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Why Are Americans Consuming Less Fluid Milk? A Look at Generational Differences in Intake Frequency

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United States Department of Agriculture

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Abstract

Americans are drinking less fluid milk, on average. In this study, ERS researchers find that declining consumption since the 1970s reflects changes in the frequency of fluid milk intake, rather than changes in portions. USDA survey data collected between 1977 and 2008 reveal that Americans are less apt to drink fluid milk with their midday and night-time meals than in earlier years, reducing the total number of consumption occasions per day. Moreover, more recent generations of Americans show greater decreases in consumption frequency, holding constant other factors such as education and race. The majority of Americans born in the 1990s consume fluid milk less often than those born in the 1970s, who, in turn, consume it less often than those born in the 1950s. All other factors constant, as newer generations with reduced demand gradually replace older ones, the population's average level of consumption of fluid milk may continue to decline.

Keywords: fluid milk, fluid milk demand, fluid milk products, intake frequency, consumption frequency, generational change, cohort effects, portion sizes, milk drinking, dairy products, dairy checkoff, school lunches, consumer habits, childhood habits

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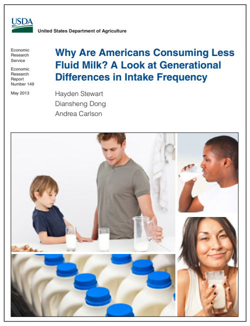

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Why Are Americans Consuming Less Fluid Milk? A Look at Generational Differences in Intake Frequency

Hayden Stewart, Diansheng Dong, and Andrea Carlson

What Is the Issue?

Most Americans do not consume enough dairy products. The *Dietary Guidelines for Americans, 2010* recommends 2 cup-equivalents per day for children aged 2 to 3 years, 2.5 for those aged 4 to 8 years, and 3 for Americans older than age 8. However, per capita dairy consumption has long held steady at about 1.5 cup-equivalents, despite rising cheese consumption. This stasis in per capita dairy consumption results directly from the fact that Americans are drinking progressively less fluid milk. Since 1970 alone, per capita fluid milk consumption has fallen from 0.96 cup-equivalents to about 0.61 cup-equivalents per day.

The Federal Government encourages dairy consumption, including fluid milk, cheese, and yogurt, among other foods, through the *Dietary Guidelines for Americans, 2010*. Special emphasis is placed on fat-free and low-fat products. USDA further supports this message through programs like the National School Lunch Program (NSLP). The NSLP stipulates that schools must provide fluid milk and it must be low-fat or skim, rather than whole. Dairy farmers and fluid milk processors are also working to promote dairy products. The popular "Got Milk?" campaign, for one, encourages drinking fluid milk.

This report examines trends in Americans' fluid milk consumption, including average portion sizes and generational differences in the frequency of milk drinking, to investigate possible explanations for the continued decreases.

What Did the Study Find?

Data from USDA dietary intake surveys conducted between the 1970s and 2000s show that Americans—on occasions when they drink fluid milk—continue to consume about 1 cup (8 fluid ounces). Given the stability of portions, trends showing decreases in per capita consumption since the 1970s mainly reflect changes in consumption frequency. Between the 1970s and 2000s, people have become less apt to drink fluid milk at mealtimes, especially with midday and nighttime meals, reducing the total number of consumption occasions:

- Between surveys in 1977-78 and 2007-08, the share of preadolescent children who did not drink fluid milk on a given day rose from 12 percent to 24 percent, while the share that drank milk three or more times per day dropped from 31 to 18 percent.

ERS is a primary source of economic research and analysis from the U.S. Department of Agriculture, providing timely information on economic and policy issues related to agriculture, food, the environment,and rural America.

- Between 1977-78 and 2007-08, the share of adolescents and adults who did not drink fluid milk on a given day rose from 41 percent to 54 percent, while the share that drank milk three or more times per day dropped from 13 to 4 percent.

Underlying these decreases in consumption frequency are differences in the habit to drink milk between newer and older generations. All else constant (e.g., race and income), succeeding generations of Americans born after the 1930s have consumed fluid milk less often than their preceding generations:

- Americans born in the early 1960s consume fluid milk on 1.1 fewer occasions per day than those born before 1930.

- Americans born in the early 1980s consume fluid milk on 0.3 fewer occasions per day than those born in the early 1960s.

Differences across the generations in fluid milk intake may help account for the observed decreases in per capita fluid milk consumption in recent decades despite public and private sector efforts to stem the decline. Furthermore, these differences will likely make it difficult to reverse current consumption trends. In fact, as newer generations replace older ones, the population's average level of fluid milk consumption may continue to decline.

How Was the Study Conducted?

ERS researchers pooled data from five USDA dietary intake surveys for analysis. These included the 1977-78 Nationwide Food Consumption Survey, the 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII), 1994-1996 CSFII, the 2003-04 National Health and Nutrition Examination Survey (NHANES), and the 2007-08 NHANES. Respondents in each survey were asked to report their intake of all foods and beverages on one or more days. This study focused on individuals' fluid milk consumption during a single, 24-hour period.

Researchers reviewed the existing literature on fluid milk demand, compared consumption data across periods in the different surveys, and then conducted a formal hypothesis test for whether newer generations are consuming fluid milk fewer times per day, and whether changes in portion sizes are also affecting consumption trends. This was accomplished by estimating an econometric model that predicts both the frequency and total quantity of fluid milk consumed by Americans who participated in USDA food consumption surveys, based on their birth year, race, household income, and demographic characteristics.

Introduction

Most Americans do not consume enough dairy products. The *Dietary Guidelines for Americans, 2010* recommends 2 cup-equivalents per day for children aged 2 to 3 years, 2.5 for those aged 4 to 8 years, and 3 for Americans older than age 8. By contrast, actual dairy consumption has held steady between 1.45 and 1.55 cup-equivalents per capita since the 1970s, despite a near tripling of cheese consumption over the past 40 years (USDA-ERS, 2013a). The reason for this stasis in overall dairy consumption is that Americans are drinking progressively less fluid milk.

Long a dietary staple, fluid milk once accounted for the majority of overall dairy consumption. However, as chronicled by Popkin (2010, p. 1), there has been a "slow continuous shift downward" in milk drinking since the 1940s. Since 1970 alone, per capita consumption has fallen from 0.96 to 0.61 cup-equivalents per day (USDA-ERS, 2013a). Moreover, this trend appears to cut across different age groups. Younger people aged 2 to 18 years consumed less fluid milk in the 2000s than did children and adolescents in the 1970s (Cavadini et al., 2000; Popkin, 2010).[1] Adults (over 18) have also been consuming less fluid milk over time (Enns et al., 1977; Popkin, 2010).

The Federal Government encourages dairy consumption, including fluid milk, cheese, and yogurt, among other products, through the *Dietary Guidelines for Americans, 2010*.[2] Special emphasis is placed on consuming more fat-free and low-fat milk and milk products in particular. These foods provide many of the same nutrients as higher fat dairy products with fewer calories (p. 38).

USDA further supports its dairy message through programs like the National School Lunch Program (NSLP), the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), and the Special Milk Program. The NSLP, for one, requires participating schools to offer students low-fat or skim fluid milk—and no whole milk. Only skim milk may be flavored (e.g., strawberry or chocolate).

Like the Federal Government, dairy farmers and fluid milk processors are concerned about low levels of dairy consumption. Both invest in checkoff[3] programs to increase sales of and demand for dairy products and ingredients (National Dairy Promotion and Research Board, 2013). Some efforts supported by checkoff programs focus primarily on fluid milk, including the popular "Got Milk?" campaign. Others like "Fuel Up to Play 60" emphasize all dairy products consump-

[1]Popkin (2010) examined the consumption of milks, sugar-sweetened beverages (SSB), diet beverages, juices, alcoholic beverages, and unsweetened tea and coffee. SSBs include carbonated and uncarbonated soft drinks, sugared waters, and energy drinks, among others. He studied consumption trends for children and adolescents aged 2 to 18 years. Popkin (2010) separately examined beverage consumption for adults aged 19 and older.

[2]The *Dietary Guidelines for Americans, 2010* are issued by USDA and the U.S. Department of Health and Human Services (DHHS) to provide evidence-based nutrition information and advice for people age 2 and older. They also serve as the nutritional basis for Federal food and nutrition assistance education programs.

[3]A *checkoff program* collects funds from producers of a particular agricultural commodity and uses these funds to promote and conduct research on that commodity.

tion, including milk drinking. This particular initiative encourages children to be physically active and "fuel up" with nutrient-rich foods like low-fat and skim milk, cheese, and yogurt. Dairy farmers contribute $0.15 per 100 pounds of milk they commercially market to checkoff programs, while fluid milk processors contribute $0.20 per 100 pounds they sell in consumer-type packages. Yet, so far, the efforts of dairy farmers, fluid milk processors, and the Federal Government have not increased dairy consumption to recommended levels, while fluid milk consumption continues to fall.

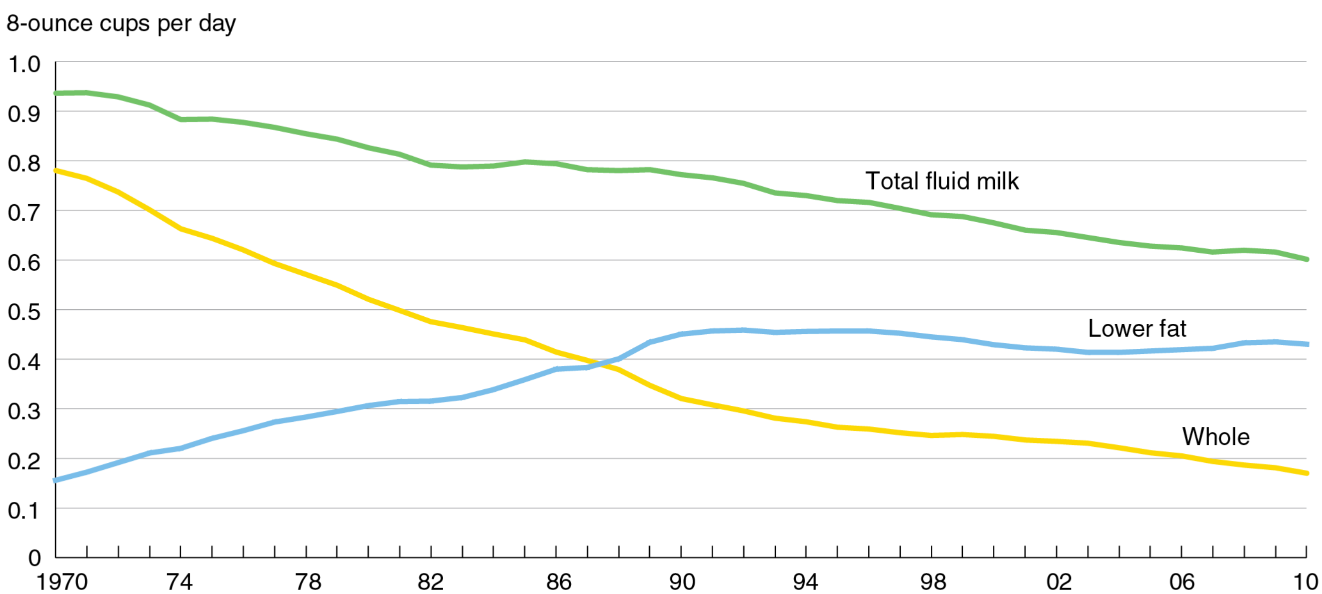
Previous research on declining fluid milk consumption—the main reason for stationary dairy consumption levels—finds that generational differences ("cohort effects") are a contributing factor. Using dietary intake surveys collected by USDA between the 1970s and the 2000s, Stewart et al. (2012) recently demonstrated that more recent generations consume smaller quantities of fluid milk. For example, on average, Americans born in the 1980s consume less fluid milk per day than Americans born in the 1960s, holding constant other factors such as income and race. These findings may reflect the persistence of childhood habits—each successive generation grows up less accustomed than their parents to drinking fluid milk and carries that habit forward into adult life.

