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Consumer Food Safety Practices: Raw Milk Consumption and Food Thermometer Use

M. Taylor Rhodes, Fred Kuchler, Ket McClelland,
and Karen S. Hamrick





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Abstract

Providing consumers with recommendations on specific food safety practices may be a cost-effective policy option, acting either as a complement to or substitute for additional food safety regulations on food suppliers, but it would require a detailed understanding of consumer food safety practices. Using data from the 2014 to 2016 American Time Use Survey–Eating and Health Module, we examine two food safety practices in which Government health and safety officials, as well as the broader food safety community, have offered unequivocal advice: meal preparers should always use a thermometer to verify that meat has reached a recommended temperature and consumers should avoid raw (unpasteurized) milk. We found that 2 percent of at-home meal preparers in the United States served raw milk during a typical week; of which 80 percent lived with two or more people, 44 percent were married, 36 percent lived with one or more children, and 28 percent lived with at least one person age 62 or older, indicating the potential that at-risk populations are consuming raw milk. While preparing meals with meat, poultry, or seafood, 14 percent of at-home meal preparers in the United States used a food thermometer. Meal preparers who use a food thermometer typically earned more, reported better physical health, were more likely to exercise, were more likely married, and had larger and younger households. Last, rates of food thermometer usage were higher for at-home meal preparers whose occupation was food-preparation related, suggesting food safety training or awareness at work may influence food safety behavior at home.

Keywords: food safety, risks of foodborne illness, nonpasteurized milk, raw milk, food thermometer use, at-home meals, food at home, consumer food safety practices, meal preparation, eating patterns, food intake, American Time Use Survey, Eating and Health Module.

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Consumer Food Safety Practices: Raw Milk Consumption and Food Thermometer Use

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What Is the Issue?

Consumers make choices that influence food safety risks, and providing them with recommendations on specific practices that reduce these risks could complement or substitute for additional Federal regulations and be a cost-effective tool for reducing the incidence of foodborne illness, provided consumers follow the advice. To better understand current food safety behaviors of consumers, this report examines the food safety practices of at-home meal preparers in the United States by investigating two recommendations of Government health and safety officials, as well as the broader food safety community: avoiding the consumption of raw (unpasteurized) milk and cooking meat to a verified recommended temperature using a food thermometer.

What Did the Study Find?

From 2014 to 2016, the American Time Use Survey–Eating and Health Module (ATUS-EHM) posed questions to respondents regarding these safeguards: Was raw (unpasteurized) milk consumed or served in the previous 7 days? Was a food or meat thermometer used when preparing any meals with meat, poultry, or seafood in the previous 7 days? Using their responses, we estimate the prevalence of raw milk and thermometer use as well as the number of people at possible risk of foodborne illnesses on a typical or weekly basis.

- Each week, an estimated 2 percent of at-home meal preparers, or 3.2 million people (1.3 percent of the U.S. population age 18 or over) consumed or served raw milk.
- Of at-home meal preparers that consumed or served raw milk, 80 percent or 2.6 million people lived with at least 1 other person; 44 percent or 1.4 million had a spouse; 36 percent or 1.1 million lived with at least 1 child; and 28 percent or 0.9 million lived in a household with at least 1 person age 62 or older.
- Each week, an estimated 14 percent of at-home meal preparers, or 19.5 million people (7.9 percent of the U.S. population age 18 or over) used a food thermometer when preparing meals with meat, poultry, or seafood.
- Of at-home meal preparers who used a food thermometer, 87 percent or 17 million lived with at least 1 other person; 65 percent or 12.6 million had a spouse; 39 percent or 7.5 million lived with at least 1 child; and 30 percent or 5.8 million lived in a household with at least 1 person age 62 or older.

- On average, at-home meal preparers who used food thermometers earned more than non-users, reported better physical health, were more likely to exercise, were more likely married, and had larger households compared to those who did not use food thermometers.
- At-home meal preparers whose occupation is related to food preparation were more likely to use a food thermometer, suggesting a potential link between mandatory on-the-job food safety training and food safety behavior at home.

How Was the Study Conducted?

The estimates of at-home meal preparers in the United States were calculated based on responses to the 2014 to 2016 ATUS-EHM, which is uniquely suited for describing food safety behaviors of at-home meal preparers. The ATUS-EHM provides information to determine if a survey respondent was the usual at-home meal preparer. Additional responses can be used to describe at-home meal preparer food safety practices in the previous 7 days regarding their use of raw milk and food thermometers while preparing any meals featuring meat, poultry, or seafood. Since the ATUS-EHM is linked with the Current Population Survey (CPS), regional, economic, demographic, and health characteristics—as well as household size/ composition and occupation of at-home meal preparers—can be examined. Last, our results were weighted, following the Bureau of Labor Statistics’ (BLS) guidelines, to produce estimates with greater precision, ensure the findings are a nationally representative analysis of at-home meal preparers in the United States, and account for the survey’s complex design.

Consumer Food Safety Practices: Raw Milk Consumption and Food Thermometer Use

Introduction

Foodborne illness is costly, with an estimated per-illness burden of \$3,700 (Minor et al., 2015) and an estimated national cost of \$15.5 billion per year (Hoffmann et al., 2015). These costs are often avoidable by following simple low-average-cost practices, including hand-washing, avoiding cross-contamination of cooking surfaces, cooking foods to verified temperatures that inactivate pathogens, refrigerating and freezing foods at recommended temperatures, and avoiding high-risk foods. To increase public awareness of these practices, Government health and safety officials, as well as the broader food safety community, advise consumers on safely handling and preparing food at home to avoid foodborne illness.¹ Conceivably, advising consumers to take additional preventative action to reduce food safety risks may be a cost-effective policy option, as a complement to or substitute for some additional food safety regulations on food suppliers. However, accurately forecasting the risk-reducing effectiveness of providing additional advice to consumers requires a detailed understanding of the current and typical food safety behaviors by consumers, which is an area of ongoing research.

Using the American Time Use Survey–Eating and Health Module (ATUS-EHM), a nationally administered and nationally representative survey, we investigate the food safety behavior of at-home meal preparers in the United States. Government health and safety officials, as well as the broader food safety community, have offered unequivocal advice: avoid raw (unpasteurized) milk and cook meat using a thermometer to verify that it has reached a safe temperature. From 2014 to 2016, the ATUS-EHM contained questions central to these cases: was raw (unpasteurized) milk consumed or served in the previous 7 days; and was a food or meat thermometer used when preparing any meals with meat, poultry, or seafood in the previous 7 days. Using these responses, we estimate the prevalence of raw milk and thermometer use as well as the number of people at possible risk on a weekly basis. These estimates contribute toward a better understanding of the possible exposure to foodborne pathogens by at-home meal preparers and at-risk populations, including children and the elderly.

Specifically, we use responses to the ATUS-EHM by at-home meal preparers to estimate raw milk use in the United States during a typical week.² For at-home meal preparers who used raw milk, regional, economic, demographic, and health characteristics are examined. Since the food safety risks taken by an at-home meal preparer may unknowingly or involuntarily expose other members

¹ As a recent example, the *Check Your Steps* campaign at Foodsafety.gov recommends meal preparers follow four steps to avoid food poisoning: Clean (wash hands and surfaces), Separate (avoid cross-contamination), Cook (use a food thermometer), and Chill (refrigerate perishable foods promptly).

² Using data from the 2006-08 ATUS-EHM, Hamrick (2016), Hamrick et al. (2016), and Hamrick et al. (2011) examined a variety of time-use behaviors based on responses to activities in the past 24 hours and, in turn, provided estimates on behavior for an average day. Similarly, we examined questions on food safety activities in the past 7 days and, consequently, present estimates of food safety behavior during a typical week.

in the household to a higher risk of foodborne illness, raw milk use in households with more than one person and with at-risk populations, including young children and the elderly, are explored (CDC, 2018; Committee on Infectious Diseases and Committee on Nutrition, 2014). Afterward, statistical differences are examined between at-home meal preparers who used raw milk and those who did not.

Similarly, we use additional survey responses by at-home meal preparers to estimate food thermometer use in the United States during a typical week. Characteristics of at-home meal preparers who used food thermometers are described. Afterward, notable statistical differences are examined between at-home meal preparers who used food thermometers and those who did not.

Last, given the specific temperature and monitoring requirements faced by restaurants for most of the activities associated with preparing and serving food, we explore whether thermometer use at home by at-home meal preparers was influenced by their occupation in food-service related industries.

Views From the Public Health Community

On Raw Milk:

In the United States from 1973 to 2012, researchers at the Centers for Disease Control and Prevention (CDC) attributed at least 169 outbreaks to consumption of raw (unpasteurized) milk, commonly referred to as raw milk, resulting in at least 3,642 illnesses (Headrick et al., 1998; Langer et al., 2012; and Mungai et al., 2015).³ From 1993 to 2012, outbreaks attributed to consumption of raw milk resulted in at least 144 hospitalizations (Langer et al., 2012; and Mungai et al., 2015). The most frequent cause of illness was *Campylobacter* spp. (Headrick et al., 1998; Langer et al., 2012; Mungai et al., 2015)—a pathogen that can cause diarrhea, abdominal pain, and fever (Peterson, 1994), with symptoms lasting from 2 to 5 days (Awofisayo-Okuyelu et al., 2017), and possible, more serious chronic complications including reactive arthritis and Guillain-Barre syndrome (Abubakar et al., 2007). Consuming unpasteurized dairy products (milk and cheese), relative to consuming pasteurized dairy products, is 839 times more likely to cause a foodborne illness and 45 times more likely to result in hospitalization (Costard et al., 2017).

The U.S. Food and Drug Administration (FDA) states that pasteurization is necessary to produce a safe product. Without pasteurization, even the best dairy management practices, such as following a Hazard Analysis and Critical Control Point (HACCP) system, do not make raw milk safe to drink. Additionally, the CDC warns that even healthy animals raised in sanitary and humane conditions can still carry harmful bacteria, including *Brucella*, *Campylobacter*, *Cryptosporidium*, *E. coli* (STEC), *Listeria*, and *Salmonella* (Centers for Disease Control and Prevention, 2017). The severity of human illness can range from diarrhea, stomach cramping, and vomiting to kidney failure, paralysis, and death.

Pasteurization is a process of heating milk at or above specific temperatures for a short period of time to kill dangerous bacteria and pathogens. The process is required for interstate shipments of all milk and milk products intended for direct human consumption, with specific temperatures and durations specified by the Code of Federal Regulations (CFR). In properly designed and operated equipment, every particle of milk and milk product must be heated according to one of the following temperatures and corresponding durations: at or above 145°F for at least 30 minutes, 161°F for at least 15 seconds, 191°F for at least 1 second, 194°F for at least 0.5 second, 201°F for at least 0.1 second, 204°F for at least 0.05 second, or 212°F for at least 0.01 second (21 C.F.R. Part 1240.61(b)).

Despite the health concerns and the inexpensiveness of pasteurization as a preventive solution, the number of States that permit the sale of raw milk from cows, sheep, or goats for human consumption has increased. From 1993 to 2006, raw milk could be legally purchased in 25 States (Langer et al., 2012), and by 2012, the number of those States grew to 30 (Mungai et al., 2015). As of 2016,

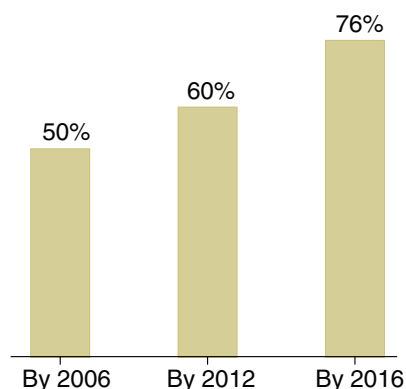
³ According to the CDC, “When two or more people get the same illness from the same contaminated food or drink, the event is called a foodborne outbreak. Illnesses that are not part of outbreaks are called ‘sporadic.’ Public health officials investigate outbreaks to control them, so more people do not get sick in the outbreak, and to learn how to prevent similar outbreaks from happening in the future” (Centers for Disease Control and Prevention, 2015).

raw milk can be legally purchased in retail stores in 13 States, on farms or via cow-share agreements⁴ in 25 States, but is not legal for human consumption in 12 States (fig. 1).

