages' is commonly used in the literature to refer to juice drinks (fruit flavored and/or juice-containing beverages comprising <100% fruit juice), caloric soft drinks, and sport and energy drinks (25, 26). Accordingly, SSBs were sub-divided into juice drinks, caloric soft drinks, and sport and energy drinks. We also created a fourth SSB subcategory, other SSBs, to capture less commonly consumed (by young children) SSBs such as sweetened teas, coffees, and hot chocolate, sweetened soymilks, horchata and other ethnic beverages. NHANES also provides combination codes, which we used to identify when beverages had sugars added (e.g., sugar to coffee) prior to consumption. One hundred percent fruit juices included all USDA food codes with descriptions containing "100% juice" or "orange juice", excluding juice drinks, and fruit nectars. Low/no-calorie beverages were defined as the sum of intakes of diet beverages, and tap, bottled, and flavored waters, as these beverages had low rates of consumption among the sample population. In total, 10 mutually exclusive beverage subgroups were identified. Our approach to beverage classification is consistent with the approaches of several prior studies (11, 25, 26). A detailed list of the USDA Food Codes and corresponding descriptions comprising each beverage group is given in **Supplemental Table 3.1**.

Statistical Analysis

All analyses were conducted using Stata (version 13, 2011, StataCorp, College Station, TX). Survey weights designed for the sample providing day one dietary data were used to compute simple mean intakes per person (in kcal/d and grams/d) of total foods, total beverages, total milks, total SSBs, 100% fruit juice, total low/no-calorie beverages, and each of 10 beverage sub-groups. Mean values from survey years 2009-10, and 2011-12 were compared to mean values from survey year 2003-04 using two-tailed z-tests. Mean values from survey years 2009-10 and 2011-12 were also compared using this approach. Similarly, overall mean values by group were compared, along with mean values by eating location, and source, within each group. P¬-values were corrected using Bonferroni adjustment for three comparisons, and $\alpha<0.05$ as the threshold for statistical significance.

Results

Select demographic characteristics of the sample are presented in **Table 3.1**. Respondents were predominantly non-Hispanic White, and from households earning >185% FPL annually. Demographic characteristics of the sample did not differ appreciably between 2003-04 and 2009-2010, between 2003-04 and 2011-12, or between 2009-10 and 2011-12.

Overall trends

Figure 3.1a shows mean total caloric intake, caloric intake from beverages, and caloric intake from foods by survey cycle. Per person mean total caloric intake fell by 132 kcal/d between 2003-04 and 2011-12, but trended upward (+49 kcal/d; $p>0.05$) between 2009-10 and 2011-12. Similarly, caloric intakes from beverages fell by 77 kcal/d between 2003-04 and 2011-12, but beverage intake did not differ between 2009-10 and 2011-12. Over the same period, there was a non-significant decrease (-55 kcal/d; $p>0.05$) in total food intake, which trended upward between 2009-10 and 2011-12 (+53 kcal/d; $p>0.05$).

Table 3.2 shows mean intake from four major beverage groups, and 10 beverage subgroups, by survey cycle among U.S. preschool children. Intake of total SSBs decreased by

57 kcal/d between 2003-04 and 2011-12. Much of this decrease was from juice drinks, which fell by 37 kcal, and soft drinks, which fell by 13 kcal/d between 2003-04 and 2011-12. There were no significant differences in total milk intake between 2003-04 and 2011-12, but intake of >1% fat, low-sugar milk decreased by 39 kcal/d. Total caloric intake from milk also trended downward between 2003-04 and 2011-12 (-21 kcal/d), but this difference was not statistically significant. Total milk intake in grams showed a similar downward trend, indicating that the shift from whole to reduced fat milk only partially attenuated this downward trend (see Appendix Table 2). Intakes of total milks, total SSBs, 100% juice, and low/no-calorie beverages did not differ between 2009-10 and 2011-12. Trends in intakes of total milks, total SSBs, 100% juice, and low/no-calorie beverages are shown in **Supplemental Table 3.2**.

Figure 3.1b shows mean caloric intake from beverages by eating location and survey cycle. In all survey cycles, the majority of beverage calories were consumed at home. Per person intake of beverage calories consumed at home fell by 73 kcal/d between 2003-04 and 2011-12, but there were no differences in beverage calories consumed at home between 2009-10 and 2011-12. There were also no significant changes in intake of beverages consumed away from home over the same period. A complete list of intakes of total foods, total beverages, and 10 major beverages by eating location and survey year are shown in **Supplemental Table 3.3**. **Figure 3.1c** shows mean caloric intake from beverages by source and survey cycle. Stores were the major source of beverage calories for all survey cycles. Between 2003-04 and 2011-12, beverage intake from stores fell by 106 kcal/d, while there were slight, but significant increases in beverages consumed from dine-in restaurants (+7 kcal/d) and all other sources (+11 kcal/d). Trends in intakes of total foods, total beverages, and 10 major beverages by source (in grams/d and kcal/d) are shown in Supplemental Table 3.4.

Discussion

Past studies found total energy intake from beverages among preschoolers fell between 2003-04 and 2009-10, and we extended this to 2011-12. We found that while energy intake from foods was also significantly lower in 2011/12 compared to 2003-04, the 2011-12 levels were not significantly different from 2009-10. These findings suggest much of the decline in intakes occurred between 2003-04 and 2009-10. However, we did find large, but non-significant increases in intakes of total foods and total calories between 2009-10 and 2011-12, which may suggest that caloric intake from foods among U.S. preschools may yet again be on the rise. We also observed a sharp decrease in intakes of SSBs between 2003-04 and 2011-12, with SSB intake decreasing by 60 kcal between 2003-04 and 2009-10 alone. While Kit, Fakhouri and Park et al. (2013) also used NHANES data, they found a smaller decrease in total SSB intake over the same period, as well as smaller mean intakes at each time in 2003-04, 2005-06, 2007-08, and 2009-10. While this difference is likely due to differences in the USDA food codes contained within the SSBs group, Kit et al. do not describe their approach in enough detail to allow for comparison of their methods with our own. Nonetheless, we followed the approaches of previous works to create our beverage groupings (25), in addition to providing a comprehensive list of the 365 USDA food codes comprising each of our beverage groupings. To our knowledge, only one other published study has supplied a similar list (11), thereby making it difficult to compare findings across studies.

In addition, recent findings showed decreases in intakes of whole-fat milks, and increases in intakes of low-fat milks, among all U.S. children (ages 2-19y) between 2001-02 and 2009-10 (11). Similarly, we found while there was a meaningful (>|10| kcal/d) but not statistically significant reduction in total milk, we found that intake of >1% fat, low-sugar milk decreased between 2003-04 and 2011-12. Also, there was a meaningful but non-significant increase in intake of low-fat, low-sugar milk (13 kcal/d; +23grams/d) which could suggest preschoolers switched from consuming higher-fat milks, to consuming 1% or skim varieties. Notably, WIC revised its packages for children ages two and older by replacing whole milk with 2% milk in 2009 (14). We did not, however, find evidence of shifts in milk intake between 2009-10 and 2011-12, which may suggest too little time has passed for the WIC changes to have appreciably influenced milk intakes.

By eating location, there was a significant decline in beverage calories consumed at home (-63 kcal/d), but no statistically significant changes in beverage calories consumed away from home. Changes in beverage calories consumed by source supported this finding, as foods/beverages consumed at home predominantly come from stores (19). Beverage calories purchased from stores decreased by 106 kcal/d between 2003-04 and 2011-12 among U.S. preschool children. Over the same period, there were marginal, but significant increases in beverage calories from other sources.

There are several important limitations to our study. First, we used a single 24-hour dietary recall survey to ascertain average daily intake of all foods and beverages, which may be insufficient for capturing usual intake of episodically-consumed beverages. Nonetheless, our focus here was to examine trends in intakes of key beverages such as milks, 100% fruit juice, and sugar-sweetened beverage, which tend to be consumed by a significant proportion of U.S. preschool children (27). Other beverages such as diet drinks, sport and energy drinks, and bottled and flavored waters have lower rates of consumption (11), and thus assessment of these beverages using a single 24-hour recall may be prone to error.

The potential for reporting bias (under- or over-reporting) is another limitation. Increasing public awareness of the adverse effects of beverages on risk of child obesity could increase the likelihood of over-reporting of foods perceived as healthy, and/or under-reporting of foods perceived as unhealthy (28). For all children included in our sample, parents/caregivers were asked to report their child's diet, which could increase the potential for intentional misreporting of the child's diet, particularly if the parent feels guilty about the healthfulness of their child's diet (29). There is, however, little evidence of this occurring in the literature.

Conclusion

Our study provides evidence the diets of U.S. preschool children changed significantly between 2003-04 and 2009-10. These changes coincide with plateauing rates of obesity among U.S. preschool children (1), which could indicate a potential link. However, while there were no significant differences, there were large increases in intakes of total calories, and calories from food between 2009-10 and 2011-12. This finding suggest that, although caloric intake from food decreased between 2003-04 and 2009-10 among U.S. preschool children, there is limited evidence that this trend may be slowing or reversing in recent years, which could be a cause for concern. By source, changes occurred primarily in foods/beverages obtained from stores, which could be the result of changes in parent/guardian purchasing behaviors, and/or food manufacturers and/or retailer initiatives to develop healthier products and sell fewer calories. This period also encompassed important changes in the economic climate, cost of living, and food and beverage prices (2), which also may have driven changes in preschooler diets. Accordingly, further study is needed to determine which (if any) public health efforts may have contributed to these changes. Thus, while our study points to improvements in the diets of U.S.

preschool children between 2003-04 and 2009-10, there is some evidence that progress may be slowing or reversing in recent years.

Tables and Figures

Table 3.1. Sample size by survey year and selected demographic characteristics of children ages 2-5y who participated in What We Eat In America, the dietary component of the National Health and Nutrition Examination Survey 2003-04, 2005-06, 2007-08, 2009-10 or 2011-12

	2003-04	2005-06	2007-08	2009-10	2011-12
Total observations	763	902	832	861	834
Age	<------------------------------------	----------	-%-	----------	------------------------------------>
2-3 y	47%	50%	51%	51%	53%
4-5 y	53%	50%	49%	49%	49%
Race/ethnicity					
Non-Hispanic White	60%	56%	56%	56%	54%
Non-Hispanic Black	14%	15%	14%	13%	16%
Hispanic	18%	22%	23%	24%	24%
Household income (%FPL)					
<100% FPL	31%	25%	25%	28%	32%
100-130%	9%	9%	9%	9%	11%
131-185%	12%	13%	11%	13%	15%
>185% FPL	48%	53%	55%	50%	42%

* Value was significantly different from value in 2003-04, Bonferroni-adjusted $p<0.05$

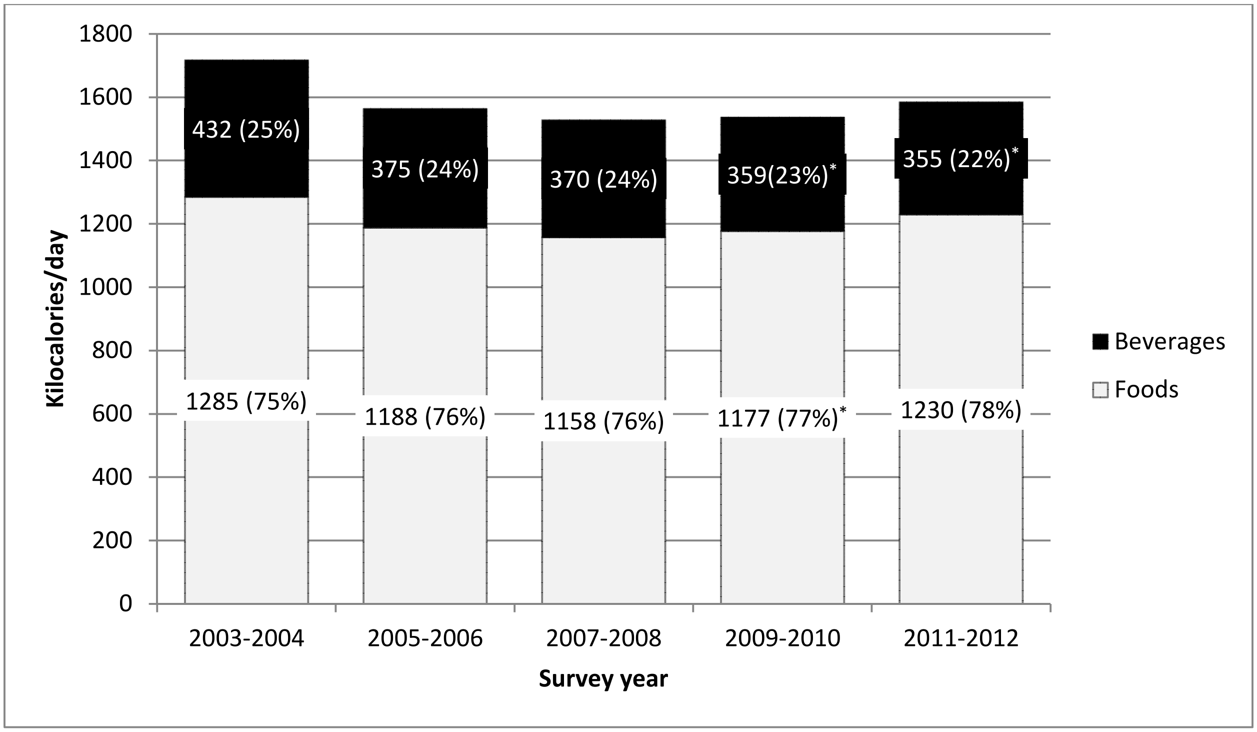
† Value in 2011-12 was significantly different from value in 2009-10, Bonferroni-adjusted $p<0.05$

Table 3.2. Mean (± standard error) beverage intake (in kcal/d and grams/d) by survey year for children ages 2-5 y who participated in What We Eat In America's National Health and Nutrition Survey 2003-04, 2005-06, 2007-08, 2009-10, or 2011-12

	2003-04	2005-06	2007-08	2009-10	2011-12
	<---------------------------------Kcals/d--------------------------------->				
Total milks	**231 ± 11**	**196 ± 9**	**217 ± 10**	**215 ± 11**	**207 ± 17**
Low-fat, low-sugar milk	18 ± 6	20 ± 4	20 ± 4	32 ± 3	31 ± 11
Low-fat, high-sugar milk	6 ± 2	3 ± 1	8 ± 3	9 ± 2	6 ± 2
>1% fat, low-sugar milk	166 ± 10	135 ± 9	137 ± 7	124 ± 8*	124 ± 11*
>1% fat, high-sugar milk	41 ± 7	38 ± 7	52 ± 6	50 ± 8	47 ± 9
100% juice	**40 ± 5**	**39 ± 8**	**43 ± 4**	**34 ± 6**	**38 ± 5**
Sugared beverages	**154 ± 8**	**134 ± 6**	**99 ± 5**	**94 ± 3***	**97 ± 9***
Juice drinks	110 ± 9	99 ± 5	69 ± 4	72 ± 3*	73 ± 7*
Sports and energy drinks	4 ± 1	3 ± 1	2 ± 1	3 ± 1	1 ± 1
Caloric soft drinks	32 ± 4	27 ± 4	24 ± 3	15 ± 2*	19 ± 2*
Other SSBs	6 ± 3	6 ± 2	4 ± 1	5 ± 1	6 ± 2
	<-------------------------------Grams/d------------------------------->				
Low/no-calorie beverages	**22 ± 7**	**19 ± 5**	**35 ± 6**	**59 ± 11***	**35 ± 5**
Diet drinks	21 ± 7	15 ± 4	34 ± 6	57 ± 11*	32 ± 5
Tap, bottled, and flavored water	1 ± 1	4 ± 3	2 ± 1	2 ± 1	3 ± 1

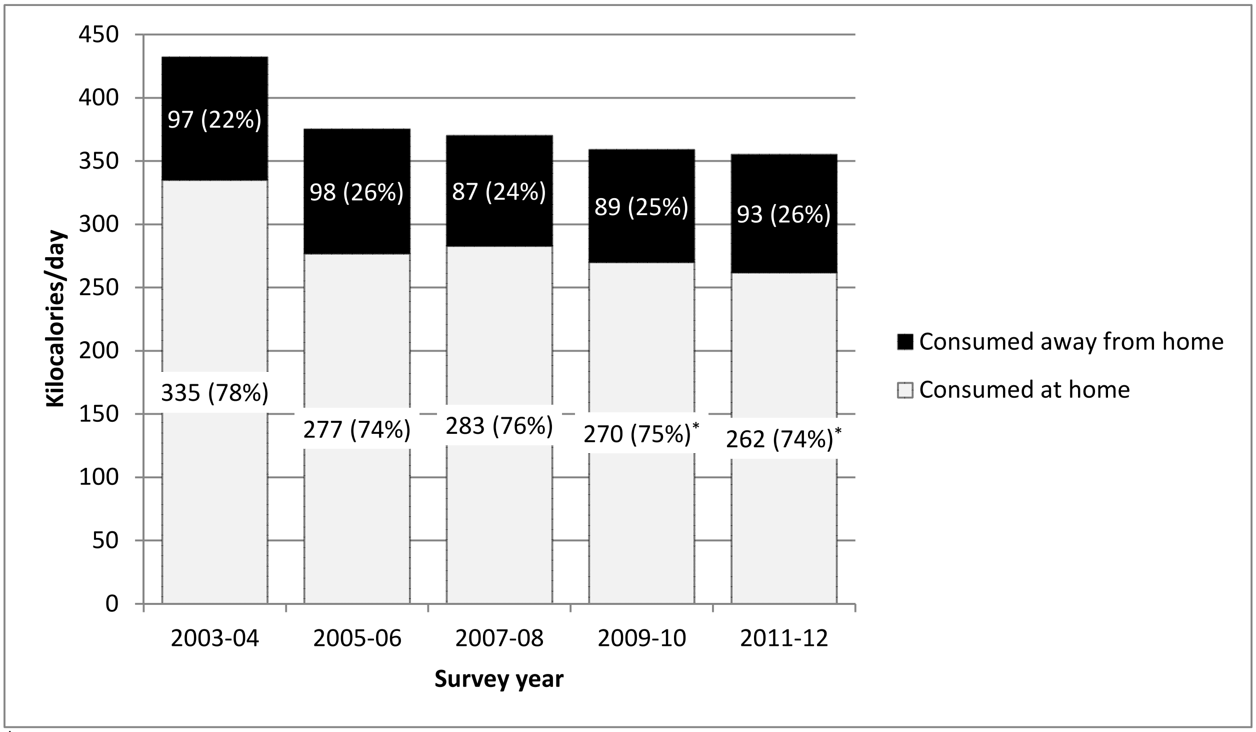
Totals intakes of milk, 100% juice, sugared beverages, and low/no-calorie beverages are shown in bold
* Value was significantly different from value in 2003-04, Bonferroni-adjusted $p<0.05$
† Value in 2011-12 was significantly different from value in 2009-10, Bonferroni-adjusted $p<0.05$

Figure 3.1a. Trends in total caloric intake from beverages, foods, and total foods and beverages (kcal/d), from 2003 to 2012 among U.S. children ages 2-5y who participated in What We Eat In America, the dietary component of the National Health and Nutrition Examination Survey during survey cycles 2003-04, 2005-06, 2007-08, 2009-10, or 2011-12.



* Value was significantly different from value in 2003-04, Bonferroni-adjusted p<0.05
† Value in 2011-12 was significantly different from value in 2009-10, Bonferroni-adjusted p<0.05

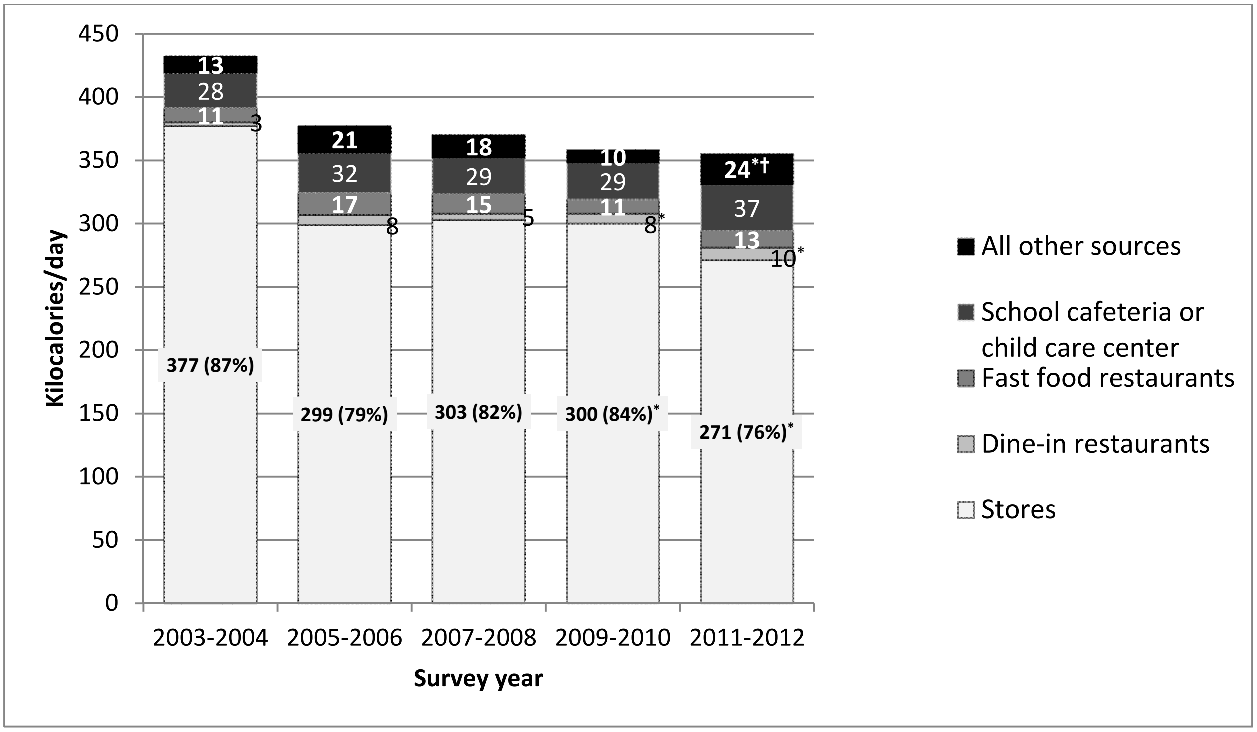
Figure 3.1b. Trends in total beverage intake (kcal/d) by eating location (home or away) from 2003 to 2012, U.S. children ages 2-5 years among U.S. children ages 2-5 years who participated in What We Eat in America's National Health and Nutrition Survey during survey cycles 2003-04, 2005-06, 2007-08, 2009-10, 2011-12.



* Value was significantly different from value in 2003-04, Bonferroni-adjusted $p<0.05$

† Value in 2011-12 was significantly different from value in 2009-10, Bonferroni-adjusted $p<0.05$

Figure 3.1c. Trends in total beverage intake by source (kcal/d) from 2003-04 to 2011-2012 among U.S. children ages 2-5y who participated in What We Eat In America, the dietary component of the National Health and Nutrition Examination Survey during survey cycles 2003-04, 2005-06, 2007-08, 2009-10, or 2011-12.



* Value was significantly different from value in 2003-04, Bonferroni-adjusted p<0.05

† Value in 2011-12 was significantly different from value in 2009-10, Bonferroni-adjusted p<0.05

Supplemental Table 3.1. Summary of USDA food codes and descriptions by beverage group*

	USDA foodcode	USDA Food description
Total milks		Low-fat, low-sugar milk
	11111160	MILK, CALCIUM FORTIFIED, COW'S, FLUID, 1% FAT
	11112120	MILK, COW'S, FLUID, ACIDOPHILUS, 1% FAT
	11112210	MILK, COW'S, FLUID, 1% FAT
	11113000	MILK, COW'S, FLUID, SKIM OR NONFAT, 0.5% OR LESS BUTTERFAT
	11114300	MILK, COW'S, FLUID, LACTOSE REDUCED, 1% FAT
	11114320	MILK, COW'S, FLUID, LACTOSE REDUCED, NONFAT
	11115000	BUTTERMILK, FLUID, NONFAT
	11121210	MILK, DRY, RECONSTITUTED, LOWFAT
	11121300	MILK, DRY, RECONSTITUTED, NONFAT
		Low-fat, high-sugar milk
	11511300	MILK, CHOCOLATE, SKIM MILK-BASE
	11511400	MILK, CHOCOLATE, LOWFAT MILK-BASE
	11513300	COCOA AND SUGAR MIXTURE, SKIM MILK ADDED
	11513600	CHOCOLATE SYRUP, LOWFAT MILK ADDED
	11513700	CHOCOLATE SYRUP, SKIM MILK ADDED
	11519200	MILK, FLAVORS OTHER THAN CHOCOLATE, LOWFAT MILK-BASE
	11519205	MILK, FLAVORS OTHER THAN CHOCOLATE, SKIM-MILK BASE
	11560000	CHOCOLATE-FLAVORED DRINK, WHEY- AND MILK-BASE
	11560020	FLAVORED MILK DRINK, WHEY- AND MILK-BASED, FLAVORS OTHER THE
	11513200	COCOA AND SUGAR MIXTURE, LOWFAT MILK ADDED
		>1 % fat, low-sugar milk
	11100000	MILK, NFS
	11111000	MILK, COW'S, FLUID, WHOLE

	11112110	MILK, COW'S, FLUID, 2% FAT
	11114330	MILK, COW'S, FLUID, LACTOSE REDUCED, 2% FAT
	11114350	MILK, COW'S, FLUID, LACTOSE REDUCED, WHOLE
	11116000	MILK, GOAT'S, FLUID, WHOLE
	11121100	MILK, DRY, RECONSTITUTED, WHOLE
	>1% fat, high-sugar milk	
	11511000	MILK, CHOCOLATE, NFS
	11511100	MILK, CHOCOLATE, WHOLE MILK-BASED
	11511200	MILK, CHOCOLATE, REDUCED FAT MILK-BASED, 2% (FORMERLY "LOWFA
	11513000	COCOA AND SUGAR MIXTURE, MILK ADDED, NS AS TO TYPE OF MILK
	11513100	COCOA AND SUGAR MIXTURE, WHOLE MILK ADDED
	11513150	COCOA AND SUGAR MIXTURE, REDUCED FAT MILK ADDED
	11513400	CHOCOLATE SYRUP, MILK ADDED, NS AS TO TYPE OF MILK
	11513500	CHOCOLATE SYRUP, WHOLE MILK ADDED
	11513550	CHOCOLATE SYRUP, REDUCED FAT MILK ADDED
	11519000	MILK BEVERAGE, MADE WITH WHOLE MILK, FLAVORS OTHER THAN CHOC
	11519040	MILK, FLAVORS OTHER THAN CHOCOLATE, NFS
	11519050	MILK, FLAVORS OTHER THAN CHOCOLATE, WHOLE MILK-BASED
	11519105	MILK, FLAVORS OTHER THAN CHOCOLATE, REDUCED FAT MILK-BASED
	11525000	MILK, MALTED, FORTIFIED, NATURAL FLAVOR, MADE WITH MILK
	11526000	MILK, MALTED, FORTIFIED, CHOCOLATE, MADE WITH MILK
	11531000	EGGNOG, MADE WITH WHOLE MILK
100% juice	100% Juice	
	61210000	ORANGE JUICE, NFS
	61210010	ORANGE JUICE, FRESHLY SQUEEZED
	61210220	ORANGE JUICE, CANNED, BOTTLED OR IN A CARTON
	61210250	ORANGE JUICE, WITH CALCIUM ADDED, CANNED, BOTTLED OR IN A CA

61210620	ORANGE JUICE, FROZEN (RECONSTITUTED WITH WATER)
61210820	ORANGE JUICE, FROZEN, WITH CALCIUM ADDED (RECONSTITUTED WITH
61213800	FRUIT JUICE BLEND, INCLUDING CITRUS, 100% JUICE
61213900	FRUIT JUICE BLEND, INCLUDING CITRUS, 100% JUICE, WITH CALCIU
61225000	PINEAPPLE-ORANGE JUICE, NFS
61225220	PINEAPPLE-ORANGE JUICE, CANNED
61226000	STRAWBERRY-BANANA-ORANGE JUICE
64100110	FRUIT JUICE BLEND, 100% JUICE
64100200	FRUIT JUICE BLEND, WITH CRANBERRY, 100% JUICE
78101000	VEGETABLE AND FRUIT JUICE BLEND, 100% JUICE, WITH HIGH VITAM
61201010	GRAPEFRUIT JUICE, FRESHLY SQUEEZED
61201020	GRAPEFRUIT JUICE, NS AS TO FORM
61201220	GRAPEFRUIT JUICE, CANNED, BOTTLED OR IN A CARTON
61201620	GRAPEFRUIT JUICE, FROZEN (RECONSTITUTED WITH WATER)
61204000	LEMON JUICE, NS AS TO FORM
61204010	LEMON JUICE, FRESHLY SQUEEZED
61204200	LEMON JUICE, CANNED OR BOTTLED
61204600	LEMON JUICE, FROZEN
61207000	LIME JUICE, NS AS TO FORM
61207010	LIME JUICE, FRESHLY SQUEEZED
61207200	LIME JUICE, CANNED OR BOTTLED
61207600	LIME JUICE, FROZEN
61210720	ORANGE JUICE, FROZEN, NOT RECONSTITUTED
61213000	TANGERINE JUICE, NFS
61213220	TANGERINE JUICE, CANNED
61213620	TANGERINE JUICE, FROZEN (RECONSTITUTED WITH WATER)
64100100	FRUIT JUICE, NFS
64104010	APPLE JUICE
64104600	BLACKBERRY JUICE

64105400	CRANBERRY JUICE, 100%, NOT A BLEND
64116020	GRAPE JUICE
64120010	PAPAYA JUICE
64121000	PASSION FRUIT JUICE
64124020	PINEAPPLE JUICE
64126000	POMEGRANATE JUICE
64132010	PRUNE JUICE
64132500	STRAWBERRY JUICE
64133100	WATERMELON JUICE
67203000	APPLE WITH OTHER FRUIT JUICE, BABY FOOD
67203200	APPLE-BANANA JUICE, BABY FOOD
67203400	APPLE-CHERRY JUICE, BABY FOOD
67203450	APPLE-CRANBERRY JUICE, BABY FOOD
67203500	APPLE-GRAPE JUICE, BABY FOOD
67203600	APPLE-PEACH JUICE, BABY FOOD
67203700	APPLE-PRUNE JUICE, BABY FOOD
67203800	GRAPE JUICE, BABY FOOD
67205000	ORANGE JUICE, BABY FOOD
67211000	ORANGE-APPLE-BANANA JUICE, BABY FOOD
67230000	APPLE-SWEET POTATO JUICE, BABY FOOD
67230500	ORANGE-CARROT JUICE, BABY FOOD
67250100	BANANA JUICE WITH LOWFAT YOGURT, BABY FOOD
73105010	CARROT JUICE
74301100	TOMATO JUICE
74301150	TOMATO JUICE, LOW SODIUM
74302000	TOMATO JUICE COCKTAIL
74303000	TOMATO AND VEGETABLE JUICE, MOSTLY TOMATO
74303100	TOMATO AND VEGETABLE JUICE, MOSTLY TOMATO, LOW SODIUM
74304000	TOMATO JUICE WITH CLAM OR BEEF JUICE