In this study, ERS researchers used USDA dietary intake surveys from the 1970s, 1980s, 1990s, and 2000s to identify the number of times per day that Americans consume fluid milk, as well as to identify portion sizes. A possible explanation for decreases in the quantity of fluid milk consumed over time is that Americans are consuming it fewer times per day. However, Americans may also be using fluid milk in different ways. For example, if Americans consume fluid milk more often than they used to as a snack in a coffee drink and less often as a standalone beverage at mealtimes, then average portion sizes could change. Given Stewart et al.'s (2012) findings on generational change, the researchers also tested whether newer generations are consuming fluid milk less frequently than older generations.

Identifying Trends in the Frequency and Quantity of Fluid Milk Consumption

To monitor trends in the American diet, ERS estimates the quantities of foods available for consumption annually (USDA-ERS, 2013b). ERS food availability data suggest that Americans have been consuming less fluid milk since the 1940s. Data on per capita consumption since the 1970s (USDA-ERS, 2013a)[4] reveal a decrease in average consumption from about 0.96 cups to about 0.61 cups of fluid milk per day over the past 40 years (fig. 1). Increases in the consumption of 2-percent, 1-percent, and skim milk have partly offset decreases in whole milk consumption.[5] These products are hereafter referred to as *lower fat* milk. Consumption of lower fat milk products accounted for about 20 percent of total consumption in the 1970s and about 70 percent by the end of the 2000s.

Figure 1
Per capita, daily fluid milk consumption declining



Notes: *Whole* milk has a fat content of at least 3.25 percent. *Lower fat* milk includes products with less milk fat than whole like 2-percent, 1-percent, and skim milk.

Source: Loss-Adjusted Food Availability, USDA-ERS (2013a).

[4]These data are created by adjusting food availability data for food spoilage and other forms of food loss to better proxy for consumption. Loss-adjusted food availability data are not available prior to 1970.

[5]Whole milk has a minimum fat content of 3.25 percent. ERS researchers were not able to separately identify consumption trends for 2 percent (reduced-fat), 1 percent (low-fat), and skim milk. As noted in the text above, current dietary recommendations place special emphasis on low-fat and skim milk.

Trends in fluid milk consumption can also be examined using USDA dietary surveys intermittently collected since the 1970s. Unlike ERS food availability data, these surveys break down food consumption data by particular segments of the population, such as children. Survey participants provided their household income, age, educational attainment, race, and ethnicity, among other characteristics. They also provided one or more 1-day "dietary recalls." These recalls include information on the foods and beverages consumed by the individual on the previous day.

The information provided shows how many times fluid milk was consumed, and whether each consumption occasion was part of a meal or snack. It is also possible to estimate the amounts of fluid milk consumed as a beverage, in cereal, or even as an ingredient in a food, such as a soup.[6] In this study, the researchers focused on individuals' fluid milk consumption over the 24-hour period covered by their initial 1-day dietary recall.

ERS limited the analysis to the consumption of plain and flavored fluid milk consumed alone as a beverage, put in cereal, poured in coffee, or used as an ingredient in selected coffee drinks.[7] In 2007-08, these products accounted for 93 percent of all fluid milk consumed by survey participants in all uses. Excluded from the study were milk in eggnog, malted milk, milkshakes, weight loss shakes, soups, and baked goods, among other foods. Also excluded from the results reported in this study were soy beverages.[8] USDA dietary records distinguish among whole, 2-percent, 1-percent, skim, and other types of fluid milk, though survey participants cannot always recall which type of milk they consumed. See also Appendix I: Comparing Consumption Across Different USDA Dietary Intake Surveys.

ERS analysis of USDA food consumption surveys collected since the 1970s confirms that fluid milk intake has declined for preadolescent children (aged 2 to 12 years), as well as for Americans beyond childhood (fig. 2). In 1977-78, preadolescent children drank, on average, 1.7 cups per day, while in 2007-08 children this age drank only 1.2 cups per day (30 percent less). Similarly, in 1977-78, Americans aged 13 and over drank, on average, 0.8 cups per day, while in 2007-08, people this age drank only 0.6 cups (25 percent less). USDA dietary intake surveys also confirm that milk drinkers in 2007-08 were more likely to choose a lower fat product than milk drinkers in 1977-78 (fig. 3).

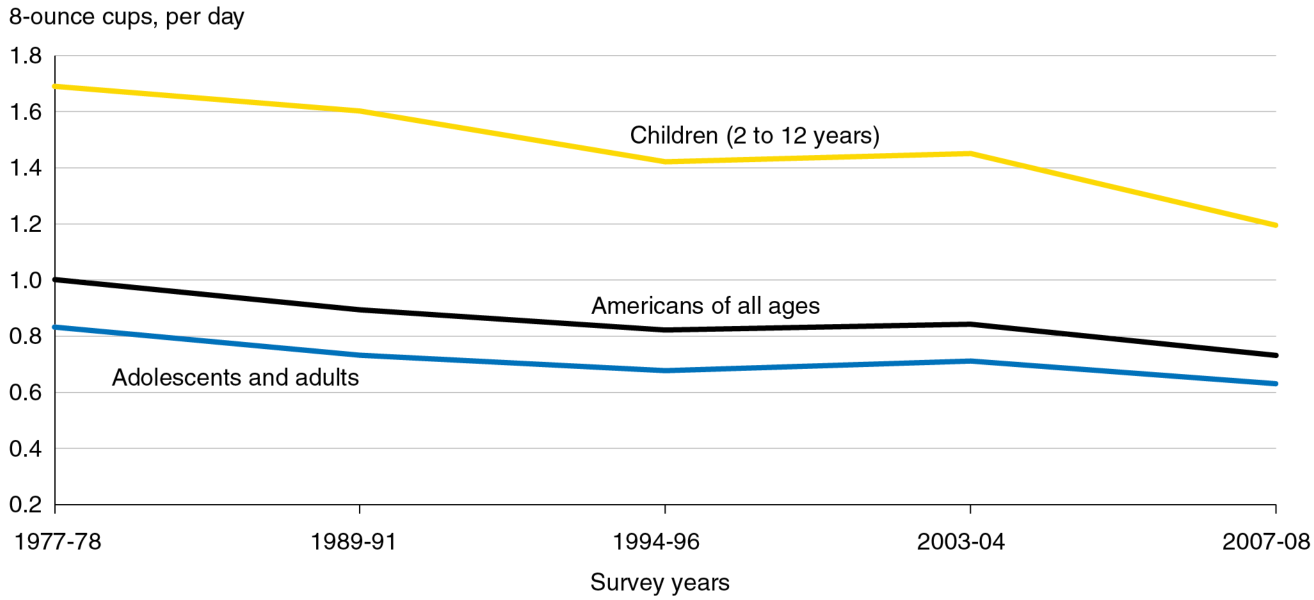
To better understand declining fluid milk consumption, ERS examined how often Americans consume fluid milk at mealtimes (table 1). For example, in 1977-78, 39 percent of adolescents and adults drank milk with a morning meal; 24 percent consumed it with a midday meal; and 21 percent had fluid milk with a nighttime

[6]Recipes developed for use with more recent food consumption surveys are available in the USDA Food and Nutrient Database for Dietary Studies (FNDDS). See USDA, Agricultural Research Service (2013a).

[7]Includes only coffee drinks that are 50 percent or more milk such as a latte (75 percent milk), café con leche (51 percent), mocha (66 percent), cappuccino (51 percent), and sweetened milk coffee with ice (58 percent).

[8]Americans consume only a small amount of soy beverages compared with their consumption of cow's milk. ERS researchers confirmed that including the former in the analysis would not significantly affect the study's results.

Figure 2
Fluid milk consumption decreasing in all age groups



Note: For all age categories shown above, daily per capita fluid milk consumption was lower in 1994-96 than in 1977-78. It was again lower in 2007-08 than in 1994-96. These differences are statistically significant at the 10-percent level.

Source: Calculated by the authors using the 1977-78 Nationwide Food Consumption Survey (NFCS), 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII), 1994-1996 CSFII, 2003-04 National Health and Nutrition Examination Survey (NHANES), and 2007-08 NHANES and accompanying sample weights. Results are based on all survey participants, including consumers who did not report consuming any fluid milk in their 1-day dietary recall.

meal.[9] By 2007-08, those percentages had decreased to 28 percent, 8 percent, and 9 percent, respectively.

From the same two surveys, similar trends were seen in the consumption habits of preadolescent children. In the later survey, young children consumed fluid milk with fewer meals (especially, fewer midday and nighttime meals) than did the young children of the earlier survey. However, unlike adolescents and adults, young children have partly offset mealtime decreases in milk consumption with increases while snacking.

In total, Americans consumed fluid milk less frequently in 2007-08 than they did in 1977-78 or 1994-96 (fig. 4). Over the 30 years between 1977-78 and 2007-08, the share of individuals not consuming any fluid milk on a given day rose from 12 to 24 percent among preadolescent children, and from 41 to 54 percent among adolescents and adults. Furthermore, the shares consuming fluid milk several times a day fell. By 2007-08, only 45 percent of preadolescent children and 14 percent of adolescents and adults consumed fluid milk on more than one occasion.

Besides consuming milk less often, Americans may be changing their fluid milk-drinking habits in other ways, but so far, those changes have had little effect on portion sizes. ERS researchers hypothesized that, if individuals are consuming fluid milk more often in a coffee beverage than they used to and less often as a standalone beverage at meals than they used to, average portion sizes may change.

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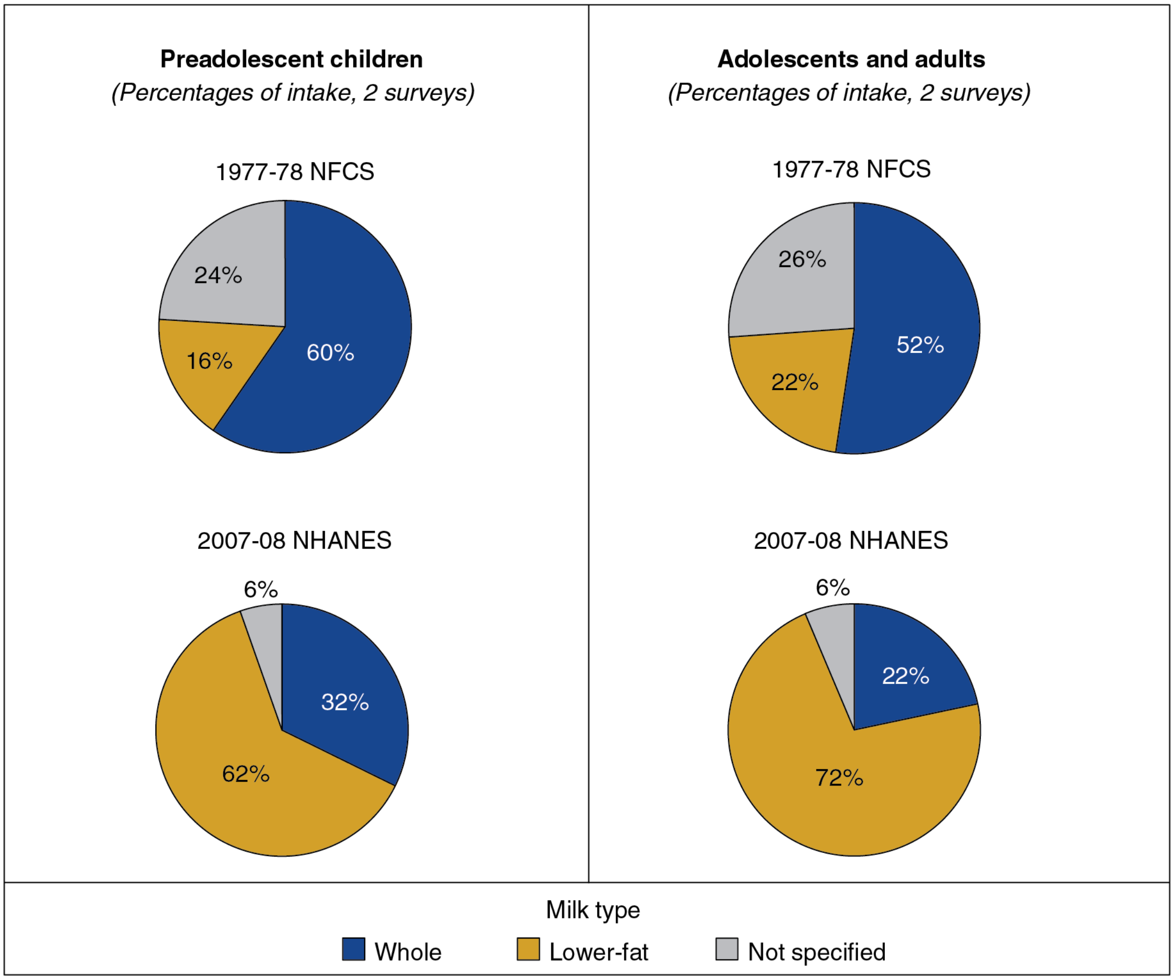
[9]Midday meal is defined as a meal occasion occurring between 11 a.m. and 5 p.m.