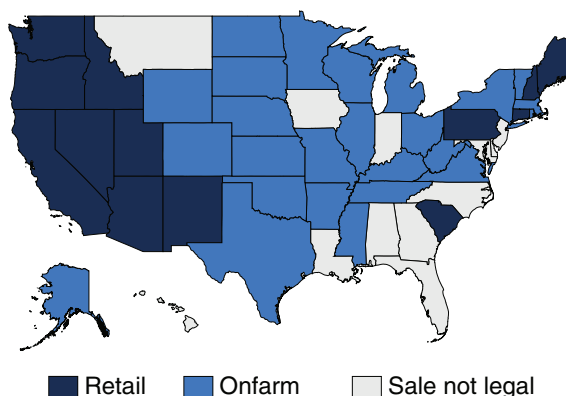
Figure 1

Legal status of raw milk in the United States as of 2016

A) Percent of States with legal access to raw milk over time



B) Legal access to raw milk by State



Notes: By 2006, raw milk could be legally purchased in 25 States; by 2012, the number of States increased to 30 States; and, by 2016, it increased to 38 States. As of 2016, raw milk from cows, goats, or sheep for human consumption could be legally purchased in retail stores in 13 States (*Retail*), on farms or via cow-share agreements in 25 States (*Onfarm*), and was not legal for human consumption in 12 States (*Sale not legal*).

Sources:

- (a) Langer, A., Ayers, T., Grass, J., Lynch, M., Angulo, F. & B. Mahon. (2012). "Nonpasteurized Dairy Products, Disease Outbreaks, and State Laws— United States, 1993–2006." *Emerging Infectious Diseases*, 18(3): 285–391.
- (b) Mungai, E., Behraves, C., & H. Gould. (2015). "Increased outbreaks associated with nonpasteurized milk, United States, 2007–2012." *Emerging Infectious Diseases*, 21(1): 119–122.
- (c) *Raw Milk Laws State-by-State*, Available online.
- (d) *State Milk Laws*, National Conference of State Legislatures (NCLS), Available online.
- (e) *NCLS Summary of Raw Milk Statutes and Administrative Codes*, National Conference of State Legislatures (NCLS), Available online.

While the sale of raw milk across State lines by producers remains illegal,⁵ consumers may legally purchase and transport it across State lines for personal or family consumption (David, 2012). The prevalence of this practice may be non-trivial. Buzby et al. (2013) found that 45 percent of raw milk drinkers lived in States where the sale of raw milk is illegal.⁶ From 1973 to 1992, 12 percent of outbreaks from raw, nonpasteurized milk occurred in States where the sale of raw milk is illegal

⁴ A cow-share agreement is a contract between a consumer and a dairy farmer in which the consumer purchases a share of a cow's milk production. This practice has been argued to be a work-around to existing restrictions on the sale of raw milk, see *Schmitmeyer v. Ohio Dept of Agric.* Dec. 29, 2006. No. 06-CV-63277. Ohio Ct. Com. Pl.

⁵ Since 1987, the sale of raw milk across State lines has been prohibited. The CFR states:

"No person shall cause to be delivered into interstate commerce or shall sell, otherwise distribute, or hold for sale or other distribution after shipment in interstate commerce any milk or milk product in final package form for direct human consumption unless the product has been pasteurized or is made from dairy ingredients (milk or milk products) that have all been pasteurized, except where alternative procedures to pasteurization are provided for by regulation, such as in part 133 of this chapter for curing of certain cheese varieties" (21 C.F.R. Part 1240.61(a)).

⁶ However in some years of their sample, raw milk could be purchased via cow shares.

(Headrick et al., 1998), increased to 21 percent from 1993 to 2006 (Langer et al., 2012), and remained at nearly 20 percent from 2007 to 2012 (Mungai et al., 2015).

The FDA and the CDC provide warnings and detailed assessments on raw milk and unequivocally advise to avoid it. In FoodFacts, the FDA states that raw milk can carry harmful bacteria, such as *Salmonella*, *E. coli*, and *Listeria*, and warns that failing to pasteurize milk can pose serious health risks, particularly for people with weakened immune system, older adults, pregnant women, and children (FoodFacts, August 2012). The FDA lists raw milk and cream, soft cheeses from raw milk, and other products derived from raw milk as unsafe to eat. It highlights the dangers of *Listeria* to pregnant women, specifically that *Listeria* can cause a miscarriage, fetal death, or infect or kill a newborn. It states pasteurization kills harmful bacteria and saves lives; pasteurization does not cause lactose intolerance or reduce milk's nutritional value.

In a review of the literature, the FDA examined 14 claims relevant to raw milk consumption that ranged from raw milk as a cure to lactose intolerance to the nutritional superiority and safety of raw milk relative to pasteurized milk. The FDA concluded that there is no merit in the positive health and safety claims made for raw milk consumption. Raw milk does not cure lactose intolerance, asthma, or allergies.⁷ It is not more effective in preventing osteoporosis, nor is it nutritionally superior to pasteurized milk.⁸ It is not an immune system-building food and there are no beneficial bacteria in raw milk for gastrointestinal health. It does not contain natural antimicrobial components that make milk safe, nor does it contain nisin for pathogen inhibition.⁹ It causes a greater rate of foodborne outbreaks than pasteurized milk and is particularly unsafe for children (U.S. Food and Drug Administration, 2011).

On Food Thermometer Use:

Government health and safety officials, as well as the broader food safety community, offer guidance on reducing the likelihood of foodborne illness. USDA's Food Safety and Inspection Service (FSIS), the FDA, and the CDC provide information on the importance of cleaning—washing hands and food preparation surfaces often; minimizing cross contamination—maintaining separate cutting boards and plates for produce and for meat, poultry, seafood, and egg dishes, as well as storing the two groups of foods separately; cooking foods to recommended temperatures; and refrigerating perishable foods promptly (see, for example, FoodSafety.gov, no date).

Advice to consumers may range from general approaches to specific actions. For example, thawing meat may be safely and slowly done in refrigerators, faster in cold water, and also in microwave ovens. In contrast, there are fixed temperature recommendations for cooking red meats, poultry, fin fish, casseroles, leftovers, and egg dishes. Meat is considered safe when cooked until its internal

⁷ A meta-analysis conducted by MacDonald et al. (2011) found evidence of an association between fewer allergy sensitivities and children raised on farms, but judged the specific causal factors examined in various studies as speculative. They found no research support for an association between raw milk consumption and reduced risk of cancer and found no significant association between raw milk consumption and lactose intolerance.

⁸ A literature review by Claeys et al. (2013) found nothing to support an association between raw milk and osteoporosis or arthritis, stating that heat treatments of milk fail to alter the bioavailability of calcium. They found that the effect of pasteurization on milk has on vitamins B5, B6, B7, B12, A, D, and E is small to negligible, and pasteurization does not significantly affect the bioavailability of calcium.

⁹ Nisin is an antibacterial protein that can kill or inhibit the growth of undesirable bacteria in food (Cleveland et al., 2001).

temperature reaches the thermometer-verified value officials recommend, while meat that is cooked without use of a thermometer-verified internal temperature, regardless of the color of the meat, is not safe (FoodSafety.gov, no date).¹⁰

Food thermometers are recommended for preparation of raw meat to verify that food is adequately cooked and pathogens are destroyed. *E. coli* O157:H7 is a pathogenic bacterium that has emerged as an important cause of both bloody diarrhea and hemolytic uremic syndrome (HUS)—the most common cause of acute renal failure in children. From 1982 to 2002, there were 350 outbreaks from *E. coli* O157:H7, resulting in 1,493 hospitalizations, 354 HUS cases, and 40 deaths (Rangel et al., 2005). From 2002 to 2012, the number of outbreaks from *E. coli* O157:H7 was 390 with 1,272 hospitalizations, 209 HUS cases, and 25 deaths (Heiman et al., 2015). The most common transmission source was food, and the most common known food source was either beef or ground beef (Rangel et al., 2005; Heiman et al., 2015).

Notably, the 1992-1993 outbreak in Western States resulted in hundreds of illnesses and four children's deaths (CDC, 1993), which prompted public health officials to take a closer look at the definition of “undercooked.” Public health officials first recommended cooking hamburgers until they were “well done” (Altekruse et al., 1996), and FDA's temperature recommendations were revised upward in 1998.¹¹ Heiman et al. (2015) concludes by recommending proper handling of raw beef and cooking to internal temperatures of at least 160°F.

Notable Research Findings:

Previous estimates of raw milk use include studies by Costard et al. (2017), Buzby et al. (2013), and Lando et al. (2016). Using responses to FoodNet (FN), a survey implemented in 10 States, which asked about the consumption of unpasteurized milk in the past 7 days, Costard et al. (2017) and Buzby et al. (2013) report that about 3 percent of the population consumed raw milk. Lando et al. (2016), using the 7th wave of the Food Safety Survey (FSS) sponsored by FDA and FSIS and designed to be nationally representative, found 4 percent of adults consumed raw milk in the previous 12 months, and of those, 32 percent consumed raw milk more than a few times per month.¹²

Several studies have surveyed consumers and estimated the extent to which they use food thermometers to verify cooking temperatures. These include smaller studies (Phang and Bruhn, 2011; McCurdy et al., 2006; Anderson et al., 2004) as well as results by Lando et al. (2016) from the nationally representative FSS. Lando et al. (2016) found that 67 percent of households owned a food

¹⁰ Temperature requirements are not the same for all foods. Poultry, including ground chicken and ground turkey, along with leftovers and casseroles, require a temperature of 165°F. Ground beef, pork, veal, and lamb, along with egg dishes, require 160°F. Steaks, roasts, chops, and fresh pork are all required to reach 145°F and have a 3-minute rest time before serving, during which the meat remains at the final temperature, after it has been removed from a grill, oven, or other heat source. During the 3 minutes after meat is removed from the heat source, its temperature remains constant or continues to rise, which destroys harmful bacteria (USDA, 2011).

¹¹ Ralston et al. (2001) noted that, in 1997, FSIS recommended that consumers cook hamburgers to 160°F—verified with a thermometer—and recommendations by CDC and FDA followed in 1998.

¹² In the 2003-2004 and 2005-2006 rounds of the National Health and Nutrition Examination Survey, respondents were asked what types of milk they usually consumed and what types of milk they usually added to cereal. Proportions answering raw, unpasteurized milk were less than 1 percent.

thermometer, and they asked how often those who owned thermometers use them for various types of meat.¹³

The ATUS-EHM is a nationally administered and nationally representative survey that allows analysts to examine the food safety behavior of at-home meal preparers—the people in a household who make decisions about food choices and food preparation. While the ATUS-EHM contains only two food safety questions, the survey facilitates the analysis of demographic, income, education, physical health, household size, and occupation characteristics for at-home meal preparers because of a data link between the ATUS and CPS. The survey’s sample size is larger than that of the FSS, and its data focus on respondents’ past 7 days, whereas FSS data focus on the previous year.

While our study does not examine food safety practices in response to specific education outreach efforts, several studies have examined what influences consumer food safety behavior. Young and Waddell’s (2016) meta-analysis of studies on what encourages safe food handling among consumers concluded that new knowledge alone is unlikely to motivate consumers to make improvements in their food safety behavior. However, improvements are relatively more likely to be made when children are present in a household and when information sources are credible, like healthcare professionals. Ralston et al. (2001) focused on the role of consumer preferences in food safety behavior, finding that consumer preference for hamburger doneness was more strongly associated with behavior than knowledge of the risks of undercooked ground beef.