	75132000	MIXED VEGETABLE JUICE (VEGETABLES OTHER THAN TOMATO)
	75132100	CELERY JUICE
	67204000	MIXED FRUIT JUICE, NOT CITRUS, BABY FOOD
	67204100	MIXED FRUIT JUICE, NOT CITRUS, WITH ADDED CALCIUM, BABY FOOD
	75200700	ALOE VERA JUICE
	67202000	APPLE JUICE, BABY FOOD
	67202010	APPLE JUICE, WITH ADDED CALCIUM, BABY FOOD
	67212000	PEAR JUICE, BABY FOOD
Total sugar-sweetened beverages	Juice drinks	
	11551050	MILK FRUIT DRINK
	64201500	BANANA NECTAR
	64202010	CANTALOUPE NECTAR
	64203020	GUAVA NECTAR
	64204010	MANGO NECTAR
	64205010	PEACH NECTAR
	64210010	PAPAYA NECTAR
	64215010	PEAR NECTAR
	92510150	APPLE JUICE DRINK
	92510170	APPLE-CRANBERRY-GRAPE JUICE DRINK
	92510610	FRUIT JUICE DRINK
	92510630	FRUIT JUICE DRINK, NFS
	92510820	GRAPE JUICE DRINK
	92511010	FRUIT FLAVORED DRINK (FORMERLY LEMONADE)
	92511250	CITRUS FRUIT JUICE DRINK, CONTAINING 40-50% JUICE
	92511260	ORANGE-CRANBERRY JUICE DRINK
	92511270	ORANGE-PEACH JUICE DRINK
	92511290	PAPAYA JUICE DRINK
	92511340	PINEAPPLE-ORANGE JUICE DRINK
	92530410	FRUIT FLAVORED DRINK, WITH HIGH VITAMIN C

92530510	CRANBERRY JUICE DRINK OR COCKTAIL, WITH HIGH VITAMIN C
92530520	CRANBERRY-APPLE JUICE DRINK W/ VITAMIN C ADDED
92530610	FRUIT JUICE DRINK, WITH HIGH VITAMIN C
92530950	VEGETABLE AND FRUIT JUICE DRINK, WITH HIGH VITAMIN C
92531030	FRUIT JUICE DRINK, WITH THIAMIN (VITAMIN B1) AND HIGH VITAMI
92541010	FRUIT FLAVORED DRINK, MADE FROM POWDERED MIX
92542000	FRUIT FLAVORED DRINK, MADE FROM POWDERED MIX,WITH HIGH VITAMIN C
92582100	FRUIT JUICE DRINK, WITH HIGH VITAMIN C, PLUS ADDED CALCIUM
92582110	FRUIT JUICE DRINK, WITH THIAMIN (VITAMIN B1) AND HIGH VITAMI
64134000	FRUIT SMOOTHIE DRINK, MADE WITH FRUIT OR FRUIT JUICE ONLY (NO DAIRY PRODUCTS)
92510720	FRUIT PUNCH, MADE WITH FRUIT JUICE AND SODA
94100300	WATER, FRUIT FLAVORED, SWEETENED, WITH HIGH FRUCTOSE CORN SYRUP AND LOW CALORIE SWEETENER
67260000	FRUIT JUICE DRINK, BABY, WITH HIGH VITAMIN C PLUS ADDED CALCIUM AND B VITAMINS
11553000	FRUIT SMOOTHIE DRINK, MADE WITH FRUIT OR FRUIT JUICE AND DAI
11553100	FRUIT SMOOTHIE DRINK, NFS
Sport and energy drinks	
92560000	FRUIT-FLAVORED THIRST QUENCHER BEVERAGE
92560100	GATORADE THIRST QUENCHER SPORTS DRINK
92560200	POWERADE SPORTS DRINK
92651000	ENERGY DRINK
95320200	GATORADE THIRST QUENCHER SPORTS DRINK
92650205	MOUNTAIN DEW AMP ENERGY DRINK
92650700	ROCKSTAR ENERGY DRINK
92650800	VAULT ENERGY DRINK
95320500	POWERADE SPORTS DRINK
95310200	FULL THROTTLE ENERGY DRINK
95310400	MONSTER ENERGY DRINK
95310500	MOUNTAIN DEW AMP ENERGY DRINK
95310550	NO FEAR ENERGY DRINK

95310555	NO FEAR MOTHERLOAD ENERGY DRINK
95310560	NOS ENERGY DRINK
95310600	RED BULL ENERGY DRINK
95310700	ROCKSTAR ENERGY DRINK
95310750	SOBE ENERGY ENERGY JUICE DRINK
95310800	VAULT ENERGY DRINK
95311000	ENERGY DRINK
95312560	OCEAN SPRAY CRAN-ENERGY CRANBERRY ENERGY JUICE DRINK
95321000	FRUIT-FLAVORED THIRST QUENCHER
92900300	FRUIT-FLAVORED THIRST QUENCHER BEVERAGE, DRY CONCENTRATE, NOT RECONSTITUTED
	Regular soft drinks
92400000	SOFT DRINK, NFS
92410310	SOFT DRINK, COLA-TYPE
92410330	SOFT DRINK, COLA-TYPE, WITH HIGHER CAFFEINE
92410340	SOFT DRINK, COLA-TYPE, DECAFFEINATED
92410360	SOFT DRINK, PEPPER-TYPE
92410390	SOFT DRINK, PEPPER-TYPE, DECAFFEINATED
92410410	CREAM SODA
92410510	SOFT DRINK, FRUIT-FLAVORED, CAFFEINE FREE
92410550	SOFT DRINK, FRUIT FLAVORED, CAFFEINE CONTAINING
92410610	GINGER ALE
92410710	ROOT BEER
92410810	CHOCOLATE-FLAVORED SODA
92411510	COLA WITH FRUIT OR VANILLA FLAVOR
92417010	SOFT DRINK, ALE TYPE
92431000	CARBONATED JUICE DRINK, NS AS TO TYPE OF JUICE
92432000	CARBONATED CITRUS JUICE DRINK
92433000	CARBONATED NONCITRUS JUICE DRINK

Other SSBs	
11321000	MILK, SOY, READY-TO-DRINK, NOT BABY'S, CHOCOLATE
11350010	MILK, ALMOND, READY-TO-DRINK, CHOCOLATE
92611010	OATMEAL BEVERAGE, PUERTO RICAN
92611100	OATMEAL BEVERAGE WITH MILK (ATOLE DE AVENA)
92611510	HORCHATA BEVERAGE, MADE WITH RICE
92611600	HORCHATA BEVERAGE, NFS
92613010	ATOLE (CORN MEAL BEVERAGE)
92613510	CORN BEVERAGE WITH CHOCOLATE AND MILK (CHAMPURRADO, ATOLE DE AVENA)
11512000	COCOA, HOT CHOCOLATE, NOT FROM DRY MIX, MADE WITH WHOLE MILK
11512500	HOT CHOCOLATE, PUERTO RICAN STYLE, MADE WITH WHOLE MILK
11512510	HOT CHOCOLATE, PUERTO RICAN STYLE, MADE WITH LOW FAT MILK
11514100	COCOA, SUGAR, AND DRY MILK MIXTURE, WATER ADDED
92301060	TEA, NS AS TO TYPE, PRESWEETENED WITH SUGAR
92301160	TEA, NS AS TO TYPE, DECAFFEINATED, PRESWEETENED WITH SUGAR
92302200	TEA, LEAF, PRESWEETENED WITH SUGAR
92302600	TEA, LEAF, DECAFFEINATED, PRESWEETENED WITH SUGAR
92305040	TEA, MADE FROM POWDERED INSTANT, PRESWEETENED WITH SUGAR
92305050	TEA, MADE FROM POWDERED INSTANT, DECAFFEINATED, PRESWEETENED WITH SUGAR
92306020	TEA, HERBAL, PRESWEETENED WITH SUGAR
92101650	COFFEE, MEXICAN, REGULAR, SWEETENED (NO MILK; NOT CAFE CON LECHE)
92101920	BLENDED COFFEE BEVERAGE, MADE WITH REGULAR COFFEE, MILK, AND ICE, SWEETENED
92101925	BLENDED COFFEE BEVERAGE, MADE WITH REGULAR COFFEE, MILK, AND ICE, SWEETENED, WITH WHIPPED CREAM
92101930	BLENDED COFFEE BEVERAGE, MADE WITH DECAFFEINATED COFFEE, MILK, AND ICE, SWEETENED
92101935	BLENDED COFFEE BEVERAGE, MADE WITH DECAFFEINATED COFFEE, MILK, AND ICE, SWEETENED, WITH WHIPPED CREAM
92121000	COFFEE, MADE FROM POWDERED INSTANT MIX, WITH WHITENER AND SUGAR, INSTANT
92121010	COFFEE, MADE FROM POWDERED INSTANT MIX, PRESWEETENED, NO WHITENER
92121020	COFFEE AND COCOA (MOCHA), MADE FROM POWDERED INSTANT MIX, WITH WHITENER, PRESWEETENED

	92130000	COFFEE, REGULAR, PRESWEETENED WITH SUGAR, PRE-LIGHTENED
	92130001	COFFEE, DECAFFEINATED, PRESWEETENED WITH SUGAR, PRE-LIGHTENED
	92130020	COFFEE, PRESWEETENED WITH SUGAR
	92192000	COFFEE AND COCOA (MOCHA) MIX, DRY INSTANT POWDER WITH WHITENER, PRESWEETENED
	92193000	COFFEE, DRY INSTANT POWDER, WITH WHITENER AND SUGAR
Low/no-calorie beverages	Diet drinks	
	92410560	SOFT DRINK, FRUIT FLAVORED, CAFFEINE CONTAINING, SUGAR-FREE
	92410520	SOFT DRINK, FRUIT-FLAVORED, SUGAR FREE, CAFFEINE FREE
	92410620	GINGER ALE, SUGAR-FREE
	92410720	ROOT BEER, SUGAR-FREE
	92410820	CHOCOLATE-FLAVORED SODA, SUGAR-FREE
	92411610	COLA WITH FRUIT OR VANILLA FLAVOR, SUGAR-FREE
	92550030	FRUIT JUICE DRINK, LOW CALORIE, WITH HIGH VITAMIN C
	92550040	FRUIT JUICE DRINK, LOW CALORIE
	92550110	CRANBERRY JUICE DRINK OR COCKTAIL, LOW CALORIE, WITH HIGH VI
	92550300	GRAPEFRUIT JUICE DRINK,LOW CALORIE,W/ VITAMIN C
	92550400	VEGETABLE AND FRUIT JUICE DRINK, LOW CALORIE, WITH HIGH VITA
	92550610	FRUIT FLAVORED DRINK, LOW CALORIE, WITH HIGH VITAMIN C
	92550620	FRUIT FLAVORED DRINK, LOW CALORIE
	92551700	JUICE DRINK, LOW CALORIE
	92552000	FRUIT FLAVORED DRINK, MADE FROM POWDERED MIX, LOW CALORIE, W
	92552010	FRUIT FLAVORED DRINK, MADE FROM POWDERED MIX, LOW CALORIE
	92553000	FRUIT-FLAVORED THIRST QUENCHER BEVERAGE, LOW CALORIE
	92565000	FRUIT-FLAVORED SPORTS DRINK OR THIRST QUENCHER BEVERAGE, LOW CALORIE
	92565100	GATORADE G2 THIRST QUENCHER SPORTS DRINK, LOW CALORIE
	92565200	POWERADE ZERO SPORTS DRINK, LOW CALORIE
	92650005	RED BULL ENERGY DRINK, SUGAR-FREE
	92650210	MOUNTAIN DEW AMP ENERGY DRINK, SUGAR-FREE
	92650705	ROCKSTAR ENERGY DRINK, SUGAR-FREE

	92650805	VAULT ZERO ENERGY DRINK
	92741000	FRUIT-FLAVORED DRINK, NON-CARB, FROM LO CAL POWDER
	95312400	MONSTER ENERGY DRINK, LO CARB
	95312500	MOUNTAIN DEW AMP ENERGY DRINK, SUGAR-FREE
	95312550	NO FEAR ENERGY DRINK, SUGAR-FREE
	95312555	NOS ENERGY DRINK, SUGAR-FREE
	95312600	RED BULL ENERGY DRINK, SUGAR-FREE
	95312700	ROCKSTAR ENERGY DRINK, SUGAR-FREE
	95312800	VAULT ZERO ENERGY DRINK
	95322200	GATORADE G2 THIRST QUENCHER SPORTS DRINK, LOW CALORIE
	92550350	LIGHT ORANGE JUICE BEVERAGE, 40-50% JUICE, LOWER SUGAR AND CALORIES, WITH ARTIFICIAL SWEETENER
	92550405	VEGETABLE AND FRUIT JUICE DRINK, LOW CALORIE, WITH HIGH VITAMIN C PLUS ADDED VITAMIN E AND VITAMIN A
	95341000	FUZE SLENDERIZE FORTIFIED LOW CALORIE FRUIT JUICE BEVERAGE
	92410420	CREAM SODA, SUGAR-FREE
	92400100	SOFT DRINK, NFS, SUGAR-FREE
	92410320	SOFT DRINK, COLA-TYPE, SUGAR-FREE
	92410350	SOFT DRINK, COLA-TYPE, DECAFFEINATED, SUGAR-FREE
	92410370	SOFT DRINK, PEPPER-TYPE, SUGAR-FREE
	92410400	SOFT DRINK, PEPPER-TYPE, DECAFFEINATED, SUGAR-FREE
	95322500	POWERADE ZERO SPORTS DRINK, LOW CALORIE
	95323000	FRUIT-FLAVORED SPORTS DRINK OR THIRST QUENCHER BEVERAGE, LOW CALORIE
	92552020	FRUIT JUICE DRINK, REDUCED SUGAR, WITH THIAMIN (VITAMIN B1)
	92552030	FRUIT JUICE DRINK, REDUCED SUGAR, WITH VITAMIN E
	92410315	SOFT DRINK, COLA TYPE, REDUCED SUGAR
	95312900	XS ENERGY DRINK
	95312905	XS GOLD PLUS ENERGY DRINK
	Tap, bottled and flavored waters	

	92410210	CARBONATED WATER, UNSWEETENED
	92410250	CARBONATED WATER, SWEETENED, WITH LOW-CALORIE OR NO-CALORIE
	94100200	WATER, BOTTLED, SWEETENED, WITH LOW OR NO CALORIE SWEETENER
	94210100	PROPEL WATER
	94210200	GLACEAU WATER
All other beverages	All other beverages	
	11514300	COCOA WITH NONFAT DRY MILK AND LOW CALORIE SWEETENER, MIXTURE, WATER ADDED
	11320000	MILK, SOY, READY-TO-DRINK, NOT BABY'S
	11320100	MILK, SOY, LIGHT, READY-TO-DRINK, NOT BABY'S
	11350000	MILK, ALMOND, READY-TO-DRINK
	11561000	CAFE CON LECHE
	41440010	ENSURE LIQUID NUTRITION
	42401010	COCONUT MILK (LIQUID EXPRESSED FROM GRATED COCONUT MEAT, WAT
	42404010	COCONUT WATER, CANNED OR BOTTLED
	92205000	RICE BEVERAGE
	92803000	NONALCOHOLIC MALT BEVERAGE
	95101000	BOOST, NUTRITIONAL DRINK, READY-TO-DRINK
	95101010	BOOST PLUS, NUTRITIONAL DRINK, READY-TO-DRINK
	95102000	CARNATION INSTANT BREAKFAST, NUTRITIONAL DRINK, REGULAR, READY-TO-DRINK
	95102010	CARNATION INSTANT BREAKFAST, NUTRITIONAL DRINK, SUGAR-FREE, READY-TO-DRIN
	95103000	ENSURE, NUTRITIONAL SHAKE, READY-TO-DRINK
	95103010	ENSURE PLUS, NUTRITIONAL SHAKE, READY-TO-DRINK
	95104000	GLUCERNA, NUTRITIONAL SHAKE, READY-TO-DRINK
	95105000	KELLOGG'S SPECIAL K PROTEIN SHAKE
	95106000	MUSCLE MILK, READY-TO-DRINK
	95106010	MUSCLE MILK, LIGHT, READY-TO-DRINK
	95110000	SLIM FAST SHAKE, MEAL REPLACEMENT, REGULAR, READY-TO-DRINK
	95110010	SLIM FAST SHAKE, MEAL REPLACEMENT, SUGAR FREE, READY-TO-DRINK

95110020	SLIM FAST SHAKE, MEAL REPLACEMENT, HIGH PROTEIN, READY-TO-DRINK
95120000	NUTRITIONAL DRINK OR MEAL REPLACEMENT, READY-TO-DRINK, NFS
95120010	NUTRITIONAL DRINK OR MEAL REPLACEMENT, HIGH PROTEIN, READY-TO-DRINK, NFS
95120020	NUTRITIONAL DRINK OR MEAL REPLACEMENT, HIGH PROTEIN, LIGHT, READY-TO-DRINK, NFS
95120050	NUTRITIONAL DRINK OR MEAL REPLACEMENT, LIQUID, SOY-BASED
95201000	CARNATION INSTANT BREAKFAST, NUTRITIONAL DRINK MIX, REGULAR, POWDER
95201010	CARNATION INSTANT BREAKFAST, NUTRITIONAL DRINK MIX, SUGAR FREE POWDER
95201200	EAS WHEY PROTEIN POWDER
95201300	EAS SOY PROTEIN POWDER
95201500	HERBALIFE, NUTRITIONAL SHAKE MIX, HIGH PROTEIN, POWDER
95201600	ISOPURE PROTEIN POWDER
95201700	KELLOGG'S SPECIAL K20 PROTEIN WATER MIX
92301000	TEA, NS AS TO TYPE, UNSWEETENED
92301080	TEA, NS AS TO TYPE, PRESWEETENED WITH LOW CALORIE SWEETENER
92301100	TEA, NS AS TO TYPE, DECAFFEINATED, UNSWEETENED
92301130	TEA, NS AS TO TYPE, PRESWEETENED, NS AS TO SWEETENER
92301180	TEA, NS AS TO TYPE, DECAFFEINATED, PRESWEETENED WITH LOW CALORIE SWEETENER
92301190	TEA, NS AS TO TYPE, DECAFFEINATED, PRESWEETENED, NS AS TO SWEETENER
92302000	TEA, LEAF, UNSWEETENED
92302300	TEA, LEAF, PRESWEETENED WITH LOW CALORIE SWEETENER
92302400	TEA, LEAF, PRESWEETENED, NS AS TO SWEETENER
92302500	TEA, LEAF, DECAFFEINATED, UNSWEETENED
92302700	TEA, LEAF, DECAFFEINATED, PRESWEETENED WITH LOW CALORIE SWEETENER
92302800	TEA, LEAF, DECAFFEINATED, PRESWEETENED, NS AS TO SWEETENER
92304000	TEA, MADE FROM FROZEN CONCENTRATE, UNSWEETENED
92304700	TEA, MADE FROM FROZEN CONCENTRATE, DECAFFEINATED, PRESWEETENED WITH LOW CALORIE SWEETENER
92305000	TEA, MADE FROM POWDERED INSTANT, PRESWEETENED, NS AS TO SWEETENER
92305010	TEA, MADE FROM POWDERED INSTANT, UNSWEETENED
92305090	TEA, MADE FROM POWDERED INSTANT, PRESWEETENED WITH LOW CALORIE SWEETENER

92305110	TEA, MADE FROM POWDERED INSTANT, DECAFFEINATED, PRESWEETENED WITH LOW CALORIE SWEETENER
92305180	TEA, MADE FROM POWDERED INSTANT, DECAFFEINATED, UNSWEETENED
92305800	TEA, MADE FROM POWDERED INSTANT, DECAFFEINATED, PRESWEETENED, NS AS TO SWEETENER
92306000	TEA, HERBAL
92306030	TEA, HERBAL, PRESWEETENED WITH LOW CALORIE SWEETENER
92306040	TEA, HERBAL, PRESWEETENED, NS AS TO SWEETENER
92306050	TEA, MADE FROM CARAWAY SEEDS
92306090	TEA, HIBISCUS
92306100	CORN BEVERAGE
92306200	BEAN BEVERAGE
92306610	TEA, RUSSIAN
92306700	TEA, CHAMOMILE
92307000	TEA, POWDERED INSTANT, UNSWEETENED, DRY
92307400	TEA, POWDERED INSTANT, SWEETENED, NS AS TO SWEETENER, DRY
92307500	HALF AND HALF BEVERAGE, HALF ICED TEA AND HALF FRUIT JUICE DRINK (LEMONADE)
92307510	HALF AND HALF BEVERAGE, HALF ICED TEA AND HALF FRUIT JUICE DRINK (LEMONADE), LOW CALORIE
92100000	COFFEE, NS AS TO TYPE
92100500	COFFEE, REGULAR, NS AS TO GROUND OR INSTANT
92101000	COFFEE, MADE FROM GROUND, REGULAR
92101500	COFFEE, MADE FROM GROUND, EQUAL PARTS REGULAR AND DECAFFEINATED
92101600	COFFEE, TURKISH
92101610	COFFEE, ESPRESSO
92101630	COFFEE, ESPRESSO, DECAFFEINATED
92101640	COFFEE, MEXICAN, REGULAR, UNSWEETENED (NO MILK; NOT CAFE CON LECHE)
92101660	COFFEE, MEXICAN, DECAFFEINATED, UNSWEETENED (NO MILK; NOT CAFE CON LECHE)
92101670	COFFEE, MEXICAN, DECAFFEINATED, SWEETENED (NO MILK; NOT CAFE CON LECHE)
92101700	COFFEE, MADE FROM GROUND, REGULAR, FLAVORED

	92101800	COFFEE, CUBAN
	92101900	COFFEE, LATTE
	92101910	COFFEE, LATTE, DECAFFEINATED
	92101950	COFFEE, MOCHA
	92101960	COFFEE, MOCHA, MADE WITH SOY MILK
	92103000	COFFEE, MADE FROM POWDERED INSTANT, REGULAR
	92104000	COFFEE, MADE FROM POWDERED INSTANT, 50% LESS CAFFEINE
	92105000	COFFEE, LIQUID CONCENTRATE
	92105010	COFFEE, MADE FROM LIQUID CONCENTRATE
	92106000	COFFEE, ACID NEUTRALIZED, FROM POWDERED INSTANT
	92111000	COFFEE, DECAFFEINATED, NS AS TO GROUND OR INSTANT
	92111010	COFFEE, DECAFFEINATED, MADE FROM GROUND
	92114000	COFFEE, DECAFFEINATED, MADE FROM POWDERED INSTANT
	67250150	MIXED FRUIT JUICE WITH LOWFAT YOGURT, BABY FOOD

* All beverage groups were created with the assistance of a licensed dietitian

Supplemental Table 3.2. Sample size by survey year and selected demographic characteristics of children ages 2-5y who participated in What We Eat In America, the dietary component of the National Health and Nutrition Examination Survey 2003-04, 2005-06, 2007-08, 2009-10 or 2011-12

	2003-04	2005-06	2007-08	2009-10	2011-12
	<------------	------------	Kcals/d	------------	------------>
Total foods	1285 ± 23	1188 ± 19	1158 ± 18	1177 ± 24*	1230 ± 19
All beverages	432 ± 15	375 ± 10	370 ± 11	359 ± 11*	355 ± 24*
Total milks	**231 ± 11**	**196 ± 9**	**217 ± 10**	**215 ± 11**	**207 ± 17**
Low-fat, low-sugar milk	18 ± 6	20 ± 4	20 ± 4	32 ± 3	31 ± 11
Low-fat, high-sugar milk	6 ± 2	3 ± 1	8 ± 3	9 ± 2	6 ± 2
>1% fat, low-sugar milk	166 ± 10	135 ± 9	137 ± 7	124 ± 8*	124 ± 11*
>1% fat, high-sugar milk	41 ± 7	38 ± 7	52 ± 6	50 ± 8	47 ± 9
100% juice	**40 ± 5**	**39 ± 8**	**43 ± 4**	**34 ± 6**	**38 ± 5**
Sugared beverages	**154 ± 8**	**134 ± 6**	**99 ± 5**	**94 ± 3***	**97 ± 9***
Juice drinks	110 ± 9	99 ± 5	69 ± 4	72 ± 3*	73 ± 7*
Sports and energy drinks	4 ± 1	3 ± 1	2 ± 1	3 ± 1	1 ± 1
Caloric soft drinks	32 ± 4	27 ± 4	24 ± 3	15 ± 2*	19 ± 2*
Other SSBs	6 ± 3	6 ± 2	4 ± 1	5 ± 1	6 ± 2
	<------------	------------	Grams/d	------------	------------>
Total foods	688 ± 15	934 ± 20	943 ± 21	957 ± 18*	976 ± 22*
All beverages	900 ± 30	777 ± 21	746 ± 25	746 ± 21*	734 ± 39*
Total milks	**401 ± 20**	**352 ± 16**	**366 ± 20**	**381 ± 18**	**358 ± 23**
Low-fat, low-sugar milk	44 ± 13	53 ± 12	49 ± 10	79 ± 6*	67 ± 20
Low-fat, high-sugar milk	10 ± 3	5 ± 2	12 ± 5	14 ± 3	9 ± 2
>1% fat, low-sugar milk	**296 ± 20**	**245 ± 17**	**240 ± 13**	**227 ± 16***	**225 ± 18***
>1% fat, high-sugar milk	52 ± 9	48 ± 8	65 ± 8	60 ± 10	58 ± 11
100% juice	**87 ± 10**	**79 ± 14**	**89 ± 9**	**72 ± 12**	**83 ± 11**
Sugared beverages	**354 ± 20**	**313 ± 14**	**239 ± 12**	**221 ± 7***	**247 ± 21***
Juice drinks	240 ± 21	219 ± 11	157 ± 9	155 ± 5*	171 ± 16*
Sports and energy drinks	15 ± 6	11 ± 2	7 ± 2	12 ± 4	5 ± 2
Caloric soft drinks	82 ± 9	68 ± 9	62 ± 9	39 ± 5*	50 ± 5*
Other SSBs	16 ± 6	14 ± 5	13 ± 2	15 ± 2	21 ± 5

Totals intakes of milk, 100% juice, sugared beverages, and low/no-calorie beverages are shown in bold
* Value was significantly different from value in 2003-04, Bonferroni-adjusted $p<0.05$
† Value in 2011-12 was significantly different from value in 2009-10, Bonferroni-adjusted $p<0.05$

Supplemental Table 3.3. Mean beverage intake (± standard error) by eating location (at home or away from home) from 2003 to 2012 among U.S. children ages 2-5 years who participated in What We Eat In America's National Health and Nutrition Survey during survey years 2003-04, 2005-06, 2007-08, 2009-10, or 2011-12

	2003-2004		2005-2006		2007-2008		2009-2010		2011-2012	
	Kcal/d	Grams/d	Kcal/d	Grams/d	Kcal/d	Grams/d	Kcal/d	Grams/d	Kcal/d	Grams/d
All foods and beverages	**1717 ± 26**	**1588 ± 33**	**1564 ± 25**	**1711 ± 21**	**1528 ± 23**	**1689 ± 29**	**1536 ± 26***	**1703 ± 29***	**1585 ± 23***	**1710 ± 32***
At home	1217 ± 38	1177 ± 38	1105 ± 33	1279 ± 29	1113 ± 27	1274 ± 36	1100 ± 22*	1258 ± 26	1109 ± 39	1253 ± 50
Away from home	499 ± 31	409 ± 25	458 ± 34	431 ± 31	415 ± 24	416 ± 20	435 ± 29	444 ± 30	476 ± 23	457 ± 24
All beverages	**432 ± 15**	**900 ± 30**	**375 ± 10**	**777 ± 21**	**370 ± 11**	**746 ± 25**	**359 ± 11***	**746 ± 21***	**355 ± 24***	**734 ± 39***
At home	335 ± 13	691 ± 26	277 ± 11	573 ± 21	283 ± 11	570 ± 23	270 ± 10*	559 ± 18*	262 ± 22*	547 ± 39*
Away from home	97 ± 8	209 ± 16	98 ± 9	204 ± 18	87 ± 5	176 ± 10	89 ± 5	187 ± 11	93 ± 6	187 ± 11
Low-fat, low-sugar milk	**18 ± 6**	**44 ± 13**	**20 ± 4**	**53 ± 12**	**20 ± 4**	**49 ± 10**	**32 ± 3**	**79 ± 6***	**31 ± 11**	**67 ± 20**
At home	15 ± 4	38 ± 10	19 ± 4	50 ± 12	18 ± 4	45 ± 11	26 ± 3	66 ± 6*	24 ± 9	52 ± 15
Away from home	3 ± 2	6 ± 4	1 ± 0	3 ± 1	2 ± 1	5 ± 2	5 ± 1	14 ± 2	6 ± 3	15 ± 6
Low-fat, high-sugar milk	**6 ± 2**	**10 ± 3**	**3 ± 1**	**5 ± 2**	**8 ± 3**	**12 ± 5**	**9 ± 2**	**14 ± 3**	**6 ± 2**	**9 ± 2**
At home	5 ± 2	7 ± 3	3 ± 1	5 ± 2	5 ± 3	8 ± 4	7 ± 2	11 ± 3	5 ± 2	6 ± 3
Away from home	1 ± 1	3 ± 2	0 ± 0	0 ± 0	3 ± 1	5 ± 2	2 ± 1	3 ± 1	1 ± 1	2 ± 1
>1% fat, low-sugar milk	**166 ± 10**	**296 ± 20**	**135 ± 9**	**245 ± 17**	**137 ± 7**	**240 ± 13**	**124 ± 8***	**227 ± 16***	**124 ± 11***	**225 ± 18***
At home	140 ± 9	247 ± 16	105 ± 8	190 ± 15	114 ± 5	199 ± 10	100 ± 6*	180 ± 12*	101 ± 10*	182 ± 16*
Away from home	26 ± 5	49 ± 9	30 ± 4	55 ± 7	23 ± 3	40 ± 6	24 ± 4	46 ± 8	23 ± 3	42 ± 6
>1% fat, high-sugar milk	**41 ± 7**	**52 ± 9**	**38 ± 7**	**48 ± 8**	**52 ± 6**	**65 ± 8**	**50 ± 8**	**60 ± 10**	**47 ± 9**	**58 ± 11**
At home	31 ± 6	38 ± 8	27 ± 4	34 ± 5	36 ± 6	44 ± 7	38 ± 8	46 ± 10	26 ± 5	32 ± 6
Away from home	11 ± 3	14 ± 4	11 ± 3	14 ± 4	16 ± 2	21 ± 2	12 ± 3	15 ± 3	21 ± 6	26 ± 7
100% juice	**40 ± 5**	**87 ± 10**	**39 ± 8**	**79 ± 14**	**43 ± 4**	**89 ± 9**	**34 ± 6**	**72 ± 12**	**38 ± 5**	**83 ± 11**
At home	34 ± 4	73 ± 9	31 ± 5	63 ± 10	33 ± 4	70 ± 9	25 ± 4	53 ± 8	32 ± 5	73 ± 10
Away from home	6 ± 1	14 ± 3	8 ± 3	17 ± 6	9 ± 2	19 ± 4	9 ± 2	19 ± 5	5 ± 1	10 ± 3
Juice drinks	**110 ± 9**	**240 ± 21**	**99 ± 5**	**219 ± 11**	**69 ± 4**	**157 ± 9**	**72 ± 3***	**155 ± 5***	**73 ± 7***	**171 ± 16***
At home	76 ± 6	167 ± 16	67 ± 6	148 ± 13	49 ± 4	114 ± 8	48 ± 3*	107 ± 7*	51 ± 7*	124 ± 17