Figure 3
Lower fat products now represent the bulk of fluid milk consumption for all age groups



Notes: *Whole* milk has a fat content of at least 3.25 percent. *Lower fat* milk includes products with less milk fat than whole, like 2-percent, 1-percent, and skim milk. However, survey participants cannot always recall the fat content of the milk they consumed. The type of milk is then "not specified."

Source: Calculated by the authors using the 1977-78 Nationwide Food Consumption Survey (NFCS), 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII), 1994-1996 CSFII, 2003-04 National Health and Nutrition Examination Survey (NHANES), and 2007-08 NHANES and accompanying sample weights.

Nonetheless, from the data available, ERS finds that, on the occasions when Americans do consume fluid milk, they have continued to drink at least as much as they did in the 1970s (fig. 5). Americans drank about 1 cup (8 fluid ounces) of fluid milk per occasion in 2007-08, on average, versus 0.8 cups in 1977-78. That portions appear not to have decreased, in turn, suggests that decreases in the frequency of consumption, shown in table 1 and figure 4, primarily underlie the downward trend in intake, shown in figures 1 and 2.

Table 1
Americans less apt to consume fluid milk at mealtimes[1]

Percentage of preadolescent children consuming fluid milk				
	Morning meal	Midday meal[2]	Night meal	Snack
1977-78 NFCS	71.3	50.7	35.5	19.9
	(0.6)	(0.7)	(0.7)	(0.5)
1989-91 CSFII	68.0	41.8	29.4	18.2
	(1.3)	(1.4)	(1.3)	(1.1)
1994-96 CSFII	64.0	33.7	23.5	21.0
	(0.9)	(0.9)	(0.8)	(0.8)
2003-04 NHANES	57.4	26.7	22.1	26.4
	(1.9)	(1.7)	(1.6)	(1.7)
2007-08 NHANES	55.6	29.3	17.5	24.7
	(1.7)	(1.5)	(1.3)	(1.4)
Percentage of adolescents and adults consuming fluid milk				
	Morning meal	Midday meal[2]	Night meal	Snack
1977-78 NFCS	38.8	24.0	21.5	13.2
	(0.4)	(0.4)	(0.3)	(0.3)
1989-91 CSFII	38.1	14.9	14.1	11.3
	(0.7)	(0.5)	(0.5)	(0.4)
1994-96 CSFII	35.8	10.4	10.6	12.1
	(0.6)	(0.4)	(0.3)	(0.4)
2003-04 NHANES	28.9	7.4	9.3	14.4
	(0.9)	(0.5)	(0.6)	(0.7)
2007-08 NHANES	28.2	8.0	8.8	13.8
	(0.8)	(0.5)	(0.6)	(0.7)

[1]Standard errors reported in parentheses.
[2]Midday meal is defined as a meal occasion occurring between 11 a.m. and 5 p.m.

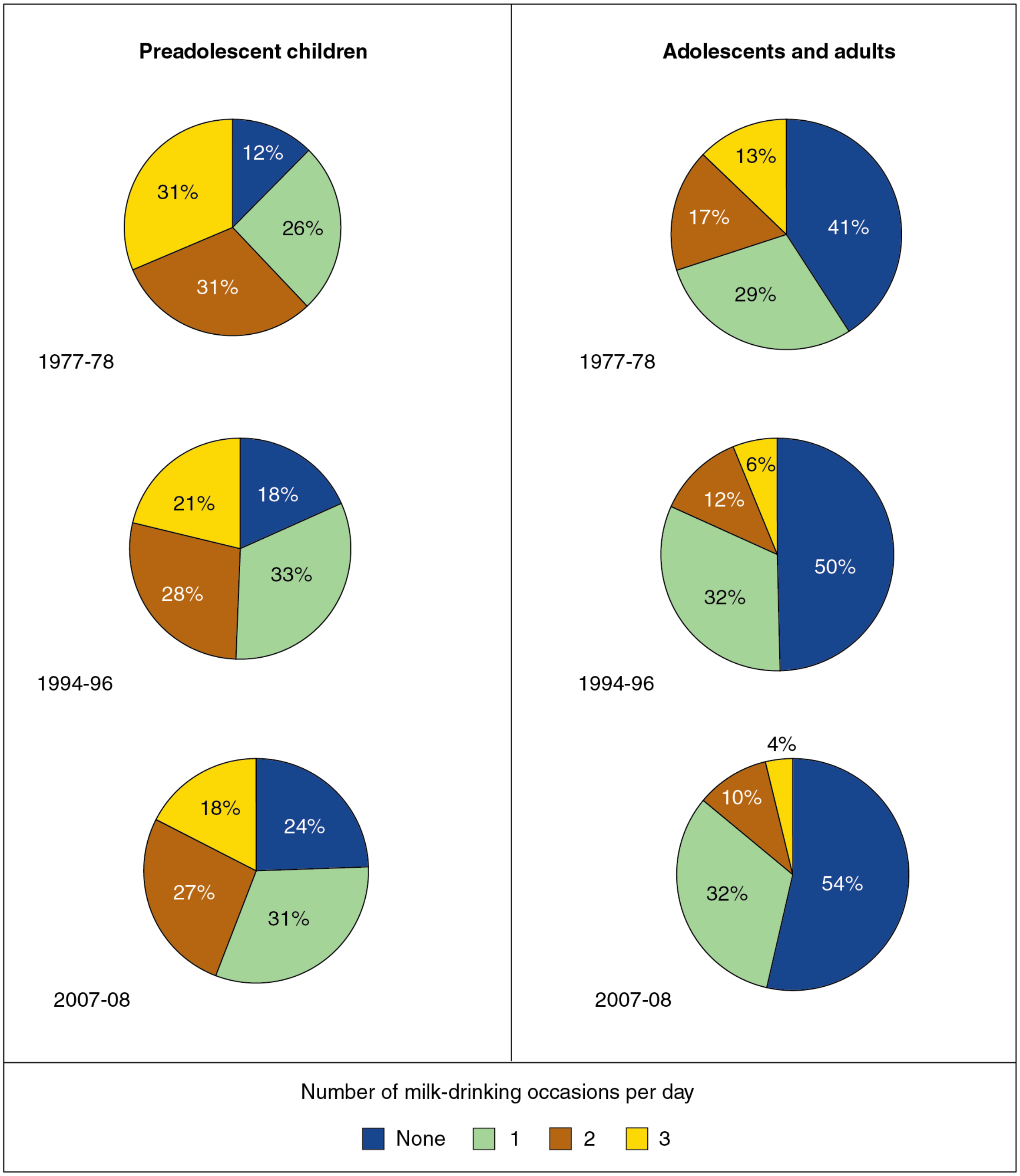
Notes: Decreases in the percentages of individuals consuming fluid milk with their morning, midday, and nighttime meals between 1977-78 and 2007-08 are statistically significant at the 10-percent level for both age groups.

Source: Calculated by the authors using the 1977-78 Nationwide Food Consumption Survey (NFCS), the 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII), the 1994-1996 CSFII, the 2003-04 National Health and Nutrition Examination Survey (NHANES), and the 2007-08 NHANES and accompanying sample weights.

Overall, the data show that Americans are consuming fluid milk less frequently and, in turn, consuming smaller quantities, but what is driving these changes in behavior? Kaiser and Dong (2006) and Kaiser (2010) confirm that promotions sponsored by checkoff programs increase demand. Gleason and Suitor (2001) confirm a positive relationship between children's participation in the NSLP and their fluid milk consumption. However, cohort effects may be exerting a greater impact on consumption in the opposite direction.

Cohort effects exist when people belonging to the same generation make more similar food choices to each other than to people born farther from them in time. Since Schrimper (1979) first raised the possibility that cohort effects exist and

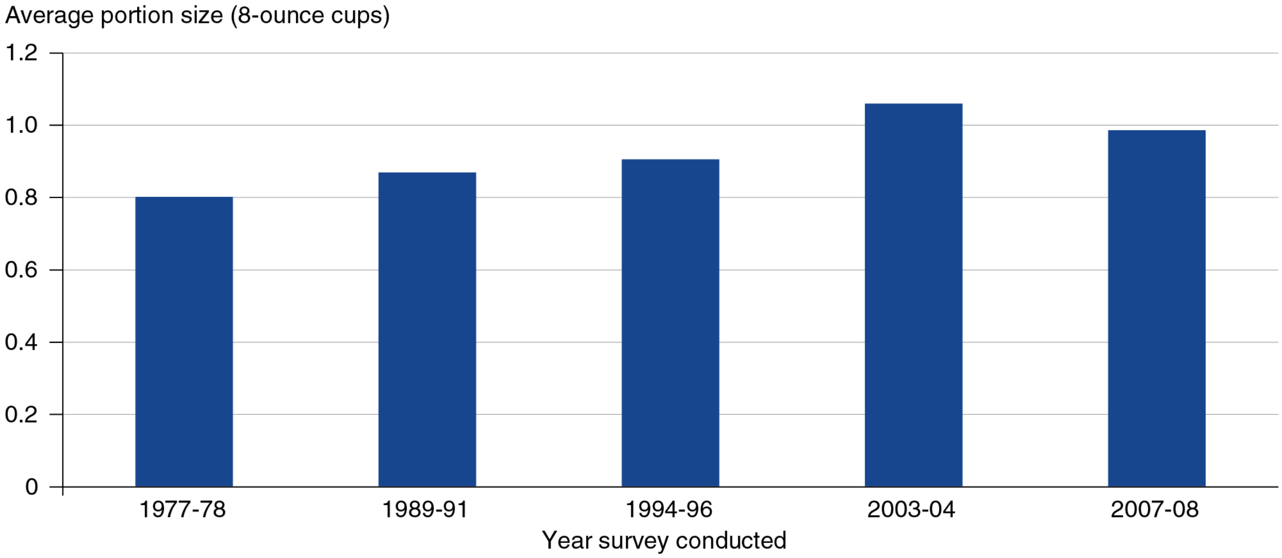
Figure 4
Americans consume fluid milk less frequently per day



Notes: Notable changes from the older to the newer surveys include increases in the percentages of individuals reporting no fluid milk consumption, as well as decreases in the percentages who consumed fluid milk on three or more occasions. These changes are statistically significant at the 10-percent level.