¹³ The highest percentage of thermometer owners reported always using the thermometer for roasts (38 percent), with lower percentages for chicken parts (19 percent) and hamburgers (10 percent).

Data and Methods

To compare and contrast the suggested practices and food safety warnings by public health officials to the actual practices by consumers, we use nationally representative data on at-home meal preparers from the 2014 to 2016 ATUS-EHM.¹⁴ From 2014 to 2016, the ATUS-EHM contained two important questions central to analyzing food safety and meal preparation of at-home meal preparers in the United States: one on consuming or serving raw (unpasteurized) milk and another on the usage of food thermometers when preparing any meals with meat, poultry, or seafood.

Specifically, the 2014 to 2016 ATUS-EHM asked, “Are you the person who usually prepares the meals in your household?” Respondents who answered “yes” or “split it equally with other household member(s)” were then asked whether they had consumed or served raw (unpasteurized) milk in the previous 7 days. They were also asked whether they had prepared any meals with meat, poultry, or seafood in the previous 7 days. Those who answered “yes” were asked if they used a food or meat thermometer when preparing any of those meals. For simplicity, we refer to both usual meal preparers and those who split the task as at-home *meal preparers*. We refer to the act of consuming or serving raw (unpasteurized) milk in the previous 7 days as *raw milk use*.¹⁵ Finally, we refer to the use of a food or meat thermometer as *food thermometer use*.¹⁶

Using weighted counts and proportions, we estimate the prevalence of raw milk use by at-home meal preparers in the United States during a typical week based on the survey responses. We also examine regional, economic, demographic, and health characteristics of at-home meal preparers who use raw milk, along with their household size and composition.¹⁷ Afterward, statistical differences between at-home meal preparers who use raw milk versus those who did not are explored.

Similarly, survey responses on food thermometer use for meals with meat, poultry, or seafood in the previous 7 days are used to estimate the prevalence of food thermometer use by at-home meal preparers in the United States during a typical week. Regional, economic, demographic, and health characteristics of at-home meal preparers who use food thermometers, along with their household size and composition, are also examined.¹⁸ Afterward, statistical differences between at-home meal preparers who use food thermometers versus those who did not are explored.

¹⁴ See Zeballos and Restrepo (2018) for a comprehensive set of findings from the entire history of the ATUS-EHM (2006-08 and 2014-16). They present national statistics on eating and health patterns for the adult population as a whole and for a wide variety of important demographic subgroups, along with changes over time. Responses to the food safety questions are examined in detail in this paper.

¹⁵ While the ATUS-EHM does not ask about the quantity or per-meal frequency of raw milk consumption within the household, it does provide a nationally representative description of households that, at a minimum, have some members who are consuming raw milk.

¹⁶ Complete respondent counts to each question are provided in table A1 of the appendix, which also contains supplemental results to all presented figures and tables.

¹⁷ When examining raw milk use, the specific variables analyzed were selected on the basis that they were reportable, meaning in compliance with BLS suppression rules for the EHM, described standard demographic characteristics of at-home meal preparers and their household, and offered some insight into at-risk populations, like children or the elderly.

¹⁸ When examining thermometer use, the variables analyzed were selected on the basis that they mirrored those analyzed for raw milk use, were reportable, described standard demographic characteristics of at-home meal preparers and their household, and offered some insight into at-risk populations, like children or the elderly.

Results

Prevalence of Raw Milk Use and Characteristics of Raw Milk Users:

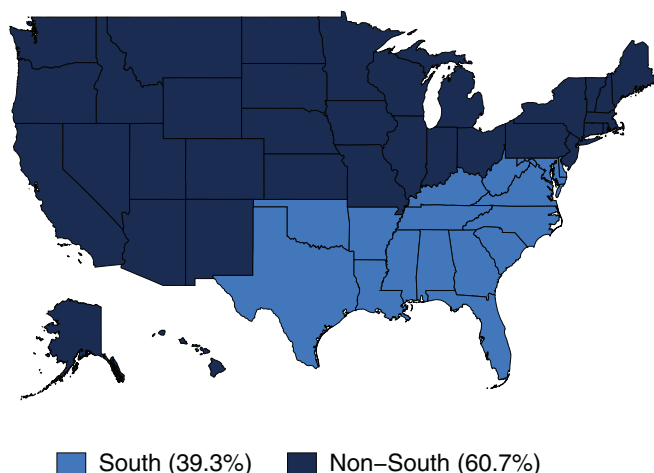
To understand current food safety behaviors and the number of people possibly exposed to food-borne pathogens by the choices made by at-home meal preparers, we estimate the prevalence of raw milk use by at-home meal preparers and examine regional, economic, demographic, and health characteristics of at-home meal preparers who use raw milk, along with their household size and composition, including the presence of children or the elderly.

From 2014 to 2016, an estimated 161 million people, or 65 percent of the U.S. population age 18 or over, were at-home meal preparers. During a typical week, nearly 2 percent of at-home meal preparers (3.2 million people) use raw milk. By region, 61 percent of at-home meal preparers who use raw milk reside in non-Southern States.¹⁹ By legal access, 28 percent live in States where retail sale of raw milk for human consumption is legal; 48 percent live in States where raw milk sales for human consumption are limited to onfarm sales, farmers markets, or cow-sharing agreements; and, 24 percent live in States where the sale of raw milk for human consumption is not legal (fig. 2).

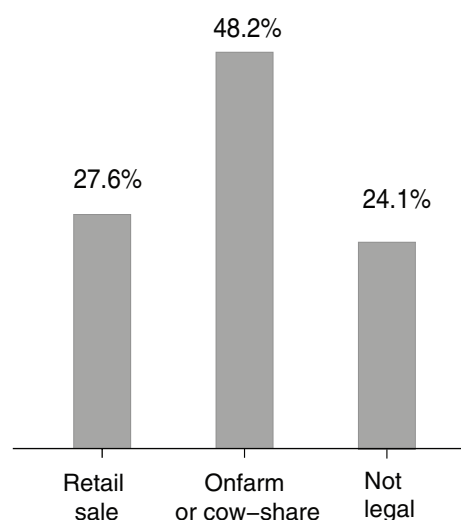
Figure 2

Raw milk use for at-home meal preparers by geographic location and legal accessibility

A) Region:



B) Access:



Notes: Raw milk use by geographic region (*Region*) and by the legal accessibility of raw milk for human consumption (*Access*) as of 2016.

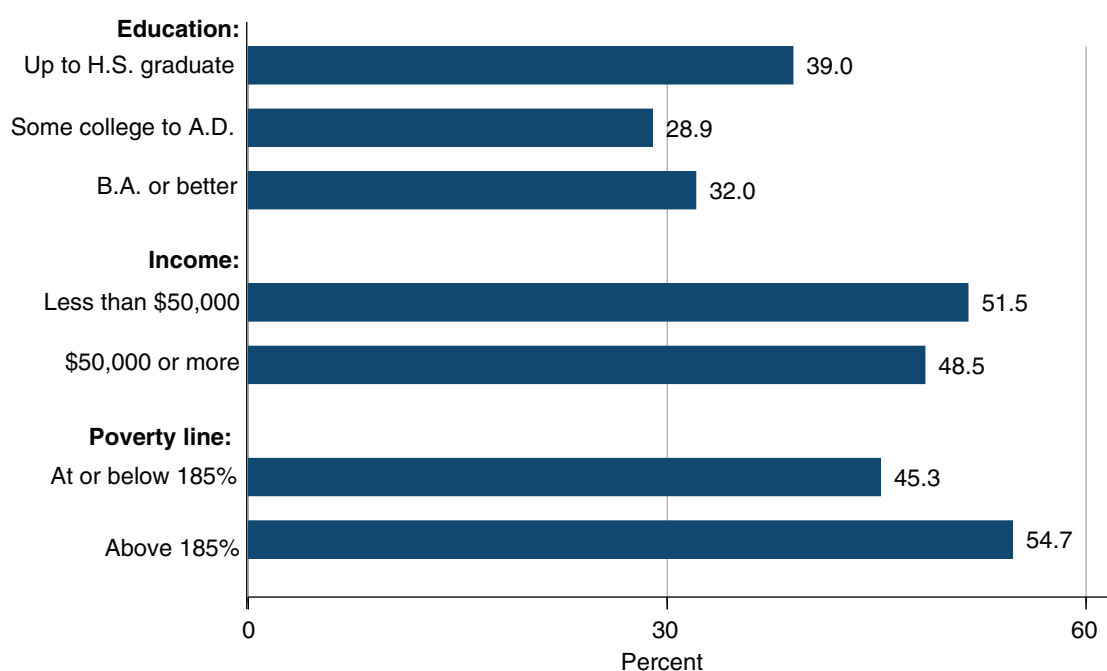
Source: USDA, Economic Research Service using pooled 2014–2016 data from the American Time Use Survey–Eating and Health Module.

¹⁹ South is defined by the Census Region Code, containing Alabama, Arkansas, District of Columbia, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

For at-home meal preparers who use raw milk, 39 percent have up to a high school degree; 29 percent have some college experience or an associate's degree; and, 32 percent have at least a bachelor's degree. In households that use raw milk, 52 percent earned less than \$50,000 in total household earnings during the last 12 months and about 48 percent earned \$50,000 or more. In the previous month, 55 percent have a pre-tax total household income level in excess of 185 percent of the Federal poverty level, corrected for household size (fig. 3).²⁰

Figure 3

Education and income for at-home meal preparers who use raw milk



Notes: Raw milk use by respondent's education level (*Education*), the combined income of all family members during the last 12 months (*Income*), and the previous month's total household income before taxes being above or below 185 percent of the U.S. Poverty Income Guidelines (*Poverty line*). H.S. = high school diploma; A.D. = associate's degree; B.A. = bachelor's degree.

Source: USDA, Economic Research Service using pooled 2014–2016 data from the American Time Use Survey–Eating and Health Module.

For general health, 44 percent of at-home meal preparers who use raw milk believe their physical health is either poor, fair, or good, and the remainder ranks their physical health as very good or excellent. Sixty-eight percent have a body mass index of at least 25.²¹ In a typical week, 36 percent do not exercise for fitness and health²² or participate in physical activities; and nearly 60 percent

²⁰ The incomes of 185 percent and 130 percent of the poverty threshold determine income eligibility for USDA food assistance programs, including the Supplemental Nutrition Assistance Program (SNAP), Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), National School Lunch Program, and School Breakfast Program, and many other Federal programs (U.S. Department of Health and Human Services, 2012).

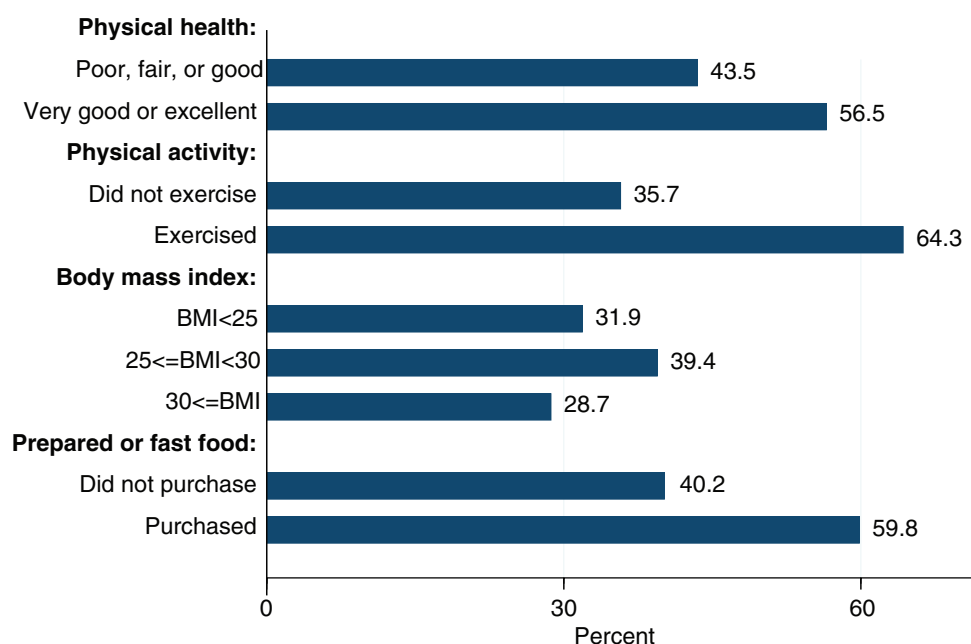
²¹ Body mass index (BMI) is a person's weight in kilograms divided by the square of height in meters. For adults, a BMI less than 25 defines the normal weight range; a BMI greater than 25 but less than 30 defines the overweight range; and a BMI of at least 30 defines the obese range (Centers for Disease Control and Prevention, 2016).