Away from home	35 ± 4	74 ± 9	32 ± 5	71 ± 11	20 ± 2	43 ± 5	23 ± 3*	48 ± 6*	21 ± 3*	47 ± 7
Sports and energy drinks	**4 ± 1**	**15 ± 6**	**3 ± 1**	**11 ± 2**	**2 ± 1**	**7 ± 2**	**3 ± 1**	**12 ± 4**	**1 ± 1**	**5 ± 2**
At home	2 ± 1	9 ± 3	3 ± 0	10 ± 2	1 ± 0	3 ± 1	1 ± 0	4 ± 1	1 ± 0	4 ± 1
Away from home	2 ± 1	6 ± 5	0 ± 0	1 ± 1	1 ± 0	4 ± 1	2 ± 1	8 ± 3	0 ± 0	2 ± 1
Caloric soft drinks	**32 ± 4**	**82 ± 9**	**27 ± 4**	**68 ± 9**	**24 ± 3**	**62 ± 9**	**15 ± 2***	**39 ± 5***	**19 ± 2***	**50 ± 5***
At home	18 ± 2	47 ± 6	13 ± 2	32 ± 5	14 ± 2	37 ± 6	9 ± 1*	25 ± 3*	10 ± 2*	25 ± 5*
Away from home	13 ± 3	35 ± 7	14 ± 2	36 ± 6	10 ± 2	26 ± 4	6 ± 1	15 ± 3*	9 ± 2	24 ± 4
Other SSBs	**6 ± 3**	**16 ± 6**	**6 ± 2**	**14 ± 5**	**4 ± 1**	**13 ± 2**	**5 ± 1**	**15 ± 2**	**6 ± 2**	**21 ± 5**
At home	6 ± 3	16 ± 6	5 ± 2	13 ± 4	3 ± 1	10 ± 2	3 ± 0	9 ± 1	4 ± 2	17 ± 4
Away from home	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Diet drinks	**1 ± 0**	**21 ± 7**	**1 ± 0**	**15 ± 4**	**7 ± 2**	**34 ± 6**	**12 ± 3***	**57 ± 11***	**7 ± 2***	**32 ± 5**
At home	1 ± 0	15 ± 4	1 ± 0	13 ± 4	6 ± 1	26 ± 6	8 ± 2*	45 ± 10*	5 ± 2	23 ± 5
Away from home	0 ± 0	6 ± 3	0 ± 0	2 ± 1	1 ± 0	8 ± 2	3 ± 1*	12 ± 3	3 ± 1*	9 ± 2
Tap, bottled and flavored water	**0 ± 0**	**1 ± 1**	**0 ± 0**	**4 ± 3**	**0 ± 0**	**2 ± 1**	**0 ± 0**	**2 ± 1**	**0 ± 0**	**3 ± 1**
At home	0 ± 0	1 ± 1	0 ± 0	3 ± 2	0 ± 0	1 ± 0	0 ± 0	2 ± 1	0 ± 0	2 ± 1
Away from home	0 ± 0	0 ± 0	0 ± 0	2 ± 1	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 0
All other beverages	**8 ± 3**	**36 ± 15**	**5 ± 2**	**14 ± 4**	**4 ± 1**	**17 ± 4**	**4 ± 1**	**13 ± 4**	**4 ± 1**	**11 ± 3**
At home	8 ± 3	34 ± 15	4 ± 2	12 ± 4	3 ± 1	13 ± 4	3 ± 1	10 ± 3	3 ± 1	7 ± 2
Away from home	0 ± 0	1 ± 1	1 ± 0	2 ± 1	1 ± 0	4 ± 1	1 ± 0	3 ± 1	1 ± 1	4 ± 2

Totals intakes of total foods and beverages, total beverages, low-fat, low-sugar milk, low-fat, high-sugar milk, >1% fat, low-sugar milk, >1% fat, high-sugar milk, 100% juice, juice drinks, sport and energy drinks, caloric soft drinks, diet drinks, and tap, bottled and flavored water, are shown in bold

* Value was significantly different from value in 2003-04, Bonferroni-adjusted $p<0.05$

† Value in 2011-12 was significantly different from value in 2009-10, Bonferroni-adjusted $p<0.05$

Supplemental Table 3.4. Mean beverage intake (± standard error) by eating location (at home or away from home) from 2003 to 2012 among U.S. children ages 2-5 years who participated in What We Eat In America's National Health and Nutrition Survey during survey years 2003-04, 2005-06, 2007-08, 2009-10, or 2011-12

	2003-04		2005-06		2007-08		2009-10		2011-12	
	Kcal/d	Grams/d	Kcal/d	Grams/d	Kcal/d	Grams/d	Kcal/d	Grams/d	Kcal/d	Grams/d
All foods and beverages										
Stores	1310 ± 36	1300 ± 43	1131 ± 29	1180 ± 29	1147 ± 19	1220 ± 24	1170 ± 24*	1249 ± 30	1112 ± 38*	1159 ± 42
Dine-in restaurants	57 ± 9	40 ± 7	66 ± 13	44 ± 9	39 ± 8	31 ± 6	60 ± 11	44 ± 8	55 ± 8	41 ± 5
Fast food restaurants	171 ± 25	99 ± 15	149 ± 19	92 ± 13	131 ± 19	83 ± 14	110 ± 10	66 ± 5	130 ± 23	79 ± 15
School cafeteria or child care center	101 ± 16	88 ± 15	111 ± 12	101 ± 12	100 ± 12	93 ± 11	119 ± 17	109 ± 13	142 ± 19	130 ± 19
All other sources	79 ± 12	60 ± 9	106 ± 17	294 ± 25	110 ± 18	263 ± 27	77 ± 8	235 ± 14*	145 ± 13*†	300 ± 16*†
All beverages										
Stores	377 ± 16	781 ± 32	299 ± 11	621 ± 22	303 ± 8	614 ± 19	300 ± 11*	626 ± 21*	271 ± 19*	571 ± 34*
Dine-in restaurants	3 ± 1	8 ± 3	8 ± 2	17 ± 4	5 ± 1	12 ± 3	8 ± 1*	15 ± 2	10 ± 2*	20 ± 3*
Fast food restaurants	11 ± 2	32 ± 7	17 ± 3	38 ± 6	15 ± 4	35 ± 8	11 ± 1	24 ± 2	13 ± 3	27 ± 7
School cafeteria or child care center	28 ± 6	49 ± 9	32 ± 4	60 ± 8	29 ± 3	50 ± 6	29 ± 4	56 ± 7	37 ± 8	64 ± 13
All other sources	13 ± 3	30 ± 6	21 ± 1	42 ± 3	18 ± 5	35 ± 9	10 ± 4	24 ± 8	24 ± 2*†	53 ± 5*†
Low-fat, low-sugar milk										
Stores	17 ± 6	42 ± 12	19 ± 4	52 ± 12	18 ± 4	46 ± 10	28 ± 3	70 ± 6	25 ± 9	53 ± 15
Dine-in restaurants	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Fast food restaurants	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 1	2 ± 2
School cafeteria or child care center	1 ± 0	1 ± 1	0 ± 0	1 ± 1	1 ± 0	3 ± 1	3 ± 1	8 ± 2*	4 ± 2	10 ± 6
All other sources	0 ± 0	0 ± 0	0 ± 1	0 ± 3	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 0	3 ± 1*
Low-fat, high-sugar milk										

Stores	5 ± 2	9 ± 3	3 ± 1	5 ± 2	4 ± 3	6 ± 4	6 ± 2	10 ± 2	5 ± 2	7 ± 3
Dine-in restaurants	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Fast food restaurants	0 ± 0	0 ± 0	0 ± 0	0 ± 0	2 ± 1	3 ± 2	1 ± 1	2 ± 1	1 ± 0	1 ± 1
School cafeteria or child care center	1 ± 1	1 ± 1	0 ± 0	0 ± 0	2 ± 1	3 ± 1	1 ± 0	1 ± 1	1 ± 1	1 ± 1
All other sources	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 1	0 ± 1
≥1% fat, low-sugar milk										
Stores	148 ± 9	264 ± 18	109 ± 8	197 ± 15	119 ± 6	210 ± 12	109 ± 7*	198 ± 13*	103 ± 10*	186 ± 16*
Dine-in restaurants	0 ± 0	0 ± 0	2 ± 1	3 ± 2	1 ± 1	2 ± 1	0 ± 0	1 ± 1	2 ± 1	4 ± 2
Fast food restaurants	1 ± 1	1 ± 1	0 ± 0	1 ± 1	0 ± 0	1 ± 1	0 ± 0	0 ± 0	0 ± 0	0 ± 0
School cafeteria or child care center	13 ± 3	24 ± 5	18 ± 2	34 ± 5	10 ± 2	19 ± 3	13 ± 2	25 ± 4	11 ± 3	21 ± 5
All other sources	4 ± 2	7 ± 3	0 ± 0	0 ± 0	5 ± 3	8 ± 4	1 ± 2	2 ± 3	7 ± 0†	13 ± 1†
≥1% fat, high-sugar milk										
Stores	34 ± 7	42 ± 9	27 ± 4	33 ± 5	39 ± 6	48 ± 8	39 ± 9	47 ± 10	26 ± 5	32 ± 5
Dine-in restaurants	0 ± 0	0 ± 0	1 ± 1	2 ± 1	1 ± 0	1 ± 0	3 ± 1	4 ± 1	4 ± 2	4 ± 2
Fast food restaurants	0 ± 0	0 ± 0	4 ± 2	5 ± 3	2 ± 1	4 ± 2	3 ± 2	3 ± 2	2 ± 2	3 ± 2
School cafeteria or child care center	7 ± 3	9 ± 4	3 ± 1	4 ± 1	9 ± 1	11 ± 2	4 ± 2	5 ± 2	14 ± 7	17 ± 8
All other sources	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 2	2 ± 2	1 ± 1	1 ± 1	1 ± 0	1 ± 0
100% juice										
Stores	38 ± 5	82 ± 10	34 ± 7	69 ± 13	37 ± 4	77 ± 9	31 ± 6	66 ± 11	35 ± 5	78 ± 10
Dine-in restaurants	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Fast food restaurants	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 0	1 ± 1	1 ± 0	1 ± 1	0 ± 0	0 ± 0
School cafeteria or child care center	1 ± 0	3 ± 1	3 ± 1	6 ± 3	2 ± 1	4 ± 3	2 ± 0	3 ± 1	1 ± 0	2 ± 1
All other sources	1 ± 0	1 ± 1	0 ± 0	0 ± 0	3 ± 1	6 ± 1	1 ± 2	2 ± 3	2 ± 0	3 ± 1
Juice drinks										
Stores	97 ± 9	212 ± 22	78 ± 5	175 ± 11	56 ± 3	128 ± 7	56 ± 3*	120 ± 6*	55 ± 7*	133 ± 15*
Dine-in restaurants	1 ± 0	2 ± 1	2 ± 1	4 ± 2	0 ± 0	1 ± 1	3 ± 1	5 ± 2	2 ± 1	3 ± 1

Fast food restaurants	2 ± 1	4 ± 2	4 ± 1	9 ± 3	3 ± 1	8 ± 3	3 ± 1	6 ± 2	4 ± 1	8 ± 2
School cafeteria or child care center	5 ± 1	9 ± 3	8 ± 1	15 ± 3	4 ± 1	10 ± 2	6 ± 1	12 ± 3	6 ± 1	12 ± 2
All other sources	6 ± 2	12 ± 4	0 ± 0	0 ± 0	5 ± 2	11 ± 5	5 ± 1	11 ± 2	6 ± 2	14 ± 4
Sports and energy drinks										
Stores	4 ± 1	15 ± 6	3 ± 1	11 ± 2	1 ± 0	5 ± 1	3 ± 1	11 ± 4	1 ± 0*	3 ± 1
Dine-in restaurants	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Fast food restaurants	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 0
School cafeteria or child care center	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
All other sources	0 ± 0	0 ± 0	0 ± 17	0 ± 25	0 ± 0	1 ± 0	0 ± 0	1 ± 1	0 ± 0	1 ± 1
Caloric Soft drinks										
Stores	21 ± 3	53 ± 8	14 ± 2	34 ± 6	14 ± 3	36 ± 6	9 ± 1*	23 ± 4*	9 ± 2*	24 ± 5*
Dine-in restaurants	2 ± 1	4 ± 1	3 ± 1	8 ± 3	2 ± 1	6 ± 2	2 ± 0	4 ± 1	2 ± 1	6 ± 2
Fast food restaurants	7 ± 1	17 ± 4	8 ± 1	20 ± 4	6 ± 1	14 ± 4	4 ± 1	11 ± 2	4 ± 2	11 ± 4
School cafeteria or child care center	0 ± 0	1 ± 1	0 ± 0	0 ± 0	0 ± 0	1 ± 1	0 ± 0	0 ± 0	0 ± 0	0 ± 0
All other sources	2 ± 1	7 ± 3	2 ± 5	6 ± 9	2 ± 1	5 ± 2	1 ± 1	1 ± 3	4 ± 0†	10 ± 0†
Other SSBs										
Stores	6 ± 3	16 ± 6	6 ± 2	14 ± 5	4 ± 1	13 ± 2	4 ± 1	12 ± 2	5 ± 2	19 ± 5
Dine-in restaurants	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 0	0 ± 0	1 ± 1
Fast food restaurants	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
School cafeteria or child care center	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
All other sources	0 ± 0	1 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 1
Diet drinks										
Stores	1 ± 0	17 ± 5	1 ± 0	13 ± 4	7 ± 2	31 ± 6	11 ± 3*	55 ± 10*	6 ± 1*	27 ± 5†
Dine-in restaurants	0 ± 0	1 ± 1	0 ± 0	0 ± 0	0 ± 0	1 ± 1	0 ± 0	0 ± 0	0 ± 0	1 ± 1
Fast food restaurants	0 ± 0	2 ± 1	0 ± 0	1 ± 1	0 ± 0	0 ± 0	0 ± 0	1 ± 0	0 ± 0	0 ± 0

School cafeteria or child care center	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 1
All other sources	0 ± 0	1 ± 1	0 ± 0	0 ± 0	0 ± 0	1 ± 0	0 ± 0	1 ± 1	1 ± 0	4 ± 1
Tap, bottled and flavored water	1 ± 0	15 ± 4	1 ± 0	13 ± 4	6 ± 1	26 ± 6	8 ± 2*	45 ± 10*	5 ± 2	23 ± 5
Stores	0 ± 0	6 ± 3	0 ± 0	2 ± 1	1 ± 0	8 ± 2	3 ± 1*	12 ± 3	3 ± 1*	9 ± 2
Dine-in restaurants	0 ± 0	1 ± 1	0 ± 0	4 ± 3	0 ± 0	2 ± 1	0 ± 0	2 ± 1	0 ± 0	3 ± 1
Fast food restaurants	0 ± 0	1 ± 1	0 ± 0	4 ± 3	0 ± 0	2 ± 1	0 ± 0	2 ± 1	0 ± 0	2 ± 1
School cafeteria or child care center	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
All other sources	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
All other beverages										
Stores	7 ± 2	29 ± 10	5 ± 2	13 ± 4	3 ± 1	12 ± 4	3 ± 1	11 ± 3	3 ± 1	7 ± 2
Dine-in restaurants	0 ± 0	0 ± 0	0 ± 0	1 ± 0	0 ± 0	1 ± 1	0 ± 0	0 ± 0	0 ± 0	1 ± 0
Fast food restaurants	1 ± 1	7 ± 6	0 ± 0	0 ± 0	1 ± 0	3 ± 1	0 ± 0	1 ± 0	0 ± 0	1 ± 1
School cafeteria or child care center	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
All other sources	0 ± 0	0 ± 0	0 ± 3	0 ± 4	0 ± 0	1 ± 0	0 ± 0	1 ± 0	1 ± 0	2 ± 0

* Value was significantly different from value in 2003-04, Bonferroni-adjusted p<0.05

† Value in 2011-12 was significantly different from value in 2009-10, Bonferroni-adjusted p<0.05

CHAPTER 4. TARGETED BEVERAGE TAXES INFLUENCE FOOD/BEVERAGE PURCHASES AMONG U.S. HOUSEHOLDS WITH A PRESCHOOL CHILD

Overview

How beverage taxes might influence purchases of foods and beverage among households with preschool children is unclear. We use data from the 2009-2012 Nielsen Homescan Panel to examine the relationship between beverage taxes and food and beverage purchases among U.S. households with a child ages 2-5 y. We used a two-part, multilevel panel model to examine the relationship between beverage simulated price increases of 10%, 15% and 20% and household-level food and beverage purchases. In this manner we simulated 'taxes' on sugar-sweetened beverages (SSBs) alone, and taxes on SSBs plus >1% fat and/or high-sugar milks. Price increases of 10%, 15%, and 20% on SSBs were associated with fewer purchases of juice drinks, while price increases of 10%, 15% and 20% simulated on both SSBs plus >1% fat and/or high-sugar milks (combined tax) were associated with fewer calories purchased from >1% fat, low-sugar milk, and meat, poultry, fish and mixed meat dishes. Increases in the prices of SSBs alone, as well as increases in the prices of SSBs and >1% fat and/or high-sugar milks, were associated with fewer total food/beverage purchases, although these relationships were not statistically significant. Our study provides further evidence that a tax on beverages high in sugar and/or fat may be associated with favorable changes in beverage purchases among U.S. households with a preschool child.

Introduction

Childhood obesity is a leading threat to public health in the U.S. (1). As treatment of childhood obesity remains challenging (2, 3), prevention is instrumental to reducing the overall burden of this public health problem in the U.S. (4-7). Preschool children (ages 2-5y) are an ideal population for dietary interventions, as eating behaviors and food preferences are formed during the first five years of life (8, 9), and because the food environments of young children are controlled by parents and/or adult caregivers. There may also be greater opportunity to prevent excess weight gain in preschoolers, among whom the prevalence of obesity is lower than that of older children (1). U.S. preschooler diets are high in beverages like high-fat (>1% fat) milk and sugar-sweetened beverages (SSBs) (10). These beverages, in particular, represent a key concern because they are thought to contribute to excess total energy intake by having a smaller relative effect on satiety than food (11-16). Thus, consuming too many calories from these beverages over time can lead to weight gain (17). Taxing such beverages has been an option proposed by a number of childhood obesity researchers and health advocates as a means to limit the consumption of beverages high in fats and/or sugars (18-24). However, there is minimal research on whether such taxes might influence foods and beverage purchases among households with preschool-aged children.

Taxes on certain beverages may have unintended consequences such as increasing purchases of other beverages or foods high in fats/sugars, and/or decreasing purchases of healthier beverages such as low-fat, low-sugar milk and 100% fruit juice (25, 26). Previous studies focus primarily on SSBs, comprising caloric soft drinks, juice drinks, and sport and energy drinks (25-30). While an SSB tax has been associated with fewer SSB purchases (25-29), only two of these studies also considered the relationship between an SSB tax and purchases of foods. To understand the overall implications of an SSB tax, including whether such a tax could influence net weight of foods/beverages purchased, the relationship between beverage taxes and purchases of both beverages and foods must be examined. It had also been suggested that higher-fat (>1% fat by weight) and/or high-sugar milks be taxed (23, 24), as intake of these beverages is discouraged for children older than two (31). Nonetheless, we were unaware of any prior study in which taxes on >1% fat and/or high-sugar milks had been explored, thus it is unclear if taxing these beverages would affect purchases of these and other foods/beverages.

To address these important gaps in the literature, we used data from the 2009-2012 Nielsen Homescan Panel to simulate 'taxes' by increasing the prices of selected beverages by 10%, 15% and 20%. We began by examining the association between simulated price increases on SSBs and purchases of an array of consumer packaged foods and beverage groups among U.S. households with a preschool child. Next, we compared these associations to those observed when simulating price increases on SSBs plus >1% fat and/or high-sugar milks. We then extrapolated our findings to estimate the associations between each beverage tax and annual weight of foods/beverages purchased per capita. By addressing these key gaps in the literature, we aimed to provide further evidence to inform policy decisions regarding the use of targeted beverage taxes as a potential means to reduce purchases of unhealthful beverages among U.S. households with preschool children.

Methods

Sample

We included quarterly household purchase data from households in 76 metropolitan and non-metropolitan areas (markets) from the 2009-2012 Nielsen Homescan Panel (The Nielsen Co.). Homescan comprises a representative panel of U.S. households who report weekly consumer packaged goods (CPG) purchases using barcode-scanners issued by Nielsen. Purchases without barcodes (e.g., fresh fruits and vegetables), were not included in this analysis. Further details regarding the sample have been published elsewhere (1-4).

In order to minimize heterogeneity in our findings due to household composition, we limited our analyses to households with one child between the ages of 2-5y of age. Data were included for these households who participated in Homescan during at least one quarter between quarter one 2009 and quarter four 2012. We used a threshold of more than 5 standard deviations from the mean weight total consumer packaged foods and beverages purchased per capita to exclude outliers (n = 56 quarterly observations) (5). Our final sample included 57,283 quarterly observations from 14,784 unique households (**Table 4.1**).

Food/beverage groups

The Nielsen Co. categorizes foods and beverages into 'modules' comprising foods/beverages with similar commercial properties. As the main focus of this work, we classified beverages with the overarching goal of creating beverage groups of public health relevance. A further goal was to disaggregate broad beverage groups commonly used in the literature (e.g., SSB) in an effort to better reflect the heterogeneity within beverage groups. Therefore, 10 mutually exclusive beverage groups were created using Homescan 'modules', product ingredient lists, product claims, and Nutrition Facts Panel information (6): 1) caloric soft drinks; 2) sports and energy drinks; 3) juice drinks; 4) >1% fat, high-sugar milk; 5) >1% fat, low-sugar milk; 6) low-fat, high-sugar milk; 7) low-fat, low-sugar milk; 8) 100% juice; 9) diet drinks; and 10) tap, bottled and flavored waters. The 2010 U.S. Dietary Guidelines for Americans (7), the American Academy of Pediatrics (8), the Institute of Medicine (9), and the 2015 U.S. Dietary Guidelines Advisory Council (10), all advise that intakes of >1% fat milks, and milks containing added sugar be limited for children ages 2 and older. Moreover, the IOM defines high-sugar beverages as those containing ≥22 g of sugar per 8 oz serving (9). Milk subgroups by fat and sugar content were therefore based on these guidelines. Additionally, summary groups were created for total beverages, total foods, total SSBs – which include caloric soft drinks (excluding low-calorie soft drinks), fruit/juice drinks (not containing 100% juice), and sports and energy drinks (excluding low-calorie options) – and total non-SSBs. A detailed description of our approach to classifying beverages is shown the appendix (**Supplemental Table 4.1**). All dried and concentrated beverages were reconstituted to 'ready-to-eat' form using standard conversion factors (29.35 g per ounce for dry weights, and 29.57 ml per ounce for liquids) and manufacturer's reconstitution instructions (e.g. frozen concentrated juice). A total of nine comprehensive, mutually exclusive food groups were created using Homescan 'modules': 1) dairy products excluding milk; 2) meat, poultry, fish and mixed meat dishes; 3) other proteins; 4) grain-products (excluding ready-to-eat [RTE] desserts); 5) fruits and vegetables; 6) fats, oils, sauces and condiments; 7) sweets and snacks; 8) 'other' foods; and 9) mixed dishes and soups.

Prices

Market-quarterly food/beverage prices per 100 g were derived using purchase data and prices paid. Additionally, in order to control for differences in the cost of living by market and quarter, a Food Price Index (FPI) was created using quarter one of 2000 in Los Angeles, California as the referent index. A detailed description of these methods is given in the appendix (**Supplemental Table 4.2**).

Unemployment rate

Market-quarterly unemployment rates were used to reflect the economic conditions for participating Homescan households (11). Using data from the Bureau of Labor Statistics Local

Area Unemployment Statistics (12), quarterly unemployment rates were computed by taking the average unemployment rate for the three months comprising each quarter (from quarter one 2009 to quarter four 2012) for the 76 markets (13).

Statistical analysis

All analyses were conducted in STATA (version 13, 2011, StataCorp, College Station, TX), and survey weights were used in all calculations to adjust for differential probability of selection. For food and beverage groups purchased by <80% of households, a right-skewed distribution and a preponderance of zeros require special consideration. It has been previously shown that a two-part marginal effects model is an appropriate statistical approach for dealing with such data (14-16). Thus, a two-part marginal effects model, comprising probit, and ordinary least squares regression, was used to estimate the relationship between price and amount purchased (14). For food/beverage outcomes reported by ≥80% of included households, only the second part of the model (OLS regression) was used. In the first part of the two-part model, probit regression was used to model the probability of a household purchasing the outcome food/beverage of interest. In the second part, conditional OLS regression was used to model the amount purchased among households reporting non-zero expenditures. Coefficients from both parts of the model were algebraically combined to estimate the amount purchased associated with simulated taxes on selected beverages among all households with a preschooler. To obtain corrected standard errors, modeled were clustered at the market-level, and bootstrapping was performed (1000 replications) to account for correlation resulting from repeated measurements (17), and potential correlation between households in the same market. For food and beverage groups purchased by ≥80% of the sample, only the second part (OLS regression) of the two-part model was used.

In all models, prices were log-transformed using the natural log. In OLS regression models, food and beverage prices and amount purchased per capita from each food/beverage group were log-transformed to simplify model interpretation (log-log model), and in keeping with prior works (5, 18-22). To account for error that may arise when outcome variables are log-transformed (23), we multiplied predicted values (e.g., predicted amount purchased with a 20% increase in SSB price) by the appropriate Duan Smearing estimator upon retransformation using the anti-log (24). Elasticities were ascertained from untransformed model coefficients, and thus Duan smear factors were not applied to these values. In separate, multilevel models, price increases of 10%, 15%, and 20% were simulated for: a) SSBs alone, and; b) SSBs *plus* >1% fat and/or high-sugar milks.

To simulate a 'tax' on selected beverages, the prices of these beverages were perturbed in statistical models, assuming 100% transference of the tax to shelf price. 'Simulated tax' is used henceforth to refer to increases in the price paid. Separate models were run with each food/beverage group of interest as the outcome, and all models were adjusted for household composition (number of household members by gender and age: 2-5y; 6-11y; 12-18y; ≥19y); household income as a percent of Federal Poverty Level (FPL) (≤100% FPL; 100>130%FPL; 130>185% FPL; 185>400% FPL; and ≥400% FPL), education level (highest level of education completed by a head of household), race/ethnicity, market-quarterly unemployment rate, year, and quarter. In addition, we tested (using joint Wald test) and found significant interactions ($p<0.10$) between price and year for regular soft drinks; juice drinks; low-fat, high-sugar milk; >1% fat, low-sugar milk; >1% fat, high-sugar milk; and sport and energy drinks. Thus, interaction terms for prices of these beverages and year were included in all models. Lastly, following previous works (18-21), assuming changes in total weight of food/beverages purchased per day per capita would be constant over time, the net effect of each ‘tax’ simulation on total foods/beverages purchased per year was estimated by multiplying adjusted estimates of changes in daily purchases of total weight by 365.25.

Results

Demographic characteristics

Characteristics of the sample, including calories and grams purchased per capita from SSBs by year, are shown in **Table 4.1**. Sample households were predominantly non-Hispanic White, with college educated heads of household, and a household income of 185>-400% FPL. Total SSB purchases, total beverage purchases, and total foods purchases decreased over time (Bonferroni-adjusted $p<0.05$).

Survey-weighted mean amounts of each beverage purchased per capita and amount purchased among reporting households are shown in **Figure 4.1**. Households with a preschool child purchased fewer total grams of beverages in 2012 than in 2009. Mean prices by market and percent of household reporting purchases of each beverage are shown in the appendix (Supplemental Table 3). More than 80% of sampled households reported purchasing >1% fat, low-sugar milk; and juice drinks, while fewer than 80% reported purchasing low-fat, low-sugar milk; low-fat, high-sugar milk; >1% fat, high-sugar milk; 100% juice; soft drinks; bottled and flavored water; sport and energy drinks; and diet beverages.

Elasticities

Own-price elasticities, defined here as the change in per capita purchases in grams of a given food/beverage divided by the change in price for the same food/beverage, are presented in **Table 4.2**. There were moderate and significant ($p < 0.05$) own-price relationships for juice drinks (-1.01), total >1% and/or high-sugar milks (-0.71), >1% fat, low-sugar milk (-0.65), low-fat, low-sugar milk (-0.79), 100% juice (-0.99) and diet beverages (-0.62). These values suggest that purchases of these beverages decrease when their price is increased.

Cross-price elasticities, defined here as the change in per capita purchases in grams divided by the change in price for another food/beverage, are also presented in **Table 4.2**. A complementary relationship, denoted by a negative cross-price elasticity, indicates that increasing the price of one beverage *decreases* purchases of another food/beverage. Total SSBs were a complement to soft drinks (-0.75), juice drinks (-1.01), low-fat, low-sugar milk (-1.50), and meat, poultry, fish and mixed meat dishes (-0.52). Juice drinks were a complement to low-fat, low-sugar milk (-1.28), while low-fat, low-sugar milk was a complement to 100% juice (-0.80). 100% juice was also a complement to low-fat, low-sugar milk (-0.79). A positive cross-price elasticity indicates that increasing the price of one beverage increases purchases of another food/beverage. This is known as a substitution relationship. Total SSBs were a substitute for sport and energy drinks (0.56), while >1% fat, low-sugar milk was a substitute for 100% juice (0.67).

Simulated taxes on SSBs (regular soft drinks, fruit drinks, and sport and energy drinks)

Table 4.3 shows adjusted purchases by weight (grams/d) per capita for selected beverages, total beverages, and total foods (with no taxes), and the estimated change in purchases associated with a increases in the prices of sugar-sweetened beverages (regular soft drinks, juice drinks, and sport and energy drinks), and tax on SSBs and >1% fat and/or high-sugar milk. Increasing the price of SSBs by 10%, 15%, and 20% was associated with fewer purchases of juice drinks (range: -1.2, -2.3 grams/d per capita), and greater purchases of sports and energy drinks (range: 0.6, 1.3 grams/d per capita. There were no significant associations between increases in the price of SSBs with total weight (grams) purchases of beverages, foods, or food/beverages, although total purchases were predicted to decrease (range: -5.2, -2.7 grams/d per capita; *P*>0.10).

Simulated taxes on SSBs and >1% fat and/or high-sugar milks

Table 4.3 also shows the predicted changes in purchase (grams/d) per capita with associated with simultaneous price increases of 10%, 15%, and 20% on SSBs *and* >1% fat and/or high-sugar milks. Increases in the prices of SSBs *and* >1% fat and/or high-sugar milks were associated with fewer purchases of >1% fat low-sugar milk (range: -10.2, -5.5 grams/d per capita), meat, poultry, fish and mixed meat dishes (range: -2.1, -1.1 grams/d per capita), and increased purchases of sport and energy drinks (range: 0.8, 1.6 grams/d per capita). Neither 10%, 15%, or 20% increases in the prices of SSBs *and* >1% fat and/or high-sugar milks was significantly related to weight or caloric purchases of individual foods or beverages, total foods, total beverages, or total foods/beverages. However, total purchases of foods/beverages were predicted to decrease (range: -20.7, -10.9 grams/d per capita; *P*>0.10).

Simulated beverage taxes and total annual caloric purchases

Figure 4.2 shows the estimated annual associations between total calories purchased from foods and beverages and increases in the prices of SSBs alone, or increases in the prices of both SSBs and >1% fat and/or high-sugar milks. Price increases of 10% to 20% on SSBs alone were associated with decreases in annual total calories purchased per capita of between 1,177 and 2,228 calories. Ten to 20% increases in the prices of both SSBs *and* >1% fat and/or high-sugar milks, were associated with decreases in annual total calories purchased of between 3,287 and 6,245 calories.