Source: Calculated by the authors using the 1977-78 Nationwide Food Consumption Survey (NFCS), 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII),1994-1996 CSFII, 2003-04 National Health and Nutrition Examination Survey (NHANES), and 2007-08 NHANES and accompanying sample weights.

Figure 5
Fluid milk portions not decreasing over time



Notes: The average portion was largest in 2003-04 and smallest in 1977-78. This difference is statistically significant at the 10-percent level.

Source: Calculated by the authors using the 1977-78 Nationwide Food Consumption Survey (NFCS), 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII), 1994-1996 CSFII, 2003-04 National Health and Nutrition Examination Survey (NHANES), and 2007-08 NHANES and accompanying sample weights. Results are based on survey participants, who reported consuming fluid milk in their 1-day dietary recall, excluding all nonconsumers.

shape trends in food consumption, much empirical research has followed. Mori et al. (2006) and Mori and Saegusa (2010) find that cohort effects influence fresh fruit and fish consumption in Japan. Stewart and Blisard (2008) find that they influence expenditures on fresh vegetables for at-home consumption in the United States.

As to cohort effects and fluid milk consumption, Stewart et al. (2012) find that more recent generations of Americans drink less fluid milk. For example, Americans born in the 1960s are consuming 0.13 cups less whole milk and 0.28 cups less lower fat milk per day than Americans born before 1930, holding constant other factors like race and income. Moreover, Americans born in the 1980s consume 0.16 cups less whole milk and 0.13 cups less lower fat milk per day than those born in the 1960s.

Cohort effects could influence U.S. fluid milk consumption for several reasons. These reasons begin with the unique experiences of each generation of American children. Every decade brings a wider selection of beverage choices at supermarkets, restaurants, and other food outlets. Soft drinks, isotonic sports drinks, bottled water, and other products increasingly compete with fluid milk for a share of the consumer's appetite. Changes have also occurred over time in the popularity of fast food, among other phenomena.

Changes in the food environment can affect children's beverage consumption. Fisher et al. (2001) and Bowman et al. (2004) suggest that children's fluid milk consumption may decrease with exposure to competing beverages and fast food, respectively. Regardless of other reasons, as successive generations of Americans have grown up amid declining rates of fluid milk consumption, they may have developed different life-long habits. The habit to drink milk may form (or not form) in childhood. According to the *Dietary Guidelines for Americans*, *2010*, individuals "who consume milk at an early age are more likely to do so as adults" (p. 38).

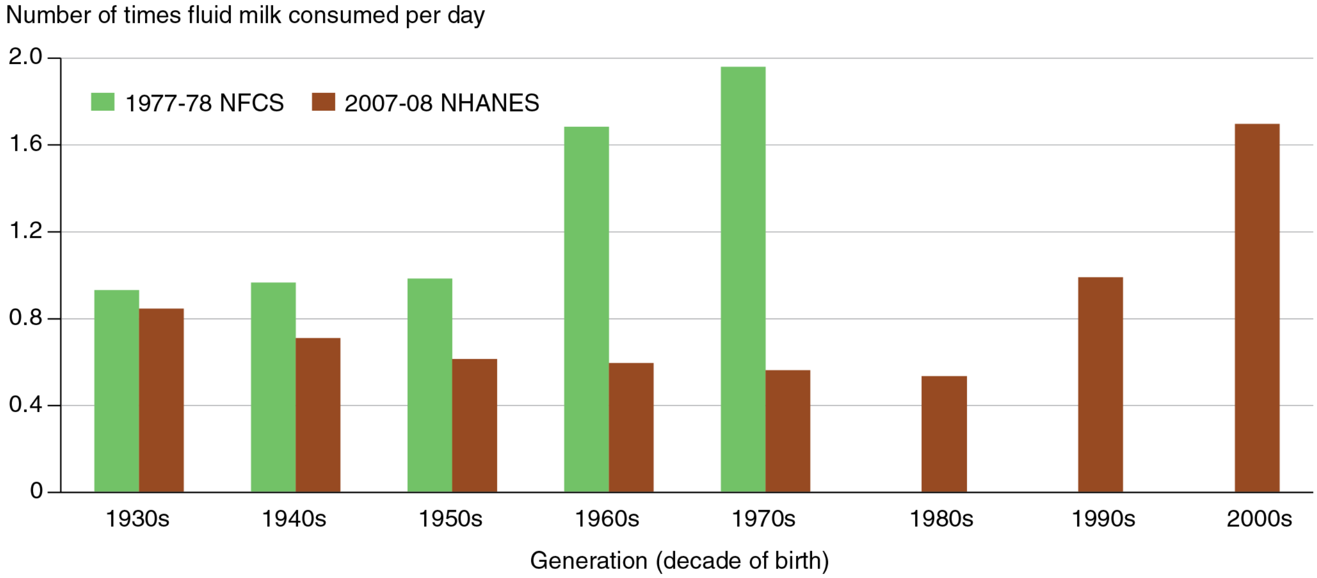
Modeling Trends in Fluid Milk Consumption Across the Generations

Investigating consumption differences over time and across generations requires a particular type of data set. Many studies of U.S. food demand use time series data. These data typically span several decades and include information on food consumption or expenditures, price, and consumer income. However, time series data also tend to be highly aggregated. They do not typically contain information on individual consumers. By contrast, cross-sectional data contain information on individual consumers and may, therefore, be suitable for investigating the effects of demographic characteristics on demand. Nonetheless, because such data seldom span more than a couple years, they are not ideal for studying longrun trends. In Deaton's (1997) terminology, researchers need a "time series of cross sections." That is, they must pool cross-sectional surveys collected over several decades. Mori and Stewart (2011) empirically demonstrate the advantages of such data over traditional time series data. In this study, ERS pools the 1977-78 Nationwide Food Consumption Survey (NFCS), 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII), 1994-1996 CSFII, 2003-04 National Health and Nutrition Examination Survey (NHANES), and 2007-08 NHANES.

A time series of cross-sectional surveys provides information on each generation's food choices at various times in history and at different ages in their lives. For example, ERS researchers observed the number of times per day that members of different generations reported consuming fluid milk in the 1977-78 NFCS and in the 2007-08 NHANES (fig. 6). As young children in 1977-78, Americans born in the 1970s tended to consume fluid milk almost twice a day; and by 2007-08, as young adults in their 20s or 30s, they consumed it only 0.56 times per day. Despite their youth, Americans born in the 1970s consumed fluid milk even less often in 2007-08 than members of some older generations. Over a 30-year span, Americans born in the 1940s decreased the frequency of their fluid milk consumption from about 0.97 times per day (in 1977-78, in their 20s or 30s) to about 0.71 times per day (in 2007-08, in their 50s or 60s).

Previous studies, including Popkin (2010), Cavadini et al. (2000), and Stewart et al. (2012), have examined trends in the level of U.S. per capita fluid milk consumption. In this study, ERS researchers further investigated whether the smaller quantities of fluid milk being consumed by Americans are a result of their consuming it fewer times throughout the day. The researchers also confirmed whether trends in portion sizes likewise affect consumption levels. This was accomplished by estimating an econometric model that predicts both the frequency and total quantity of fluid milk consumed by Americans based on their generation (decade of birth), incomes, and demographic characteristics. Definitions and mean values are provided in table 2 for the model's dependent and explanatory variables. In the next section, these variables are explained and the model outlined.

Figure 6
Frequency of fluid milk intake for different generations at different points in time



Notes: Statistically significant differences at the 10-percent level between the generations include those between Americans born in the 1940s and Americans born in the 1970s, both in 1977-78 and 2007-08.

Source: Calculated by the authors using the 1977-78 Nationwide Food Consumption Survey (NFCS) and 2007-08 National Health and Nutrition Examination Survey (NHANES) and accompanying sample weights. Results are based on all survey participants, including those who did not report consuming any fluid milk in their 1-day dietary recall.

Variables Used in the Analysis

The analysis focuses on fluid milk consumption by USDA survey participants over 24 hours. The number of times that an individual drank fluid milk during this period is denoted as FREQUENCY. Preadolescent children consumed fluid milk on 1.65 occasions, on average, with moderate person-to-person variation. FREQUENCY had a standard deviation of 1.2, among preadolescent children. By contrast, adolescents and adults consumed fluid milk 0.81 times, on average, with a standard deviation of 1.01. Of all survey participants, 58 consumed fluid milk on more than 6 occasions. Three people consumed it on more than 10 occasions. The maximum value of FREQUENCY was 16 occasions.

Also of interest was a survey participant's total consumption of fluid milk. This dependent variable is denoted as QUANTITY. During the 24 hours covered by the dietary recall of preadolescent children, the children—including those who consumed no fluid milk at all—reported consuming 1.48 cups of fluid milk, on average, over all consumption occasions. Adolescents and adults consumed a total of 0.71 cups, on average. On the occasions when Americans do drink fluid milk, they may consume it in portions that are about what they were in the 1970s (see fig. 5). If portions have changed little, then changes over time in QUANTITY may reflect primarily changes in FREQUENCY.

The researchers also created explanatory variables to proxy for exogenous factors that may influence a person's demand for fluid milk. FREQUENCY and QUANTITY were hypothesized to vary with a person's income, demographic characteristics, and his or her decade of birth, among other factors. Extensive research

Table 2
Mean values of variables used in the model

		Children (age 2-12)	Adolescents and adults
FREQUENCY	Number of times fluid milk was consumed	1.65	0.81
QUANTITY	Total intake of fluid milk over 24 hours (cups)	1.48	0.71
INCOME	Household income (per capita 2003 dollars)	10,893.84	18,282.27
AGE	Age at the time of survey participation (years)	6.96	42.21
HHSIZE	Number of people living in household	4.52	3.13
PREGNANT	1 for pregnant; 0 otherwise		0.01
DIETING	1 for on a special diet; 0 otherwise		0.07
HISPANIC	1 for Hispanic ethnicity; 0 otherwise	0.14	0.09
BLACK	1 for Black; 0 otherwise	0.15	0.11
MALE	1 for male; 0 otherwise	0.51	0.46
COLLEGE	1 if household head finished college; 0 otherwise	0.28	0.29
WEEKEND	1 if dietary recall for a weekend; 0 otherwise	0.25	0.26
C1	1 if born prior to 1930; 0 otherwise		0.17
C2	1 if born between 1930-1934; 0 otherwise		0.05
C3	1 if born between 1935-1939; 0 otherwise		0.05
C4	1 if born between 1940-1944; 0 otherwise		0.07
C5	1 if born between 1945-1949; 0 otherwise		0.08
C6	1 if born between 1950-1954; 0 otherwise		0.09
C7	1 if born between 1955-1959; 0 otherwise		0.10
C8	1 if born between 1960-1964; 0 otherwise		0.11
C9	1 if born between 1965-1969; 0 otherwise		0.07
C10	1 if born between 1970-1974; 0 otherwise		0.07
C11	1 if born between 1975-1979; 0 otherwise		0.06
C12	1 if born between 1980-1984; 0 otherwise		0.04
C13	1 if born between 1985-1989; 0 otherwise		0.03
C14	1 if born between 1990-1994; 0 otherwise		0.02
TIME1	1 if 1977-78 NFCS; 0 otherwise	0.17	0.16
TIME2	1 if 1989-91 CSFII; 0 otherwise	0.21	0.20
TIME3	1 if 1994-96 CSFII; 0 otherwise	0.37	0.35
TIME4	1 if 2003-04 NHANES; 0 otherwise	0.13	0.14
TIME5	1 if 2007-08 NHANES; 0 otherwise	0.13	0.15

Source: Calculated by the authors using the 1977-78 Nationwide Food Consumption Survey (NFCS), the 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII), the 1994-1996 CSFII, the 2003-04 National Health and Nutrition Examination Survey (NHANES), and the 2007-08 NHANES and accompanying sample weights.

has been conducted on methods for specifying this type of model. In this study, ERS followed procedures outlined by Deaton (1997), Johnson (1980), and Stewart and Blisard (2008) for defining explanatory variables and identifying cohort effects.