²² In the ATUS-EHM, exercising for fitness and health includes running, bicycling, working out in a gym, walking for exercise, or playing sports.

purchased prepared food from a deli, carry-out, delivery food, or fast food in the previous week (fig. 4).

Figure 4

Health and activity for at-home meal preparers who use raw milk



Notes: Raw milk use by respondent's assessment of physical health (*Physical health*), respondent's participation in physical activities or exercises for fitness and health during the past 7 days (*Physical activity*), respondent's body mass index (*Body mass index*), and respondent's purchase of any prepared, delivered, or fast food in the past 7 days (*Prepared or fast food*).

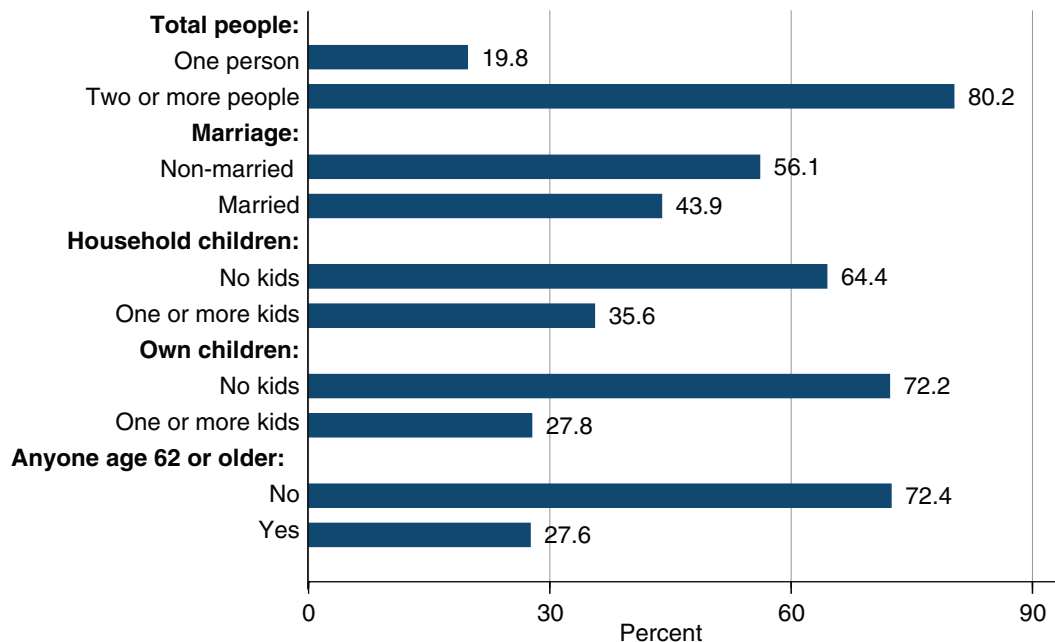
Source: USDA, Economic Research Service using pooled 2014–2016 data from the American Time Use Survey–Eating and Health Module.

Over 80 percent of at-home meal preparers (2.6 million people) who use raw milk live with at least 1 other person. Approximately 44 percent of at-home meal preparers (nearly 1.4 million people) who use raw milk are married. Of the at-home meal preparers who use raw milk, 36 percent (1.1 million people) have at least 1 child residing in the household. These children are under the age of 18 and may or may not be related to the meal preparer (i.e., the respondent). Further, 28 percent (0.9 million people) have at least 1 own child (which includes biological and step- or adopted children but not foster children) who resides in the meal preparer's home or in another home. Last, 28 percent of at-home meal preparers who use raw milk (0.9 million people) have at least 1 person in the household age 62 years or older (fig. 5).²³

²³ The age of 62 was selected to ensure the finding was reportable.

Figure 5

Household size for households that use raw milk



Notes: Raw milk use by total number of persons in the household (*Total people*), respondent's present marital status (*Marriage*), the total number of household children under 18 years of age (*Household children*), the total number of own children under 18 years of age (*Own children*), and if any person in the household is age 62 years or older (*Anyone age 62 or older*).

Source: USDA, Economic Research Service using pooled 2014–2016 data from the American Time Use Survey–Eating and Health Module.

Statistical Differences Between Raw Milk Users and Non-Users:

To understand how current raw milk use may be related to differences in characteristics of at-home meal preparers and their household, we examine the statistical differences between those who use raw milk and those who do not. Comparing observable characteristics across those households indicated some statistically significant differences. In the previous month, monthly total household income before taxes was more likely to be less than 185 percent of the poverty line for households that use raw milk relative to households that do not use raw milk. Additionally, a larger proportion of households that use raw milk are non-married and do not have someone in the household older than 62 years (Table 1).

Table 1

Statistical differences in raw milk use

	Used raw milk (1)	Did not use raw milk (2)
	<i>Percent</i>	<i>Percent</i>
Raw milk use:	2.0	98.0
Poverty line:		
Above 185%	54.7	63.0
At or below 185%	45.3	37.0
Marriage:		
Married	43.9	52.6
Non-married	56.1	47.4
Anyone age 62+:		
Yes	27.6	32.5
No	72.4	67.5

Notes: The columns examine differences in the proportion of raw milk use for at-home meal preparers (*Raw milk use*); and differences in the proportion of the previous month's total household income before taxes being above or below 185 percent of the U.S. Poverty Income Guidelines (*Poverty line*), marriage status (*Marriage*), and if any person in the household is age 62 years or older (*Anyone age 62+*) for households where the at-home meal preparer used raw milk versus who did not. P-values examining the difference in the reported proportions were all less than .10, indicating statistically significant differences.

Source: USDA, Economic Research Service using pooled 2014-2016 data from the American Time Use Survey—Eating and Health Module.

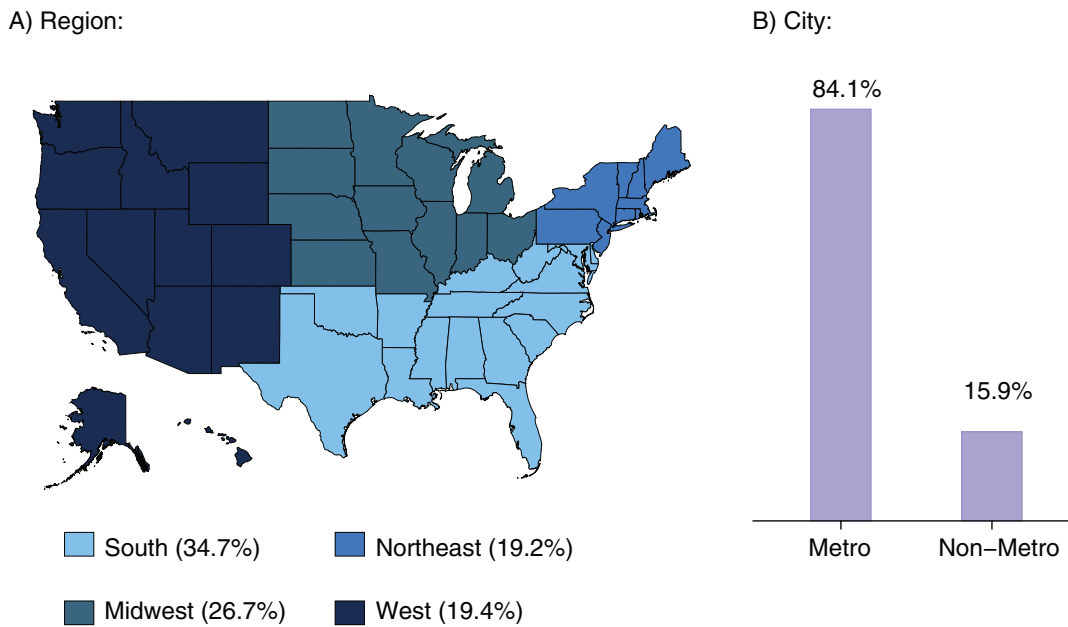
Because of the few statistical differences, it appears that the demographic characteristics for raw milk and non-raw milk at-home meal preparers are similar. This may suggest that raw milk consumers may be similar in observable demographic characteristics to pasteurized milk consumers. Alternatively, the lack of significant differences may reflect the limited statistical power from a relatively small sample size of raw milk users (431 respondents) in contrast with a large sample size of non-raw milk users (22,600).

Prevalence of Food Thermometer Use and Characteristics of Food Thermometer Users:

To understand current food preparation practices and the number of people possibly exposed to foodborne pathogens, we estimate the prevalence of food thermometer use by at-home meal preparers and examine regional, economic, demographic, and health characteristics of at-home meal preparers who use food thermometers, along with their household size and composition, including the presence of children or the elderly.

While an estimated 67 percent of adults have a food thermometer (Lando et al., 2016), 14 percent of at-home meal preparers (almost 19.5 million people) use a food thermometer during a typical week. By region, 35 percent of at-home meal preparers who use a food thermometer reside in the South, 27 percent reside in the Midwest, and about 19 percent reside in each of the West and Northeast regions. Regardless of geographic region, about 84 percent of at-home meal preparers who use a food thermometer live in metropolitan areas (fig. 6).

Figure 6
Location of at-home meal preparers who use food thermometers



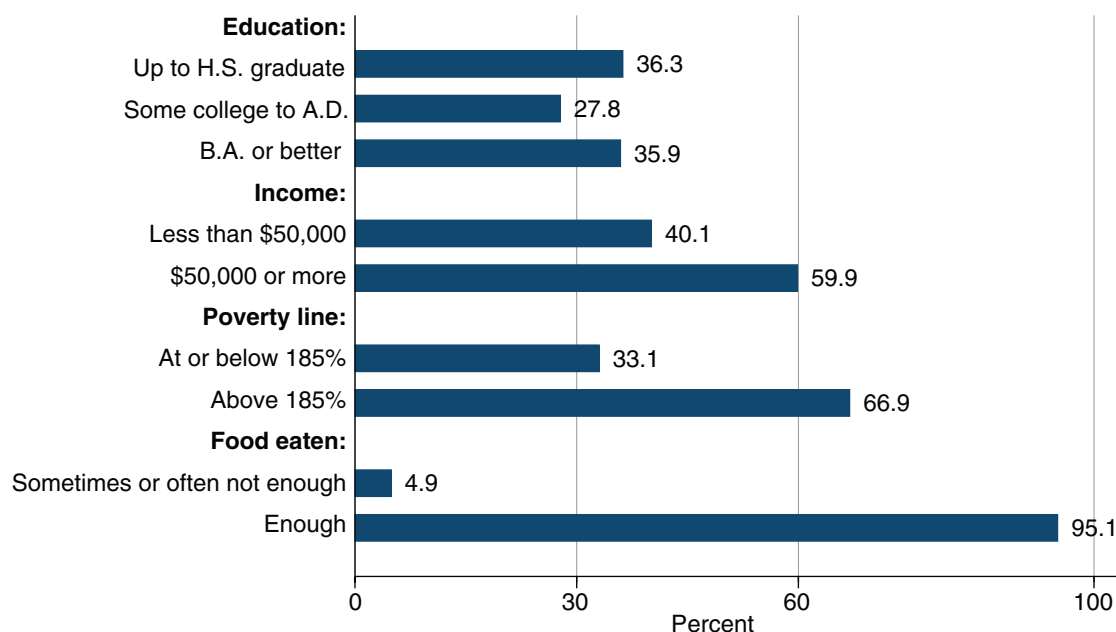
Notes: Food thermometer use by geographic region (*Region*) and by metropolitan status (*City*).