Discussion

In this paper, we used simulated price increases as a proxy for 'taxes' to examine the association between 'taxes' of 10%, 15% and 20% on SSBs and food and beverage purchases among households with a child ages 2-5y. We compared this model to one in which price increases were simulated for both SSBs and >1% fat and/or high-sugar milks, and contrasted associations with calories purchased from SSBs, non-SSBs, total beverages and total foods between 'tax' models. Increases in the prices of SSBs alone were significantly related with fewer purchases of juice drinks. In contrast, concomitant increases in the prices of SSBs and >1% fat and/or high-sugar milks were associated with fewer purchases of >1% fat low-sugar milk, but were not associated with significant reductions in purchases of any SSB. In all models, there were no significant associations between prices increases (on SSBs or SSB *and* >1% fat and/or high-sugar milks) and calories or grams purchased from total beverages, total foods, or total foods and beverages. Although not statistically significant, total calories purchased was expected to decrease in both models, but to a greater extent when the prices of both SSBs and >1% fat and/or high-sugar milks were increased.

Regardless of their fat or sugar content, milks have some redeeming nutritional qualities, like calcium and vitamin D (10). Moreover, despite prevailing recommendations to limit intakes of >1% fat and/or high-sugar milks in children 2 and older (25-27), the relationship between intakes of high-fat milks and overweight in preschool children is unclear (28). In contrast, there is a general consensus that SSBs have little nutritional value (10), and that their consumption may promote excess weight gain in children (29). Thus, although there appear to be benefits from both tax models, the relationship between increases in the prices of SSBs alone and beverage purchases were marginally more favorable than those associated with a combined tax.

While this is the first study to focus exclusively on preschooler households, our main findings are consistent with prior studies. Finkelstein, Zhen and Bilger (2012), who also used data from the Nielsen Homescan Panel (year: 2006), reported that a 20% tax on SSBs (regular soda, fruit drinks, and sports drinks) was associated with a reductions in purchases of juice drinks and soft drinks, and increases in substantial increases in purchases of fruit juices. This finding was also supported by Smith, Lin and Lee (2010), who reported that a 20% tax SSBs (regular soft drinks, juice drinks, sports drinks and energy drinks, and powdered mixes with added sugars) would simultaneously decrease purchases of SSBs while increasing purchases of juices (19). Similarly, we found that increasing the prices of SSBs would shift purchases away from juice drinks and toward purchases of 100% juice. We did not, however, observe a significant reduction in purchases of soft drinks, although point estimates were in the expected direction.

Ours is also the first study to our knowledge to simulate simultaneous increases in the prices of both SSBs *and* >1% fat,/high-sugar milks. Thus, there are no studies with which to compare our results. However, our observed own-price elasticities for the additional beverages included in the combined tax model are consistent with previous reports. For example, we observed an own-price elasticity for juice drinks of -1.01, whereas recent studies also using Homescan data have reported values in the range of -1.19 to -1.02 for juices and juice drinks (5, 19, 21). Similarly, we observed an own-price elasticity for low-fat, low-sugar milk of -0.79, while others have reported elasticities for 1% and skim milk in the range of -0.90 to -0.40 (30-32). We found an own-price elasticity for >1% fat, low-sugar milk of -0.65, while others have reported values ranging from -0.90 to -0.43 for 2% and whole milks (30-34). Nonetheless, these prior studies do not provide a one-to-one comparison as they did not discern between high- and low- sugar milks. Notably, we observed a smaller own-price elasticity for soft drinks than has been previously reported (35). However, it should be noted that these estimates were based on both diet and caloric soft drinks (35), which could explain some of the discrepancy. Moreover, while we observed an own-price elasticity for caloric soft drinks of -0.15, we observed an own-price elasticity for diet beverages (comprising mostly diet soft drinks) of -0.62. This would suggest that had we combined caloric in diet soft drinks, we may have obtained similar estimates to those typically reported in the literature. The lower own-price elasticity for soft drinks may also be attributable to preschool children consuming fewer calories from soft drinks than older children and adults (97 kcal/d vs. 301 kcal/d for children ages 12-19y) (36, 37), which would also be reflected in household purchases.

We also examined the potential for 'unintended consequences' as a result of a targeted beverage 'taxes' (20). We found no evidence, however, that either beverage 'tax' scenario (SSBs alone, or SSBs and >1% fat and/or high-sugar milks) would significantly influence total calories purchased. This was true for simulated price increases of 10%, 15%, and 20%. Notably, two prior studies, each comprising a general sample of US households, reported that a 20% tax on SSBs was predicted to decrease total calories purchased by -17.9 calories/d per capita (20), and by -24.3 calories/d per capita (respectively) (16). In comparison, we found that a 20% tax on SSBs was associated with purchasing -22 calories/d per capita, although this result did not reach statistical significance. Notably, our sample was limited to US households with a single preschool child, and we performed statistical adjustments in order to best scale our estimates relative to a preschool child. Thus, differences in our sample offer one potential explanation for the discrepant finding, as our sample was limited to households with a single preschool child, while most prior studies examine these relationships in a general sample of households.

Lastly, as the predominance of studies examine taxes of 20% or more (5, 16, 19-21), we sought to determine whether price increases (on SSBs, or SSBs and >1% fat and/or high-sugar milks) of less than 20% (10% and 15%) were significantly associated with purchases of SSBs and/or >1% fat, high-sugar milks. It has been previously suggested that taxes less than 20% would not have an appreciable influence on consumer behavior (38-40). However, the few prior studies to examine how beverages taxes of less than 20% influence consumer behavior (39, 40), used state-level soft drink sales taxes – which tend to be small in magnitude – to explore this relationship. Moreover, because sales taxes are not typically reflected in shelf price, they are unlikely to influence consumer behavior (41). In contrast, our 'tax' models assume an excise tax for which 100% of the tax is transferred to the shelf price, which is in keeping with previous works (5, 18, 20, 21). We found that price increases as little as 10% on SSBs were significantly associated with fewer purchases of juice drinks, and greater purchases of 100% juice and low-fat, low-sugar milk. Increases in the prices of SSBs were also non-significantly related to fewer total purchases of foods and beverages by weight. However, such changes, even with a 20% increase in price, were small in magnitude (<15 grams/capita/d). While it is possible that the actual effects of a tax may be larger than those we observed, as Homescan does not capture all food/beverage purchases (4), our findings suggest that taxes of 20% or more would be needed for more meaningful changes in food/beverage purchases among U.S. households with a preschool child.

There are several key limitations to our study. Foremost, our findings reflect associations, rather than causal relationships, as the outcomes (amount purchased) and primary exposures (prices paid) were ascertained at the same point in time. Additionally, we are unable to directly determine which foods or beverages are consumed by whom in each household in as purchases are measured at the household- rather than individual-level. However, we have undertaken several steps in order to best estimate per capita purchases. First, we included only households with a single preschool child, in an effort to minimize heterogeneity in household composition. We also controlled for household composition in all of our statistical models, including number of household members by gender and age (0-2; 2-5; 6-11; 12-18; ≥19y). Nonetheless, inferences from our findings are limited to households with a preschool child.

A further limitation of the Homescan data is that foods and beverages without barcodes – including fresh produce and meats, as well as foods purchased at restaurants, school cafeterias, or child care centers – tend to be poorly reported (or not reported altogether) (4). Thus, these items were excluded from the analysis. Notably, these items are non-trivial, with fruits, vegetables and meat expenditures combined comprising roughly 17% of total household food expenditures among U.S. Homescan respondents (42). Additionally, U.S. preschool children obtain approximately 27% from sources outside the home (Ford, Ng & Popkin, 2014 *in* press). Nonetheless, the principal aim of this paper was estimate the association between taxes on high-sugar and/or >1% fat beverages and beverage purchases. As beverages, along with consumer packaged foods – many of which are key sources of fats and sugars (43), are well-represented in Homescan (44), we are confident that these data allow us to examine our research aim.

Conclusion

Our study provides further evidence that a tax on beverages high in sugar and/or fat may be associated with favorable shifts in food/beverage purchases among U.S. households with a preschool child. We also found no evidence that either a tax on SSBs alone, or a tax on both

SSBs and >1% fat and/or high-sugar milks, would increase purchases of other foods/beverages or total calories. Moreover targeted beverage taxes as little as 10% could shift purchases away from beverages high in fats and/or added sugars while decreasing total food/beverage purchases. However, observed changes even at 20% tax rates were small, suggesting that taxes of 20% or more on SSBs may be needed in order to appreciably change food/beverage purchases among U.S. households with a preschool child.

Tables and Figures

Table 4.1. Sample characteristics, households with a preschool child from Nielsen Homescan years 2009-2012[1,2]

	2009	2010	2011	2012
Total observations	15,088	14,272	13,756	14,167
Number of unique households	3,892	3,689	3,557	3,646
Total per capita purchases in grams/day				
Sugar-sweetened beverages	130.6 ± 6.4	127.4 ± 3.1	108.3 ± 1.7*	105.9 ± 1.9*
All beverages	500.9 ± 4.0	479.7 ± 4.1*	458.5 ± 4.0*	446.7 ± 3.7*
All foods	344.0 ± 2.1	340.5 ± 2.2	329.5 ± 2.2*	330.4 ± 2.1*
Total per capita purchases in calories/day				
Sugar-sweetened beverages	88.7 ± 3.4	86.9 ± 2.4	74.2 ± 1.4*	71.0 ± 1.6*
All beverages	139.6 ± 1.2	131.9 ± 1.2*	121.4 ± 1.1*	120.0 ± 1.1*
All foods	777.1 ± 4.9	762.5 ± 5.1	734.7 ± 4.8*	739.8 ± 4.7*
Race/ethnicity				
Non-Hispanic White	67.4% ± 0.6%	66.8% ± 0.6%	67.9% ± 0.6%	66.8% ± 0.5%
Non-Hispanic Black	9.1% ± 0.3%	9.5% ± 0.4%	9.9% ± 0.4%	10.3% ± 0.3%*
Hispanic	16.9% ± 0.5%	17.0% ± 0.5%	15.3% ± 0.5%	16.2% ± 0.4%
Head of household education				
<HS	1.2% ± 0.1%	1.4% ± 0.2%	1.8% ± 0.2%*	1.4% ± 0.1%
HS	16.8% ± 0.4%	15.0% ± 0.4%*	15.7% ± 0.5%	13.3% ± 0.4%*
Some college	30.9% ± 0.5%	30.7% ± 0.6%	29.4% ± 0.6%	31.2% ± 0.5%
College graduate	51.1% ± 0.6%	53.0% ± 0.6%	53.0% ± 0.6%*	54.0% ± 0.6%*
Household income (%FPL)				
≤100.0% FPL	10.1% ± 0.4%	11.0% ± 0.4%	10.9% ± 0.4%	12.1% ± 0.4%*
100>-130.0% FPL	7.6% ± 0.3%	8.0% ± 0.3%	8.5% ± 0.3%	7.3% ± 0.3%
130>-185% FPL	13.4% ± 0.4%	11.7% ± 0.4%*	13.1% ± 0.4%	16.8% ± 0.4%*
185>-400.0% FPL	51.0% ± 0.6%	50.3% ± 0.6%	48.8% ± 0.6%*	45.7% ± 0.5%*
≥400.0% FPL	17.8% ± 0.4%	19.0% ± 0.5%	18.7% ± 0.5%	18.2% ± 0.4%

[1] All values are given as mean ± SE
[2] Abbreviations: Federal Poverty Level (FPL); High School (high school diploma)
[*] Different from 2009, P<0.05
University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services for all food categories, Including beverages and alcohol for the 2009-2012 periods, for the U.S. market.

Table 4.2 Elasticities of demand with respect to the price of beverages[1-3]

Elasticity of the quantity (in grams) of	With respect to the price of: Total SSBs	Soft drinks	Sport and energy drinks	Juice drinks	Total >1% fat and/or high-sugar milks	>1% fat, high-sugar milk	>1% fat, low-sugar milk	Low-fat, high-sugar milk	Low-fat, low-sugar milk	100% juice	Diet beverages	Bottled and flavored water
Total SSBs	-0.29 ± 0.28	0.02 ± 0.16	-0.04 ± 0.03	-0.27 ± 0.26	-0.09 ± 0.25	-0.12 ± 0.12	0.16 ± 0.23	-0.13 ± 0.05***	-0.13 ± 0.17	-0.03 ± 0.19	-0.14 ± 0.17	0.00 ± 0.01
Soft drinks	-0.75 ± 0.51***	-0.15 ± 0.21	0.01 ± 0.05	-0.60 ± 0.47	-0.01 ± 0.46	-0.19 ± 0.17	0.35 ± 0.46	-0.17 ± 0.08**	-0.33 ± 0.34	0.10 ± 0.33	-0.23 ± 0.29	-0.02 ± 0.02
Sport and energy drinks	0.56 ± 0.34*	0.16 ± 0.21	-0.04 ± 0.05	0.44 ± 0.32	0.37 ± 0.33	-0.02 ± 0.14	0.43 ± 0.35	-0.05 ± 0.07	0.15 ± 0.28	0.41 ± 0.32	0.26 ± 0.28	-0.01 ± 0.01
Juice drinks	-1.01 ± 0.39***	0.04 ± 0.24	-0.04 ± 0.04	-1.01 ± 0.35***	0.21 ± 0.30	0.15 ± 0.14	0.17 ± 0.30	-0.12 ± 0.06**	-0.22 ± 0.21	-0.41 ± 0.24*	-0.19 ± 0.23	0.02 ± 0.01*
Total >1% fat and/or high-sugar milks	0.16 ± 0.39	0.12 ± 0.16	0.02 ± 0.03	0.02 ± 0.35	-0.71 ± 0.33**	0.03 ± 0.11	-0.71 ± 0.30**	-0.03 ± 0.06	0.18 ± 0.22	0.49 ± 0.20**	-0.10 ± 0.19	-0.01 ± 0.01
>1% fat, high-sugar milk	-0.23 ± 0.34	0.12 ± 0.19	0.00 ± 0.03	-0.35 ± 0.29	-0.72 ± 0.29***	-0.32 ± 0.10***	-0.32 ± 0.31	-0.09 ± 0.05	0.07 ± 0.23	0.16 ± 0.22	0.08 ± 0.20	-0.01 ± 0.01
>1% fat, low-sugar milk	0.12 ± 0.38	0.07 ± 0.15	0.02 ± 0.03	0.03 ± 0.35	-0.58 ± 0.33*	0.08 ± 0.12	-0.65 ± 0.29**	-0.02 ± 0.06	0.09 ± 0.22	0.33 ± 0.20*	0.02 ± 0.18	0.00 ± 0.01
Low-fat, high-sugar milk	-0.12 ± 0.19	-0.07 ± 0.10	0.02 ± 0.02	-0.07 ± 0.17	-0.08 ± - 0.48	0.03 ± 0.07	-0.01 ± 0.18	-0.09 ± 0.04**	0.25 ± 0.14*	0.18 ± 0.13	0.01 ± 0.12	0.01 ± 0.01
Low-fat, low-sugar milk	-1.50 ± 0.58***	-0.18 ± 0.27	-0.05 ± 0.06	-1.28 ± 0.51**	0.54 ± 0.54	-0.11 ± 0.19	0.30 ± 0.55	-0.13 ± 0.08	-0.79 ± 0.38**	-0.79 ± 0.40**	0.24 ± 0.31	-0.06 ± 0.02***
100% juice	-0.09 ± 0.38	-0.05 ± 0.22	0.00 ± 0.04	-0.04 ± 0.35	0.52 ± 0.33	-0.08 ± 0.13	0.67 ± 0.34*	-0.07 ± 0.06	-0.80 ± 0.26***	-0.99 ± 0.25***	-0.04 ± 0.24	0.02 ± 0.01*
Diet beverages	0.46 ± 0.52	0.33 ± 0.32	-0.05 ± 0.04	0.18 ± 0.48	0.11 ± 0.45	0.09 ± 0.15	0.05 ± 0.47	-0.04 ± 0.09	-0.02 ± 0.34	-0.15 ± 0.31	-0.62 ± 0.28**	-0.05 ± 0.02***
Bottled and flavored water	0.66 ± 0.44	0.11 ± 0.21	-0.05 ± 0.04	0.60 ± 0.39	0.28 ± 0.35	0.05 ± 0.14	0.15 ± 0.34	0.09 ± 0.07	0.01 ± 0.26	0.15 ± 0.24	-0.12 ± 0.23	-0.04 ± 0.01***
Dairy products (excluding milk)	-0.37 ± 0.23	0.03 ± 0.10	-0.04 ± 0.02*	-0.37 ± 0.21*	0.20 ± 0.20	0.14 ± 0.07**	-0.39 ± 0.20*	-0.03 ± 0.05	-0.03 ± 0.15	-0.14 ± 0.17	0.01 ± 0.14	0.00 ± 0.01
Meat, poultry, fish and mixed meat dishes	-0.52 ± 0.28*	-0.08 ± 0.13	-0.05 ± 0.02**	-0.40 ± 0.25	-0.28 ± - 1.07	0.11 ± 0.09	-0.41 ± 0.25	0.01 ± 0.04	-0.05 ± 0.18	-0.03 ± 0.18	0.19 ± 0.14	0.00 ± 0.01
Other protein sources	-0.06 ± 0.21	-0.06 ± 0.11	-0.03 ± 0.02	0.03 ± 0.20	-0.06 ± 0.22	0.15 ± 0.08*	-0.25 ± 0.22	0.05 ± 0.04	-0.04 ± 0.15	-0.01 ± 0.16	0.06 ± 0.15	0.00 ± 0.01
Grain-products (excluding RTE	-0.19 ± 0.17	0.07 ± 0.10	-0.03 ± 0.02*	-0.23 ± 0.16	-0.19 ± 0.17***	0.09 ± 0.06	-0.25 ± 0.16	-0.03 ± 0.03	-0.01 ± 0.12	-0.15 ± 0.11	0.06 ± 0.10	0.00 ± 0.01

desserts)												
Fruits and vegetables	-0.38 ± 0.23	-0.08 ± 0.12	-0.05 ± 0.03**	-0.25 ± 0.22	-0.11 ± 0.24	0.10 ± 0.08	-0.16 ± 0.24	-0.05 ± 0.04	-0.26 ± 0.16	-0.29 ± 0.17*	-0.02 ± 0.15	-0.02 ± 0.01**
Fats, oils, sauces and condiments	-0.42 ± 0.28	-0.05 ± 0.14	-0.01 ± 0.02	-0.36 ± 0.24	-0.22 ± 0.25	0.08 ± 0.08	-0.26 ± 0.23	-0.05 ± 0.04	0.15 ± 0.26	-0.27 ± 0.17	-0.01 ± 0.13	0.00 ± 0.01
Sweets and snacks	-0.07 ± 0.19	0.03 ± 0.10	-0.01 ± 0.02	-0.08 ± 0.16	-0.02 ± 0.17	0.12 ± 0.06*	-0.11 ± 0.15	-0.03 ± 0.04	-0.10 ± 0.12	-0.16 ± 0.12	0.01 ± 0.11	-0.01 ± 0.01
'Other' foods	-0.21 ± 0.27	0.12 ± 0.11	-0.03 ± 0.03	-0.30 ± 0.25	-0.20 ± 0.21	0.13 ± 0.09	-0.36 ± 0.21*	0.04 ± 0.05	0.20 ± 0.16	-0.48 ± 0.18***	-0.48 ± 0.16***	0.01 ± 0.01
Mixed dishes and soups	-0.19 ± 0.28	-0.07 ± 0.12	-0.04 ± 0.02*	-0.08 ± 0.25	-0.32 ± 0.21	0.05 ± 0.09	-0.40 ± 0.21*	0.02 ± 0.04	0.26 ± 0.16	0.10 ± 0.16	-0.19 ± 0.14	0.00 ± 0.01
Total sugar-sweetened beverages	-0.29 ± 0.28	0.02 ± 0.16	-0.04 ± 0.03	-0.27 ± 0.26	-0.09 ± 0.25	-0.12 ± 0.12	0.16 ± 0.23	-0.13 ± 0.05***	-0.13 ± 0.17	-0.03 ± 0.19	-0.14 ± 0.17	0.00 ± 0.01
All other beverages	-0.19 ± 0.17	0.07 ± 0.10	-0.03 ± 0.02*	-0.23 ± 0.16	-0.19 ± 0.17	0.06 ± 0.07	-0.05 ± 0.22	-0.02 ± 0.04	-0.28 ± 0.15*	-0.15 ± 0.11	0.06 ± 0.10	0.00 ± 0.01
Total beverages	-0.33 ± 0.22	-0.05 ± 0.10	-0.02 ± 0.02	-0.27 ± 0.20	0.04 ± 0.20	0.05 ± 0.07	0.03 ± 0.19	-0.04 ± 0.04	-0.28 ± 0.13**	-0.15 ± 0.13	-0.07 ± 0.12	-0.01 ± 0.01
Total foods	-0.20 ± 0.14	0.00 ± 0.07	-0.03 ± 0.02**	-0.17 ± 0.13	-0.13 ± 0.13	0.14 ± 0.07**	-0.39 ± 0.20*	-0.03 ± 0.05	-0.03 ± 0.15	-0.15 ± 0.09*	-0.05 ± 0.08	0.00 ± 0.00

[1] Values are given as mean ± SE; standard errors were computed using bootstrapping for all foods/beverages purchased by fewer than 80% of households sampled

[2] Estimates shown were computed using a two-part marginal effects model (probit regression; ordinary least squares [OLS] regression) for all foods/beverages purchased by fewer than 80% of households sampled. For all other foods/beverages, OLS regression alone was used.

[3] Abbreviations: Ready-to-eat (RTE); Sugar-sweetened beverages (SSBs)

*** Significantly different from the null value, P<0.01

** Significantly different from the null value, P<0.05

* Significantly different from the null value, P<0.10

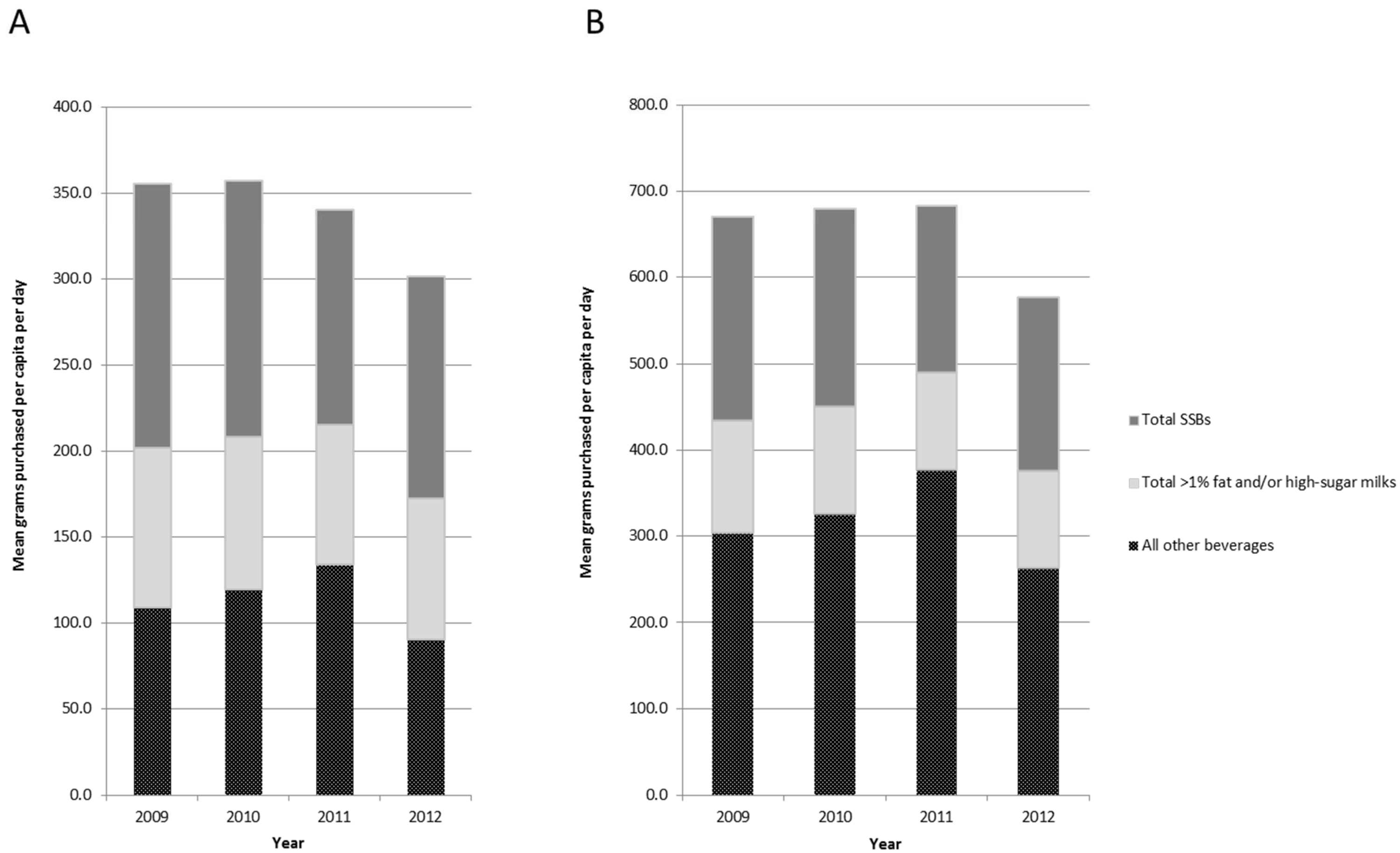
Table 4.3 Regression-adjusted mean purchases of >1% fat, low-sugar milk; total SSBs; non-SSBs; total beverages; and total foods; and predicted change in grams purchased per capita for select beverages associated with taxes of 10%, 15% and 20% on SSBs, and on SSBs and >1% fat/high-sugar milks[1-3]

Change in quantity purchased	Regression-adjusted mean purchases (no taxes)[1]	% increase in the price of: 10		15		20	
		SSBs	SSBs and >1% fat and/or high-sugar milks	SSBs	SSBs and >1% fat and/or high-sugar milks	SSBs	SSBs and >1% fat and/or high-sugar milks
	<--Grams (SE)-->						
Total SSBs	106.3 ± 1.8	-1.8 ± 2.5	-1.5 (3.1)	-2.6 ± 3.6	-2.1 (4.6)	-3.4 ± 4.7	-2.8 (6.0)
Soft drinks	28.8 ± 2.0	-1.0 ± 1.2	0.5 (1.5)	-1.4 ± 1.8	0.8 (2.3)	-1.9 ± 2.4	1.0 (3.0)
Sport and energy drinks	7.5 ± 3.2	0.6 ± 0.3**	-0.1 (0.3)	0.9 ± 0.4**	-0.2 (0.4)	1.3 ± 0.5**	-0.2 (0.5)
Juice drinks	24.0 ± 1.6	-1.2 ± 0.8*	-1.0 (0.8)	-1.8 ± 1.1*	-1.5 (1.2)	-2.3 ± 1.5*	-1.9 (1.5)
Total >1% fat and/or high-sugar milks	88.7 ± 1.6	0.5 ± 1.0	-6.2 (2.4)*	0.8 ± 1.5	-8.9 (3.5)*	1.0 ± 1.9	-11.4 (4.6)*
>1% fat, high-sugar milk	3.5 ± 1.9	0.0 ± 0.1	-0.1 (0.1)*	0.0 ± 0.1	-0.2 (0.1)*	0.0 ± 0.2	-0.3 (0.2)*
>1% fat, low-sugar milk	86.1 ± 1.6	0.0 ± 2.7	-6.0 (8.2)	0.0 ± 4.0	-8.6 (12.4)	0.1 ± 5.2	-11.1 (16.6)
Low-fat, high-sugar milk	1.8 ± 1.6	0.0 ± 0.0	0.0 (0.0)	0.0 ± 0.0	0.0 (0.0)	0.0 ± 0.0	-0.1 (0.1)
Low-fat, low-sugar milk	7.4 ± 1.9	-0.1 ± 0.4	1.0 (0.5)*	-0.1 ± 0.5	1.6 (0.8)*	-0.1 ± 0.7	2.2 (1.1)*
100% juice	8.3 ± 1.8	0.1 ± 0.3	0.5 (0.6)	0.2 ± 0.4	0.8 (0.8)	0.3 ± 0.6	1.1 (1.1)
Diet beverages	12.3 ± 2.2	0.6 ± 0.6	-0.4 (0.8)	0.8 ± 0.9	-0.5 (1.2)	1.1 ± 1.2	-0.7 (1.6)
Bottled and flavored water	28.3 ± 13.6	0.6 ± 1.1	-0.1 (1.0)	0.8 ± 1.6	-0.2 (1.5)	1.1 ± 2.2	-0.3 (1.9)
Other (non-SSB) beverages	339.5 ± 1.4	2.6 ± 6.6	-2.5 (12.8)	3.8 ± 9.7	-3.6 (18.9)	5.0 ± 12.7	-4.7 (24.9)
Total beverages	433.9 ± 1.3	-3.2 ± 7.4	-2.7 (10.2)	-4.6 ± 10.9	-3.9 (15.1)	-6.0 ± 14.3	-5.1 (19.8)
Dairy products (excluding milk)	30.8 ± 1.4	-0.2 ± 0.0	-0.7 (48.4)	-0.2 ± 0.0	-1.0 (4.7)	-0.3 ± 0.0	-1.2 (0.5)
Meat, poultry, fish and mixed meat dishes	20.7 ± 1.5	-0.5 ± 0.0	-0.4 (93.1)	-0.7 ± 0.0	-0.6 (92.9)	-0.9 ± 0.0	-0.7 (6.2)
Other proteins	9.4 ± 1.4	0.2 ± 0.2	-0.2 (0.2)	0.2 ± 0.3	-0.4 (0.3)	0.3 ± 0.4	-0.5 (0.5)
Grain-products (excluding RTE desserts)	64.0 ± 1.2	-0.2 ± 0.0	-0.9 (105.7)	-0.3 ± 0.0	-1.2 (105.8)	-0.4 ± 0.0	-1.6 (13.9)

Fruits and vegetables	63.2 ± 1.4	-0.5 ± 1.2	-1.0 (1.4)	-0.8 ± 1.8	-1.5 (2.1)	-1.0 ± 2.4	-1.9 (2.7)
Fats, oils, sauces and condiments	28.4 ± 4.7	-0.2 ± 0.6	-0.4 (0.5)	-0.3 ± 0.9	-0.5 (0.8)	-0.4 ± 1.2	-0.7 (1.0)
Sweets and snacks	66.9 ± 1.3	0.4 ± 1.0	0.4 (1.3)	0.7 ± 1.4	0.5 (1.9)	0.9 ± 1.8	0.7 (2.4)
'Other' foods	6.7 ± 2.0	0.1 ± 0.2	0.0 (0.2)	0.1 ± 0.2	-0.1 (0.3)	0.1 ± 0.3	-0.1 (0.4)
Mixed dishes and soups	40.6 ± 1.5	0.2 ± 0.9	-1.2 (0.8)	0.3 ± 1.3	-1.8 (1.2)	0.4 ± 1.7	-2.3 (1.6)
Total foods	330.9 ± 1.2	-0.1 ± 3.8	-3.0 (9.1)	-0.1 ± 5.5	-4.3 (13.4)	-0.1 ± 7.2	-5.7 (17.6)
Total foods/beverages	766.5 ± 1.2	-2.7 ± 8.7	-7.4 (21.4)	-4.0 ± 12.8	-10.8 (31.6)	-5.2 ± 16.8	-14.0 (41.5)

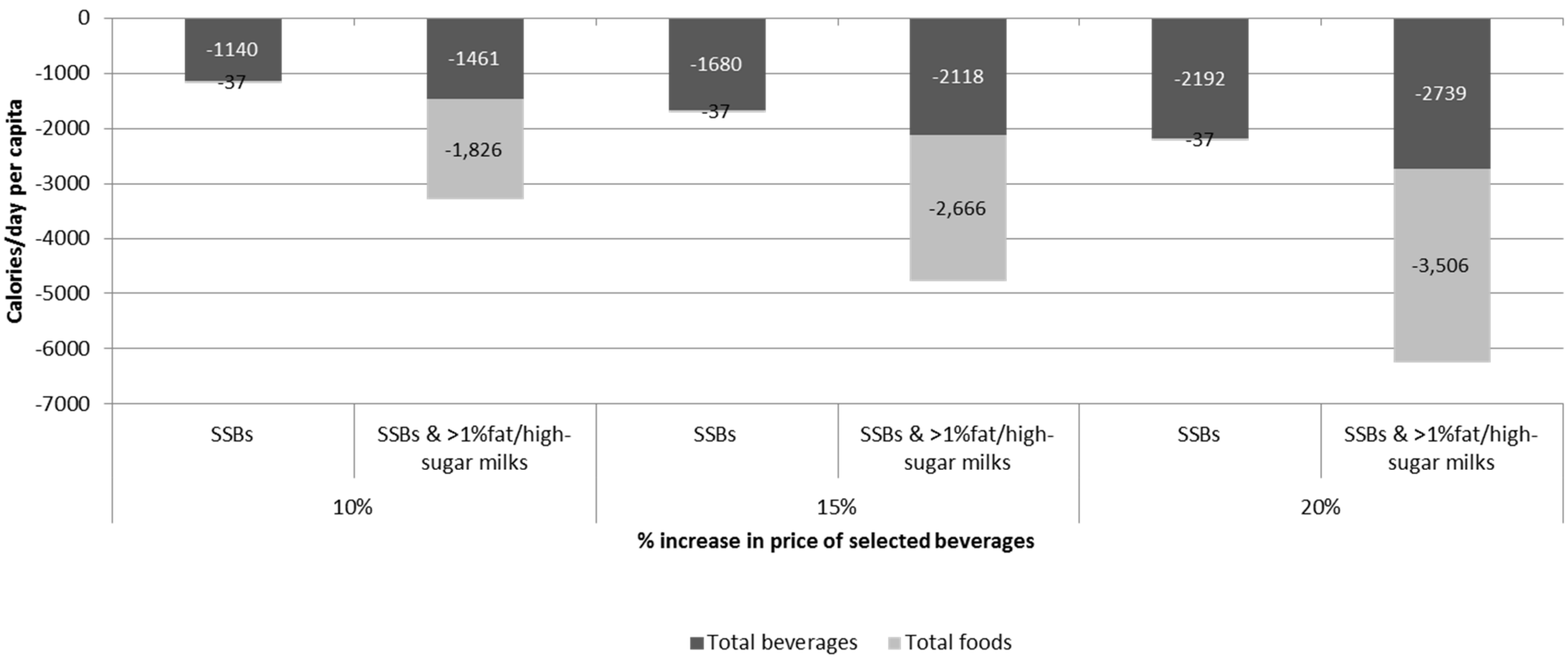
[1] Values are given as means ± SE
[2] Models were adjusted for household composition (number of household members by gender and age: 2-5y; 6-11y; 12-18y; ≥19y); household income as a percent of Federal Poverty Level (FPL) (≤100% FPL; 100>-130%FPL; 130>-185% FPL; 185>-400% FPL; and ≥400% FPL), education level (highest level of education completed by a head of household), race/ethnicity, quarterly unemployment rate by market, year, and quarter
*** Significantly different from mean value with no tax, P<0.01
** Significantly different from mean value with no tax, P<0.05
* Significantly different from mean value with no tax, P<0.10

Figure 4.1. Mean grams purchased per capita per day among households with a preschool child participating in the Nielsen Homescan Panel, years 2009-2012. Panel A shows mean grams purchased per capita among all households in the sample. Panel B shows mean grams purchased per capita among reporting households (denominator is reporting households only). All values are given as mean grams purchased per capita per day.