Previous studies have analyzed the effects of income, age, gender, race, ethnicity, and other demographic characteristics on fluid milk consumption. Based on Lin et al. (2003) and Davis et al. (2010), among other papers cited in this study, researchers defined several variables for inclusion in the model (table 2). These included the natural logarithm of a person's age (AGE), which is consistent with research showing that fluid milk consumption tends to be stable in childhood, falls in adolescence, and continues to fall at a slower rate throughout adulthood (e.g., Lin et al., 2003; Mannino et al., 2004; Sebastian et al., 2010). The researchers also included the natural logarithms of a person's household income (INCOME) and household size (HHSIZE), as well as binary variables for gender (MALE), race (BLACK), ethnicity (HISPANIC), whether at least one head of household has completed college (COLLEGE), and whether consumption was reported for a Saturday or Sunday (WEEKEND). For teenagers and adults, the researchers added binary variables to control for whether survey participants were dieting (DIETING) or pregnant (PREGNANT) during the 24 hours described in their 1-day dietary recall.

In addition to factors identified as important determinants of fluid milk consumption in past studies, researchers included explanatory variables for testing whether the number of times per day that a person consumes fluid milk varies across the generations. These binary explanatory variables include C2, for people born 1930-34; C3, 1935-39; and so on in 5-year intervals, up to C14, 1990-94. By including C2 through C14 in the econometric model, the researchers could calculate the expected differences in consumption between each of these more recent cohorts and Americans born prior to 1930.[10] Evidence that more recently born cohorts consume fluid milk less often than older cohorts would confirm that a cohort effect is contributing to declining consumption frequency. By contrast, finding no consistent variance of consumption frequency across generations would refute the hypothesis that cohort effects are part of the trend.

ERS researchers also created binary variables that identify which USDA survey an individual joined. One of these binary variables, TIME2, indicates that an individual participated in the 1989-91 CSFII. Likewise, TIME3 identifies participants in the 1994-96 CSFII. And, finally, TIME4 and TIME5 denote participants in the 2003-04 and the 2007-08 NHANES. The estimation results on these four variables compare participants in the 1977-78 NFCS with participants in each of the subsequent surveys, holding all other explanatory variables in the model constant.[11] Unlike C2 through C14, which capture differences between the generations likely related to their experiences as children, TIME2 through TIME5 were hypothesized

[10]Individuals born prior to 1930 would not have likely been influenced as preadolescent children by the changes in milk consumption that started in the 1940s. ERS researchers, therefore, hypothesized that generational effects exist only for Americans born in 1930 or more recently.

[11]For example, given that the other explanatory variables included a person's income, demographic characteristics, and his or her birth year, ERS researchers could interpret the results on TIME5 to answer the question, "If the same population that existed in 1977-78 still existed in 2007-08, how much would consumption have fallen or risen?"

to capture the contemporaneous effects on all individuals of the availability of competing beverages and other aspects of the food marketing system.

Finally, ERS created a variable to account for prices. Prices for fluid milk have tended to fluctuate relative to prices for other nonalcoholic beverages. The researchers divided the Consumer Price Index (CPI) for fresh whole milk by the CPI for all nonalcoholic beverages.[12] The ratio of the two CPIs was 0.98 in 1977, 1.03 in 1989, 1.04 in 1994, 1.16 in 2003, and 1.34 in 2007. Values greater than one indicate that the cost of fresh whole milk has increased faster than the cost of nonalcoholic beverages in general. However, the inclusion of the price variable in addition to TIME2 through TIME5 did not improve estimation results. The likely reason is that, as compared with data in a typical time series study, the available data showed the food choices of Americans at only a small number of different price levels. Although the USDA dietary surveys pooled for this study collectively span over 30 years, data were available only for the years in which one of the five surveys was administered. Thus, the price variable was excluded from the final model.

Model Specification

How many times per day will an individual consume fluid milk products? The dependent variable FREQUENCY takes on only integer values: zero for nonconsumers, 1 for single occasion consumers, 2 for those who consumed on two occasions, and so on. Econometric models optimized for analyzing this type of data include the Poisson and negative binomial regression models. Greene (1997) provides a technical overview of each. Dong et al. (2000) used these models to study the number of times individuals patronize a restaurant. He et al. (2004) used the negative binomial model to analyze the number of times people consume beef, poultry, and seafood. In this study, ERS researchers assumed that the number of times a person drinks fluid milk could be approximated by the outcome of a Poisson distribution. By this model, the predicted value (conditional mean) of FREQUENCY is $\lambda = e^{\beta X}$ where e is the base of the natural logarithm, X is a set of explanatory variables, and β includes the parameters that describe the relationship between the dependent and explanatory variables by their sign (+/-) and magnitude. The researchers included in X a person's income, demographic characteristics, decade of birth, and survey year. Of course, the number of times that a particular individual consumes fluid milk may vary from the predicted value on any given day. The Poisson regression model assumes that the mean and variance of FREQUENCY conditional on X are the same. Both equal λ. However, the closely related negative binomial regression model relaxes this assumption. It instead assumes that FREQUENCY has conditional mean λ and conditional variance $\lambda(1 + (1/\theta)\lambda)$ where $1/\theta$ is an "overdispersion" parameter. Thus, the conditional variance of FREQUENCY may exceed its conditional mean because of either heterogeneity across survey participants or omission from the regression model of demand determinants for which the necessary data do not exist to explicitly create explanatory variables. Researchers who work with count data will commonly

[12]The Bureau of Labor Statistics (BLS) has been publishing a CPI for whole fresh milk since at least the 1970s and a CPI for fresh milk other than whole milk since 1997. The two series have moved together closely. Changes in the two CPIs share a correlation coefficient of 0.98 in the years for which both indices are available.

estimate both a Poisson and negative binomial model. They then select between the two specifications by conducting a test for overdispersion.

The model further adds a second equation to the basic count data model for a survey participant's total daily intake of fluid milk over all consumption occasions. The value of QUANTITY is zero if FREQUENCY equals zero (i.e., for consumers who drank no milk). For other consumers, QUANTITY = αZ, where Z is a set of explanatory variables and α contains the parameters that describe the relationship among the variables. Researchers hypothesized that QUANTITY depends partly on the number of times a person consumed fluid milk. Thus, FREQUENCY is included in Z, along with the demographic characteristics of an individual that may influence portion sizes, such as his or her gender and age. Finally, the four survey date variables are included in Z. If the parameters on TIME2 through TIME5 are found to be negative and increasingly large in magnitude from older to newer surveys, then that would suggest that portion sizes have tended to decrease since the 1970s. Otherwise, it can be concluded that changing portion sizes have not contributed much to the decline in fluid milk consumption shown in figures 1 and 2.

The two-equation model in this study is a triangular system. FREQUENCY is modeled in the first equation and, in turn, helps to determine the value of QUANTITY in the second equation. However, in this type of model, biased estimates of the relationship between FREQUENCY and QUANTITY may result if FREQUENCY is simply included among the other explanatory variables in Z in our second equation.[13] To mitigate this problem, ERS researchers instead included the number of times per day that an individual is predicted to consume fluid milk, $\lambda = e^{\beta X}$, in Z.[14]

The researchers also allowed for the possibility that different factors may influence the food choices of preadolescent children and Americans age 13 and older. The two-equation model is estimated separately for people in these two age groups. Excluded from the model for preadolescent children are C2 through C14, PREGNANT, and DIETING. C2 through C14 are excluded from this model because it is customary to assume that young children are free of any habits associated with their year of birth (e.g., Mori and Saegusa, 2010); rather, they are still forming the habits that will later define their generation.

Estimation of the model in the present study makes a novel contribution to research on fluid milk consumption and the broader body of research on food demand. In contrast to previous studies of milk demand like Lin et al. (2003) and Davis et al. (2010) that use cross-sectional data, this study instead pools surveys collected over 30 years. Moreover, to the authors' knowledge, this study represents the first application of count models to pooled survey data for testing whether generational change contributes to trends in the consumption of any food commodity. Additional information on the model, including the complete likelihood function, is provided in Appendix II: Model Specification and Estimation.

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[13]Unobservable differences in tastes, dietary knowledge, and medical conditions between individuals could contribute to the error terms in both our equations for FREQUENCY and QUANTITY. That is, these omitted variables could affect both the frequency of consumption and portion sizes. This would then lead to endogeneity bias.

[14]This is an instrumental variable approach.

Estimating the Model and Examining Results

Using data from the pooled USDA food consumption surveys, researchers estimated both the model for preadolescent children and the model for Americans beyond their preadolescent years by weighted maximum likelihood.[15] As a preliminary exercise, the researchers initially estimated only the first equation for FREQUENCY as a standalone model. Poisson and negative binomial specifications were both considered. The researchers then used tests for overdispersion to select between these two specifications. Based on these test results, the researchers selected a Poisson model for preadolescent children and a negative binomial model for teenagers and adults.[16] The complete models, including the second equation for QUANTITY, were then estimated. The standard errors of $\hat{\beta}$ and $\hat{\alpha}$ were calculated using a bootstrap procedure.[17] Lastly, ERS researchers confirmed the robustness of their key results.[18] The results of model estimation are reported in table 3 and table 4. As a supplementary exercise, the researchers used these results to predict how a change in each of the birth year (C2 through C14) and time variables (TIME2 through TIME5) would affect the number of times per day that a person consumes fluid milk products (FREQUENCY).[19] These marginal effects are shown in figures 7 and 8.

Generational Change Contributing to Decreases in Frequency of Consumption

The results confirm that newer generations of Americans are consuming fluid milk products fewer times per day. For adolescents and adults, the marginal effects of the birth year variables represent the expected differences in consumption between a person born before 1930 and one born more recently, all else constant. For example, Americans born in the early 1960s are expected to consume fluid milk on about 1.1 fewer occasions per day at age 20, age 30, and so on than Americans born before 1930 consume at each of these same ages. This marginal effect is calculated using the estimation results for C8 (fig. 7). Moreover, Americans born in the early 1980s

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[15]Sample weights provided by USDA for use with its surveys were incorporated into the estimation.

[16]Consistent with test results for adolescents and adults, ERS researchers noted that the mean of FREQUENCY (0.81) was less than the variance of FREQUENCY (1.01). This was not the case for preadolescent children. FREQUENCY had a mean and variance of 1.65 and 1.43 among survey respondents in this age group, respectively.

[17]Efron and Tibshirani (1998, p. 52) report that 100 replications "gives quite satisfactory results" and "very seldom" are more than 200 replications needed. For this study, ERS researchers used 250 replications. Each replication included 64,192 observations drawn from the original sample with replacement and a probability proportional to the sample weight (Efron and Tibshirani, 1998; Lee and Forthofer, 2006).

[18]For example, ERS checked that the findings on C2 through C14 for adolescents and adults were not driven by any correlation with changes in prices, changes in the availabilities of milk and competing beverages, or changes in other factors correlated with time. This was accomplished by re-estimating the equation for FREQUENCY for adolescents and adults excluding all time variables, TIME2 through TIME5. Estimation results on C2 through C14 were qualitatively unchanged, confirming the robustness of our findings.

[19]ERS estimated these effects for each individual in the sample. They then used the sample weights to calculate the weighted averaged effect across all individuals. See also notes to figures 7 and 8.