Source: USDA, Economic Research Service using pooled 2014–2016 data from the American Time Use Survey–Eating and Health Module.

For at-home meal preparers in households that use food thermometers, 36 percent have up to a high school diploma; 28 percent have some college experience or an associate’s degree; and nearly 36 percent have at least a bachelor’s degree. For total household earnings, 40 percent earned less than \$50,000 during the last 12 months, and about 60 percent earned \$50,000 or more. In the previous month, 67 percent have a monthly, pre-tax total household income level in excess of 185 percent of the Federal poverty level, and 95 percent report having enough food to eat in the past month (fig. 7).

Figure 7

Education and income for at-home meal preparers who use food thermometers



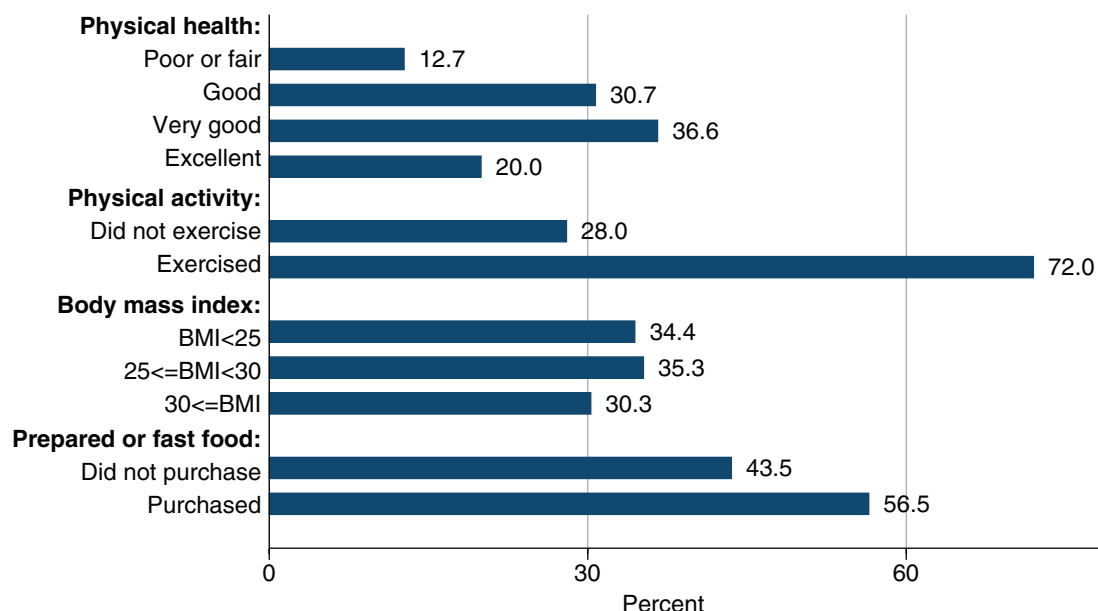
Notes: Food thermometer use by respondent's education level (*Education*), the combined income of all family members during the last 12 months (*Income*), the previous month's total household income before taxes being above or below 185 percent of the U.S. Poverty Income Guidelines (*Poverty line*), and the respondent's assessment on the amount of food eaten in the household in the past 30 days (*Food eaten*). H.S. = high school diploma; A.D. = associate's degree; B.A. = bachelor's degree.

Source: USDA, Economic Research Service using pooled 2014–2016 data from the American Time Use Survey – Eating and Health Module.

For general health, 43 percent of at-home meal preparers who use food thermometers believe their physical health is either poor, fair, or good, and 66 percent have a body mass index of at least 25. In a typical week, 28 percent do not exercise for fitness and health or participate in non-job-related physical activities, and nearly 57 percent purchased prepared food from a deli, carry-out, delivery food, or fast food in the past 7 days (fig. 8).

Figure 8

Health and prepared food purchases for at-home meal preparers who use food thermometers

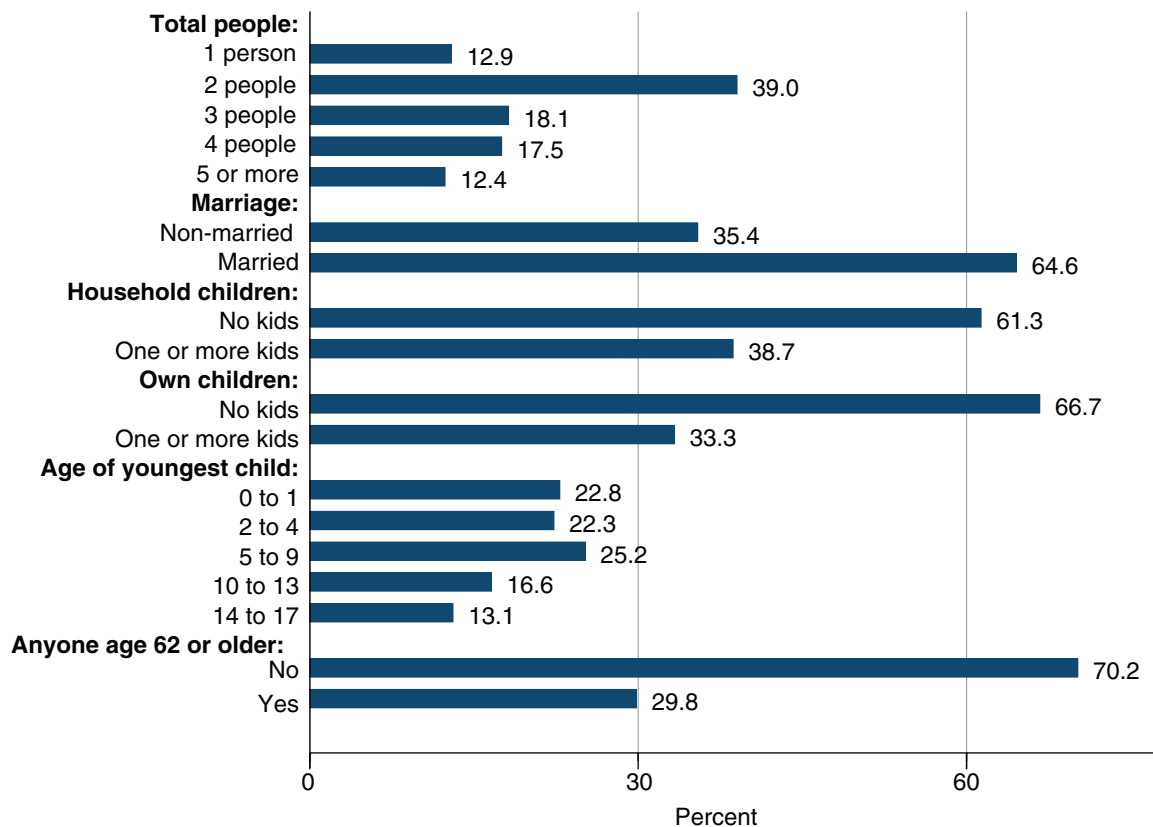


Notes: Food thermometer use by respondent's assessment of physical health (*Physical health*), respondent's participation in physical activities or exercises for fitness and health during the past 7 days (*Physical activity*), respondent's body mass index (*Body mass index*), and respondent's purchase of any prepared, delivered, or fast food in the past 7 days (*Prepared or fast food*).

Source: USDA, Economic Research Service using pooled 2014–2016 data from the American Time Use Survey–Eating and Health Module.

Nearly 87 percent of at-home meal preparers (17 million people) who use food thermometers live with at least 1 other person; 39 percent (7.6 million people) live with 1 other person, 18 percent (3.5 million people) live with 2 other people, about 18 percent (3.4 million people) live with 3 other people, and 12 percent (2.4 million people) live with at least 4 other people (fig. 9).

Figure 9

Household size for households that use food thermometers

Notes: Food thermometer use by total number of persons in the household (*Total people*), respondent's present marital status (*Marriage*), the total number of household children under 18 years of age (*Household children*), the total number of own children under 18 years of age (*Own children*), age of the youngest child in the household under 18 years of age (*Age of youngest child*), and if any person in the household is age 62 years or older (*Anyone age 62 or older*).

Source: USDA, Economic Research Service using pooled 2014–2016 data from the American Time Use Survey–Eating and Health Module.

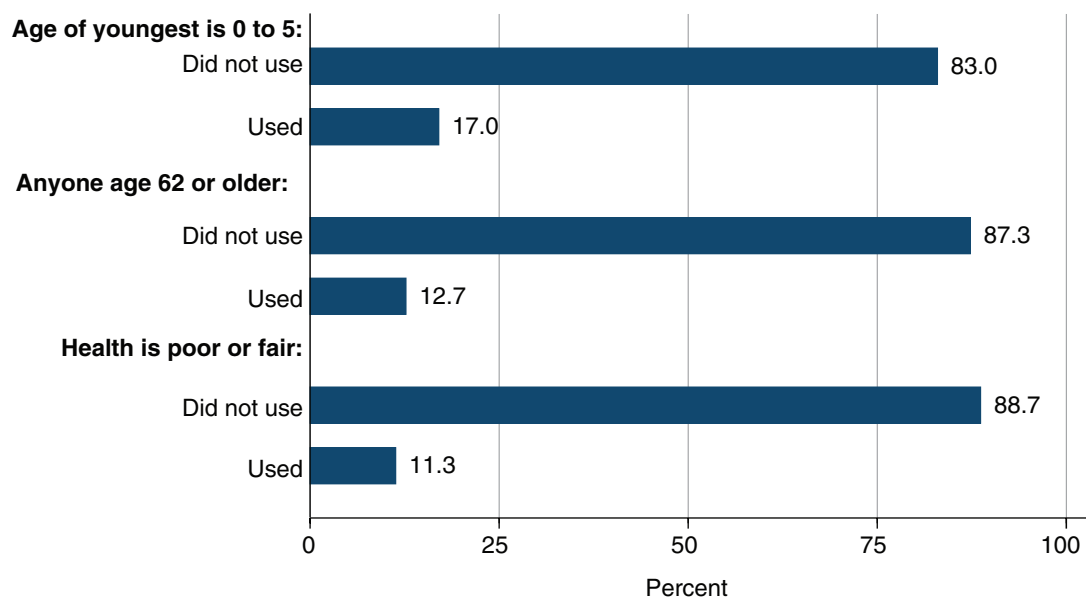
Of the at-home meal preparers who use food thermometers, 65 percent (12.6 million people) are married; 33 percent (6.5 million people) have at least one own child (which includes biological and step- or adopted children but not foster children) who resides in the meal preparer's home or in another home; and 39 percent (7.5 million people) have at least one child residing in the household who is under the age of 18 who may or may not be related to the meal preparer (i.e., the respondent). By children's age, 23 percent have a youngest child between the ages of 0 and 1; 22 percent have a youngest child between the ages of 2 and 4; 25 percent have a youngest child between the ages of 5 and 9; and 30 percent have a youngest child between the ages of 10 and 17. Last, nearly 30 percent of at-home meal preparers who use food thermometers (5.8 million people) have at least 1 person in the household age 62 years or older.