University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services for all food categories, Including beverages and alcohol for the 2009-2012 periods, for the U.S. market. Copyright © 2015, The Nielsen Company.

Figure 4.2. Change in mean grams purchased annually per capita with price increases of 10%, 15% and 20% on sugar-sweetened beverages (regular soft drinks, juice drinks, and sport and energy drinks), or on sugar-sweetened beverages and >1% fat and/or high-sugar milks. Values are given as mean annual change in calories purchased per capita among U.S. households with a preschool child who participated in the Nielsen Homescan panel, years 2009-2012.



University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services for all food categories, Including beverages and alcohol for the 2009-2012 periods, for the U.S. market. Copyright © 2015, The Nielsen Company.

Supplemental Table 4.1. Description of approach to classifying beverages reported by participants in the Nielsen Homescan Panel, years 2009 to 2012

Beverage group	Homescan
Sugar-sweetened beverages	Includes all regular soft drinks, juice drinks, and sports and energy drinks
Regular soft drinks	Identified using keyword searches of modules and ingredient lists. Includes all beverages in the ‘soft drinks’ module. Excludes beverages meeting any of the following criteria: 1) Ingredients do not include carbonation 2) Product contains <10 kcal per 100 grams 3) Ingredient list does not contain one or more caloric sweetener(s)
Sports and energy drinks	Identified using keyword searches of modules and ingredient lists. Includes beverages in the ‘sports drink’ module and beverages described as ‘Powerade’ or ‘Gatorade’. Includes beverages from the ‘soft drinks’ module whose description includes “energy drink”, “Red Bull”, “Rockstar”, or “Monster”. Excludes beverages with <10 kcal/100 grams
Juice drinks	Identified using keyword searches of modules and ingredient lists. Includes beverages in the “fruit juice” module not classified as 100% fruit juice; beverages in the “fruit drinks” module whose ingredient list contains juice, but was not classified as 100% juice; and excludes beverages with <10 kcal/100 grams
>1% fat, high-sugar milk	Identified using nutrition information. Includes milks containing >1% fat by volume, and ≥8.8 g of sugar per 100 g
>1% fat, low-sugar milk	Identified using nutrition information. Includes milks containing >1% fat by volume, and <8.8 g of sugar per 100 g
Low-fat, high-sugar milk	Identified using nutrition information. Includes milks containing ≤1% fat by volume, and ≥8.8 g of sugar per 100 g
Low-fat, low-sugar milk	Identified using nutrition information. Includes milks containing ≤1% fat by volume, and <8.8 g of sugar per 100 g
100% Fruit juice	Identified using keyword searches of modules and ingredient lists. Includes

	beverages in the "fruit juice" module meeting one of the following criteria: 1) Ingredient list does not contain sweeteners 2) Ingredient list contains "100%" 3) Claims contain "100% juice" 4) Ingredients do not include water Includes beverages "fruit drinks" module meeting both of the following criteria: 1) First and second ingredient are juice, fruit juice concentrate or water but not sweetener 2) Ingredients contain "100%", claims contain "100% juice" or ingredients contain neither water nor sweeteners
Diet drinks	All soft drinks, sports and energy drinks, and juice drinks containing <10 kcal/100 grams
Bottled and flavored waters	Includes all beverages from the "water" module. Excludes beverages with <10 kcal/100 grams
Non sugar-sweetened beverages	Includes all beverages other than regular soft drinks, juice drinks, and sport and energy drinks

Supplemental Table 4.2. Description of methods used to create quarterly market food/beverage group prices, and Food Price Index (FPI), for years 2009-2012 of the Nielsen Homescan Panel

Variable	Description
Food/beverage prices	Market-quarter beverage prices were derived as a weighted average price of beverage groups per 100g/100ml, by commercial beverage category, by market, by quarter. All dried and concentrated beverages were reconstituted to 'ready-to-eat' form using standard conversion factors (29.35 g per ounce for dry weights, and 29.57 ml per ounce for liquids) and manufacturer's reconstitution instructions (e.g. frozen concentrated juice). Market quarterly average price by beverage group were derived using a two-step approach: 1) compute household quarterly average price per 100 grams for beverage group (k); then, 2) using household quarterly average price for beverage group (k), compute market quarterly average price for beverage group (k). HH_Price_{khq}, average household (h) quarterly price per 100 grams for each food/beverage group (k), was derived by summing the total household (h) expenditures (p) from all UPCs (i) comprising beverage group (k) during quarter (q), then dividing this value by the sum of grams (g) purchased from beverage group (k) during quarter (q) by household (h). $$HH\_Price_{khq} = \frac{\left(\sum_{i=1}^{n} p_{h,i}\right) * 100\ grams}{\sum_{i}^{n} g_{h,i}}$$ M_Price_{kmq}, average quarterly price for each food/beverage group (k) per 100 grams by market (m), was computed by summing the product of household quarterly average price for food/beverage group (k) and household weight for all households in market (m), and dividing this value by the sum of household weights for all households in market (m). $$M\_Price_{kmq} = \frac{\sum_{h=1}^{n}(HH\_weight * HH_{Price_{khq}})}{\sum_{h=1}^{n} HH\_weight_h}$$
Food Price Index (FPI)	The Food Price Index computed by first computing the proportion of total market-quarter food/beverage purchases for all households in market (m): $$FGweight_{mq} = \frac{\sum_{h=1}^{n} TotalHH\_purchases_{hmq}}{\sum_{h=1}^{n} Total\_purchases_{mq}}$$ Then, we summed the product of the market-quarter weight and market-

	quarterly average price for each food/beverage group (k), and divided this value by the sum of food/beverage group weights for market (m) in quarter (q): $$FPI_{m,q} = \frac{\sum_{k=1}^{n}(FGweight_{m,q,k} * M_{Price\,k,m,q})}{\sum_{k=1}^{n} FGweight_{m,q,k}}$$
	Food Price Index was created to reflect food/beverage-associated costs of living by market and quarter. All indexes were computed using quarter 1 of 2000 in Los Angeles, California as the referent index. The Food Price Index computed by first computing the proportion of total market-quarter food/beverage purchases for all households in market (m): $$FGweight_{mq} = \frac{\sum_{h=1}^{n} TotalHH\_purchases_{hmq}}{\sum_{h=1}^{n} Total\_purchases_{mq}}$$ Then, we summed the product of the market-quarter weight and market-quarterly average price for each food/beverage group (k), and divided this value by the sum of food/beverage group weights for market (m) in quarter (q): $$FPI_{m,q} = \frac{\sum_{k=1}^{n}(FGweight_{m,q,k} * M_{Price\,k,m,q})}{\sum_{k=1}^{n} FGweight_{m,q,k}}$$

Supplemental Table 4.3. Price (per 100 grams), mean grams purchased per capita, mean grams purchased among reporting households, and percentage of households reporting for selected beverages

Food/beverage	Price, mean (SD), $	Percentage of households who purchased, mean (SE), %
Soft drinks	$0.08 (0.00)	76.0% (0.2%)
Sport and energy drinks	$0.08 (0.00)	31.5% (0.3%)
Juice drinks	$0.12 (0.00)	85.4% (0.2%)
>1% fat, high-sugar milk	$0.17 (0.00)	28.1% (0.3%)
>1% fat, low-sugar milk	$0.09 (0.00)	88.3% (0.2%)
Low-fat, high-sugar milk	$0.17 (0.00)	6.3% (0.1%)
Low-fat, low-sugar milk	$0.09 (0.00)	33.4% (0.3%)
100% juice	$0.16 (0.00)	59.9% (0.3%)
Diet beverages	$0.08 (0.00)	49.9% (0.3%)
Bottled and flavored water	$0.03 (0.00)	27.3% (0.3%)

University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services for all food categories, Including beverages and alcohol *for the* 2000-2012 *periods, for the U.S. market. Copyright © 2014, The Nielsen Company.*

CHAPTER 5. A SIMULATED 20% SUGAR-SWEETENED BEVEARGE TAX SHOWS PROMISE FOR IMPROVING THE DIETS OF U.S. PRESCHOOL CHILDREN

Overview

How beverage taxes might influence food and beverage intakes among U.S. preschool children is unclear. We used purchase and price data from the 2003-2012 Nielsen Homescan Panel, and dietary intake data from the National Health and Nutrition Examination Survey (2003-04; 2005-06; 2007-08; 2009-10, and 2011-12) to examine the relationship between beverage simulated price increases and food/beverage intakes among U.S. children ages 2-5y. We used a two-part, multilevel panel model to estimate demand relationships between sugar-sweetened beverage (SSBs) price increases of 10%, 15% and 20% and food and beverage purchases. Resulting estimates of beverage demand relationships were applied to dietary intake data from NHANES to simulate 'taxes' on SSBs of 10%, 15% and 20% and their associations with food/beverage intake among U.S. preschoolers. Relationships were examined overall, and by household income level (0-185% Federal Poverty Level [FPL]; 185-350% FPL and >350% FPL). A simulated 20% increases in the prices of SSBs was associated with lower caloric intakes from total SSBs ($p<0.01$), total beverages ($p<0.01$), and grain-based desserts ($p<0.05$), among U.S. preschool children. A 20% tax on SSBs was also predicted to meaningfully decrease total caloric intake (-21.9 kcal/capita/d), although this finding was not statistically significant ($p>0.10$). Our study suggests that a 20% increase in price of SSBs, could potentially decrease caloric intakes from total SSBs and total beverages among U.S. preschool children.

Introduction

Beverages, such as sugar-sweetened beverages (SSB) and whole-fat milk consistently rank among the leading sources of calories from solid fats and added sugars (empty calories) in the diets of U.S. children (1, 2). Though certain foods also rank among the top sources of empty calories in children's diets (2), consuming too many calories from beverages may promote overeating in ways foods do not. This is because, relative to the calories they provide, satiety from consuming beverages may be less than that from foods (3-8). Consequently, consuming too many empty calories from beverages may promote weight gain (9, 10).

In recent years, the diets of preschool children (ages 2-5y) has been seen as a major focus for preventing excess weight gain in children. Not only is this developmental period marked by the formation of dietary preferences and behaviors that may track into later stages of life (11, 12), but the prevalence of obesity is lower among preschoolers (13). More importantly, a large proportion of children are already overweight by ages 6-11y (13), which makes preschoolers an important population for preventing weight gain.

Among modifiable obesity-related dietary factors, certain beverages have become an appealing public health target. SSBs in particular are the focus of one prominent strategy – taxes – that continues to gain momentum (14-21). However, there is little empirical evidence on how imposing taxes on SSBs may influence the overall diet for children, particularly preschoolers. A predominance of previous studies have used household purchase data to examine these relationships (22-27). While these studies have yielded important insights into how targeted beverage taxes influence food/beverage purchases at the household level, it remains unclear how these taxes relate to the dietary intakes of individuals within the household. Moreover, even after adjustments for household composition, individuals' dietary intake may be poorly reflected in household purchases (28). Thus, there is a particular need for studies examining the relationships between targeted beverage taxes and food/beverage intakes. Furthermore, there is a need to examine these relationships at different household income levels, as it has been previously noted that a tax on SSBs might be more burdensome for low- vs. high-income households (25, 29). To our knowledge, ours is the first study to combine household purchase data with dietary intake data to explore these relationships exclusively in preschool children.

Given their importance for obesity prevention, we focused our analyses on U.S. preschool children who participated in the National Health and Nutrition Examination Survey (NHANES) during survey years 2003-04, 2005-06, and 2007-08, 2009-10, and 2011-12. We used food/beverage purchase data for households with a preschooler from the Nielsen Homescan Panel (2003-2012) to estimate demand relationships (elasticities) between prices of SSBs (caloric soft drinks, juice drinks, and sport and energy drinks) and food/beverage purchases overall, and by household income as a percent of the Federal Poverty Level (FPL) (0-185% FPL; 185-350%; and >350% FPL) . We subsequently applied the elasticities (representing the percent change in amount purchased relative to the percent change in price) obtained from these models to dietary intake data from preschool children in NHANES, to estimate changes in caloric intakes for selected beverages, foods, total foods, and total beverages overall, and by household income. By using price change to simulate taxes on selected beverages we aimed to: 1) examine how these taxes relate to estimated daily intakes of beverages, foods and total calories; 2) highlight important differences in these relationships by household income; and 3) characterize beverage demand relationships at simulated 'taxes' of 10%, 15% and 20% in an effort to determine the minimal tax rate associated with meaningful decreases in intakes of beverages high in sugar and/or fat among U.S. preschoolers.

Methods

Sample

NHANES dietary intake data

We used data from the What We Eat In America survey, which is the dietary component of the National Health and Nutrition Examination Survey (NHANES), years 2003-04, 2005-06, 2007-08, 2009-10, and 2011-12. NHANES comprises a nationally representative survey administered by the U.S. Department of Health and Human Services and the U.S. Department of Agriculture in order to monitor the diets and health of the U.S. population (30). Respondents' dietary intake was ascertained using interviewer-administered 24-hour dietary recall surveys, as well as the five-step automated multipass method to improve the accuracy of recall (31). For all children younger than six, dietary intake was reported by proxy (the child's primary guardian/caretaker) (30). Nutrient intakes were derived using a survey-specific version of the USDA Food and Nutrient Database for Dietary Studies (32). From these data, we included data for children ages 2-5 years who participated in NHANES 2003-04, 2005-06, 2007-08, 2009-10, and 2011-12. The first of two 24-hour recall surveys was used to compute mean daily caloric intake per person for 10 beverages, total SSBs, total >1% fat/high-sugar milks, total beverages, selected foods, total foods, and total energy.

Nielsen Homescan purchase and price data

We used food and beverage purchase and price data from the 2003-2012 Nielsen Homescan Panel, which comprises a nationally representative prospective survey of U.S. households from across 76 major markets (metropolitan and non-metropolitan areas) who reported purchases of all barcoded consumer packaged food and beverage (CPGs) using scanner technology (33). Respondents provided information on the retailer shopped, amount purchased, and price paid for each food/beverage purchased, and these data were transmitted electronically to Nielsen weekly and compiled quarterly (34). To best approximate beverage demand relationships for preschool children and their families, we included households with a single child who participated in Homescan during survey years 2003-2012. In addition, unemployment rate data, from the Bureau of Labor Statistics Local Area Unemployment Statistics (35), were matched by market and quarter with the Homescan data.

Using the Homescan data, we estimated average quarterly market-level prices for 10 beverage categories and 51 food categories. Prices represent the weighted average price per 100g/100ml, by food or beverage category, by market, by quarter and year. A detailed description of our approach to computing quarterly-market food and beverage prices has been published previously (36). Additionally, we created a measure of the average costs of foods and beverages, a Food Price Index (FPI), relative to the first quarter of the year 2000 in Los Angeles, CA. Including this variable in our analyses scaled all costs relative to a single geographic location and time point in order to account for differences in costs of living (including the costs of foods/beverages) by region and time. A detailed description of this approach is given elsewhere (36).

Food/beverage groups

Foods and beverages reported by subjects in NHANES were grouped into categories comprising foods/beverages with similar nutrition properties. Beverages, as the key focus of this work, were partitioned into 10 mutually exclusive groups: 1) caloric soft drinks; 2) sports and energy drinks; 3) juice drinks; 4) >1% fat, high-sugar milk; 5) >1% fat, low-sugar milk; 6) low-fat, high-sugar milk; 7) low-fat, low-sugar milk; 8) 100% juice; 9) tap, bottled and flavored waters; and 10) diet beverages. SSBs, comprising caloric soft drinks, sports and energy drinks; and juice drinks (fruit-flavored or fruit-juice containing beverages with <100% fruit juice) were summed to compute total SSBs (9, 37, 38). When necessary, nutrition information from the USDA food database was examined and a criterion of ≥9.0% sugar by volume was used to identify SSBs. Milk groups were based on fat and sugar content cut-points specified by the Institute of Medicine (IOM). In a 2007 report, the IOM recommended choosing 1% fat and skim milk over those containing >1% fat. The IOM further advised that intake of milk containing >22 g of sugar per 8-oz serving (9.0% by volume) be limited (39). Moreover, these guidelines are consistent with recent (2009) changes in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) food packages provided to children ages two and older (40). In accordance with these guidelines milks were categorized by low- vs. high- sugar content, as well as low-fat vs. >1% fat by volume. 'Tap, bottled and flavored waters' included all food codes corresponding to bottled or tap water, as well as low-calorie flavored waters (e.g., Propel water). Lastly, all USDA food codes corresponding to diet/reduced calories sodas, diet/reduced calorie sport and energy drinks, low-calorie flavored waters, etc., comprised the 'diet beverages' group. In addition to these beverage groups, we created summary categories for total beverages, total >1% fat/high-sugar milks, total foods, and total foods/beverages. A complete listing of the beverage groups and subgroups, including the USDA food codes comprising each group has been published elsewhere (41). In addition, we used the UNC-CH approach to characterize mean intakes of eight key food groups: 1) grain-based desserts; 2) savory snacks; 3) fruit; 4) pizza/calzones; 5) ready-to-eat (RTE) cereals; 6) sweet snacks and candy; 7) dairy-based desserts, and 8) vegetables. In this approach, USDA food codes and corresponding food descriptions were used by a team of nutritionists (including dietitians and food scientists) to partition foods and beverages in 62 mutually exclusive groups. A description of the UNC-CH approach, as well as a detailed description of the food groups included in our analysis has been published previously (42).

Within the Homescan data, we created 10 mutually exclusive beverage groups, and eight food groups, and summary categories for total SSBs, total beverages, total >1% fat/high-sugar milks, total foods, and total foods/beverages, comparable to those created in NHANES using product ingredient lists, Homescan 'modules', and product claims. A description of the food/beverage groups created in both NHANES and Homescan is given in **Supplemental Table 5.1**.

Statistical analyses

All analyses were conducted in Stata (version 13, 2011, StataCorp, College Station, TX), using appropriate survey weighting procedures for both the Homescan analyses, and analyses using NHANES data. Estimation of demand elasticities with the Homescan data: All demand relationships estimated using the Homescan data were done so using purchases in grams, and price per 100 gram-based prices. To model demand relationships using the Homescan data, either a two-part model or ordinary least square regression was used. For foods/beverages purchased by ≤80% of households, a two-part marginal effects model was used to obtain estimates of demand relationships among the whole sample (both reporters and non-reporters of the target outcome of interest). This approach, which incorporates the probability of reporting the food/beverage of interest, is suitable for modeling outcomes with a significant proportion of non-reporters (43). In the first part of the two-part model, probit regression was used to estimate the overall probability of purchasing the outcome food/beverage of interest conditioned on food/beverage prices and other covariates. In part two of the model, the same regressors were used as in part one, and the amount purchased (in grams per capita) among reported purchasers was estimated using conditional OLS regression. Lastly, estimates from both models were algebraically combined to obtain predicted amounts purchased in all households (purchasers and non-purchasers of the outcome of interest) included in the sample. To account for correlation in repeated measures in the same households, and potential market-level correlation between households (44), corrected standard errors were computed using 1000 bootstrap replications with clustering at the market level. For more commonly purchased foods/beverages, only part two of the two-part model was used.

All prices were entered into the models as natural logs, as the distribution of prices was skewed. Similarly, all outcome variables were transformed using natural logs to account for skewness and to simplify the interpretability of coefficients as elasticities, which represent the proportion change in purchases of a food/beverage relative to the proportion change in price of a food/beverage. As log-transformation of the dependent variable may induce bias upon simple retransformation using the anti-log (exponent) (45), Duan's smearing estimators were computed for each model (46), and model coefficients were multiplied by the appropriate estimator upon retransformation. Because resulting coefficients from the log-log model can be interpreted as elasticities without retransformation, this approach was applied only to compute predicted changes in amounts purchased under each tax condition.

All years (2003-2012) were pooled in all analyses to compute average demand relationships. We tested and found significant ($p<0.10$) interactions between household income level and beverage prices. Thus, in addition to analyses performed using the full sample (overall model), we stratified by level of income (0-185% FPL; >185-350% FPL; and >350% FPL). Only the overall model was adjusted for household income, whereas all models were adjusted for household composition (including the number of individuals by age and gender), head of household race/ethnicity, head of household education level, Food Price Index (FPI), quarterly market prices of all foods/beverages other than the main exposure, quarterly market-level unemployment rate, year (using 2-year increments corresponding to NHANES survey years) and quarter (both using disjoint indicator variables). In addition, to adjust for potential heterogeneity in the relationship between beverage price and purchases over time, interaction terms were included for regular soft drinks; juice drinks; low-fat, high-sugar milk; >1% fat, low-sugar milk; >1% fat, high-sugar milk; and sport and energy drinks interacted with 2-year increments (corresponding to survey-year in NHANES). We used indicator variables for each of five categories of year (2003-04; 2005-06; 2007-08; 2009-10; and 2011-12) and 8 categories of quarter (e.g. quarters 1-4 of 2003, quarters 5-8 of 2004).

Mean dietary intakes from NHANES

NHANES dietary intake data were used to estimate mean caloric intakes for the 10 beverages (described above), total SSBs, total >1% fat/high-sugar milks, total beverages, grain-based desserts, savory snacks, fruit (fresh, frozen, canned or dried), vegetables (fresh, frozen, canned or dried), ready-to-eat (RTE) cereals, sweet snacks and candy, dairy-based desserts, and total foods. , Simple means were computed for all selected foods and beverages using NHANES survey weights to account for different probability of selection. Overall mean intakes (using the full sample) were estimated, in addition to mean intakes by household income level (0-185% FPL; >185-350%; and >350% FPL).

Predicted changes in dietary intakes in NHANES

Following previous works (23, 25), elasticity estimates obtained using the Homescan data were applied to mean dietary intakes computed using NHANES data. Overall elasticities (using the full sample) and elasticities by household income level, from Homescan were applied to corresponding mean food/beverage intakes by corresponding household income level from NHANES. Average per person (per capita) changes in caloric intakes from all selected foods and beverages were computed by multiplying mean intake values by elasticities. Predicted changes were assumed to be statistically significant if analogous predicted changes were significant in the Homescan demand model. Predicted changes were computed using simulated price increases of 10%, 15% and 20% on SSBs (caloric soft drinks, juice drinks, and sport and energy drinks). A general overview of this approach is given in Supplemental Table 2. Lastly, predicted annual changes in caloric intakes were computed by multiplying predicted changes in per capita intake per day by 365.25.

Results

Selected demographic characteristics of the NHANES sample (age, race/ethnicity, and household income) are shown in Table 1 along with mean intakes (grams/d and kcal/d) of total SSBs, total beverages and total foods by survey year. While there were minor differences in the age distribution of the sample between 2003-04 and 2005-06, and between 2005-06 and 2007-08, there were no statistically significant differences across survey years in the distributions of race/ethnicity and household income. Total SSB intake was highest among U.S. preschoolers in 2003-04 and was lower in 2005-06 than in 2007-08 (-35 kcal/capita/d). Total grams/day intake of foods was higher in 2003-04 than in 2005-06 (+241 g/capita/d), while total *caloric* intake from foods in 2011-12 was 100 kcal/capita/d lower than in 2003-04 among U.S. preschool children.

Price elasticity estimates from Homescan data

Elasticities with respect to grams, which represent the change in grams purchased per capita (per person) relative to change in price for the all household income levels, are shown in Table 2. All such elasticities were based on our demand models using the Homescan data.

Own-price elasticities, shown in bold, represent the change in calories purchased per capita for a given beverage relative to a change in price for that same beverage. Own-price elasticities less than or equal -1.0 are characterized as elastic, indicating increasing the price of that beverage by 1% decreases intake by at least 1%. Own-price elasticities greater than -1.0 are said to be inelastic, meaning intake falls by less than 1% when the price of that beverage is increased by 1%. All beverages were found to be own-price inelastic, although there were statistically significant negative own-price elasticities observed for total SSBs (-0.48), juice drinks (-0.50), total >1% fat/high-sugar milks (-0.44), >1% fat high-sugar milk (-0.38), low-fat, high-sugar milk (-0.31), low-fat, low-sugar milk (-0.50), and 100% juice (-0.66).

Cross-price elasticities reflect the change in calories purchased per capita of a given food or beverage relative to the change in price of another food/beverage. Negative cross-price elasticities indicate a complementary relationship, in which increasing the price of one beverage decreases purchases of another food/beverage. Total SSBs were a complement for juice drinks (-0.49), and grain-based desserts (-0.41). Total >1% fat/high-sugar milks were a complement for >1% fat, high-sugar milk (-0.43), grain-based desserts (-0.33), RTE cereals (-0.38), and dairy-based desserts (-0.41). Conversely, positive cross-price elasticities denote a substitution relationship, whereby increasing the price of one beverage increases purchases of another food/beverage. Soft drinks (0.54), and 100% juice (0.35) were found to be substitutes for sports and energy drinks.

Elasticities of demand with respect to the prices of selected beverages by household income (0-185% FPL; >185-350%; and >350% FPL) are shown in Table 3. As shown, own-price elasticities for total SSBs were stronger (greater absolute value) for total SSBs, juice drinks, and 100% among households earning >185-350% FPL, indicative of stronger relationships between beverage prices and purchases of these beverages. Complementary relationships were found between total SSBs and low-fat, high-sugar milk (0.59), and between soft drinks and low-fat, high-sugar milk (0.30), but only among households earning 0-185% FPL.

Simulated taxes and food/beverage intakes

Predicted relative (represented as percent change) and absolute (kcal/capita/d) changes in calories purchased per capita under a simulated 20% increase in the price of SSBs, among all household income groups combined, and by the three household income levels are shown in Table 4. Predicted relative and absolute for SSB simulated price increases of 10%, 15% and 20% for all included foods and beverages are shown in Supplemental Table 3 and Supplemental Table 4. These demand relationships, derived from our demand models using the Homescan data, were combined with mean dietary intakes from preschool children in NHANES to compute the predicted changes in caloric intakes in these children with a 'tax' on SSBs.

In all household income groups combined, increasing the price of SSBs by 10% to 20% was associated with decreases in intakes of total SSBs (range: -4.6, -8.7 kcal/capita/d), total beverages (range: -5.6, -10.7 kcal/capita/d), juice drinks (range: -5.3, -9.8 kcal/capita/d), and grain-based desserts (range: -2.4, -4.6 kcal/capita/d). Intakes of 100% juice were expected to increase with increases in the price of SSBs (range: 2.3, 4.4 kcal/capita/d). Total caloric intake was predicted to decrease (range: 11.5, -21.9 kcal/capita/d) with a 'tax' on SSBs, although these changes were not statistically significant (p>0.10).

In stratified analyses by household income, SSB price increases were associated with decreases in total SSB intakes only among children from households earning >185-350% FPL, and those from households earning >350% FPL. In addition, the inverse relationship between SSB price increases and total beverage intake was no longer significant in stratified analyses. The decrease in intakes of juice drinks, and grain-based desserts, were most pronounced in preschoolers from households earning 185-350% FPL. Lastly, while not significant among all household income groups combined, SSB price increases were predicted to increase intakes of sweet snacks and candy among children from households earning 185-350% FPL.

Simulated beverage taxes and annual per capita caloric intake

Prior related works have extrapolated their findings to a year to demonstrate the potential long-term effects associated with SSB 'taxes' (1-6). Accordingly, Figure 1 shows estimated annual changes in caloric intake for selected foods and beverages (among U.S. preschoolers) associated with a 20% increase in the price of SSBs for preschool children from households at the three income levels. Estimates are shown for total SSBs, sports and energy drinks, juice drinks, 100% juice, grain-based desserts, and RTE cereals. As shown, a 20% increase in the price of SSBs was predicted to be associated with an annual per capita decrease in total caloric intake from SSBs by 3,398 kcal/capita/year, and reduce total caloric intake from beverages by 4,106 kcal/capita/year, among U.S. preschool children. In stratified analyses, preschoolers from households at the 185-350% FPL were predicted to see the greatest annual change, with lower juice drinks intakes of 4,608 kcal/capita/year, and increase intakes of 100% juice by 1,593 kcal/capita/year.