Table 3
Frequency and quantity of fluid milk consumption, coefficient estimates for adolescents and adults

	FREQUENCY		QUANTITY	
	Coefficient	Std. Error	Coefficient	Std. Error
Birth year (generation) variables				
C2	-0.31*	0.03		
C3	-0.48*	0.03		
C4	-0.60*	0.03		
C5	-0.64*	0.04		
C6	-0.82*	0.04		
C7	-0.92*	0.04		
C8	-0.90*	0.05		
C9	-1.21*	0.05		
C10	-1.28*	0.06		
C11	-1.30*	0.07		
C12	-1.35*	0.08		
C13	-1.47*	0.09		
C14	-1.42*	0.10		
Time (survey) variables				
TIME2	0.04	0.02	0.05	0.03
TIME3	0.04	0.02	0.04	0.03
TIME4	0.05	0.03	0.27*	0.04
TIME5	0.10*	0.04	0.10	0.04
Income and demographic variables				
ln(INCOME)	-0.03*	0.01	-0.02*	0.01
ln(AGE)	-0.70*	0.04	-0.52*	0.02
ln(HHS)	0.04*	0.01		
MALE	0.05*	0.01	0.39*	0.01
WEEKEND	-0.12*	0.01		
COLLEGE	0.09*	0.01	-0.05*	0.02
PREGNANT	0.44*	0.04	0.39*	0.06
DIETING	-0.04	0.02	-0.07	0.03
BLACK	-0.55*	0.02	-0.14*	0.03
HISPANIC	-0.04	0.02	-0.19*	0.02
Other model parameters				
CONSTANT	3.27*	0.18	3.13*	0.11
$1/\theta$	0.22*	0.01		
λ			0.17*	0.06

* = significant at the 1-percent level

Source: Model estimated by ERS researchers using weighted maximum likelihood, sample weights provided by data in the 1977-78 Nationwide Food Consumption Survey (NFCS), the 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII), the 1994-1996 CSFII, the 2003-04 National Health and Nutrition Examination Survey (NHANES), and the 2007-08 NHANES. Standard error of equation for QUANTITY was 1.2.

are expected to consume fluid milk on about 0.3 occasions less per day than those born in the early 1960s. This finding follows from the estimation result for C8 and C12 and is also depicted in figure 7. Such large decreases in the frequency of consumption between individuals born several decades apart could gradually reduce per capita consumption as successively newer generations slowly replace older generations and account for a steadily larger share of the overall population.

If there were no cohort effect and the other explanatory variables in the model had remained unchanged, American adolescents and adults would have likely maintained the frequency of their fluid milk consumption from the 1970s into the 2000s. This conclusion follows from the marginal effects of TIME2 through TIME5 (fig. 8). As discussed above, these variables are hypothesized to capture the contemporaneous effects of the food marketing system such as the availability of competing beverages. For adolescents and adults, these effects are small and do not tend to increase or decrease in magnitude from the older to more recent USDA food consumption surveys. Once people are past childhood, their food choices seem to be much more influenced by their childhood-formed habits than by changes over their life times in the environment in which their food choices are made.

Table 4

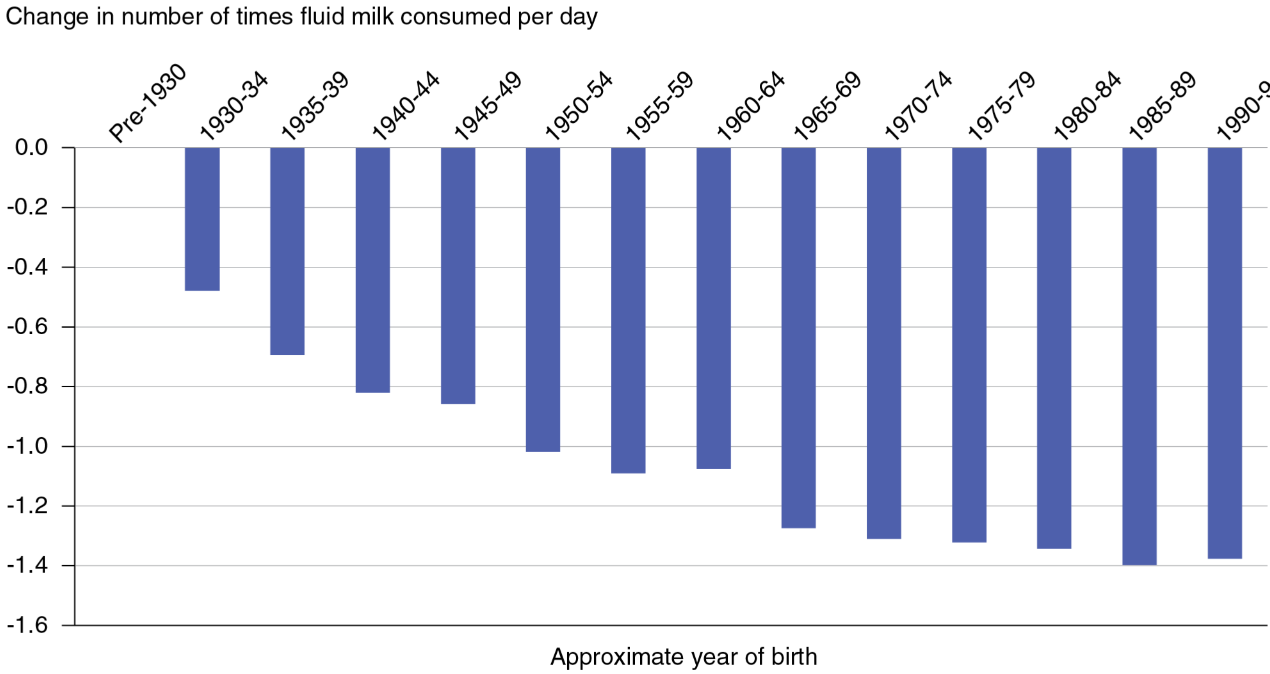
Frequency and quantity of fluid milk consumption, coefficient estimates for preadolescent children

	FREQUENCY		QUANTITY	
	Coefficient	Std. Error	Coefficient	Std. Error
Time (survey) variables				
TIME2	-0.10*	0.02	0.00	0.04
TIME3	-0.16*	0.02	-0.10*	0.04
TIME4	-0.19*	0.03	0.03	0.05
TIME5	-0.25*	0.02	-0.22*	0.05
Income and Demographic variables				
ln(INCOME)	-0.04*	0.01	-0.02	0.01
ln(AGE)	-0.19*	0.01	0.18*	0.03
ln(HHS)	0.02	0.03		
MALE	0.05*	0.01	0.19*	0.02
WEEKEND	-0.22*	0.02		
COLLEGE	0.08*	0.02	0.01	0.03
BLACK	-0.32*	0.02	-0.19*	0.05
HISPANIC	-0.01	0.02	0.06	0.03
Other model parameters				
CONSTANT	1.37*	0.11	1.18*	0.27
λ			0.30*	0.08

* = significant at the 1-percent level

Source: Model estimated by ERS researchers using weighted maximum likelihood, sample weights provided by data in the 1977-78 Nationwide Food Consumption Survey (NFCS), the 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII), the 1994-1996 CSFII, the 2003-04 National Health and Nutrition Examination Survey (NHANES), and the 2007-08 NHANES. Standard error of equation for QUANTITY was 1.12.

Figure 7
Marginal effects of birth cohort on fluid milk consumption, adolescents and adults



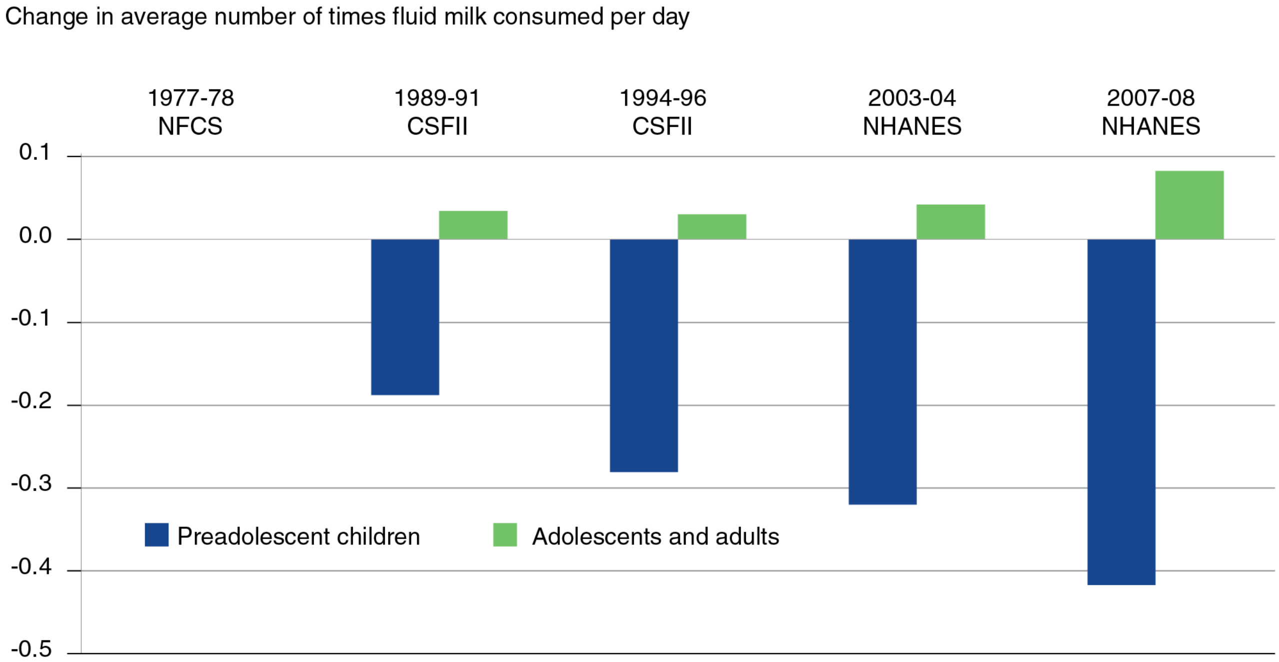
Notes: Estimated model for FREQUENCY used to calculate marginal effects. In the first step, ERS used the estimated model to predict the number of times per day that each adolescent and adult in the sample would have consumed fluid milk, if he or she had been born prior to 1930. All birth year variables, C2 through C14, were set equal to zero for this simulation. In the second step, the researchers re-predicted the value of FREQUENCY for each individual, once for each of 13 alternative scenarios: if the survey participant had instead been born from 1930 to 1934 (only C2 equals one), from 1935 to 1939 (only C3 equals one), and so on. Finally, the first-step results were subtracted from the second-step results. Marginal effects equal the average differences in the predicted value of COUNT, if individuals had been born prior to 1930 versus having been born during each of these subsequent time intervals, weighted by the sample weight. All effects are statistically significant at the 1-percent level.

Source: Marginal effects calculated by ERS researchers. Using standard techniques for nonlinear models, ERS researchers calculated the marginal effects from data in the 1977-78 Nationwide Food Consumption Survey (NFCS), the 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII), the 1994-1996 CSFII, the 2003-04 National Health and Nutrition Examination Survey (NHANES), and the 2007-08 NHANES.

However, changes over time in the food environment—that is, trends in prices, mix of competing products, etc.—appear responsible for reducing children's fluid milk consumption. As also shown in figure 8, these effects are increasingly negative from the older to the newer surveys for preadolescent children. We find that preadolescent children tended to drink milk on 0.28 fewer occasions per day in 1994-96 than did preadolescent children in 1977-78, all else constant. By 2007-08, they were consuming it on 0.42 fewer occasions per day than in 1977-78.