For the population of at-home meal preparers with a youngest child between the ages of 0 and 5 years old, 17 percent use a food thermometer (higher than the national average of 14 percent). For the population of at-home meal preparers in households with at least one person age 62 years or older, 13 percent use a food thermometer (lower than the national average). For the population of

at-home meal preparers with a self-reported physical health status of poor or fair, 11 percent use a food thermometer (also lower than the national average) (fig. 10).

Figure 10

Conditional on young children, elderly and physical health, prevalence of food thermometer use for at-home meals



Notes: Food thermometer use by respondent, conditional on having a youngest child in the household between the ages of 0 and 5 years old (*Age of youngest is 0 to 5*), conditional on any household member having an age of at least 62 years (*Anyone age 62 or older*), and conditional on respondent reporting physical health is poor or fair (*Health is poor or fair*).

Source: USDA, Economic Research Service using pooled 2014–2016 data from the American Time Use Survey–Eating and Health Module.

Statistical Differences Between Food Thermometer Users and Non-Users:

To better understand how current food-thermometer use may be related to characteristics of at-home meal preparers and their household, we examine statistical differences between at-home meal preparers who use and do not use food thermometers. Comparing observable characteristics across those households that do and do not use food thermometers indicated several statistical differences. Households that use food thermometers are more likely to earn above \$50,000 in total household annual earnings. Based on monthly total household earnings before taxes, they are less likely to be below and more likely to be above 185 percent of the Federal poverty line. They are more likely to have two or more people in the household, have at least one child, and be married. They are more likely to have an at-home meal preparer in very good or excellent physical health and less likely to have an at-home meal preparer in fair or poor physical health. They are more likely to have an at-home meal preparer who participates in physical activities or exercises for fitness in a given week. Last, they are less likely to have someone in the household who is over 62 years old (Table 2).

Table 2

Statistical differences in thermometer use

Variable / Category	Outcome	Used Thermometer (1)	Did Not Use Thermometer (2)
		<i>Percent</i>	<i>Percent</i>
Food Thermometer Use:	Used Food Thermometer	13.7	86.3
Region:	Midwest	26.7	23.8
Region:	South	34.7	37.5
Region:	West	19.4	21.3
Education:	Up to H.S. Graduate	36.3	39.0
Income:	Less than \$50,000	40.1	47.5
Income:	\$50,000 or More	59.9	52.5
Poverty Line:	At or Below 185%	33.1	37.2
Poverty Line:	Above 185%	66.9	62.8
Physical Health:	Poor or Fair	12.7	15.8
Physical Health:	Excellent	20.0	17.4
Physical Activity:	Did Not Exercise	28.0	36.6
Physical Activity:	Exercised	72.0	63.4
Total People:	1 Person	12.9	21.9
Total People:	2 People	39.0	35.2
Total People:	4 People	17.5	15.2
Total People:	5 or More	12.4	10.6
Marriage:	Non-Married	35.4	46.7
Marriage:	Married	64.6	53.3
Household Children:	No Kids	61.3	66.7
Household Children:	One or More Kids	38.7	33.3
Own Children:	No Kids	66.7	71.1
Own Children:	One or More Kids	33.3	28.9
Age of Youngest Child:	0 to 1	22.8	19.2
Age of Youngest Child:	14 to 17	13.1	16.6
Anyone Age 62+:	Yes	29.3	32.5
Anyone Age 62+:	No	70.2	67.5

Notes: The columns examine differences in the proportion of thermometer use for at-home meal preparers (*Food Thermometer Use*); differences in observable characteristics for at-home meal preparers who use food thermometers versus those who do not (*Education, Physical Health, Physical Activity, Marriage*); and, differences in observable characteristics for households where the at-home meal preparer used food thermometers versus those who did not (*Region, Income, Poverty Line, Total People, Household Children, Own Children, Age of Youngest Child, and Anyone Age 62+*). Provided are estimated proportions, expressed as a percent. P-values examining the difference in the reported proportions were all less than .10, indicating statistically significant differences. H.S. = high school diploma; A.D. = associate's degree; B.A. = bachelor's degree.

Source: USDA, Economic Research Service using pooled 2014-2016 data from the American Time Use Survey–Eating and Health Module.

Occupation and Food Thermometer Use

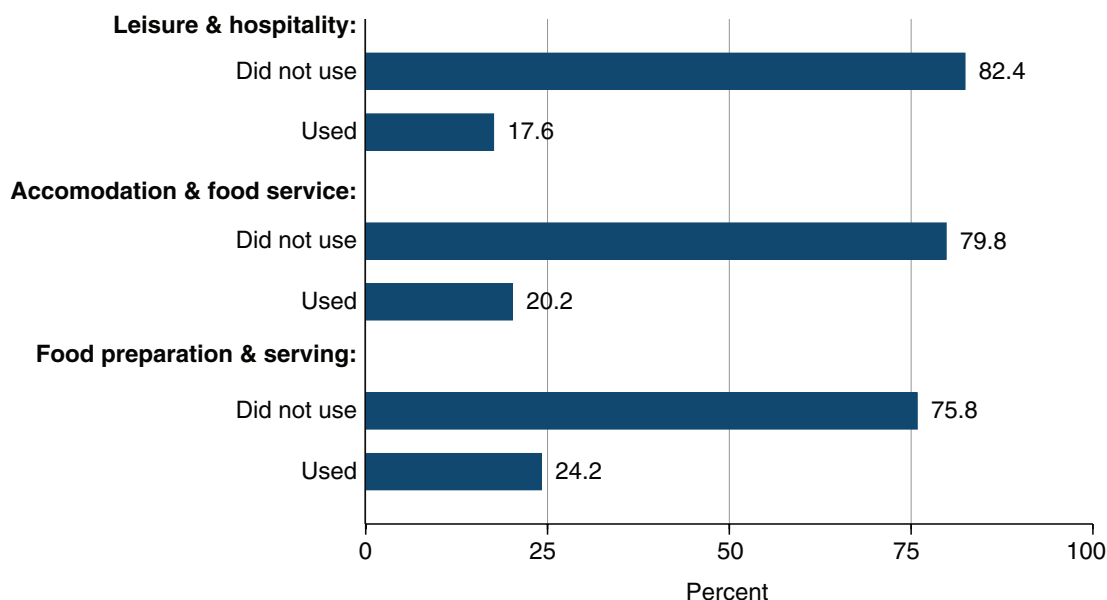
Almost all local health departments adopt FDA's Food Code, advice for reducing the risk factors of foodborne illnesses and outbreaks, as their system of regulation to ensure that food at retail is safe and properly protected and presented. The Food Code specifies that for any food establishment, at least one employee is required to be a certified food protection manager, passing a test as part of a certified program. Any training that would familiarize a person with the demands of the Food Code would repeatedly emphasize the importance of temperature and verifying temperature with a thermometer.

Given that those working in the food industry may have received formal food safety training or may work with someone who has, we examined if working in a food-service-related job influenced food safety practices at home. Specifically, we categorized at-home meal preparers according to the most relevant industries and occupations to food preparation in the ATUS: leisure and hospitality, accommodation and food service, and food preparation and serving.

For at-home meal preparers who work in the leisure and hospitality industry, 18 percent use food thermometers at home. For those who work in the accommodation and food service industry, 20 percent use food thermometers. For those who work in food preparation and serving occupations, 24 percent use food thermometers. Each of these estimates is statistically higher than the national average of 14 percent (fig. 11).

Figure 11

Conditional on employment, prevalence of food thermometer use for at-home meals



Notes: Food thermometer use by respondent, conditional on a respondent's main job having an industry category of "Leisure and Hospitality" (*Leisure & hospitality*), having an intermediate industry category of "Accommodation and Food Services" (*Accommodation & food services*), or having an occupation category of "Food Preparation and Serving Related Occupations" (*Food preparation & serving*).

Source: USDA, Economic Research Service using pooled 2014–2016 data from the American Time Use Survey—Eating and Health Module.

These findings provide suggestive evidence that the possible exposure to food safety practices at work, either by formal training or being aware of the food safety behaviors of others, may influence food safety practices at home.

Conclusion

This paper examined the food safety practices of at-home meal preparers in the United States by analyzing two unique survey questions in the 2014 to 2016 ATUS-EHM, which asked at-home meal preparers about their use of raw milk and of food thermometers when cooking any meals with meat, poultry, or seafood during the previous week. These practices are particularly relevant given the unequivocal advice by Government health and safety officials, as well as the broader food safety community, to avoid consuming raw (unpasteurized) milk and to use a thermometer to verify that meat has reached a recommended temperature.

Our estimates indicate that about 2 percent of at-home meal preparers in the United States, or over 3.2 million people, use raw milk during a typical week. About 14 percent of at-home meal preparers in the United States, or 19.5 million people, use food thermometers during a typical week when preparing any meal with meat, poultry, or seafood.

Of the 3.2 million at-home meal preparers who use raw milk, 2.6 million live in multi-member households, up to 1.1 million live with at least 1 child, and nearly 0.9 million live with at least 1 person age 62 years or older. This suggests that in a typical week, millions of people are at a greater potential risk of foodborne illness from consuming raw milk relative to consuming properly pasteurized milk. Additionally, these at-home meal preparers may be serving raw milk to multiple people, including children and the elderly.

This exposure is relevant to policy makers, public health officials, and the broader public, given raw milk can contain harmful bacteria such as *Salmonella*, *Campylobacter*, *E. coli* (STEC), and *Listeria*. Last, the result that 1.1 million households that use raw milk have 1 or more child present indicates a potential exposure of raw milk to an at-risk population, which is a persistent and common warning by multiple public health agencies and the general public health community.

While in a typical week, 14 percent of at-home meal preparers used a food thermometer, those employed in a food preparation and serving occupation had a higher usage rate of 24 percent. This result does not measure the effect of food safety training, since we do not have data on the respondents' exposure to food safety education or on their behavior before and after training. Nonetheless, it does suggest that the possible exposure to food safety training or practices at work may influence food safety behavior at home. Last, while food thermometer use was 10 percentage points higher for at-home meal preparers who work in a food preparation and serving occupation, 76 percent of these at-home meal preparers did not use food thermometers when preparing at-home meals. These results highlight the challenge of influencing the food safety behavior of consumers; most of those consumers who are potentially more aware and possibly exposed to food safety practices fail to utilize them once at home.

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Appendix

The American Time Use Survey (ATUS) is a Bureau of Labor Statistics (BLS) survey conducted by the U.S. Census Bureau with a stated purpose of developing nationally representative estimates of how people spend their time (ATUS User's Guide, 2017). Individuals are sampled from the panel of households that have completed their eighth and final month of interviews for the Current Population Survey (CPS). Those who participate are then interviewed one time about how they spend their time from 4:00 a.m. the previous day to 4:00 a.m. of the interview day as well as answer other questions that recall events within the past 7 or 30 days. Since these respondents have already participated in the CPS, demographic information, such as age, education, income, and household size including number and age of children, is available as well as detailed labor force participation information and limited geographic information.

The American Time Use Survey's Eating and Health Module (ATUS-EHM) was sponsored by U.S. Department of Agriculture (USDA), Economic Research Service (ERS), with funding partner USDA, Food and Nutrition Service (FNS), and technical assistance partner National Institutes of Health's (NIH) National Cancer Institute (NCI). The objective was to collect data to analyze the relationships among time use patterns and eating patterns, nutrition, and obesity; food and nutrition assistance programs; food safety practices and meal preparation; and grocery shopping and food adequacy. For more information on the ATUS-EHM, see Hamrick (2016, May).

The 2014 to 2016 ATUS-EHM featured new questions on consumers' choices in selecting or preparing certain foods and their food safety actions. The specific questions central to this report are provided below.