Discussion

Our main finding was that a simulated 20% increase in the prices of SSBs was associated with reduced caloric intakes from total SSBs and total beverages. These findings are supported by a number of prior studies, in which simulated taxes on SSBs of 20% were associated with significant reductions in calories from SSBs and total beverages (1-5). Comparatively, however, we observed a smaller relative change in caloric intake from SSBs (~8% vs. ~21%) as a result of the simulated 20% tax on SSBs (3, 7), which we may have anticipated for several reasons. First, ours is the only study to exclusively examine preschool children, who consume fewer calories from SSBs and total beverages than older children (8). In addition, whereas others have used an estimate of a single set of demand relationships for children and adults (1, 3-5), we undertook additional steps in our analyses in order to model these associations specifically for U.S. preschool children and their households. These findings, which seem to suggest the caregivers (who presumable buy food/beverages on behalf of the child) of preschool children may be less sensitive to beverage price changes than older children and adults, lend to our confidence in the findings of the current study.

Previous studies have suggested a tax on SSBs may be 'regressive', or more burdensome for households earning 0-185 FPL (3, 7). Thus, we sought to evaluate whether a simulated SSB tax would be 'regressive' by examining beverage price demand relationships by household income using 0-185% FPL; >185%-350% FPL; and >350% FPL. We found caloric intake from total SSBs was least own-price elastic (as indicated by a smaller absolute value) among children from households earning 0-185% FPL compared to those from households earning >185% FPL (>185-350% FPL; >350% FPL). We also observed that, by household income, children from households earning 0-185% FPL consumed the most calories from total SSBs.

Zhen et al (5), who also used data from the Nielsen Homescan Panel, observed that a 20% tax was predicted to result in a greater reduction in total purchases of SSBs among households earning >185% FPL vs. those earning 0-185% FPL (7). However, households earning 0-185% FPL purchased more SSBs than those earning >185% FPL, and SSBs were less price elastic among households earning 0-185% FPL. Based on these findings, the authors concluded a tax on SSBs would be regressive (7). This conclusion was supported by Lin et al. (3), who also used Nielsen Homescan Data to simulate a 20% SSB 'tax'. Thus, in keeping with these studies, our findings would also suggest a tax on SSBs might be more burdensome for households earning 0-185% FPL compared to higher-earning households, though our study is unique in examining these relationships among U.S. preschool children and their households. Nonetheless, it should be noted that SSBs, namely caloric soft drinks, juice drinks, and sport and energy drinks, are largely accepted to be non-essential sources of calories (9-13). Therefore, even though an SSB tax might be regressive, the beverages/food impacted by such taxes are not essential for survival. Moreover, children from households earning 0-185% FPL may be protected by food assistance programs such as the Supplemental Nutrition Assistance Program (SNAP) and WIC (households earning 0-185% FPL are eligible for both programs) (14). We speculate that participation in such programs might offer additional assurance that, even if such taxes were more burdensome to low-income households, such taxes would not reduce access to essential sources of calories.

We also examined the potential for targeted beverage taxes to influence intakes of foods. Although just a handful of studies have examined how increases in the price of SSBs relate to purchases of beverages and foods (5, 15, 16), our study appears to be unique in applying these relationships to individual food and beverage intakes among preschool-aged children. We found no evidence that a 20% increase in price of SSBs would be associated with an increase in total caloric intake from foods. Although a 20% increase in SSB price was predicted to increase intakes of RTE cereals, there were concomitant predicted decreases in intakes of grain-based desserts in excess of these predicted increases. Thus, we find no evidence that a tax on SSBs would increase total food intake among U.S. preschoolers.

We also examined 10% and 15% SSB simulated price increases in an effort to determine if there were significant predicted changes in food/beverage intakes with SSB 'taxes' of less than 20%. We found that, while there were similar statistically significant associations observed with simulated price increases of 10% and 15%, predicted decreases in intakes of total SSBs and total beverages were smaller at these lower simulated 'tax' rates (~5-7 kcal/capita/d). It was previously believed targeted taxes of at least 20% would be necessary in order to bring about meaningful changes in consumer behavior (17-19). Similarly, although we found that simulated SSB 'taxes' of 10% and 15% might also reduce intakes of beverages high in sugar and/or fat among U.S. preschool children, taxes of 20% or more would be needed to bring about more substantial (≥|10| kcal/capita/d) changes. Most importantly, meaningful predicted reductions in total calories were only observed with a 20% SSB tax, the net effect of which was a (non-significant) reduction of 5.4 to 36.0 kcal/capita/d, depending on the preschooler's household income level.

There are several important limitations to our study that bear mentioning here. First, we used data from the Nielsen Homescan Panel to estimate demand relationships between beverage prices and food/beverage purchases. As such, it is important to note that food/beverage purchase data reported by Homescan participants were limited to items with barcodes. Moreover, items such as fresh meats and produce, restaurant foods/beverages, and foods/beverages from cafeterias or vending machines, were not well-represented in the Homescan data (20). Thus, the demand relationships estimated using the Homescan data pertain mostly to barcoded, store-bought foods and beverages. Following previous works (3, 4), however, we assumed the demand relationships for the foods/beverages in our analyses did not differ for barcoded and non-barcoded items.

In addition to this limitation related to our analyses of the Homescan data, there are several important limitations related to our use of the NHANES data. Foremost, our use of a single 24-hour recall to estimate mean intakes of selected foods and beverages among U.S. preschool children may be seen as a potential limitation, as two 24-hour recalls are available. However, it has been previously noted that respondents report differently on the first and second days of recall (21). Thus, to use both days of recall, the analysis would need to be limited to those who provided recalls on both days in order minimize the potential for systematic bias. As not all respondents provided recalls on both days, choosing to use both days of recall would significantly limit our already limited sample size. Even with the use of a single 24-hour recall, however, unbiased estimates of mean usual intakes of even episodically-consumed foods/beverages for a sample can be obtained (22). Nonetheless, estimation of standard errors corresponding to mean intakes of less frequently consumed beverages in our analyses, such as waters, diet beverages, and sport and energy drinks (23), may be biased.

There are also a number of strengths to our study. First, in addition to being the only study to examine these demand relationships in preschool children, ours is one of only three studies to examine how targeted beverage taxes influence both beverage *and* food intakes in children (3, 4). Furthermore, unlike these other studies, we endeavored to estimate demand relationships specific to U.S. preschool children and their households by restricting our analyses to households with a single preschool child, and by controlling for important household characteristics. In contrast, prior studies have estimated a single set of demand relationships for both children and adults (1, 3-5). Lastly, whereas previous studies have used discordant survey years in Homescan and NHANES (e.g., Homescan 1998-2007; NHANES 2003-6) (3, 4) our study is the only one to our knowledge to include a full ten years of concordant survey years in Homescan and NHANES.

Conclusion

Our study suggests a tax on SSBs may decrease caloric intakes from SSBs and total beverages among U.S. preschool children. However, our results would suggest taxes of 20% or more would be necessary to bring about meaningful reductions in caloric intakes of total SSBs and total beverages among US preschoolers. Predicted changes in caloric intakes were expected to be greatest among children from households earning >350% FPL. Furthermore, there was no evidence that a targeted beverage tax might increase caloric intake from total foods in children from any household income group. In concert, these findings suggest that targeted beverage taxes may be a potentially effective strategy for reducing intakes of SSBs and perhaps even preventing excess weight gain among preschoolers. Although we found no apparent evidence that a simulated 'tax' on SSBs may be more burdensome to low-income households, such a tax was expected to decrease intakes of only juice drinks (a non-nutritive beverage) among children from low-income households. Thus, our study lends further support for a tax on SSBs as a means to improve the diets of U.S. children, specifically those ages 2-5 years.

Tables and Figures

Table 5.1 Sample characteristics, U.S. children ages 2-5y who participated in What We Eat In America, the dietary component of the National Health and Nutrition Examination Survey during survey years 2003-04, 2005-06, 2007-08, 2009-10 and 2011-12

	All years	2003-04	2005-06	2007-08	2009-10	2011-12
Sample size	4,192	763	902	832	861	834
		<-----------------------------------Mean ± SE----------------------------------->				
Mean per person intake in grams/d						
Sugar-sweetened beverages	277 ± 8	376 ± 21	313 ± 14	245 ± 12*	221 ± 8	236 ± 21
All beverages	781 ± 13	904 ± 31	778 ± 21*	747 ± 25	749 ± 21	733 ± 38*
All foods	887 ± 10	681 ± 15	922 ± 22*	927 ± 22	931 ± 19	963 ± 22
Mean per person intake in kilocalories/d						
Sugar-sweetened beverages	115 ± 3	155 ± 8	134 ± 6	99 ± 5*	93 ± 3	97 ± 9
All beverages	379 ± 7	435 ± 16	379 ± 10*	370 ± 12	357 ± 9	355 ± 24
All foods	1193 ± 9	1276 ± 22	1176 ± 21*	1143 ± 22	1161 ± 22	1215 ± 18
		<--------------------------------------% (SE)-------------------------------------->				
Age						
2-3 y	50.5% (1.3%)	46.9% (2.1%)	49.5% (2.8%)	51.0% (3.8%)	51.4% (2.4%)	53.2% (3.0%)
4-5 y	49.5% (1.3%)	53.1% (2.1%)	50.5% (2.8%)	49.0% (3.8%)	48.6% (2.4%)	46.8% (3.0%)
Race/ethnicity						
Non-Hispanic White	55.3% (2.2%)	60.2% (4.3%)	55.7% (4.1%)	55.7% (5.6%)	53.7% (2.9%)	51.4% (6.3%)
Non-Hispanic Black	14.4% (1.2%)	14.3% (2.2%)	14.7% (2.6%)	14.4% (3.0%)	12.9% (1.2%)	15.8% (3.6%)
Hispanic	22.5% (1.6%)	18.4% (3.5%)	22.5% (3.1%)	22.7% (3.9%)	24.3% (3.2%)	24.4% (4.3%)
Household income (%FPL)						
0-185% FPL	50.6% (1.6%)	52.6% (4.2%)	47.0% (3.8%)	45.3% (3.4%)	50.7% (2.8%)	57.3% (3.8%)
>185-350%	23.6% (1.2%)	25.7% (2.8%	26.4% (2.9%)	23.5% (1.9%)	26.6% (3.3%)	16.0% (2.4%)
>350% FPL	25.8% (1.6%)	21.7% (3.2%	26.6% (3.6%)	31.3% (3.8%)	22.7% (2.5%)	26.6% (4.4%)

[*] Value was significantly different from value in preceding survey, Wald test, Bonferroni-adjusted for multiple comparisons (p<0.05)

Table 5.2. Elasticities of demand with respect to the price of beverages[1-3]

	With respect to the price of											
Grams purchased per capita/d	Total SSBs	Soft drinks	Sports and energy drinks	Juice drinks	Total >1%/high-sugar milks	>1% fat, high-sugar milk	>1% fat, low-sugar milk	Low-fat, high-sugar milk	Low-fat, low-sugar milk	100% juice	Diet drinks	Tap, bottled and flavored waters
Total SSBs	-0.48 (0.24)**	0.01 (0.19)	0.02 (0.02)	-0.50 (0.31)*	0.04 (0.15)	-0.17 (0.07)**	0.14 (0.17)	0.07 (0.06)	-0.06 (0.10)	0.14 (0.07)**	-0.04 (0.08)	0.00 (0.01)
Soft drinks	-0.56 (0.38)	-0.28 (0.26)	0.09 (0.05)*	-0.37 (0.44)	0.37 (0.27)	-0.35 (0.15)**	0.63 (0.31)**	0.09 (0.10)	-0.39 (0.17)**	0.22 (0.13)*	0.03 (0.13)	0.00 (0.01)
Sports and energy drinks	0.38 (0.36)	0.54 (0.28)*	-0.04 (0.03)	-0.12 (0.37)	-0.34 (0.24)	-0.16 (0.09)*	-0.27 (0.22)	0.09 (0.07)	0.30 (0.12)**	0.35 (0.11)***	-0.11 (0.11)	-0.01 (0.01)
Juice drinks	-0.49 (0.27)*	0.04 (0.19)	-0.02 (0.02)	-0.50 (0.29)*	0.02 (0.13)	0.04 (0.06)	-0.07 (0.16)	0.05 (0.04)	-0.02 (0.09)	0.06 (0.07)	-0.01 (0.07)	0.01 (0.01)
Total >1% fat/high-sugar milks	0.08 (0.32)	-0.01 (0.18)	0.03 (0.02)	0.06 (0.26)	-0.44 (0.17)**	-0.11 (0.08)	-0.22 (0.22)	-0.11 (0.06)*	0.19 (0.09)**	-0.05 (0.08)	0.06 (0.08)	-0.01 (0.01)**
>1% fat, high-sugar milk	0.34 (0.25)	0.27 (0.17)	0.02 (0.03)	0.05 (0.25)	-0.40 (0.25)	-0.38 (0.10)***	0.04 (0.23)	-0.07 (0.05)	0.22 (0.09)**	-0.08 (0.09)	0.14 (0.08)*	-0.01 (0.01)**
>1% fat, low-sugar milk	0.10 (0.31)	-0.04 (0.18)	0.02 (0.02)	0.12 (0.25)	-0.43 (0.16)***	-0.10 (0.09)	-0.26 (0.20)	-0.07 (0.06)	0.12 (0.08)	-0.08 (0.08)	0.08 (0.08)	-0.01 (0.01)**
Low-fat, high-sugar milk	0.09 (0.23)	0.09 (0.15)	-0.02 (0.01)	0.02 (0.20)	-0.24 (0.12)**	0.05 (0.05)	0.02 (0.11)	-0.31 (0.06)***	0.14 (0.08)*	0.03 (0.07)	0.03 (0.06)	0.00 (0.01)

Low-fat, low-sugar milk	-0.06 (0.60)	-0.05 (0.32)	-0.02 (0.03)	0.01 (0.54)	0.21 (0.29)	-0.07 (0.15)	0.39 (0.28)	-0.11 (0.09)	-0.50 (0.18)***	-0.04 (0.18)	0.28 (0.16)*	-0.04 (0.01)***
100% juice	0.10 (0.56)	-0.12 (0.37)	0.01 (0.03)	0.21 (0.35)	-0.32 (0.22)	-0.08 (0.13)	-0.16 (0.26)	-0.09 (0.07)	-0.08 (0.13)	-0.66 (0.12)***	-0.33 (0.11)***	0.02 (0.01)
Diet drinks	-1.16 (0.81)	-0.44 (0.32)	0.04 (0.03)	-0.76 (0.65)	-0.21 (0.27)	-0.11 (0.12)	0.06 (0.30)	-0.15 (0.09)*	0.08 (0.17)	0.15 (0.14)	-0.07 (0.13)	-0.01 (0.01)
Tap, bottled and flavored waters	-0.10 (0.30)	-0.04 (0.18)	0.03 (0.03)	-0.09 (0.29)	-0.16 (0.21)	-0.07 (0.08)	-0.11 (0.23)	0.01 (0.05)	0.04 (0.14)	0.07 (0.10)	0.09 (0.09)	-0.03 (0.01)***
Total beverages	-0.36 (0.22)	-0.22 (0.12)*	0.02 (0.01)*	-0.16 (0.16)	0.00 (0.09)	-0.12 (0.05)**	0.09 (0.10)	0.03 (0.04)	-0.02 (0.06)	0.00 (0.04)	0.03 (0.05)	0.00 (0.00)
Vegetables	-0.07 (0.22)	-0.10 (0.15)	0.00 (0.02)	0.02 (0.16)	-0.23 (0.16)	-0.10 (0.06)	-0.12 (0.16)	-0.01 (0.04)	0.04 (0.08)	-0.10 (0.07)	-0.01 (0.06)	0.00 (0.01)
Grain-based desserts	-0.41 (0.25)*	-0.11 (0.12)	0.02 (0.02)	-0.32 (0.25)	-0.33 (0.14)**	-0.11 (0.05)**	-0.21 (0.12)*	-0.01 (0.03)	0.02 (0.07)	0.03 (0.06)	-0.02 (0.06)	0.00 (0.00)
Savory snacks	-0.18 (0.24)	-0.04 (0.12)	0.01 (0.02)	-0.15 (0.19)	-0.20 (0.15)	-0.12 (0.08)	-0.08 (0.13)	0.01 (0.03)	-0.05 (0.08)	0.01 (0.06)	0.06 (0.05)	0.00 (0.00)
Fruit	0.00 (0.26)	0.05 (0.14)	0.00 (0.02)	-0.05 (0.22)	-0.32 (0.17)*	-0.12 (0.09)	-0.19 (0.17)	-0.01 (0.04)	-0.22 (0.11)**	-0.07 (0.08)	-0.05 (0.07)	-0.01 (0.01)**
Pizza, calzones	-0.11 (0.30)	-0.22 (0.22)	0.00 (0.02)	0.11 (0.27)	-0.18 (0.21)	-0.33 (0.11)***	0.26 (0.24)	-0.11 (0.08)	-0.26 (0.14)*	0.09 (0.09)	0.20 (0.10)**	-0.02 (0.01)**
RTE cereals	0.15 (0.29)	-0.05 (0.15)	-0.01 (0.02)	0.20 (0.20)	-0.38 (0.12)***	-0.08 (0.06)	-0.29 (0.13)**	-0.02 (0.03)	0.12 (0.08)	-0.11 (0.07)	0.05 (0.06)	0.00 (0.00)
Sweet snacks, candy	0.19 (0.26)	0.25 (0.16)	0.02 (0.02)	-0.07 (0.22)	-0.28 (0.19)	0.01 (0.08)	-0.30 (0.23)	0.02 (0.05)	0.12 (0.10)	0.09 (0.08)	0.14 (0.07)**	0.00 (0.01)

Dairy-based desserts	-0.46 (0.37)	-0.12 (0.21)	0.03 (0.02)	-0.38 (0.28)	-0.41 (0.22)*	-0.04 (0.08)	-0.42 (0.26)	0.05 (0.06)	0.08 (0.08)	-0.09 (0.08)	-0.03 (0.08)	-0.01 (0.01)*
Total foods	-0.06 (0.15)	-0.02 (0.09)	0.00 (0.01)	-0.04 (0.10)	-0.18 (0.09)*	-0.08 (0.04)*	-0.11 (0.08)	0.01 (0.02)	0.03 (0.04)	-0.03 (0.03)	0.00 (0.03)	0.00 (0.00)
Total foods and beverages	-0.22 (0.17)	-0.13 (0.09)	0.01 (0.01)	-0.11 (0.12)	-0.09 (0.07)	-0.10 (0.04)*	-0.02 (0.08)	0.02 (0.03)	0.01 (0.04)	-0.02 (0.03)	0.01 (0.04)	0.00 (0.00)

[1] Values are given as mean (SE)
[2] Same-price elasticities are shown in bold
[3] Models were adjusted for household income (0-185% Federal Poverty Level [FPL]; >185-350% FPL; and >350% FPL), household composition (including the number of individuals by age and gender), head of household race/ethnicity, head of household education level, Food Price Index (FPI), quarterly market prices of all foods/beverages other than the main exposure, quarterly market-level unemployment rate, year and quarter
*** Value was different from the null value, (Wald test) p<0.01
** Value was different from the null value, (Wald test) p<0.05
* Value was different from the null value, (Wald test) p<0.10

University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services for all food categories, Including beverages and alcohol for the 2000-2012 periods, for the U.S. market. Copyright © 2015, The Nielsen Company.

Table 5.3. Elasticities of demand with respect to the price of beverages, by households income level (0-185% Federal Poverty Level [FPL]; >185-350% FPL; and >350% FPL)[1-3]

Grams purchased per capita/d	With respect to the price of											
	Total SSBs			Soft drinks			Juice drinks			Total >1%/high-sugar milks		
	0-185% FPL	>185-350% FPL	>350% FPL	0-185% FPL	>185-350% FPL	>350% FPL	0-185% FPL	>185-350% FPL	>350% FPL	0-185% FPL	>185-350% FPL	>350% FPL
Total SSBs	**-0.45 (0.67)**	**-0.51 (0.33)**	**-0.51 (0.38)**	0.35 (0.40)	-0.25 (0.26)	0.04 (0.20)	-0.82 (0.62)	-0.27 (0.40)	-0.57 (0.38)	0.05 (0.32)	0.18 (0.23)	-0.15 (0.19)
Soft drinks	-1.13 (0.73)	-0.23 (0.62)	-0.74 (0.78)	**0.00 (0.44)**	**-0.21 (0.37)**	**-0.54 (0.45)**	-1.21 (0.68)*	-0.09 (0.60)	-0.31 (0.65)	0.85 (0.46)*	0.53 (0.38)	-0.21 (0.38)
Sports and energy drinks	0.77 (0.52)	0.44 (0.56)	-0.30 (0.81)	0.83 (0.44)*	0.26 (0.31)	0.47 (0.46)	-0.03 (0.51)	0.23 (0.42)	-0.74 (0.67)	-0.59 (0.29)**	-0.29 (0.29)	-0.12 (0.38)
Juice drinks	-0.61 (0.73)	-0.91 (0.34)***	-0.21 (0.77)	-0.03 (0.43)	-0.11 (0.30)	0.06 (0.43)	**-0.56 (0.58)**	**-0.78 (0.36)****	**-0.25 (0.66)**	0.08 (0.36)	0.12 (0.17)	0.03 (0.36)
Total >1% fat/high-sugar milks	0.51 (0.52)	-0.10 (0.43)	0.15 (0.39)	0.17 (0.29)	-0.26 (0.30)	0.11 (0.27)	0.31 (0.44)	0.14 (0.35)	-0.01 (0.40)	**-0.39 (0.27)**	**-0.39 (0.26)**	**-0.47 (0.25)***
>1% fat, high-sugar milk	0.50 (0.53)	-0.10 (0.45)	0.74 (0.92)	0.37 (0.44)	-0.07 (0.25)	0.50 (0.53)	0.07 (0.43)	-0.05 (0.46)	0.27 (0.70)	-0.42 (0.25)*	-0.33 (0.35)	-0.35 (0.44)
>1% fat, low-sugar milk	0.70 (0.60)	0.06 (0.41)	-0.02 (0.42)	0.12 (0.28)	-0.18 (0.29)	0.01 (0.24)	0.56 (0.52)	0.23 (0.32)	-0.07 (0.42)	-0.36 (0.25)	-0.46 (0.22)**	-0.42 (0.24)*
Low-fat, high-sugar	0.59 (0.32)*	-0.12 (0.20)	-0.04 (0.84)	0.30 (0.18)*	0.02 (0.15)	0.00 (0.49)	0.29 (0.24)	-0.11 (0.23)	-0.03 (0.62)	-0.26 (0.14)*	-0.15 (0.14)	-0.12 (0.39)

milk												
Low-fat, low-sugar milk	-0.57 (0.73)	1.06 (0.69)	-0.34 (1.24)	0.13 (0.39)	0.15 (0.47)	-0.13 (0.66)	-0.62 (0.60)	0.85 (0.64)	-0.16 (0.92)	0.11 (0.35)	0.39 (0.44)	0.07 (0.43)
100% juice	0.46 (0.77)	-0.13 (0.69)	0.42 (0.82)	0.02 (0.46)	-0.20 (0.44)	-0.10 (0.45)	0.41 (0.60)	0.06 (0.51)	0.49 (0.69)	-0.34 (0.35)	-0.27 (0.31)	-0.29 (0.37)
Diet drinks	-1.78 (0.81)**	-0.49 (0.93)	-1.51 (1.04)	-0.57 (0.47)	-0.24 (0.44)	-0.55 (0.52)	-1.27 (0.61)**	-0.31 (0.84)	-0.94 (0.77)	0.15 (0.35)	-0.07 (0.40)	-0.66 (0.43)
Tap, bottled and flavored waters	0.04 (0.78)	-0.03 (0.41)	-0.12 (0.90)	0.18 (0.46)	-0.26 (0.27)	0.10 (0.48)	-0.22 (0.59)	0.20 (0.35)	-0.24 (0.72)	-0.20 (0.35)	-0.12 (0.26)	-0.20 (0.40)
Total beverages	-0.41 (0.57)	-0.19 (0.22)	-0.42 (0.32)	-0.09 (0.42)	-0.24 (0.17)	-0.27 (0.19)	-0.35 (0.40)	0.05 (0.20)	-0.19 (0.23)	0.00 (0.27)	0.09 (0.14)	-0.09 (0.16)
Grain-based desserts	-0.19 (0.35)	-0.34 (0.30)	-0.62 (0.42)	-0.02 (0.26)	-0.15 (0.23)	-0.18 (0.20)	-0.19 (0.31)	-0.20 (0.33)	-0.48 (0.39)	-0.54 (0.24)**	-0.14 (0.17)	-0.37 (0.21)*
Pizza, calzones	-0.11 (0.75)	0.12 (0.38)	-0.39 (0.84)	-0.25 (0.45)	-0.19 (0.29)	-0.16 (0.46)	0.13 (0.58)	0.32 (0.39)	-0.21 (0.67)	0.05 (0.36)	-0.23 (0.27)	-0.30 (0.38)
RTE cereals	0.46 (0.55)	0.35 (0.40)	-0.12 (0.48)	-0.11 (0.41)	-0.06 (0.24)	-0.04 (0.21)	0.56 (0.44)	0.40 (0.39)	-0.07 (0.38)	-0.68 (0.28)**	-0.23 (0.23)	-0.31 (0.15)**
Dairy-based desserts	-0.30 (0.66)	-0.43 (0.49)	-0.69 (0.78)	-0.09 (0.40)	-0.45 (0.31)	0.12 (0.44)	-0.28 (0.59)	0.01 (0.40)	-0.81 (0.66)	-0.32 (0.33)	-0.49 (0.30)*	-0.37 (0.37)

[1] Values are given as mean (SE)

[2] Bolded values represent own-price elasticities

[3] Models were adjusted for household composition (including the number of individuals by age and gender), head of household race/ethnicity, head of household education level, Food Price Index (FPI), quarterly market prices of all foods/beverages other than the main exposure, quarterly market-level unemployment rate, year and quarter

*** Value was different from the null value, (Wald test) p<0.01

** Value was different from the null value, (Wald test) $p<0.05$
* Value was different from the null value, (Wald test) $p<0.10$
University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services for all food categories, Including beverages and alcohol for the 2000-2012 periods, for the U.S. market. Copyright © 2015, The Nielsen Company.

Table 5.4. Mean caloric intake, and predicted change in caloric intake with increases in the prices of SSBs by 20% among U.S. children ages 2-5y who participated in the National Health and Nutrition Examination Survey (NHANES) during survey years 2003-04, 2005-06, 2007-08, 2009-10, and 2011-12

	Mean daily caloric intake per person per day (no tax)[1]				% change in calories purchased				Predicted change in caloric intake			
	Overall	0-185% FPL[2]	>185-350% FPL	>350% FPL	Overall	0-185% FPL	>185-350% FPL	>350% FPL	Overall	0-185% FPL	>185-350% FPL	>350% FPL
Total SSBs	115 ± 3	128 ± 4	117 ± 8	89 ± 6	-7.5%***	-6.0%	-7.0%*	-10.2%*	-8.7***	-7.6	-8.2*	-9.1*
Soft drinks	23 ± 1	28 ± 2	25 ± 2	14 ± 3	-6.0%	-10.4%	-2.8%	-8.5%	-1.4	-2.9	-0.7	-1.2
Sports and energy drinks	3 ± 0	2 ± 0	5 ± 1	2 ± 0	4.4%	11.2%*	6.0%	-5.7%	0.1	0.3*	0.3	-0.1
Juice drinks	84 ± 3	91 ± 3	83 ± 8	71 ± 5	-11.7%***	-13.2%*	-15.1%***	-11.0%	-9.8***	-12.0*	-12.6***	-7.8
Total >1% fat/high-sugar milks	190 ± 5	194 ± 16	194 ± 16	175 ± 7	0.2%	2.5%	0.5%	-0.5%	0.4	4.8	1.0	-0.9
>1% fat, high-sugar milk	46 ± 3	47 ± 4	51 ± 7	42 ± 7	1.3%	4.9%	-4.0%	5.2%	0.6	2.3	-2.0	2.2
>1% fat, low-sugar milk	138 ± 4	155 ± 7	139 ± 8	106 ± 7	0.3%	2.3%	2.5%	-1.4%	0.5	3.6	3.4	-1.5
Low-fat, high-sugar milk	7 ± 1	6 ± 1	5 ± 2	8 ± 3	-2.7%	4.2%	-4.0%**	-3.1%	-0.2	0.3	-0.2**	-0.3
Low-fat, low-sugar milk	24 ± 3	19 ± 5	22 ± 5	35 ± 4	1.0%	-7.9%	7.3%	9.5%	0.2	-1.5	1.6	3.3
100% juice	38 ± 2	41 ± 3	41 ± 6	29 ± 4	11.5%***	9.4%	10.6%**	15.0%	4.4***	3.9	4.4**	4.4
Diet drinks	5 ± 1	6 ± 1	7 ± 1	3 ± 1	-3.0%	-1.2%	0.8%	-5.8%	-0.2	-0.1	0.1	-0.2
Tap, bottled and flavored waters	0 ± 0	0 ± 0	0 ± 0	0 ± 0	-3.0%	-1.2%	0.8%	-5.8%	0.0	0.0	0.0	0.0
Total beverages	378 ± 7	406 ± 8	385 ± 14	324 ± 11	-2.8%*	-3.9%	-1.7%	-2.2%	-10.7*	-15.6	-6.7	-7.1
Vegetables, fresh/frozen/processed	10 ± 1	8 ± 1	10 ± 1	13 ± 2	0.2%	-3.1%	0.7%	3.0%	0.0	-0.2	0.1	0.4
Grain-based desserts	103 ± 3	107 ± 4	107 ± 10	90 ± 6	-4.5%**	-2.6%	-4.5%*	-6.6%	-4.6**	-2.8	-4.8*	-5.9
Savory snacks	73 ± 3	70 ± 3	75 ± 5	78 ± 5	0.2%	1.2%	1.5%	-1.7%	0.1	0.8	1.1	-1.3
Fruit, fresh/frozen/canned/dried	62 ± 2	59 ± 3	59 ± 4	72 ± 5	1.1%	-3.6%	2.9%	2.8%	0.7	-2.2	1.7	2.0

Pizza, calzones	51 ± 4	53 ± 5	55 ± 8	46 ± 7	-3.3%	-4.1%	-1.7%	-5.7%	-1.7	-2.2	-1.0	-2.6
RTE cereals	59 ± 2	69 ± 2	58 ± 5	43 ± 3	5.1%**	4.3%	8.4%	3.2%	3.0**	2.9	4.9	1.4
Sweet snacks, candy	47 ± 2	51 ± 3	45 ± 4	46 ± 5	2.6%	4.9%	8.0%**	-4.6%	1.2	2.5	3.6**	-2.1
Dairy-based desserts	37 ± 2	35 ± 3	44 ± 5	38 ± 4	-2.9%	0.1%	-2.9%	-5.4%	-1.1	0.0	-1.3	-2.1
Total foods	1193 ± 10	1219 ± 13	1179 ± 26	1151 ± 17	0.4%	-0.2%	1.4%	0.2%	4.6	-2.9	17.1	2.6
Total foods and beverages	1572 ± 12	1625 ± 14	1565 ± 30	1475 ± 20	-1.4%	-2.2%	-0.3%	-1.1%	-21.9	-36.0	-5.4	-15.9

[1] Values are given as mean ± SE

[2] FPL: Federal Poverty Level

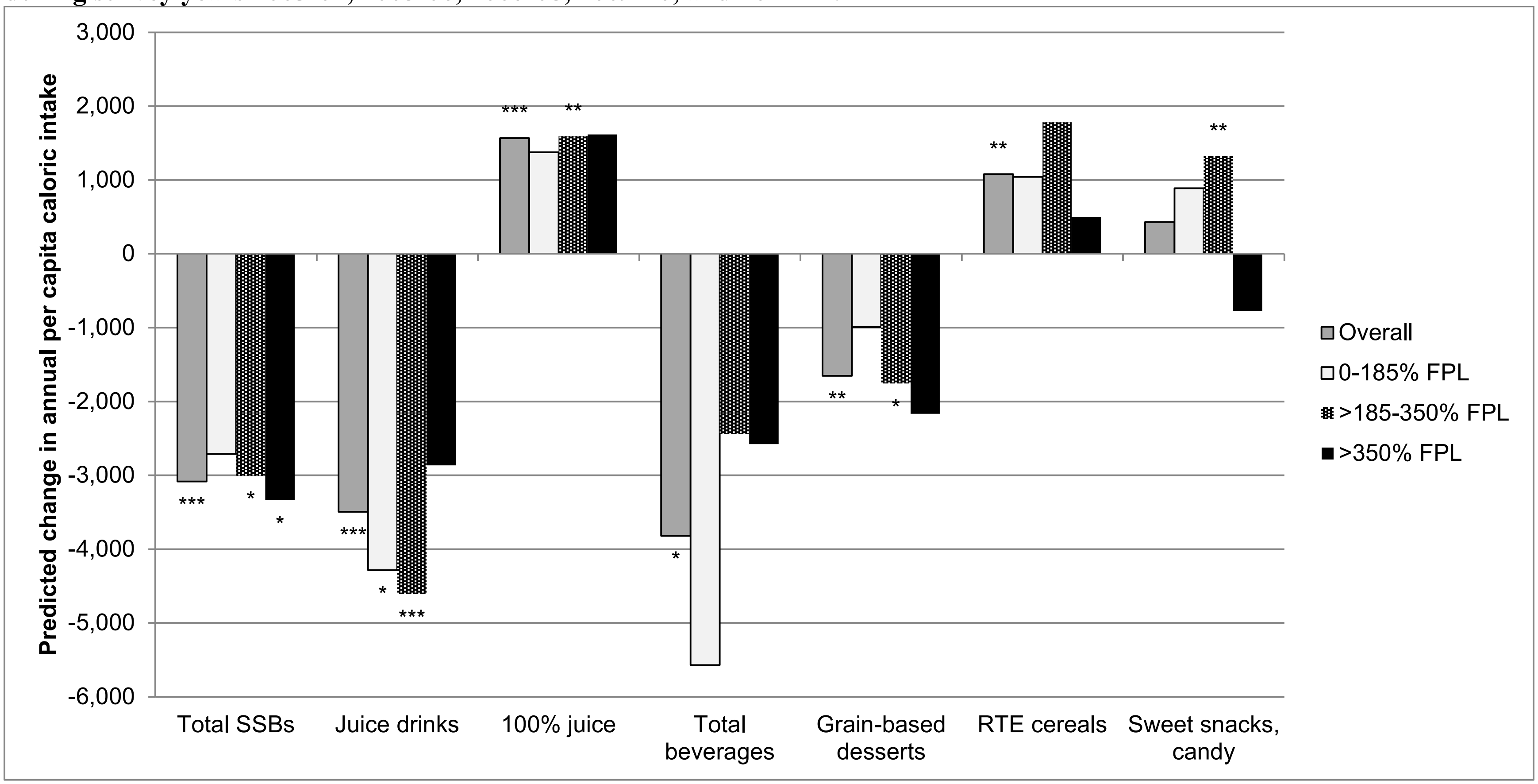
*** Value was different from the null value, (Wald test) p<0.01

** Value was different from the null value, (Wald test) p<0.05

* Value was different from the null value, (Wald test) p<0.10

University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services for all food categories, Including beverages and alcohol for the 2003-2012 periods, for the U.S. market. Copyright © 2015, The Nielsen Company.