Finally, the estimation results for household income and demographic variables generally agree with past studies. As shown in table 3, Americans drink milk fewer times per day as they age. They also consume it more frequently if at least one head of household has completed college. From these results and the findings of existing studies, it follows that economic and demographic changes in the Nation's population are enhancing or mitigating the declining frequency of fluid milk consumption. For example, more Americans are completing college (Cromartie, 2002). The median age of the U.S. population has also increased from 28.1 years in 1970 to 32.9 years in 1990, and 37.2 years in 2010 (Hobbs and Stoops, 2002; Howden and Meyer, 2011).

Figure 8
Marginal effects of time period on fluid milk consumption, all ages



Notes: Estimated model for FREQUENCY used to calculate marginal effects. In the first step, ERS researchers evaluated the model setting TIME2 through TIME5 equal to zero. In the second step, the researchers re-evaluated the model setting only TIME2 equal to one, then only TIME3 equal to one, and so on. Finally, results from the first and second steps were compared. Marginal effects are the average differences in the expected value of FREQUENCY between the same individuals if they had participated in 1977-78 survey versus each subsequent survey, all else constant, weighted by sample weight. All effects are negative and statistically significant at the 1-percent level for preadolescent children. However, only effects associated with the 2007-08 NHANES are positive and significant at the 1-percent level for adolescents and adults. Those for the other surveys are not significantly different than zero.

Source: Marginal effects calculated by ERS researchers. Using standard techniques for nonlinear models, ERS researchers calculated the marginal effects from data in the 1977-78 Nationwide Food Consumption Survey (NFCS), the 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII), the 1994-1996 CSFII, the 2003-04 National Health and Nutrition Examination Survey (NHANES), and the 2007-08 NHANES.

Portions Remaining Largely Stable

Changes in portions over time appear to contribute little to trends in fluid milk consumption. For both preadolescent children and Americans age 13 and older, estimates of the parameters in the model's second equation reveal a positive relationship between FREQUENCY and QUANTITY. Americans who consume fluid milk on more occasions per day tend to consume a larger quantity overall. However, ERS researchers obtained negative, positive, and zero values for the parameters on TIME2 through TIME5 in the same second equation. Thus, there is no evidence of a trend in quantities consumed after accounting for the other variables in the second equation of the model. This result is consistent with the earlier discussions of figures 4 and 5. It again suggests that portions have changed relatively little and, therefore, that changes over time in QUANTITY reflect primarily changes in FREQUENCY.

Considering the Health Implications of Trends in Milk Consumption

Americans are consuming less fluid milk, on average, because they drink it on fewer occasions per day. In particular, they drink it less often with their midday and nighttime meals. Mitigating the decline are programs supported by dairy farmers, fluid milk processors, and the Federal Government. Kaiser (2010) confirms that promotions sponsored by checkoff programs increase the demand for fluid milk. Gleason and Suitor (2001) similarly identify a positive association between children's participation in the NSLP and their consumption of fluid milk. These programs moderated the decline in U.S. per capita fluid milk consumption between the 1970s and the 2000s. However, because greater decreases in consumption frequency are observed among more recent generations of Americans, it may be difficult to reverse ongoing consumption trends. Indeed, holding all other factors constant, the gradual replacement in the population of older generations by newer generations will exert downward pressure on Americans' average consumption of fluid milk.

Sustained decreases in per capita fluid milk consumption would work against efforts to raise Americans' overall dairy consumption to recommended levels. To date, Americans have merely maintained their total intake of dairy products by consuming more Cheddar cheese and more mozzarella cheese (USDA-ERS, 2013a). However, the Nation's population would be closer to satisfying dairy recommendations in the *Dietary Guidelines for Americans, 2010* if Americans were still drinking as much fluid milk as they did in the 1970s, in addition to the amounts of other dairy products they now consume.[20] Additionally, cheese products can contain as many or more calories than fluid milk. On a per cup-equivalent basis,[21] regular Cheddar cheese (171 calories) has more calories than a glass of whole milk (149 calories). Whole-fat mozzarella (128 calories) has slightly more calories than 2 percent milk (122 calories). Part-skim mozzarella (108 calories) has slightly more calories than 1 percent milk (102 calories) and somewhat more than skim milk (86 calories).

Nutrition and health policy researchers have warned of the potential health implications of declining fluid milk consumption (e.g., Cavadini et al. 2000; Popkin 2010). If fluid milk consumption continues to decline in response to cohort effects, then raising Americans' dairy intakes and improving overall diet quality would require substantially greater increases in the consumption of non-fluid products in skim and low-fat form. Maintaining a focus on children may also be key to mitigating or halting the downward trend in fluid milk consumption, because habit formation implies that childhood food choices can affect longrun behavior.

[20]ERS food availability data show that Americans consume 1.53 cup-equivalents of dairy products, on average, including 0.61 cup-equivalents of fluid milk (USDA-ERS, 2013a). Thus, raising fluid milk consumption to 0.96 cup-equivalents per person, as in the early 1970s, would raise the per capita total to about 2 cup-equivalents. As noted above, The *Dietary Guidelines for Americans, 2010* recommends 2 cup-equivalents per day for children aged 2 to 3 years, 2.5 for those aged 4 to 8 years, and 3 for Americans older than age 8.

[21]Consuming 8 ounces of fluid milk, 1.5 ounces of Cheddar cheese, or 1.5 ounces of mozzarella cheese all count equally toward an individual's consumption of dairy products. Each is considered to be 1 cup-equivalent. Each is also available in higher and lower fat forms. ERS researchers used the USDA National Nutrient Database for Standard Reference, Release 25 (USDA, Agricultural Research Service, 2013b) to compare the number of calories in selected forms of these foods' per cup-equivalents.

References

Bowman, S., S. Gortmaker, C. Ebbeling, M. Pereira, and D. Ludwig. 2004. "Effects of Fast-Food Consumption on Energy Intake and Diet Quality Among Children in a National Household Survey," *Pediatrics*, Vol. 113: pp. 112-118.

Cavadini C., A. Siega-Riz, and B. Popkin. 2000. "U.S. adolescent food intake trends from 1965 to 1996," *Archives of Disease in Childhood*, Vol. 83: pp. 18–24.

Conway J., L. Ingwersen, and A. Moshfegh. 2004. "Accuracy of Dietary Recall Using the USDA Five-Step Multiple-Pass Method in Men: An Observational Validation Study," *Journal of the American Dietetic Association*, Vol. 104: pp. 595-603.

Cromartie J. 2002. "Population Growth and Demographic Change, 1980-2020," *FoodReview,* Vol. 25(1): pp. 10-12. Available at http://www.ers.usda.gov/publications/FoodReview/May2002/DBGen.htm.

Davis C., D. Dong, D. Blayney, and A. Owens. 2010. *An Analysis of U.S. Household Dairy Demand*, TB-1928, U.S. Department of Agriculture, Economic Research Service. Available at http://www.ers.usda.gov/publications/tb1928/tb1928.pdf .

Deaton A. 1997. *The Analysis of Household Surveys: A Microeconometric Approach to Development Policy*. Baltimore: The Johns Hopkins University Press.

Dong D., P. Byrne, A. Saha, and O. Capps. 2000. "Determinants of Food-Away-From-Home (FAFH) Visit Frequency: A Count-Data Approach," *Journal of Restaurant & Foodservice Marketing*, Vol. 4(1): pp. 31-46.

Efron B., and R. Tibshirani. 1998. *An Introduction to the Bootstrap*. New York: Chapman & Hall.

Enns C., J. Goldman, and A. Cook. 1997. "Trends in Food and Nutrient Intakes by Adults: NFCS 1977-78, CSFII 1989-91, and CSFII 1994-95," *Family Economics and Nutrition Review*, Vol. 10(4): pp. 2-15.

Fisher J., D. Mitchell, H. Smiciklas-Wright, and L. Birch. 2001. "Maternal Milk Consumption Predicts the Tradeoff Between Milk and Soft Drinks in Young Girls' Diets," *Journal of Nutrition,* Vol. 131(2): pp. 246-250.

Gleason P., and C. Suitor. 2001. *Children's Diets in the Mid-1990s: Dietary Intake and Its Relationship with School Meal Participation*, Special Nutrition Programs Report No. CN-01-CD1, U.S. Department of Agriculture, Food and Nutrition Service. Available at http://www.fns.usda.gov/ora/menu/published/CNP/FILES/ChilDiet.pdf

Greene W. 1997. *Econometric Analysis*, 3rd ed., New Jersey: Prentice Hall.

He S., S. Fletcher, and A. Rimal. 2004. "Identifying Factors Influencing Beef, Poultry, and Seafood Consumption," *Journal of Food Distribution Research*, Vol. 34(1): pp. 50-55.

Hobbs F., and N. Stoops. 2002. *Demographic Trends in the 20th Century*, Census 2000 Special Reports, Series CENSR-4, U.S. Department of Commerce, Census Bureau. Available at http://www.census.gov/prod/2002pubs/censr-4.pdf

Howden L., and J. Meyer. 2011. *Age and Sex Composition: 2010*, C2010BR-03, U.S. Department of Commerce, Census Bureau. Available at http://www.census.gov/prod/cen2010/briefs/c2010br-03.pdf

Johnson W. 1980. "Vintage Effects in the Earnings of White American Men," *The Review of Economics and Statistics*, Vol. 62(3): pp. 399-407.

Kaiser H. 2010. *Measuring the Impacts of Generic Fluid Milk and Dairy Marketing*, Research Bulletin 2010-01, Cornell University, National Institute for Commodity Promotion & Research Evaluation. Available at http://dyson.cornell.edu/research/researchpdf/rb/2010/Cornell_Dyson_rb1001.pdf.

Kaiser, H., and D. Dong. 2006. *Measuring the Impacts of Generic Fluid Milk and Dairy Marketing*, Research Bulletin 2006-05, Cornell University, National Institute for Commodity Promotion & Research Evaluation. Available at http://commodity.dyson.cornell.edu/nicpre/bulletins/rb0605/rb2006_05.pdf

Lee, E., and R. Forthofer. 2006. *Analyzing Complex Survey Data*, 2nd. ed. Thousand Oaks, California: Sage Publications.

Lin B-H, J. Variyam, J. Allshouse, and J. Cromartie. 2003. *Food and Agricultural Commodity Consumption in the United States: Looking Ahead to 2020*, AER-820, U.S. Department of Agriculture, Economic Research Service. Available at http://www.ers.usda.gov/Publications/AER820/ .

Mannino M., Y. Lee, D. Mitchell, H. Smiciklas-Wright, and L. Birch. 2004. "The Quality of Girls' Diets Declines and Tracks Across Middle Childhood," *International Journal of Behavioral Nutrition and Physical Activity,* Vol. 1(5).

Mori H., D. Clason, and J. Lillywhite. 2006. "Estimating Price and Income Elasticities in the Presence of Age-Cohort Effects," *Agribusiness: An International Journal*, Vol. 22(2): pp. 201-217.

Mori H., and Y. Saegusa. 2010. "Cohort Effects in Food Consumption: What They Are and How They Are Formed," *Evolutionary and Institutional Economics Review*, Vol. 7(1): pp. 43–63.

Mori, H., and H. Stewart. 2011. "Cohort Analysis: Ability to Predict Future Consumption – The Cases of Fresh Fruit in Japan and Rice in Korea," *The Annual Bulletin of Social Science*, Vol. 45: pp. 153-173.

Moshfegh A., D. Rhodes, D. Baer, T. Murayi, J. Clemens, W. Rumpler, D. Paul, R. Sebastian, K. Kuczynski, L. Ingwersen, R. Staples, and L. Cleveland. 2008. "The US Department of Agriculture Automated Multiple-Pass Method Reduces Bias in the Collection of Energy Intakes," *American Journal of Clinical Nutrition*, Vol. 88: pp. 324-32.