- a. TUS-EHM Variable EUPRPMEL: *Are you the person who usually prepares the meals in your household?*
Valid Entries: 1 Yes; 2 No; 3 Split it equally with other household member(s).
- b. Question for ATUS-EHM Variable EUMILK: *In the last 7 days, did you drink or serve unpasteurized or raw milk?*
Valid Entries: 1 Yes; 2 No.
- c. Question for ATUS-EHM Variable EUMEAT: *In the last 7 days, did you prepare any meals with meat, poultry, or seafood?*
Valid Entries: 1 Yes; 2 No.
- d. Question for ATUS-EHM Variable EUTHERM: *Did you use a food or meat thermometer when preparing any of those meals?*
Valid Entries: 1 Yes; 2 No.

The ATUS-EHM asked the raw milk question and the meat thermometer questions of those respondents who reported that they were the household's usual meal preparer or that they split meal preparation equally with other household members. The ATUS is designed to be a nationally representative survey of Americans age 15 years old or older. After households are sampled for the ATUS, a "designated person" in the household is chosen randomly to be surveyed.

There is no reason to think that households with randomly chosen respondents who reported they are the meal preparer or reported splitting equally preparation are different from households with randomly chosen respondents who report that they are not the meal preparer. Also, because the ATUS is a time-use survey that followed the CPS, a labor-force participation survey, respondents would not have expected to be asked questions about meal preparation or food consumption. As a result, we do not think that there is any bias from those who would not want to reveal their household practices and would self-select themselves out of the survey. Because of the survey design, the random selection of the respondent from each sampled household and the lack of any announcement effect of the food safety practices questions, we are confident that the results can be interpreted as nationally representative.

The CPS has both a stratified and clustered sampling procedure and thus is nonrandom; the ATUS follows a similar sampling procedure. The replicate weights method is a treatment for stratified and/or clustered sampling in order to produce estimates with more precise standard errors than a method assuming a random sample. Both SAS and Stata have procedures for calculating estimates using replicate weights. Note that calculating an estimate without using replicate weights and without using a Fay coefficient will generate the correct estimates but an incorrect standard error. Comparable to Hamrick (2016, May), this report used the following notable Stata commands and use of weights:

1. `svyset TUCASEID [pweight=WGT], brrweight(WGT1-WGT160) fay(0.5)`
2. `svy brr: proportion VAR, level(90)`
3. `svy brr: tabulate VAR`

For command (1), TUCASEID identifies each ATUS case and WGT is the final weight. Following the ATUS Data Dictionary: EHM Data (2017), we used EUFINLWGT as the final weight; and, following the ATUS User's Guide (2017), we divided EUFINLWGT by the total number of days in our sample (i.e., 365+365+366) to accurately estimate weighted counts and proportions for our pooled sample of 2014 to 2016. The chosen variance method is BRR (balanced repeated replication). WGT1-WGT160 are the replicate weights. Following the ATUS User's Guide (2017) and CPS Technical Paper 66 (2006), setting $FAY=0.5$ ensures the correct standard error will be generated. Command (2) was used to estimate proportions; all confidence intervals are calculated using a logit transformation to ensure estimates are bounded between 0 and 1, inclusively; and level (90) specifies a 90-percent confidence interval. The 90-percent confidence level is the standard used with the CPS and ATUS (CPS Technical Paper 66, 2006). Command (3) was used to estimate population counts. Statistical differences were formally tested using an adjusted Wald test.²⁴

The ERS standard is to suppress estimates for cells with unweighted counts fewer than 77 ($N < 77$). This research followed the rule of 77 observations, which was determined by BLS as the minimum number of respondents who could support an ATUS-EHM cell estimate and was followed for this research.

Statistics based on the ATUS and EHM data are subject to both sampling and nonsampling error. For a discussion of ATUS sampling error, see the technical notes of the ATUS annual news releases (Bureau of Labor Statistics, 2016). The EHM may be affected by non-sampling error if respondents overstate their contribution to the household's meal preparation. There is some indication that

²⁴ Comparable SAS code is available in the 2014-16 EHM user's guide (Hamrick, 2016, May).

there may be overreporting, which would result in an overestimate of meal preparers. However, it is unclear if those who overstate their household contribution would be more or less likely to be raw milk consumers or more or less likely to be food thermometer users, so any net bias is unclear although population estimates for all food safety practices will be slight overestimates. In addition, we also exclude those households where the randomly chosen respondent is 15-17 years old, as is ERS practice for analyzing the usual meal preparer population. Because of this, the food safety practices of the households represented by the 15-17 year old respondents are not represented in our estimates, resulting in a slight underestimate of the population for all food safety practices.

The following table provides the respondent count for each question after combining the 2014, 2015, and 2016 ATUS-EHM data.

Table A1
Respondent Counts for 2014-2016 ATUS-EHM, Overall and for Usual At-Home Meal Preparers

i. Participated in ATUS-EHM, Age 15+					
ATUS-EHM Variable	Yes	No	Split	Missing	Total
EUPRPMEL	20,080	8,796	3,100	72	32,048
EUMILK	434	22,700		8,914	32,048
EUMEAT	20,374	2,768		8,906	32,048
EUTHERM	2,514	17,839		11,695	32,048
ii. Participated in ATUS-EHM, EUPRPMEL=1 or 3, Age 18+					
ATUS-EHM Variable	Yes	No	Split	Missing	Total
EUPRPMEL	20,046		3,031		23,077
EUMILK	431	22,600		46	23,077
EUMEAT	20,300	2,739		38	23,077
EUTHERM	2,499	17,781		2,797	23,077

Source: USDA, Economic Research Service using pooled 2014-2016 data from the American Time Use Survey – Eating and Health Module.

The number of unweighted observations on raw milk use by at-home meal preparers age 18 or over (i.e., EUMILK=Yes) is 431. For this subsample, further analyzing outcomes of a given variable of interest often resulted in unweighted observation counts that failed to comply with BLS suppression rules and thus were unreportable. Consequently, when examining raw milk use, the variables analyzed and outcomes reported in this paper were selected on the basis that they: complied with BLS suppression rules; described standard demographic characteristics of at-home meal preparers and their household; and offered some insight into at-risk populations, like children or the elderly. Similarly when examining thermometer use, the variables analyzed and outcomes reported were selected on the basis that they: mirrored those analyzed for raw milk use; complied with BLS suppression rules; described standard demographic characteristics of at-home meal preparers and their household; and, offered some insight into at-risk populations, like children or the elderly.

Supplemental results to Figures 2 to 11 and Tables 1 and 2 are provided hereafter.

Table A2
Supplemental Results for Figures 2 to 5

Variable / Category	Outcome	Obs.	Pop.	Prop.	Std. Error
Raw Milk Use:	Used Raw Milk	431	3.21	0.02	0.001
Region:	South	169	1.26	0.39	0.034
Region:	Non-South	262	1.95	0.61	0.034
Access:	Retail Sale	121	0.89	0.28	0.030
Access:	On-farm or Cow-share	207	1.55	0.48	0.030
Access:	Not Legal	103	0.78	0.24	0.025
Education:	Up to H.S. Graduate	163	1.25	0.39	0.030
Education:	Some College to A.D.	125	0.93	0.29	0.032
Education:	B.A. or Better	143	1.03	0.32	0.034
Income:	Less than \$50,000	255	1.66	0.52	0.032
Income:	\$50,000 or More	176	1.56	0.48	0.032
Poverty Line:	At or Below 185%	199	1.45	0.45	0.034
Poverty Line:	Above 185%	232	1.76	0.55	0.034
Physical Health:	Poor, Fair or Good	202	1.39	0.43	0.031
Physical Health:	Very Good or Excellent	226	1.81	0.57	0.031
Physical Activity:	Did Not Exercise	165	1.14	0.36	0.032
Physical Activity:	Exercised	264	2.06	0.64	0.032
Body Mass Index:	BMI<25	121	0.96	0.32	0.033
Body Mass Index:	25<=BMI<30	157	1.18	0.39	0.033
Body Mass Index:	30<=BMI	122	0.86	0.29	0.029
Prepared or Fast Food:	Did Not Purchase	176	1.29	0.40	0.031
Prepared or Fast Food:	Purchased	254	1.92	0.60	0.031
Total People:	One Person	154	0.64	0.20	0.019
Total People:	Two or More People	277	2.58	0.80	0.019
Marriage:	Non-Married	262	1.80	0.56	0.035
Marriage:	Married	169	1.41	0.44	0.035
Household Children:	No Kids	254	2.07	0.64	0.032
Household Children:	One or More Kids	177	1.14	0.36	0.032
Own Children:	No Kids	278	2.32	0.72	0.027
Own Children:	One or More Kids	153	0.89	0.28	0.027
Anyone Age 62+:	No	302	2.33	0.72	0.029
Anyone Age 62+:	Yes	129	0.89	0.28	0.029

Notes: Shown are unweighted observation (*Obs*), estimated number of at-home meal preparers (*Pop.*) measured in millions, estimated proportions (*Prop.*) expressed as a decimal, and standard errors for the proportions (*Std. Error*).

H.S. = high school diploma; A.D. = associate's degree; B.A. = bachelor's degree.

Source: USDA, Economic Research Service using pooled 2014-2016 data from the American Time Use Survey – Eating and Health Module.

Table A3

Supplemental Results for Figures 6 to 9

Variable / Category	Outcome	Obs.	Pop.	Prop.	Std. Error
Food Thermometer Use:	Used Food Thermometer	2,499	19.49	0.14	0.003
Region:	Midwest	664	5.21	0.27	0.012
Region:	Northeast	450	3.74	0.19	0.011
Region:	South	859	6.77	0.35	0.012
Region:	West	526	3.77	0.19	0.010
City:	Metro	2,069	16.24	0.84	0.009
City:	Non-Metro	404	3.07	0.16	0.009
Education:	Up to H.S. Graduate	773	7.07	0.36	0.013
Education:	Some College to A.D.	777	5.42	0.28	0.011
Education:	B.A. or Better	949	7.00	0.36	0.013
Income:	Less than \$50,000	1,055	7.82	0.40	0.013
Income:	\$50,000 or More	1,444	11.67	0.60	0.013
Poverty Line:	At or Below 185%	862	6.44	0.33	0.012
Poverty Line:	Above 185%	1,637	13.05	0.67	0.012
Food Eaten:	Sometimes/Often Not Enough	118	0.96	0.05	0.006
Food Eaten:	Enough	2,376	18.50	0.95	0.006
Physical Health:	Poor or Fair	315	2.47	0.13	0.009
Physical Health:	Good	776	5.96	0.31	0.011
Physical Health:	Very Good	922	7.10	0.37	0.012
Physical Health:	Excellent	474	3.87	0.20	0.010
Physical Activity:	Did Not Exercise	721	5.43	0.28	0.011
Physical Activity:	Exercised	1,770	13.96	0.72	0.011
Body Mass Index:	BMI<25	823	6.37	0.34	0.014
Body Mass Index:	25<=BMI<30	838	6.52	0.35	0.014
Body Mass Index:	30<=BMI	713	5.61	0.30	0.013
Prepared or Fast Food:	Did Not Purchase	1,090	8.46	0.44	0.012
Prepared or Fast Food:	Purchased	1,403	10.98	0.56	0.012
Total People:	1 Person	555	2.52	0.13	0.007
Total People:	2 People	729	7.61	0.39	0.013
Total People:	3 People	471	3.54	0.18	0.010
Total People:	4 People	462	3.42	0.18	0.009
Total People:	5 or More	282	2.41	0.12	0.010
Marriage:	Non-Married	1,007	6.91	0.35	0.012
Marriage:	Married	1,492	12.58	0.65	0.012
Household Children:	No Kids	1,336	11.95	0.61	0.012
Household Children:	One or More Kids	1,163	7.54	0.39	0.012
Own Children:	No Kids	1,463	13.00	0.67	0.011
Own Children:	One or More Kids	1,036	6.49	0.33	0.011
Age of Youngest Child:	0 to 1	235	1.72	0.23	0.017

—continued

Table A3

Supplemental Results for Figures 6 to 9—continued

Variable / Category	Outcome	Obs.	Pop.	Prop.	Std. Error
Age of Youngest Child:	2 to 4	259	1.68	0.22	0.016
Age of Youngest Child:	5 to 9	312	1.90	0.25	0.016
Age of Youngest Child:	10 to 13	217	1.25	0.17	0.013
Age of Youngest Child:	14 to 17	140	0.99	0.13	0.013
Anyone Age 62+:	No	1,762	13.7	0.70	0.011
Anyone Age 62+:	Yes	737	5.8	0.30	0.011

Notes: Shown are unweighted observation (*Obs*), estimated number of at-home meal preparers (*Pop.*) measured in millions, estimated proportions (*Prop.*) expressed as a decimal, and standard errors for the proportions (*Std. Error*).