Figure 5.1. Predicted annual change in caloric intake from selected foods and beverages under a 20% increase in the prices of SSBs among all U.S. preschool children, and those from low- (0-185% Federal Poverty Level [FPL]), middle- (>185-350% FPL) and high-income (>350% FPL) households, who participated in the National Health and Nutrition Examination Survey during survey years 2003-04, 2005-06, 2007-08, 2009-10, and 2011-12.



*** Value was different from the null value, (Wald test) p<0.01.

** Value was different from the null value, (Wald test) p<0.05.

* Value was different from the null value, (Wald test) p<0.10.

University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services for all food categories, Including beverages and alcohol for the 2003-2012 periods, for the U.S. market. Copyright © 2015, The Nielsen Company.

Supplemental Table 5.1 Description of approach to classifying foods and beverages groups using data from the 2003-2012 Homescan Panel, and data from NHANES (2003-04, 2005-06, 2007-08, 2009-10, and 2011-12)

Beverage group	NHANES	Homescan
Caloric soft drinks	Caloric soft drinks were classified from all food codes corresponding to 'soft drinks'. Beverages with USDA food descriptions containing 'sugar-free' or 'diet' were excluded.	Identified using keyword searches of modules and ingredient lists. Includes all beverages in the 'soft drinks' module. Excludes beverages meeting any of the following criteria: 4) Ingredients do not include carbonation 5) Product contains <10 kcal per 100 grams Ingredient list does not contain one or more caloric sweetener(s)
Sport and energy drinks	USDA food codes corresponding to 'liquid milks' were used to identify milks. Milks containing ≤1% fat by volume, and <22g of sugar per 245g (8 oz.) were classified as low-fat, low-sugar milk.	Identified using keyword searches of modules and ingredient lists. Includes beverages in the 'sports drink' module and beverages described as 'Powerade' or 'Gatorade'. Includes beverages from the 'soft drinks' module whose description includes "energy drink", "Red Bull", "Rockstar", or "Monster". Excludes beverages with <10 kcal/100 grams
Juice drinks*	Juice drinks were identified from USDA food codes corresponding to 'juice drinks', 'baby juices', and 'fruit nectars'. Fruit juices not otherwise classified as 100% fruit juice were also included.	Identified using keyword searches of modules and ingredient lists. Includes beverages in the "fruit juice" module not classified as 100% fruit juice; beverages in the "fruit drinks" module whose ingredient list contains juice, but was not classified as 100% juice; and excludes beverages

		with <10 kcal/100 grams
Total sugar-sweetened beverages	Includes all caloric soft drinks, sport and energy drinks, and juice drinks (as defined above)	Includes all caloric soft drinks, sport and energy drinks, and juice drinks (as defined above)
>1% fat, high-sugar milk	USDA food codes corresponding to ‘liquid milks’ containing >1% fat by volume, and ≥8.8 g of sugar per 100 g	Identified using nutrition information. Includes milks containing >1% fat by volume, and ≥8.8 g of sugar per 100 g
>1% fat, low-sugar milk	USDA food codes corresponding to ‘liquid milks’ containing >1% fat by volume, and <8.8 g of sugar per 100 g	Identified using nutrition information. Includes milks containing >1% fat by volume, and <8.8 g of sugar per 100 g
Low-fat, high-sugar milk	USDA food codes corresponding to ‘liquid milks’ containing ≤1% fat by volume, and ≥8.8 g of sugar per 100 g	Identified using nutrition information. Includes milks containing ≤1% fat by volume, and ≥8.8 g of sugar per 100 g
Low-fat, low-sugar milk	USDA food codes corresponding to ‘liquid milks’ containing ≤1% fat by volume, and <8.8 g of sugar per 100 g	Identified using nutrition information. Includes milks containing ≤1% fat by volume, and <8.8 g of sugar per 100 g
100% Fruit juice	100% fruit juices were classified using USDA food codes corresponding to ‘fruit juices’, and using USDA food descriptions.	Identified using keyword searches of modules and ingredient lists. Includes beverages in the “fruit juice” module meeting one of the following criteria: 5) Ingredient list does not contain sweeteners 6) Ingredient list contains “100%” 7) Claims contain “100% juice” 8) Ingredients do not include water

		Includes beverages "fruit drinks" module meeting both of the following criteria: 3) First and second ingredient are juice, fruit juice concentrate or water but not sweetener Ingredients contain "100%", claims contain "100% juice" or ingredients contain neither water nor sweeteners
Diet drinks	Includes all USDA food codes corresponding to diet, sugar-free, low/no-calorie soft drinks, juice drinks, sports and energy drinks	All soft drinks, sports and energy drinks, and juice drinks containing <10 kcal/100 grams
Tap, bottled and flavored water	Includes all USDA food codes corresponding to tap or bottled, and artificially sweetened waters	Includes all beverages from the "water" module.
Non sugar-sweetened beverages	Includes >1% fat, low-sugar milk; low-fat, low-sugar milk; 100% juice; diet drinks; and tap, bottled and flavored waters (as defined above)	Includes >1% fat, low-sugar milk; low-fat, low-sugar milk; 100% juice; diet drinks; and tap, bottled and flavored waters (as defined above)
Total beverages	Includes caloric soft drinks; sport and energy drinks; juice drinks; >1% fat, high-sugar milk; >1% fat, low-sugar milk; low-fat, low-sugar milk; 100% juice; diet drinks; and tap, bottled and flavored waters (as defined above)	Includes caloric soft drinks; sport and energy drinks; juice drinks; >1% fat, high-sugar milk; >1% fat, low-sugar milk; low-fat, low-sugar milk; 100% juice; diet drinks; and tap, bottled and flavored waters (as defined above)
Pizza/calzones	Includes All types of pizzas and calzones	Includes all frozen and refrigerated pizzas
RTE cereals	Includes all kinds of ready-to-eat cereal products, including loose granola	Includes all ready-to-eat cereals and granolas

Grain-based desserts	Includes all cakes, cookies, pies, pastries, doughnuts and other grain-based desserts	Includes all ready-to-eat cereal bars and pastries, ready-to-eat grain-based desserts, and cookies
Savory snacks	All kinds of savory potato and other starchy vegetable chips, popcorn, pretzels, rice crackers, savory crackers, zwieback toast	Includes all crackers and shelf-stable snacks
Sweet snacks and candy	Includes sweet snacks, other sweets and chocolate and candies	Includes all candy and gum
Dairy-based desserts	Includes all dairy desserts	Includes all frozen and refrigerated pudding and ice cream
Fruit	Includes all fruit, fresh, frozen, canned or dried	Includes all fresh, frozen, canned and dried fruit
Vegetables	Includes all non-starchy vegetables (canned, fresh, fried, frozen, pickled, sliced non-starchy vegetables with breading and/or sauce)	Includes all fresh, frozen, canned and dried vegetables

Supplemental Table 5.2. Overview of conceptual approach[1]

	Column 1	Column 2	Column 3	Column 4
	Mean intake in NHANES	SSB elasticity in Homescan	Effective tax rate	Predicted caloric change in NHANES
Total SSBs	150 kcal	-0.8	20%	-24 kcal
Total beverages	375 kcal	-1.2	20%	-90 kcal
Total foods	950 kcal	0.1	20%	19 kcal

[1] Where Column 4 = Column 1 * Column 2 * Column 3

Supplemental Figure 5.3 Predicted percent change grams purchased per capita with increases in the prices SSBs, or SSBs and >1% fat/high-sugar milks, by 10%, 15%, and 20% estimated using data from the Nielsen Homescan Panel, years 2003-2012

	% change in per capita calories purchased under selected taxes							
	10% tax				15% tax			
	Overall	0-185% FPL	>185-350% FPL	>350% FPL	Overall	0-185% FPL	>185-350% FPL	>350% FPL
Total SSBs	-4.0%***	-3.2%	-3.7%*	-5.5%*	-5.8%***	-4.6%	-5.4%*	-7.9%*
Soft drinks	-3.2%	-5.5%	-1.5%	-4.5%	-4.6%	-8.0%	-2.2%	-6.5%
Sports and energy drinks	2.2%	5.6%*	3.1%	-3.0%	3.3%	8.4%*	4.6%	-4.4%
Juice drinks	-6.3%***	-7.2%*	-8.2%***	-5.9%	-9.1%***	-10.3%*	-11.8%***	-8.6%
Total >1% fat/high-sugar milks	0.1%	1.3%	0.3%	-0.3%	0.2%	1.9%	0.4%	-0.4%
>1% fat, high-sugar milk	0.7%	2.4%	-2.2%	2.7%	1.0%	3.7%	-3.1%	4.0%
>1% fat, low-sugar milk	0.2%	1.2%	1.3%	-0.7%	0.3%	1.8%	1.9%	-1.1%
Low-fat, high-sugar milk	-1.5%	2.0%	-2.2%**	-1.7%	-2.1%	3.0%	-3.2%**	-2.4%
Low-fat, low-sugar milk	0.4%	-4.3%	3.6%	4.8%	0.7%	-6.2%	5.4%	7.2%
100% juice	5.9%***	4.8%	5.5%**	7.6%	8.7%***	7.1%	8.1%**	11.3%
Diet drinks	-1.6%	-0.7%	0.5%	-3.1%	-2.3%	-1.0%	0.7%	-4.5%
Tap, bottled and flavored waters	-1.6%	-0.7%	0.5%	-3.1%	-2.3%	-1.0%	0.7%	-4.5%
Total beverages	-1.5%*	-2.0%	-0.9%	-1.1%	-2.2%*	-3.0%	-1.3%	-1.7%
Vegetables, fresh/frozen/processed	0.1%	-1.6%	0.3%	1.6%	0.2%	-2.4%	0.5%	2.3%
Grain-based desserts	-2.4%**	-1.4%	-2.4%*	-3.5%	-3.5%**	-2.0%	-3.5%*	-5.1%
Savory snacks	0.1%	0.6%	0.8%	-0.9%	0.1%	0.9%	1.1%	-1.3%
Fruit, fresh/frozen/canned/dried	0.6%	-1.9%	1.5%	1.5%	0.8%	-2.8%	2.2%	2.1%
Pizza, calzones	-1.8%	-2.2%	-0.9%	-3.0%	-2.6%	-3.2%	-1.3%	-4.4%
RTE cereals	2.7%**	2.2%	4.3%	1.7%	3.9%**	3.3%	6.4%	2.4%
Sweet snacks, candy	1.3%	2.6%	4.1%**	-2.4%	2.0%	3.8%	6.1%**	-3.6%
Dairy-based desserts	-1.5%	0.1%	-1.5%	-2.8%	-2.2%	0.1%	-2.3%	-4.1%
Total foods	0.2%	-0.1%	0.8%	0.1%	0.3%	-0.2%	1.1%	0.2%
Total foods and beverages	-0.7%	-1.2%	-0.2%	-0.6%	-1.1%	-1.7%	-0.3%	-0.8%

*** Value was different from the null value, (Wald test) $p<0.01$
** Value was different from the null value, (Wald test) $p<0.05$
* Value was different from the null value, (Wald test) $p<0.10$
University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services for all food categories, Including beverages and alcohol for the 2003-2012 periods, for the U.S. market. Copyright © 2015, The Nielsen Company.

Supplemental Figure 5.4 Mean caloric intake, and predicted change in caloric intake with increases in the prices SSBs, or SSBs and >1% fat/high-sugar milks, by 10%, 15%, and 20%, among U.S. children ages 2-5y who participated in the National Health and Nutrition Examination Survey (NHANES) during survey years 2003-04, 2005-06, 2007-08, 2009-10, and 2011-12

	Mean caloric intake per person/day (no taxes)[1]				Predicted change in caloric intake							
					10% tax				15% tax			
	Overall	0-185% FPL	>185-350% FPL	>350% FPL	Overall	0-185% FPL	>185-350% FPL	>350% FPL	Overall	0-185% FPL	>185-350% FPL	>350% FPL
Total SSBs	115 ± 3	128 ± 4	117 ± 8	89 ± 6	-4.6***	-4.0	-4.4*	-4.9*	-6.7***	-5.9	-6.4*	-7.1*
Soft drinks	23 ± 1	28 ± 2	25 ± 2	14 ± 3	-0.7	-1.5	-0.4	-0.6	-1.1	-2.2	-0.5	-0.9
Sports and energy drinks	3 ± 0	2 ± 0	5 ± 1	2 ± 0	0.1	0.1*	0.1	-0.1	0.1	0.2*	0.2	-0.1
Juice drinks	84 ± 3	91 ± 3	83 ± 8	71 ± 5	-5.3***	-6.5*	-6.8***	-4.2	-7.6***	-9.4*	-9.9***	-6.1
Total >1% fat/high-sugar milks	190 ± 5	194 ± 16	194 ± 16	175 ± 7	0.2	2.5	0.5	-0.5	0.3	3.7	0.8	-0.7
>1% fat, high-sugar milk	46 ± 3	47 ± 4	51 ± 7	42 ± 7	0.3	1.1	-1.1	1.1	0.5	1.7	-1.6	1.6
>1% fat, low-sugar milk	138 ± 4	155 ± 7	139 ± 8	106 ± 7	0.2	1.9	1.8	-0.8	0.3	2.7	2.6	-1.2
Low-fat, high-sugar milk	7 ± 1	6 ± 1	5 ± 2	8 ± 3	-0.1	0.1	-0.1**	-0.1	-0.1	0.2	-0.1**	-0.2
Low-fat, low-sugar milk	24 ± 3	19 ± 5	22 ± 5	35 ± 4	0.1	-0.8	0.8	1.7	0.2	-1.2	1.2	2.5
100% juice	38 ± 2	41 ± 3	41 ± 6	29 ± 4	2.3***	2.0	2.2**	2.2	3.3***	2.9	3.3**	3.3
Diet drinks	5 ± 1	6 ± 1	7 ± 1	3 ± 1	-0.1	0.0	0.0	-0.1	-0.1	-0.1	0.0	-0.1
Tap, bottled and flavored waters	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total beverages	378 ± 7	406 ± 8	385 ± 14	324 ± 11	-5.6*	-8.3	-3.5	-3.7	-8.2*	-12.0	-5.1	-5.4
Vegetables, fresh/frozen/processed	10 ± 1	8 ± 1	10 ± 1	13 ± 2	0.0	-0.1	0.0	0.2	0.0	-0.2	0.1	0.3
Grain-based desserts	103 ± 3	107 ± 4	107 ± 10	90 ± 6	-2.4**	-1.5	-2.5*	-3.1	-3.6**	-2.1	-3.7*	-4.6

Savory snacks	73 ± 3	70 ± 3	75 ± 5	78 ± 5	0.1	0.4	0.6	-0.7	0.1	0.6	0.8	-1.0
Fruit, fresh/frozen/canned/dried	62 ± 2	59 ± 3	59 ± 4	72 ± 5	0.4	-1.1	0.9	1.0	0.5	-1.7	1.3	1.5
Pizza, calzones	51 ± 4	53 ± 5	55 ± 8	46 ± 7	-0.9	-1.2	-0.5	-1.4	-1.3	-1.7	-0.7	-2.0
RTE cereals	59 ± 2	69 ± 2	58 ± 5	43 ± 3	1.6**	1.5	2.5	0.7	2.3**	2.2	3.7	1.0
Sweet snacks, candy	47 ± 2	51 ± 3	45 ± 4	46 ± 5	0.6	1.3	1.9**	-1.1	0.9	1.9	2.8**	-1.6
Dairy-based desserts	37 ± 2	35 ± 3	44 ± 5	38 ± 4	-0.6	0.0	-0.7	-1.1	-0.8	0.0	-1.0	-1.6
Total foods	1193 ± 10	1219 ± 13	1179 ± 26	1151 ± 17	2.4	-1.5	8.9	1.4	3.5	-2.3	13.1	2.0
Total foods and beverages	1572 ± 12	1625 ± 14	1565 ± 30	1475 ± 20	-11.5	-18.9	-2.8	-8.3	-16.8	-27.6	-4.2	-12.2

[1] Values are given as mean ± SE
*** Value was different from the null value, (Wald test) $p<0.01$
** Value was different from the null value, (Wald test) $p<0.05$
* Value was different from the null value, (Wald test) $p<0.10$
University of North Carolina calculation based in part on data reported by Nielsen through its Homescan Services for all food categories, Including beverages and alcohol for the 2003-2012 periods, for the U.S. market. Copyright © 2015, The Nielsen Company.

CHAPTER 6. SYNTHESIS

Overview of findings

Consuming too many calories from beverages can lead to excess weight gain in children (1), which has made beverages high in sugar and/or fat (2) the focus of a number of U.S. child obesity prevention initiatives (3-5). Preschool children (ages 2-5y) provide a unique window of opportunity for the development of healthy eating behaviors that track into later stages of development (6, 7). Thus, in Aim 1a we examined trends in beverage and food intakes among U.S. preschool children (ages 2-5y) from 2003 to 2012. It has been previously shown that eating location (at home vs. away from home), and source (where obtained; e.g., store, restaurant, cafeteria, etc.) are important dietary domains in the diets of children. Moreover, the majority of foods/beverages consumed at home come from stores. Therefore, in Aim 1b we examined how eating location (at home vs. away from home), and source of calories (stores, restaurants, cafeterias, etc.) may have contributed to trends in food/beverage intakes among U.S. preschoolers over this period.

In Aim 2a, in light of increasing calls for taxes on beverages high in sugar and/or sugar, we examined how simulated 'taxes' of 10%, 15%, and 20% on beverages high in sugar (sugars-sweetened beverages [SSBs]) and/or fat (SSBs and >1% fat/high-sugar milks) might influence purchases of these and other foods and beverages among U.S. households with a preschool child. In Aim 2b, we extended our approach in Aim 2a to examine the changes in intakes of beverages, select foods, and total calories predicted with 10%, 15% and 20% 'taxes' on SSBs among U.S. preschool children. Lastly, in Aim 2c, we explored these relationships by level of household income using 0-185% Federal Poverty Level (FPL), >185-350% FPL, and >350% FPL.

In **Aim 1a,** we used data from the What We Eat In America survey, which is the dietary component of the National Health and Nutrition Examination Survey (NHANES), years 2003-04, 2005-06, 2007-08, 2009-10, and 2011-12. As NHANES comprises a nationally representative survey of diet in the U.S. population, this data allowed us to examine important trends in intakes of 10 beverages, total beverages, as well as total foods and total foods and beverages, among U.S. preschool children (ages 2-5y). Using dietary intake data from a single 24-hour recall, we examined dietary intake trends for total food/beverage intake, total beverages, total foods, total milks, total SSBs, 100% juice, low/no-calorie beverages, and all other beverages, and 10 beverage subgroups. In **Aim 1b**, we examined how changes eating location (at home vs. away from home) and source of calories (e.g., stores, restaurants, cafeterias, etc.) may have contributed to this trend.

Summary of key findings, Aim 1

Between 2003-04, and 2011-12, there were significant decreases in total intakes of beverages, sugar-sweetened beverages, juice drinks and caloric soft drinks among U.S. preschool children. However, there were no significant changes in intakes of total beverages, total foods, or foods and beverages between 2009-10 and 2011-12, thereby suggesting that much of these changes occurred between 2003-04 and 2009-10. However, there were large but non-significant increases in intakes of total foods, and total foods and beverages, between 2009-10 and 2011-12, which suggests that intakes of total foods and total calories could be on the rise. By eating location and source, there were large decreases in at-home beverage consumption, and caloric intake store-bought beverages, suggesting that these two domains may have driven dietary intake trends in U.S. preschoolers during this period.

While our findings showed that intakes of beverages high in sugar and/or fat decreased among U.S. preschoolers between 2003 and 2012, SSBs and >1% fat milks remain leading contributors to solid fats and added sugars in the diets of young children (1). Consequently, placing excise taxes on beverages high in sugar and/or fat has been proposed as a means to discourage their intake. Yet, it was unclear how such taxes might influence purchases of other beverages and foods, particularly among households with young children. Thus, in **Aim 2a**, we used data from the Nielsen Homescan Panel (years 2009-2012) to simulate price increases of 10%, 15% and 20% on either SSBs alone, or both SSBs and >1% fat/high-sugar milks. We then examined the relationship between these taxes and weight (grams/day per capita) and caloric purchases of 10 beverages, total SSBs, total >1% fat/high-sugar milks, total beverages, select foods, total foods, and total foods and beverages.

Key findings, Aim 2a

We found that 10%, 15% and 20% increases in the prices of SSBs (caloric soft drinks, juice drinks, and sports and energy drinks) were associated with reduced purchases of juice drinks among U.S. households with a preschool child. When simultaneous price increases of 10%, 15%, and 20% were simulated for SSBs *and* >1% fat/high-sugar milks, purchases of >1% fat, low-sugar milk, and meat, poultry, fish and mixed meat dishes were predicted to decrease However, there was no significant relationship between the combined tax and purchases of any SSBs (caloric soft drinks, juice drinks, and sport and energy drinks). In both tax models (SSBs only; SSBs *and* >1% fat/high-sugar milks), total calories purchased from foods and beverages were predicted to decrease (not statistically significant), but predicted changes were most pronounced with price increases on both SSBs and >1% fat/high-sugar milks. Significant changes were observed at price increases of 10%, 15%, and 20%, although more substantial changes in total food/beverage purchases were only seen with 'taxes' of 20% on both SSBs and >1% fat/high-sugar milks.

In **Aim 2b**, we extended our approach in Aim 2a to examine the relationship between targeted beverage taxes and *intakes* of foods/beverages amount U.S. preschool children. Similarly, we estimated beverage demand relationships among U.S. households with a preschool child who participated in the 2003-2012 Nielsen Homescan Panel. Next we computed survey weighted mean caloric intakes for 10 beverages, total SSBs, total >1% fat/high-sugar milks, total beverages, selected foods, total foods, and total foods and beverages, among U.S. preschool children who participated in NHANES between 2003 and 2012. Estimated demand relationships derived using the Homescan data were then applied to dietary intake data from NHANES in order to estimate changes in intakes among U.S. preschoolers with 10%, 15% and 20% increases in the prices of SSBs. **In Aim 2c**, we examined whether these relationships differ by household income using 0-185% Federal Poverty Level (FPL); >185-350% FPL; >350% FPL.

Key findings, Aims 2b & 2c

We found that taxes on SSBs as small as 10% were expected to decrease caloric intakes from total SSBs and total beverages among U.S. preschool children when all household income groups were combined. However, predicted decrease in total SSB intakes were most pronounced among children from households earning >350%, and non-significant among those from households earning 0-185% FPL. Expected decreases in total caloric intakes from beverages were no longer significant after stratifying by household income level. Furthermore, we found no evidence that taxes of 10%, 15% or 20% on SSBs would increase intakes of total foods among U.S. preschool children. While intakes of ready-to-eat cereals were expected to increase, such predicted changes were offset by larger decreases in intakes of grain-based desserts. As in Aim 2a, significant changes in food/beverage intakes seen with a 20% tax on SSBs were also seen with 'taxes' of 10% and 15%. However, meaningful changes in intakes (>|10| kcal/capita/d) were only seen with a 20% SSB tax. Lastly, although not statistically significant, a 20% SSB tax was predicted to decrease total energy intake by ~22 kcal/capita/d among U.S. preschool children, which could be sufficient to prevent excess weight gain in preschoolers.

Strengths and limitations

Strengths

There are a number of strengths to our study. First, ours (Aim 1a) is the only study to our knowledge to focus exclusively on dietary trends in preschool children between 2003 and 2012. This period marked an important turning point for obesity in preschool-aged children, thereby compelling our investigation into major dietary changes among U.S. preschoolers during this period. Prior studies had investigated earlier portions of this period (e.g., up to 2006), but their use of broad beverage groups left it unclear how intakes of beverages comprising these larger groups may have changed over time among U.S. preschool children. In addition, only a single prior study had examined how eating location (at home vs. away from home), and source of calories (store, restaurant, cafeteria, etc.) may have contributed to dietary changes in children during this period. Ours, however (Aim 1b), is the first to examine beverage and total food intake trends in preschool children, and the first to examine how eating location and source of calories may have contributed to dietary changes in this population, between 2003 and 2012.

Similarly, while a number of studies have explored the relationship between beverage prices and beverage purchases, ours (Aim 2a) is one of only a handful of studies to also examine how beverage prices relate to purchases of *foods*. Accordingly, we were able to determine whether such taxes would be expected to have 'unintended consequences' (2), such as increasing purchases of other foods high in sugar and/or fat. Although it had been suggested that other beverages high in sugar and/or fat – other than SSBs – also be taxed, no study prior to ours (Aim 2a) had examined the relationship between concomitant increases in the prices of SSBs and >1% fat/high-sugar milks and food/beverage purchases. Furthermore, our study (Aim 2a, Aim 2b and Aim 2c) was unique in examining these demand relationships exclusively among preschool children and their households. Unlike prior studies, we endeavored to estimate demand relationships specific to U.S. preschool children and their households by restricting our analyses to households with a single preschool child, and by controlling for important household characteristics. In contrast, prior studies had estimated a single set of demand relationships for both children and adults (2-5). Lastly, whereas previous studies had used discordant survey years in Homescan and NHANES (e.g., Homescan 1998-2007; NHANES 2003-6) (3, 4) our study (Aim 2b and Aim 2c) is the only one to our knowledge to include a full ten years of concordant survey years in Homescan and NHANES.

Limitations

There are several important limitations to our study that bear mentioning here. First, in Aim 1, we used a single 24-hour recall to estimate usual dietary intake, which may be insufficient for measuring usual intake of episodically consumed foods and beverages. Nonetheless, while the variances of episodically-consumed foods may be poorly approximated using only a single recall, estimates of mean intakes for a population are typically unbiased (6). Nonetheless, we focused our analyses on beverages commonly consumed by preschool children, like milks, fruit juices and SSBs (7), in order to minimize the potential for such bias. As an additional measure, we grouped less frequently consumed beverages wherever possible (e.g., diet drinks – comprising several varieties of low-calorie beverages with low rates of consumption). Use of parent-reporting may be another potential limitation. As NHANES dietary data for children younger than six are provided by the child's primary guardian, there is limited potential for intentional misreporting. There is, however, little evidence of this occurring in the literature.

There are also a number of limitations for Aims 2a. Foremost among these limitations is the cross-sectional nature of the exposure (prices) and outcomes (purchases and intakes), which were ascertained at the same point in time. Such a relationship delimits inferences of a causal nature, as the directional relationship between exposure and outcome is unclear. Thus, our findings from Aim 2a reflect associations, rather than causal relationships. In addition, because the purchases of Homescan participants are reported at the household level, we were unable to ascribe per capita household food/beverage purchases to specific individuals within the household. Nevertheless, we controlled for household composition (including the number of individuals comprising several age groups by gender) in an effort to best approximate food/beverage purchases at the individual level. Lastly, foods/beverages without barcodes (such as fresh produce and meats, and foods from cafeterias, restaurants, and child care centers) are not typically reported by Homescan participants (8), and were therefore excluded from our analyses. Therefore, our findings from Aim 2a may have implications only for barcoded food/beverage purchases. Nonetheless, our primary objective in Aim 2a was to examine the association between taxes on high-sugar and/or >1% fat beverages and purchases of beverage (primary outcome) and foods (secondary outcome) high in fats and/or sugar. Consumer packaged foods/beverages include many key sources of dietary fats and sugars (9), and are well-represented in Homescan (10). Consequently, we are confident in our ability to carry out our primary objective in Aim 2a using the Homescan data.

The limitations for Aim 1 and Aim 2a also apply to Aims 2b and 2c, which used data from both Homescan and NHANES. Like Aim 1a, Aims 2b and 2c used a single 24-hour recall survey to ascertain usual dietary intake of the sample population. It had been previously shown that individuals may report differently on the first and second days of recall (11). Rather than further limiting our sample to those who reported on both days of recall in order to minimize the potential for systematic bias, we chose to include only the first of two 24-hour recalls available in NHANES. While this approach tends to yield unbiased estimates of mean usual intakes of even episodically-consumed for a sample (12), again, estimation of standard errors corresponding to intakes of less frequently consumed beverages in our analyses, such as waters, diet beverages, and sport and energy drinks (13), may be biased.