National Dairy Promotion and Research Board. 2013. Dairy Checkoff Programs. Available at http://www.dairycheckoff.com

Popkin, B. 2010. "Patterns of Beverage Use Across the Lifecycle," *Physiology & Behavior* Vol. 100(1): pp. 4-9.

Schrimper, R. 1979. "Demographic Changes and the Demand for Food: Discussion," *American Journal of Agricultural Economics* 61(5): pp. 1058-60.

Sebastian, R., J. Goldman, C. Enns, and R. LaComb. 2010. "Fluid Milk Consumption in the United States: What We Eat In America, NHANES 2005-2006." 2010. Food Surveys Research Group Dietary Data Brief. No. 3, U.S. Department of Agriculture, Agricultural Research Service. Available at http://ars.usda.gov/SP2UserFiles/Place/12355000/pdf/DBrief/fluid_milk_0506.pdf

Stewart, H., D. Dong, and A. Carlson. 2012. "Is generational change contributing to the decline in fluid milk consumption?" *Journal of Agricultural and Resource Economics* Vol. 37(3): pp. 435-54.

Stewart H., and N. Blisard. 2008. "Are Younger Cohorts Demanding Less Fresh Vegetables?" *Review of Agricultural Economics*, Vol. 30(1): pp. 43-60.

Tippett K., and Y. Cypel. 1997. *Design and Operation: The Continuing Survey of Food Intakes by Individuals and the Diet and Health Knowledge Survey, 1994–96*, NFS Report No. 96-1, U.S. Department of Agriculture, Agricultural Research Service. Available at http://www.ars.usda.gov/sp2userfiles/place/12355000/pdf/Dor9496.pdf.

U.S. Department of Agriculture, Agricultural Research Service. 2013a. *Food and Nutrient Database for Dietary Studies*. Available at http://www.ars.usda.gov/Services/docs.htm?docid=12089

U.S. Department of Agriculture, Agricultural Research Service. 2013b. *National Nutrient Database for Standard Reference* (Release 25). Available at http://www.ars.usda.gov/.

U.S. Department of Agriculture, Agricultural Research Service. 2013c. USDA Food Surveys, 1935-1998. Available at http://www.ars.usda.gov/Services/docs.htm?docid=14392 .

U.S. Department of Agriculture, Agricultural Research Service. 2013d. What We Eat in America. Available at http://www.ars.usda.gov/Services/docs.htm?docid=13793.

U.S. Department of Agriculture, Economic Research Service. 2013a. Loss-Adjusted Food Availability. Available at http://www.ers.usda.gov/Data/FoodConsumption/FoodGuideIndex.htm/.

U.S. Department of Agriculture, Economic Research Service. 2013b. Food Availability (Per Capita) Data System. Available at http://www.ers.usda.gov/Data/FoodConsumption/

U.S. Department of Agriculture and U.S. Department of Health and Human Services. 2010. *Dietary Guidelines for Americans, 2010* 7th ed. Washington, DC, December. Available at http://www.cnpp.usda.gov/dietaryguidelines.htm

Appendix I: Comparing Consumption Across Different USDA Dietary Intake Surveys

USDA has been surveying individuals about their dietary intake for several decades. A history of these surveys is available online.[22] The 1977-78 Nationwide Food Consumption Survey (NFCS) was USDA's first survey to be administered nationwide, to cover all four seasons of the year, and to record the food and beverage intakes of a large number of individuals. Subsequent surveys include the 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII) and the 1994-1996 CSFII. In 2002, the dietary recall portion of the CSFII was integrated with the National Health and Nutrition Examination Survey (NHANES), which is administered by the U.S. Department of Health and Human Services (DHHS). USDA and DHHS now release the results of their integrated survey every 2 years. All of these USDA surveys are nationally representative when analyzed using sample weights.

Pooling food consumption surveys collected intermittently over time is complicated by changes in USDA's survey methodology. For example, in the 1977-78 NFCS and the 1989-91 CSFII, USDA interviewed individuals to complete a 1-day dietary recall for the previous day.[23] Participants then self-reported their own intakes over the subsequent two days (a 2-day diary). By contrast, starting with the 1994-96 CSFII, USDA has interviewed individuals twice to obtain two 1-day dietary recalls for nonconsecutive days. The NHANES continues to collect multiple 1-day dietary recalls as did the 1994-96 CSFII.

USDA has been consistently administering 1-day dietary recalls for more than 30 years, notwithstanding other changes in survey methodology. It is, therefore, possible to study long-run trends in the American diet by pooling data from only that component of different surveys. Enns et al. (1997) used the 1977-78 NFCS and both CSFIIs to study food consumption trends between the late 1970s and the late 1990s. Cavadini et al. (2000) used these same surveys to focus on dietary trends among American adolescents. Both studies used only the day 1 dietary recall collected shortly after the start of each survey. "This method avoids the biasing of intake results that may occur because of the different dietary data collection methods used ..." (Cavadini et al., 2000, p. 18-19).

USDA has also been improving its protocol for dietary recall interviews since the initial surveys. Research conducted after the 1989-91 CSFII confirmed that survey participants were having difficulty recalling all the foods and beverages consumed the previous day. To aid their memory and reduce the potential for underreporting food intakes, USDA developed a "multiple-pass" protocol. Beginning with the 1994-96 CSFII, interviewers first instructed participants to report all foods and beverages consumed the previous day from midnight to midnight. Then, in a second pass, they asked questions about food items that participants may commonly forget (including, for example, milk on cereal). Finally, in a third pass, interviewers asked

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[22]See USDA, Agricultural Research Service (2013c, 2013d).

[23]In the 1977-78 NFCS, USDA also collected information on household food use over a 1-week period. In the 1989-91 CSFII, USDA ceased to collect household food use data and concentrated exclusively on the diets of individuals.

questions about eating occasions that survey participants commonly forget. For example, they would ask questions like "Did you nibble or sip on anything while preparing a meal or while waiting to eat that you haven't already told me about?" (see, for example, Tippett and Cypel, 1997). After the merger of the CSFII and NHANES surveys, USDA's three-step methodology was extended to five steps. Studies continue to evaluate the accuracy of dietary recall data collected using the latest multiple-pass protocol (e.g., Conway et al., 2004; Moshfegh et al., 2008).

Because of the introduction of USDA's multiple-pass protocol, it is possible that participants in earlier surveys were more likely to underreport fluid milk consumption than participants in later surveys, though the size of any bias remains unknown. However, figures 1 and 2 reveal that estimates of per capita fluid milk consumption reported in ERS loss-adjusted food availability data are similar to estimates of per capita consumption based on the five USDA food consumption surveys for Americans of all ages. For example, both sources report that Americans, on average, consumed about 1 cup of fluid milk per day in 1977-78 and about 0.7 cups per day in 2007-08. ERS researchers, therefore, expect that any bias in reported consumption of fluid milk due to the evolution of USDA's multiple-pass protocol is small.

In the current study, ERS researchers focused on fluid milk consumption by participants in USDA surveys over 24 hours. As noted in the text, the researchers included both plain and flavored products consumed alone as a beverage, put in cereal, poured in coffee, or used as an ingredient in selected coffee drinks. USDA dietary records report fluid milk consumption in grams. These quantities were converted into fluid ounces (8 fluid ounces = 1 cup). Quantities of milk consumption were converted from weight to volume by using the USDA National Nutrient Database for Standard Reference, Release 25 (USDA, Agricultural Research Service, 2013b). One 8-ounce cup weighs about 244 grams. The final data set includes information on 64,192 individuals excluding people who failed to provide a reliable day 1 dietary recall, did not provide complete household income or demographic information, or were young children and still breast-feeding.

Appendix II: Model Specification and Estimation

The Poisson and negative binomial regression models are widely used to analyze count data. In this study, ERS researchers investigated the number of times per day that a person consumes fluid milk (FREQUENCY) and tested whether generational change is contributing to long-run trends in that number. ERS researchers also augmented the basic count data model with a second equation that predicts a survey participant's overall intake of fluid milk (QUANTITY). The goal in adding this second equation was to confirm or refute the possibility that changes in portions sizes are also contributing to trends in fluid milk consumption.

The primary dependent variable in our study, FREQUENCY, can only equal zero or a positive integer value. The probability that it equals a particular value, 0,1,2,3,...,∞, using the negative binomial regression model, is:

$$f(\text{FREQUENCY}|X) = \frac{\Gamma(\text{FREQUENCY}+\theta)}{\Gamma(1+\text{FREQUENCY})\Gamma(\theta)}\left(\frac{\theta}{\theta+\lambda}\right)^{\theta}\left(\frac{\lambda}{\theta+\lambda}\right)^{\text{FREQUENCY}}$$

where $\lambda = e^{\beta X}$ is the conditional mean of FREQUENCY, X is a set of explanatory variables, β is a vector of parameters, e is the base of the natural logarithm, $\Gamma(\cdot)$ is the gamma function, and $1/\theta$ is the overdispersion parameter. As discussed in the text, if there is no overdispersion, then θ approaches infinity, the conditional mean and variance of FREQUENCY become equal, and the negative binomial and Poisson regression models become identical.

Among survey participants who consumed fluid milk on zero occasions, both FREQUENCY and QUANTITY equal zero. This occurs with probability

$$P(\text{FREQUENCY}=0) = \frac{\Gamma(\theta)}{\Gamma(1)\Gamma(\theta)}\left(\frac{\theta}{\theta+\lambda}\right)^{\theta}.$$

For other survey participants, FREQUENCY and QUANTITY are outcomes of the two variables' joint probability distribution:

$$h(\text{FREQUENCY},\text{QUANTITY}|X,Z) = g(\text{QUANTITY}|\,Z)\cdot f(\text{FREQUENCY}|X)$$

where f(FREQUENCY|X) is above and g(QUANTITY| Z) is the distribution of QUANTITY conditional on Z. We assume that

$$g(\text{QUANTITY}|\,Z) = \frac{1}{\sqrt{2\pi}\sigma}e^{-\frac{1}{2}\left(\frac{\text{QUANTITY}-\alpha Z}{\sigma}\right)^{2}}$$

where α is a vector of parameters, e is the base of the natural logarithm, and Z is a set of explanatory variables. That is, we assume $g(\cdot)$ is a normal distribution with mean αZ and variance σ^2. As discussed in the text, we include FREQUENCY among the variables in Z, but use $\lambda=e^{\beta X}$ for estimation purposes to reduce the potential for endogeneity bias.

Participants in USDA food consumption surveys must belong to one of two regimes. As noted above, if an individual reported consuming no fluid milk, then both FREQUENCY and QUANTITY equal zero. The contribution to the likelihood function of these individuals follows from the probability of this event as shown above:

$$L1(\beta) = \frac{\Gamma(\theta)}{\Gamma(1)\Gamma(\theta)}\left(\frac{\theta}{\theta+\lambda}\right)^{\theta}.$$

For survey participants who consumed fluid milk one or more times, the contribution to the likelihood function is

$$L2(\alpha,\beta) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{1}{2}\left(\frac{QUANTITY-\alpha Z}{\sigma}\right)^2} \frac{\Gamma(FREQUENCY+\ \theta)}{\Gamma(1+FREQUENCY)\Gamma(\theta)}\left(\frac{\theta}{\theta+\lambda}\right)^{\theta}\left(\frac{\lambda}{\theta+\lambda}\right)^{FREQUENCY}$$

Finally, the weighted likelihood function for the full sample of i=1,…,N individuals is :

$$L(\alpha,\beta) = \prod_{i=1}^{N} L_i^{w_i}$$

where w_i is the sample weight for individual i, L_i equals L1 if $FREQUENCY_i = 0$, and L_i equals L2 if $FREQUENCY_i > 0$. Estimates of model parameters α and β can be obtained by maximizing the weighted log-likelihood,

$$\ln L(\alpha,\beta) = \sum_{i=1}^{N} w_i \ln L_i \,.$$