H.S. = high school diploma; A.D. = associate's degree; B.A. = bachelor's degree.

Source: USDA, Economic Research Service using pooled 2014-2016 data from the American Time Use Survey – Eating and Health Module.

Table A4

Supplemental Results for Figure 10

Conditional Sample	Thermometer Use	Obs.	Pop.	Prop.	Std. Error
Age of Youngest is 0 to 5:	Used	557	3.77	0.17	0.010
Age of Youngest is 0 to 5:	Did Not Use	2,890	18.36	0.83	0.010
Anyone Age 62 or Older:	Used	737	5.81	0.13	0.005
Anyone Age 62 or Older:	Did Not Use	6,048	40.01	0.87	0.005
Health is Poor or Fair:	Used	315	2.47	0.11	0.008
Health is Poor or Fair:	Did Not Use	2,977	19.30	0.89	0.008

Notes: Shown are unweighted observation (*Obs*), estimated number of at-home meal preparers (*Pop.*) measured in millions, estimated proportions (*Prop.*) expressed as a decimal, and standard errors for the proportions (*Std. Error*).

Source: USDA, Economic Research Service using pooled 2014-2016 data from the American Time Use Survey – Eating and Health Module.

Table A5

Supplemental Results for Figure 11

Industry	Thermometer Use	Obs.	Pop.	Prop.	Std. Error
Leisure & Hospitality:	Used	151	1.33	0.18	0.019
Leisure & Hospitality:	Did Not Use	767	6.23	0.82	0.019
Accommodation & Food Service:	Used	124	1.14	0.20	0.024
Accommodation & Food Service:	Did Not Use	529	4.52	0.80	0.024
Food Preparation & Serving:	Used	119	1.07	0.24	0.025
Food Preparation & Serving:	Did Not Use	391	3.36	0.76	0.025

Notes: Shown are unweighted observation (*Obs*), estimated number of at-home meal preparers (*Pop.*) measured in millions, estimated proportions (*Prop.*) expressed as a decimal, and standard errors for the proportions (*Std. Error*).

P-values examining if the proportions for thermometer use by at-home meal preparers working in Leisure & Hospitality Industry, Accommodation & Food Service Industry, and Food Preparation & Serving Occupations differed from the national rate of .137 were 0.04, 0.008, and 0.00006, respectively.

Source: USDA, Economic Research Service using pooled 2014-2016 data from the American Time Use Survey – Eating and Health Module.

Table A6

Supplemental Results for Table 1

Var./Cat.	Outcome	Used Raw Milk		Did Not Use		Difference
		(1)	(2)	(3)	(4)	(5)
		<i>Prop.</i>	<i>Std. Error</i>	<i>Prop.</i>	<i>Std. Error</i>	<i>P-value</i>
Raw Milk Use:	Used Raw Milk	0.02	0.001	0.98	0.001	0.000
Region:	South	0.39	0.034	0.38	0.004	0.597
Region:	Non-South	0.61	0.034	0.62	0.004	0.597
Access:	Retail Sale	0.28	0.030	0.26	0.005	0.562
Access:	On-farm or Cow-share	0.48	0.030	0.50	0.005	0.625
Access:	Not Legal	0.24	0.025	0.24	0.004	0.904
Education:	Up to H.S. Graduate	0.39	0.030	0.39	0.003	0.987
Education:	Some College to A.D.	0.29	0.032	0.27	0.004	0.552
Education:	B.A. or Better	0.32	0.034	0.34	0.004	0.565
Income:	Less than \$50,000	0.52	0.032	0.47	0.004	0.225
Income:	\$50,000 or More	0.48	0.032	0.53	0.004	0.225
Poverty Line:	At or Below 185%	0.45	0.034	0.37	0.004	0.016
Poverty Line:	Above 185%	0.55	0.034	0.63	0.004	0.016
Physical Health:	Poor, Fair or Good	0.43	0.031	0.48	0.004	0.170
Physical Health:	Very Good or Excellent	0.57	0.031	0.52	0.004	0.170
Physical Activity:	Did Not Exercise	0.36	0.032	0.36	0.004	0.897
Physical Activity:	Exercised	0.64	0.032	0.64	0.004	0.897
Body Mass Index:	BMI<25	0.32	0.033	0.35	0.004	0.321
Body Mass Index:	25<=BMI<30	0.39	0.033	0.35	0.004	0.139
Body Mass Index:	30<=BMI	0.29	0.029	0.30	0.004	0.611
Prepared or Fast Food:	Did Not Purchase	0.40	0.031	0.43	0.005	0.450
Prepared or Fast Food:	Purchased	0.60	0.031	0.57	0.005	0.450
Total People:	One Person	0.20	0.019	0.23	0.003	0.158
Total People:	Two or More People	0.80	0.019	0.77	0.003	0.158
Marriage:	Non-Married	0.56	0.035	0.47	0.004	0.014
Marriage:	Married	0.44	0.035	0.53	0.004	0.014
Household Children:	No Kids	0.64	0.032	0.67	0.003	0.376
Household Children:	One or More Kids	0.36	0.032	0.33	0.003	0.376
Own Children:	No Kids	0.72	0.027	0.72	0.003	0.917
Own Children:	One or More Kids	0.28	0.027	0.28	0.003	0.917
Anyone Age 62+:	No	0.72	0.029	0.67	0.003	0.082
Anyone Age 62+:	Yes	0.28	0.029	0.33	0.003	0.082

Notes: Shown in columns 1 and 2 are estimated proportions (*Prop.*) expressed as a decimal and standard errors for the proportions (*Std. Error*) for a sub-sample where at-home meal preparers report using raw milk. Shown in columns 3 and 4 are estimated proportions (*Prop.*) expressed as a decimal and standard errors for the proportions (*Std. Error*) for a sub-sample where at-home meal preparers report not using raw milk. Column 5 provides a p-value which examines if the difference in proportions is statistically significant. H.S. = high school diploma; A.D. = associate's degree; B.A. = bachelor's degree.

Source: USDA, Economic Research Service using pooled 2014-2016 data from the American Time Use Survey – Eating and Health Module.

Table A7

Supplemental Results for Table 2

Var./Cat.	Outcome	Used Thermometer		Did Not Use		Diff.
		(1)	(2)	(3)	(4)	(5)
		<i>Prop.</i>	<i>Std. Error</i>	<i>Prop.</i>	<i>Std. Error</i>	<i>P-value</i>
Food Thermometer Use:	Used Food Thermometer	0.14	0.003	0.86	0.003	0.000
Region:	Midwest	0.27	0.012	0.24	0.004	0.024
Region:	Northeast	0.19	0.011	0.17	0.004	0.139
Region:	South	0.35	0.012	0.37	0.005	0.040
Region:	West	0.19	0.010	0.21	0.005	0.063
City:	Metro	0.84	0.009	0.84	0.005	0.751
City:	Non-Metro	0.16	0.009	0.16	0.005	0.751
Education:	Up to H.S. Graduate	0.36	0.013	0.39	0.004	0.059
Education:	Some College to A.D.	0.28	0.011	0.27	0.004	0.686
Education:	B.A. or Better	0.36	0.013	0.34	0.004	0.102
Income:	Less than \$50,000	0.40	0.013	0.48	0.005	0.000
Income:	\$50,000 or More	0.60	0.013	0.52	0.005	0.000
Poverty Line:	At or Below 185%	0.33	0.012	0.37	0.005	0.002
Poverty Line:	Above 185%	0.67	0.012	0.63	0.005	0.002
Food Eaten:	Sometimes/Often Not Enough	0.05	0.006	0.06	0.002	0.322
Food Eaten:	Enough	0.95	0.006	0.94	0.002	0.322
Physical Health:	Poor or Fair	0.13	0.009	0.16	0.004	0.002
Physical Health:	Good	0.31	0.011	0.32	0.005	0.198
Physical Health:	Very Good	0.37	0.012	0.35	0.005	0.114
Physical Health:	Excellent	0.20	0.010	0.17	0.004	0.014
Physical Activity:	Did Not Exercise	0.28	0.011	0.37	0.005	0.000
Physical Activity:	Exercised	0.72	0.011	0.63	0.005	0.000
Body Mass Index:	BMI<25	0.34	0.014	0.34	0.005	0.974
Body Mass Index:	25<=BMI<30	0.35	0.014	0.35	0.005	0.882
Body Mass Index:	30<=BMI	0.30	0.013	0.31	0.005	0.846
Prepared or Fast Food:	Did Not Purchase	0.44	0.012	0.42	0.005	0.147
Prepared or Fast Food:	Purchased	0.56	0.012	0.58	0.005	0.147
Total People:	1 Person	0.13	0.007	0.22	0.003	0.000
Total People:	2 People	0.39	0.013	0.35	0.005	0.007
Total People:	3 People	0.18	0.010	0.17	0.004	0.278
Total People:	4 People	0.18	0.009	0.15	0.004	0.020
Total People:	5 or More	0.12	0.010	0.11	0.003	0.093
Marriage:	Non-Married	0.35	0.012	0.47	0.004	0.000
Marriage:	Married	0.65	0.012	0.53	0.004	0.000

—continued

Table A7

Supplemental Results for Table 2

Var./Cat.	Outcome	Used Thermometer		Did Not Use		Diff.
		(1)	(2)	(3)	(4)	(5)
		<i>Prop.</i>	<i>Std. Error</i>	<i>Prop.</i>	<i>Std. Error</i>	<i>P-value</i>
Household Children:	No Kids	0.61	0.012	0.67	0.003	0.000
Household Children:	One or More Kids	0.39	0.012	0.33	0.003	0.000
Own Children:	No Kids	0.67	0.011	0.71	0.003	0.000
Own Children:	One or More Kids	0.33	0.011	0.29	0.003	0.000
Age of Youngest Child:	0 to 1	0.23	0.017	0.19	0.006	0.037
Age of Youngest Child:	2 to 4	0.22	0.016	0.21	0.006	0.285
Age of Youngest Child:	5 to 9	0.25	0.016	0.26	0.006	0.699
Age of Youngest Child:	10 to 13	0.17	0.013	0.18	0.005	0.344
Age of Youngest Child:	14 to 17	0.13	0.013	0.17	0.006	0.016
Anyone Age 62+:	No	0.70	0.011	0.67	0.004	0.021
Anyone Age 62+:	Yes	0.30	0.011	0.33	0.004	0.021

Notes: Shown in columns 1 and 2 are estimated proportions (*Prop.*) expressed as a decimal and standard errors for the proportions (*Std. Error*) for a sub-sample where at-home meal preparers report using food thermometers. Shown in columns 3 and 4 are estimated proportions (*Prop.*) expressed as a decimal and standard errors for the proportions (*Std. Error*) for a sub-sample where at-home meal preparers report not using food thermometers. Column 5 provides a p-value which examines if the difference in proportions is statistically significant. H.S. = high school diploma; A.D. = associate's degree; B.A. = bachelor's degree.

Source: USDA, Economic Research Service using pooled 2014-2016 data from the American Time Use Survey – Eating and Health Module.