Like Aim 2a, Aims 2b and 2c used data from the Nielsen Homescan Panel, which does not include foods/beverages without barcodes. Thus, the demand relationships estimated using the Homescan data pertain mostly to barcoded, store-bought foods and beverages. As a result, we assumed similar demand relationships for food/beverages with and without barcodes. This approach is consistent with the approaches of prior related studies (3, 4). Lastly, as prices and purchases were assessed at the same time point in Homescan, and our models did not use time-lagged prices, our conclusions in Aims 2b and 2c also reflect associations rather than causal relationships.

Significance and public health impact

Our findings from Aim 1 showed a decline in intakes of juice drinks, caloric soft drinks, and all milks between 2003-04 and 2011-12. While much of the decline in milk intake was due to decreasing intakes of >1% fat, low-sugar milk, only some of this decrease was offset by increasing intakes of low-fat, low-sugar milk. *Healthy People 2020*, which is the most recent edition of public health goals for the nation set every 10 years by the U.S. Department of Health and Human Services, aimed to reduce caloric intake from added sugars among those ages two and older (14). As a top source of added sugars in the diets of U.S. preschool children, our findings from Aim 1 appear to show progress toward *Healthy People 2020's* goal. The public health implications of the changes in milk intakes between 2003-04 and 2011-12 are less clear. The American Academy of Pediatrics (AAP) (15), the Special Supplemental Program for Women, Infants, and Children (WIC) (16), and the Institute of Medicine (17), recommend that healthy children ages two and older consume milks containing ≤1% fat by volume. In fact, WIC changed their food packages in 2009 in accordance with these guidelines (16). We found encouraging evidence of increasing intakes of low-fat, low-sugar milk and decreasing intakes of >1% fat milks, which would be consistent with these changes. However, total grams/day intake of milk still decreased between 2003 and 2012.

It had been previously shown that eating location and source of calories are important domains of food/beverage intake (18). In children, the majority of total calories consumed are done so at home (vs. away from home), and come predominantly from stores (as a source of calories), which contribute more to total caloric intake than all other sources (e.g., restaurants, cafeterias, vending) combined. Moreover, stores – and by extension, foods consumed at home – had recently become the focus of retailer-based initiatives to reformulate food/beverage products, and to reduce the total number of calories sold. In light of these considerations, it was important that we examine how eating location (at home vs. away from home) and source (where foods/beverages were obtained) may have contributed to trends in food/beverage intakes among

U.S. We found that decreases in home-consumption, and intakes of foods/beverages from stores, played a major role in the overall trend. This finding would suggest that stores were the major locus of dietary changes, which was also reflected in at-home food/beverage consumption. It is unclear, however, whether such changes were the result of retailer-based initiatives, other public health efforts, secular changes in consumer behavior, some combination of these, or other factors (19-21). Further studies will be needed to explore these relationships. Moreover, if said future studies confirm that retailer-based initiatives played a significant role in improving the diets of young children between 2003 and 2012, there would cause for additional collaborations between obesity prevention advocates to improve the diets of U.S. children.

Although we observed decreases in intakes of beverages high in sugar and/or fat between 2003 and 2012, intakes of these beverages among U.S. preschoolers remains high (1). In fact, the White House Task Force on Child Obesity, as well as the Institute of Medicine have suggested that other beverages high in sugar and/or fat be taxed in addition to SSBs (22, 23). Such beverages would include >1% fat/high-sugar milks. Findings from our study, thus, may also have implications for future recommendations regarding imposing targeted taxes on beverages high in sugar and/or fat. We found that simultaneous taxes on SSBs *and* >1% fat/high-sugar milks were associated with greater decreases in total calories purchased than when SSBs alone were 'taxed', though neither relationship was statistically significant. However, only the SSBs only 'tax' was associated with a reduction in juice drinks, whereas the combined 'tax' was only associated with decreased purchases of >1% fat/high-sugar milks. Notably, although it is recommended that children ages 2 and older consume only 1% or skim milk with no added sugar (16, 24, 25), such recommendations are seen by some as controversial. In fact, recent evidence has impugned the relationship between the fat content of milk and weight status in preschool children (26). Moreover, regardless of fat and/or sugar content, milk is an essential source of calcium and vitamin D. And while most young children (≥90%) consume adequate calcium, 28-47% of children ages 1-8y don't meet recommendations for vitamin D intake (27). On the other hand, there is a general consensus that SSBs have little to no nutritive value, and that their consumption may promote excess weight gain in children (28). In light of these considerations, a combined tax on SSBs and >1% fat/high-sugar milks would need to also be significantly related to fewer purchases of one or more SSBs, in addition to fewer purchases of >1% fat/high-sugar milks, for such a tax to be advisable. Therefore, our findings would marginally favor imposing a tax on SSBs alone, versus a tax on both SSBs and >1% fat/high-sugar milks.

Despite our finding significant changes at 10% and 15% 'taxes' on beverages high in sugar and/or fat, whether such changes would be meaningful among U.S. preschool children is not clear from our findings. On one hand, it stands to reason that lower taxes of 10% or 15% on SSBs might garner more public favor than a 20% 'tax', since a number of attempts to implement SSBs taxes of ~20% have met with strong opposition from voters (29-33). Our findings suggest that while significant reductions in caloric intakes from total SSBs and total beverages would be seen with tax rates of 10% and 15% on SSBs, small but possibly meaningful changes (≥|10| kcal/capita/d) would only be seen with taxes of 20% or more. With a 20% 'tax' on SSBs, total intake of beverages was predicted to decrease by 10.7 calories/d per capita, while the predicted decrease in total energy intake from the total diet of foods and beverages was more than twice this amount (-21.9 calories/d per capita). These changes would be meaningful for preschool children, who reported consuming between 1,441 and 1,822 calories/d per capita in the 2011-12 NHANES data (Figure 6.1).

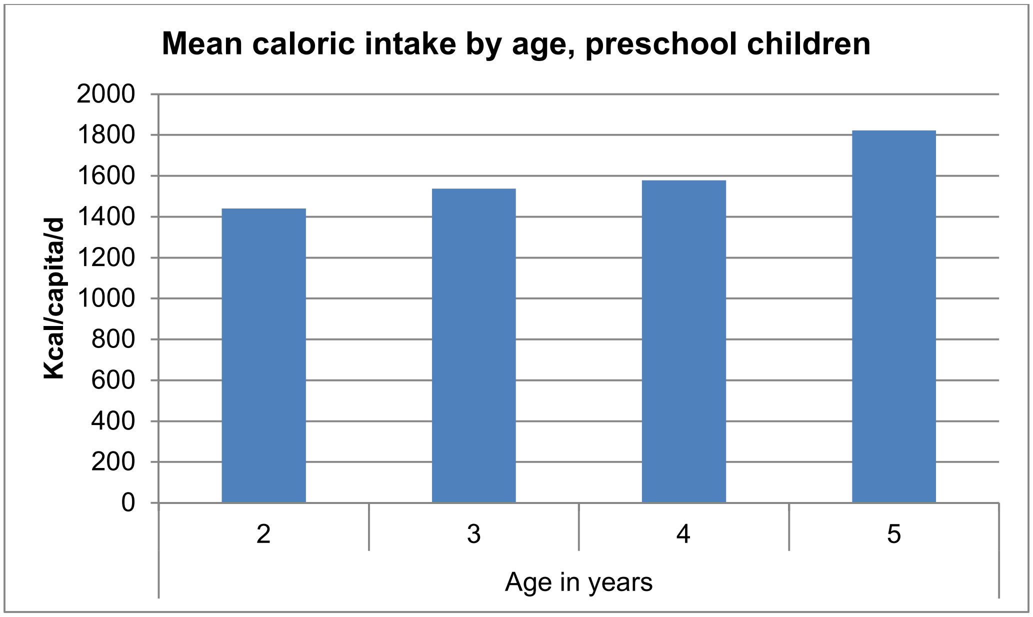


Figure 6.1. Mean total energy intake by age among U.S. children ages 2-5y who participated in NHANES 2011-12

According to Dr. Kevin Hall, whose research focuses on the metabolic underpinnings of obesity, approximately 7 calories/d per person underlies the average weight gain in adults (34). By comparison, adults consume roughly 2,500 calories/d on average – far more than the average preschool child. While the magnitude of caloric reduction necessary to prevent excess weight gain in young children is not yet clear, it follow from the example given for adults that even a 10-calorie reduction may be enough to prevent excess weight gain in preschool children. However, it is important to note that regardless of weight status, preschool children are a rapidly growing population (35), and thus caloric deficit would never be the intended goal of a tax on beverages high in sugar and/or fat. Rather, such a tax would be aimed only at reducing intakes of solid fats and/or added sugars (SoFAS) in an effort to reach the goal of consuming <120 calories/d from SoFAS among children ages 2-8y, as advised by the U.S. Dietary Guidelines Advisory Council (36). Therefore, our study would suggest that local governments seeking to impose a tax on SSBs in order to improve the diets of children should push for taxes of 20% or more. Moreover, such endeavors should follow the example set in Berkeley, California, where a penny-per-ounce tax on SSBs was passed largely due to a successful grassroots campaign (37). Still, caution is warranted, measurement error in assessing food/beverage purchases is great, thereby making these relationships less certain.

It had also been previously reported that a 20% tax on SSBs would be more burdensome to households earning 0-185% FPL, as these households tend to purchase more SSBs per capita, and are less responsive to SSB price changes, than higher-earning households. In our stratified analysis by level of household income, we had similar findings. However, we found no evidence that taxes as high as 20% on SSBs would significantly impact intakes of total foods. And, while purchases of RTE cereals were expected to increase under such a tax, projected decreases in intakes of grain-based desserts would more than offset this increase in calories. Additionally, our findings showed that the only intakes of beverages not considered an essential source of nutrients for which intakes were expected to decrease (juice drinks). Moreover, the predicted decrease in calories from all foods and beverages in households earning 0-185% FPL was more than twice that of children from higher-earning households (>185% FPL). This could suggest that, for these households, when prices of SSBs increase, they tend to make all-around changes to their purchases, rather than simply decreasing purchases of SSBs. In light of these considerations, our findings suggest that imposing a 20% tax on SSBs as a means to improve the diets of U.S. preschool children produces small but potentially meaningful changes in daily caloric intake.

Future directions

In our examination of beverage and total food intake trends between 2003 and 2012 among U.S. preschool children, we noted that there was a sharp, but non-significant increase in caloric intakes from total foods between 2009-10 and 2011-12. This could suggest that total caloric intakes from foods, which declined substantially between 2003-04 and 2009-10, could be on the rise again in recent years among U.S. preschoolers. Conversely, such changes in caloric intake could be spurious, and instead reflect measurement error rather than real changes. Thus, in future studies it will be important to determine if such changes are in fact part of a larger trend toward increasing intake of total calories from total foods among U.S. preschool children since 2010. Such future studies will require the use of the most recent NHANES survey (2013-2014), which is expected to be released in the summer of 2016.

Additionally, decreases in at-home calorie consumption, and store-bought beverage calories, were major contributors to dietary trends among U.S. preschoolers between 2003 and 2012. Importantly, during this period, there was also a major retailer-based initiative to reformulate products and reduce the number of calories sold known as the Healthy Weight Commitment Foundation (38). At the same time, there was increasing public awareness of the U.S. burden of child obesity, as well as major economic changes that may have influenced dietary intake trends among U.S. preschool children. Moreover, in the latter years of this period, the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) made significant revisions to their food packages in addition to expanding their nutrition education programs, which may have also affected dietary trends among U.S. preschoolers. Thus, there is a need for future studies examining these factors to determine to what extent they may have driven dietary changes among U.S. preschool children during this period.

In Aim 2, we examined the relationship between targeted beverage taxes and food/beverage purchases and intakes among U.S. preschool children and their households. While our findings from Aim 2 would support imposing such a tax on SSBs as a means to discourage their purchase and consumption, our conclusions are nonetheless limited by the cross-sectional relationship between prices and purchases/intakes. Moreover, because we used observational data, we are limited in our ability to infer causality. Thus, stronger evidence to support a tax on beverages high in sugar and/or fat as a means to improve the diets of young children will require evaluation of actual interventions such as the taxation programs of SSB's in Berkeley, France and Mexico. Or alternatively, large randomized controlled trials, in which the treatment condition – whether or not SSBs (or SSBs and >1% fat/high-sugar milks) are taxed – is randomly assigned. Although we aimed to control to potential confounding of the relationship between beverage prices and food/beverage purchases, only successful randomization of the treatment condition (beverage taxes) can truly delimit the potential for uncontrolled confounding. Nonetheless, for practical reasons, randomized controlled trials (RCT) of beverage taxes may not be possible, as implementing such taxes typically requires policy change at the community-level. An attractive alternative to such RCT studies, however, are the 'natural experiments' noted above (Berkeley, France, Mexico, etc.), in which communities adopting a tax on beverage high in sugar and/or fat are compared to similar communities without such taxes over the same period of time. Although such studies are still susceptible to confounding bias, the temporal sequence of the exposure and outcome variables can provide stronger evidence of a causal relationship than that provided by our study. Thus, such natural experiments – conducted with careful consideration of potential confounding variables, are poised to provide stronger evidence of how such taxes might influence food/beverage purchases and intakes among U.S. preschool children and their households.

REFERENCES

1. Reedy J, Krebs-Smith SM. Dietary sources of energy, solid fats, and added sugars among children and adolescents in the United States. J Am Diet Assoc 2010;110(10):1477-84.

2. Poti JM, Slining MM, Popkin BM. Where Are Kids Getting Their Empty Calories? Stores, Schools, and Fast-Food Restaurants Each Played an Important Role in Empty Calorie Intake among US Children During 2009-2010. Journal of the Academy of Nutrition and Dietetics 2014;114(6):908-17.

3. Hulshof T, de Graaf C, Weststrate JA. The effects of preloads varying in physical state and fat content on satiety and energy intake. Appetite 1993;21(3):273-86.

4. Bolton RP, Heaton KW, Burroughs LF. The role of dietary fiber in satiety, glucose, and insulin: studies with fruit and fruit juice. Am J Clin Nutr 1981;34(2):211-7.

5. De Graaf C, Hulshof T. Effects of weight and energy content of preloads on subsequent appetite and food intake. Appetite 1996;26(2):139-52.

6. Tournier A, Louis-Sylvestre J. Effect of the physical state of a food on subsequent intake in human subjects. Appetite 1991;16(1):17-24.

7. DiMeglio DP, Mattes RD. Liquid versus solid carbohydrate: effects on food intake and body weight. Int J Obesity 2000;24(6):794-800.

8. Mattes RD. Dietary compensation by humans for supplemental energy provided as ethanol or carbohydrate in fluids. Physiol Behav 1996;59(1):179-87.

9. Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review. The American journal of clinical nutrition 2006;84(2):274-88.

10. Ebbeling CB, Feldman HA, Chomitz VR, Antonelli TA, Gortmaker SL, Osganian SK, Ludwig DS. A Randomized Trial of Sugar-Sweetened Beverages and Adolescent Body Weight. New England Journal of Medicine 2012;0(0):null. doi: doi:10.1056/NEJMoa1203388.

11. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011-2012. JAMA 2014;311(8):806-14.

12. Birch LL, Fisher JO. Development of eating behaviors among children and adolescents. Pediatrics 1998;101(Supplement 2):539-49.

13. Savage JS, Fisher JO, Birch LL. Parental influence on eating behavior: conception to adolescence. J Law Med Ethics 2007;35(1):22-34.

14. Slining MM, Popkin BM. Trends in intakes and sources of solid fats and added sugars among U.S. children and adolescents: 1994-2010. Pediatr Obes 2013. doi: 10.1111/j.2047-6310.2013.00156.x.

15. Brownell KD, Frieden TR. Ounces of prevention--the public policy case for taxes on sugared beverages. N Engl J Med 2009;360(18):1805-8. doi: 10.1056/NEJMp0902392.

16. Wang YC, Coxson P, Shen Y-M, Goldman L, Bibbins-Domingo K. A Penny-per-ounce tax on sugar-sweetened beverages would cut health and cost burdens of diabetes. Health Aff 2012;31(1):199-207.

17. Andreyeva T, Chaloupka FJ, Brownell KD. Estimating the potential of taxes on sugar-sweetened beverages to reduce consumption and generate revenue. Preventive medicine 2011;52(6):413-6.

18. Chaloupka FJ, Powell LM, Chriqui J. Sugar-Sweetened Beverage Taxes and Public Health. Healthy Eating Research and Bridging the Gap: Robert Wood Johnson Foundation, 2009.

19. Center for Science in the Public Interest. CSPI Annual Report: 40 Years; 1971-2011. Washington, DC, 2011.

20. IOM (institute of Medicine). Local government actions to prevent childhood obesity. Washington, DC: National Academies Press, 2009.

21. White House Task Force on Childhood Obesity. Report to the President. Solving the problem of childhood obesity within a generation 2010. Internet: http://www.letsmove.gov/sites/letsmove.gov/files/TaskForce_on_Childhood_Obesity_May2010_FullReport.pdf accessed Date Accessed)|.

22. Dharmasena S, Capps O. Intended and unintended consequences of a proposed national tax on sugar-sweetened beverages to combat the US obesity problem. Health Econ 2011;21(6):669-94.

23. Finkelstein EA, Zhen C, Nonnemaker J, Todd JE. Impact of targeted beverage taxes on higher- and lower-income households. Arch Intern Med 2010;170(22):2028-34. doi: 10.1001/archinternmed.2010.449.

24. Harding M, Lovenheim M. The Effect of Prices on Nutrition: Comparing the Impact of Product- and Nutrient-Specific Taxes. 2014.

25. Lin BH, Smith TA, Lee JY, Hall KD. Measuring weight outcomes for obesity intervention strategies: the case of a sugar-sweetened beverage tax. Econ Hum Biol 2011;9(4):329-41. doi: 10.1016/j.ehb.2011.08.007.

26. Smith TA, Lin B-H, Lee J-Y. Taxing Caloric Sweetened Beverages. United States Department of Agriculture, Economic Research Report 2010(100).

27. Zhen C, Finkelstein EA, Nonnemaker JM, Karns SA, Todd JE. Predicting the Effects of Sugar-Sweetened Beverage Taxes on Food and Beverage Demand in a Large Demand System. Am J Agric Econ 2014;96(1):1-25.

28. Gibson J, Kim B. Measurement error in recall surveys and the relationship between household size and food demand. Am J Agric Econ 2007;89(2):473-89.

29. Zhen C, Wohlgenant MK, Karns S, Kaufman P. Habit formation and demand for sugar-sweetened beverages. Am J Agric Econ 2011;93(1):175-93.

30. Stallings VA, Yaktine AL. Nutrition standards for foods in schools: Leading the way toward healthier youth: National Academies Press, 2007.

31. U.S. Department of Agriculture. Special Supplemental Nutrition Program for Women, Infants and Children (WIC): Revisions in the WIC Food Packages; Final Rule. In: Food and Nutrition Service, ed., 2014.

32. Chetty R, Looney A, Kroft K. Salience and Taxation: Theory and Evidence. The American Economic Review 2009;99(4):1145-77.

33. Finkelstein EA, Zhen C, Bilger M, Nonnemaker J, Farooqui AM, Todd JE. Implications of a sugar-sweetened beverage (SSB) tax when substitutions to non-beverage items are considered. J Health Econ 2013;32(1):219-39.

34. Brownell KD, Farley T, Willett WC, Popkin BM, Chaloupka FJ, Thompson JW, Ludwig DS. The public health and economic benefits of taxing sugar-sweetened beverages. N Engl J Med 2009;361(16):1599-605. doi: 10.1056/NEJMhpr0905723.

35. Fletcher JM, Frisvold DE, Tefft N. The effects of soft drink taxes on child and adolescent consumption and weight outcomes. J Public Econ 2010;94(11):967-74.

36. Powell LM, Chriqui J, Chaloupka FJ. Associations between state-level soda taxes and adolescent body mass index. J Adolesc Health 2009;45(3 Suppl):S57-63. doi: 10.1016/j.jadohealth.2009.03.003.

37. Stanford D. Anti-Obesity Soda Tax Fails as Lobbyists Spend Millions: Retail. Bloomberg 2012.

38. Velazquez M. Voters overwhelmingly reject El Monte's 'soda tax' measure. San Gabriel Valley Tribune 2012.

39. Volsky I. How Beverage Industry Defeated New York's Penny-Per-Ounce Soda Tax. Think Progress 2010.

40. Wahba P. New York governor defends soda tax. Reuters 2010.

41. Zurick M. Soda tax defeated at Capitol. Chicago Tribune 2014.

42. Ng SW, Slining MM, Popkin BM. Turning point for US diets? Recessionary effects or behavioral shifts in foods purchased and consumed. Amer J Clin Nutr 2014;98(3):609--16.

43. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010. JAMA 2012;307(5):483-90.

44. Gortmaker SL, Swinburn BA, Levy D, Carter R, Mabry PL, Finegood DT, Huang T, Marsh T, Moodie ML. Changing the future of obesity: science, policy, and action. The Lancet 2011;378(9793):838-47. doi: http://dx.doi.org/10.1016/S0140-6736(11)60815-5.

45. Whitlock EP, O'Connor EA, Williams SB, Beil TL, Lutz KW. Effectiveness of weight management interventions in children: a targeted systematic review for the USPSTF. Pediatrics 2010;125(2):e396-e418.

46. Wofford LG. Systematic Review of Childhood Obesity Prevention. J Pediatr Nurs 2008;23(1):5-19. doi: http://dx.doi.org/10.1016/j.pedn.2007.07.006.

47. Dietz WH, Gortmaker SL. Preventing Obesity in Children and Adolescents 1. Annu Rev Public Health 2001;22(1):337-53.

48. Brownell KD. The humbling experience of treating obesity: Should we persist or desist? Behav Res Ther 2010;48(8):717-9.

49. Birch LL, Parker L, Burns A. Early childhood obesity prevention policies: National Academies Press, 2011.

50. Health UDo, Services H. Dietary guidelines for Americans 2010. US Department of Agriculture, 7th edition Washington (DC): US Government Printing Office 2010.

51. Ng SW, Slining MM, Popkin BM. Use of caloric and noncaloric sweeteners in US consumer packaged foods, 2005-2009. J Acad Nutr Diet 2012;112(11):1828-34 e1-6. doi: 10.1016/j.jand.2012.07.009.

52. Einav L, Leibtag E, Nevo A. On the accuracy of Nielsen Homescan data: USDA, Economic Research Service, 2008.

53. Einav L, Leibtag E, Nevo A. Recording discrepancies in Nielsen Homescan data: Are they present and do they matter? QME 2010;8(2):207-39.

54. Zhen C, Taylor JL, Muth MK, Leibtag E. Understanding Differences in Self-Reported Expenditures between Household Scanner Data and Diary Survey Data: A Comparison of Homescan and Consumer Expenditure Survey. Rev Agr Econ 2009;31(3):470-92. doi: 10.1111/j.1467-9353.2009.01449.x.

55. Ng SW, Popkin BM. Monitoring foods and nutrients sold and consumed in the United States: Dynamics and Challenges. Journal of the Academy of Nutrition and Dietetics 2012;112(1):41-5.ed. doi: 10.1016/j.jada.2011.09.015.

56. Gidding SS, Dennison BA, Birch LL, Daniels SR, Gilman MW, Lichtenstein AH, Rattay KT, Steinberger J, Stettler N, Van Horn L. Dietary recommendations for children and adolescents: a guide for practitioners. Pediatrics 2006;117(2):544-59.

57. Office of Disease Prevention and Health Promotion. Scientific Report of the 2015 Dietary Guidelines Advisory Committee. health.gov: U.S. Department of Health and Human Services; U.S. Department of Agriculture, 2015.

58. Stuckler D, Basu S, Suhrcke M, Coutts A, McKee M. The public health effect of economic crises and alternative policy responses in Europe: an empirical analysis. The Lancet 2009;374(9686):315-23.

59. U.S. Burea of Labor Statistics. Unemployment. Local Area Unemployment Statistics 2013. Internet: http://www.bls.gov/data/#employment accessed Date Accessed)|.

60. Ng SW, Guilkey DK, Popkin BM. How do recessions affect Consumer Packaged food and beverage purchases in the U.S.? Under review.

61. Haines PS, Popkin BM, Guilkey DK. Modeling food consumption decisions as a two-step process. Am J Agric Econ 1988;70(3):543-52.

62. Angeles G, Guilkey DK, Mroz TA. The Impact of Community-Level Variables on Individual-Level Outcomes Theoretical Results and Applications. Sociological Methods & Research 2005;34(1):76-121.

63. Sprugel D. Correcting for bias in log-transformed allometric equations. Ecology 1983;64(1):209-10.

64. Duan N. Smearing estimate: a nonparametric retransformation method. J Amer Statistical Assoc 1983;78(383):605-10.

65. Gidding SS, Dennison BA, Birch LL, Daniels SR, Gillman MW, Lichtenstein AH, Rattay KT, Steinberger J, Stettler N, Van Horn L, et al. Dietary recommendations for children and adolescents: a guide for practitioners. Pediatrics 2006;117(2):544-59. doi: 10.1542/peds.2005-2374.

66. U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans 2010. 7th ed. Washington, DC, 2010.

67. Huh SY, Rifas-Shiman SL, Rich-Edwards JW, Taveras EM, Gillman MW. Prospective Association between Milk Intake and Adiposity in Preschool-Aged Children. J Am Diet Assoc 2010;110(4):563-70. doi: http://dx.doi.org/10.1016/j.jada.2009.12.025.

68. Malik VS, Pan A, Willett WC, Hu FB. Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. The American journal of clinical nutrition 2013;98(4):1084-102.

69. Chouinard HH, Davis DE, LaFrance JT, Perloff JM. The effects of a fat tax on dairy products. Department of Agricultural & Resource Economics, UCB 2005.

70. Maynard LJ. Empirical tests of the argument that consumers value stable retail milk prices. Journal of Agribusiness 2000;18(2):155-72.

71. Schmit TM, Dong D, Chung C, Kaiser HM, Gould BW. Identifying the effects of generic advertising on the household demand for fluid milk and cheese: a two-step panel data approach. J Agric Resour Econ 2002:165-86.

72. Gould BW. Factors affecting US demand for reduced-fat fluid milk. J Agric Resour Econ 1996:68-81.

73. Green GM, Park JL. Retail demand for whole vs. low-fat milk: new perspectives on loss leader pricing. Annual Meeting of the American Agricultural Economics Association, 1998.

74. Volpe R, Okrent A. Assessing the Healthfulness of Consumers' Grocery Purchases: BiblioGov, 2013.

75. Reedy J, Krebs-Smith SM. Dietary sources of energy, solid fats, and added sugars among children and adolescents in the United States. J Am Diet Assoc 2010;110(10):1477-84. doi: 10.1016/j.jada.2010.07.010.

76. Duffey KJ, Gordon-Larsen P, Shikany JM, Guilkey D, Jacobs DR, Jr., Popkin BM. Food price and diet and health outcomes: 20 years of the CARDIA Study. Arch Intern Med 2010;170(5):420-6. doi: 10.1001/archinternmed.2009.545.

77. Slining M, Popkin B. Trends in intakes and sources of solid fats and added sugars among US children and adolescents: 1994–2010. Pediatric obesity 2013;8(4):307-24.

78. Slining M, Mathias C, Popkin BM. Trends in Food and Beverage Sources among US Children and Adolescents: 1989-2010. J Acad Nutr Diet 2013.

79. Wang YC, Bleich SN, Gortmaker SL. Increasing caloric contribution from sugar-sweetened beverages and 100% fruit juices among US children and adolescents, 1988-2004. Pediatrics 2008;121(6):e1604-14. doi: 10.1542/peds.2007-2834.

80. American Academy of Pediatrics. Internet: http://www2.aap.org/obesity/SSB.html (accessed 12/04/2013.

81. Oliveira V. The Food Assistance Landscape: FY 2013 Annual Report. USDA-ERS Economic Information Bulletin 2014(120).

82. Ma Y, Olendzki BC, Pagoto SL, Hurley TG, Magner RP, Ockene IS, Schneider KL, Merriam PA, Hébert JR. Number of 24-hour diet recalls needed to estimate energy intake. Ann Epidemiol 2009;19(8):553-9.

83. National Cancer Institute (NCI), National Institutes of Health (NIH). Internet: http://appliedresearch.cancer.gov/diet/usualintakes/ (accessed February 9th 2015).

84. Mesirow MS, Welsh JA. Changing Beverage Consumption Patterns Have Resulted in Fewer Liquid Calories in the Diets of US Children: National Health and Nutrition Examination Survey 2001-2010. J Acad Nutr Diet 2014. doi: 10.1016/j.jand.2014.09.004.

85. U.S. Department of Health and Human Services. Internet: http://www.healthypeople.gov/2020/topics-objectives/topic/nutrition-and-weight-status/objectives (accessed 12/04/2013 2013).

86. Obama M. Internet: http://www.letsmove.gov/ (accessed October 10, 2014.

87. Dodd KW, Guenther PM, Freedman LS, Subar AF, Kipnis V, Midthune D, Tooze JA, Krebs-Smith SM. Statistical methods for estimating usual intake of nutrients and foods: a review of the theory. J Am Diet Assoc 2006;106(10):1640-50.

88. Fox MK, Condon E, Briefel RR, Reidy KC, Deming DM. Food consumption patterns of young preschoolers: are they starting off on the right path? J Am Diet Assoc 2010;110(12 Suppl):S52-9. doi: 10.1016/j.jada.2010.09.002.

89. U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion. Healthy People 2020. Washington, DC. 2012.

90. Committee to Review Child and Adult Care Food Program Meal Requirements, Institute of Medicine. Child and Adult Care Food Program: Aligning Dietary Guidance for All: National Academies Press, 2011.

91. Poti JM, Popkin BM. Trends in energy intake among US children by eating location and food source, 1977-2006. J Am Diet Assoc 2011;111(8):1156-64.

92. Ng SW, Popkin BM. The Healthy Weight Commitment Foundation Pledge. American Journal of Preventive Medicine 2014;47(4):520-30. doi: 10.1016/j.amepre.2014.05.030.

93. Ng SW, Slining MM, Popkin BM. Turning point for US diets? Recessionary effects or behavioral shifts in foods purchased and consumed. Am J Clin Nutr 2014;99(3):609-16. doi: 10.3945/ajcn.113.072892.

94. Ng SW, Popkin, Barry M. The Healthy Weight Commitment Foundation Marketplace Commitment and Consumer Packaged Goods purchased by US households with children. . american journal of preventive medicine 2014.

95. Scharf RJ, Demmer RT, DeBoer MD. Longitudinal evaluation of milk type consumed and weight status in preschoolers. Arch Dis Child 2013;98(5):335-40.

96. Bailey RL, Dodd KW, Goldman JA, Gahche JJ, Dwyer JT, Moshfegh AJ, Sempos CT, Picciano MF. Estimation of total usual calcium and vitamin D intakes in the United States. The Journal of nutrition 2010;140(4):817-22.

97. Hall KD, Sacks G, Chandramohan D, Chow CC, Wang YC, Gortmaker SL, Swinburn BA. Quantification of the effect of energy imbalance on bodyweight. The Lancet 2011;378(9793):826-37. doi: http://dx.doi.org/10.1016/S0140-6736(11)60812-X.

98. The American Academy of Pediatrics (AAP). Internet: http://www.healthychildren.org/English/ages-stages/preschool/Pages/Your-Preschoolers-Physical-Appearance-and-Growth.aspx (accessed March 9 2015).

99. Frizell S. Nation's first soda tax passed in California city. Time 2014.

100. Ng SW, Popkin BM. The Healthy Weight Commitment Foundation pledge: calories purchased by US households with children, 2000–2012. Am J Prev Med 2014;47(4):520-30.