RESEARCH
Research Paper

Human Milk, Infant Formula, and Other Milks Fed to Infants and Toddlers in the United States, NHANES 2007-2018

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ABSTRACT

Background For the first time, the 2020-2025 Dietary Guidelines for Americans provide specific guidance regarding the types of foods and beverages that should be offered in the first 2 years of life. Milk, in various forms (eg, human milk, infant formula, and cow's milk) contributes a large proportion of key nutrients to the diets of infants and toddlers in the United States.

Objective The aim of this study was to determine the types of milk (human milk, infant formula, and other milk) fed to US infants and toddlers in the past 12 years and to describe trends over time.

Design This was a cross-sectional analysis of 2-day, 24-hour dietary recalls.

Participants/setting Data from the 2007-2018 National Health and Nutrition Examination Survey were used for these analyses. Infants and toddlers aged 0 through 23.9 months with 2 days of dietary recall data (n = 3,079) were included.

Main outcome measures The main outcome was proportion of infants and toddlers fed different milk types.

Statistical analyses performed Survey-adjusted weighted percentages were used to report sociodemographic characteristics and the proportion of subjects fed each milk type category by age group and survey cycles. Binary and multinomial logistic regressions were used to assess differences in subject characteristics by age groups.

Results Sociodemographic characteristics did not differ by age group. The proportion of infants aged 0 to <6 months fed infant formula only was 60.2% in 2007-2012 and 44.8% in 2013-2018. The proportion of infants aged 6 to <12 months fed partially hydrolyzed infant formula only was 7.3% in 2007-2012 and 13.1% in 2013-2018. In toddlers (>12 months old), cow's milk was the predominant milk type in both 2007-2012 and 2013-2018.

Conclusions The percentage of infants fed any human milk increased over the past decade. Unsweetened cow's milk was the most predominate milk type consumed among toddlers.

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INFANTS START THE FIRST YEAR OF LIFE CONSUMING A liquid diet typically consisting of human milk and/or infant formula. In the second year of life (12 through 23.9 months) these sources of milk are replaced with other types of milk. Human milk is considered the gold standard for infant nutrition, as recognized by the 2020-2025 Dietary Guidelines for Americans (DGA),[1] Academy of Nutrition and Dietetics,[2] American Academy of Pediatrics,[3] World Health Organization,[4] and European Society for Paediatric Gastrointestinal Health and Nutrition.[5] When human milk cannot be fed as an exclusive or partial source of nutrition, infant formula is considered the nutritionally suitable feeding alternative.[1-3,5] Data from the 2020 Centers for Disease Control and Prevention Breastfeeding Report Card indicate that 46.9% of 3-month-old infants and 25.6% of 6-month-old infants in the United States were fed human milk exclusively.[6] The 2020 Breastfeeding Report Card also indicated that as early as 3 months of age, many infants (53%) were fed infant formula as a supplement to human milk or as a sole source of nutrition.[6]

Infant formulas, according to the US Food and Drug Administration (FDA) Code of Federal Regulations, are defined as "a food which purports to be or is represented for special dietary use solely as a food for infants by reason of its simulation of human milk or its suitability as a complete or partial substitute for human milk" and are intended for infants <12 months of age.[7] Infant formulas marketed in the United States differ in nutrient composition to some extent,

however, all must meet minimum and maximum nutrient composition requirements for protein, carbohydrates, fats, vitamins, and minerals, as set forth by the FDA,[7] as well as all requirements of the Infant Formula Act[7] and other pertinent FDA regulations.[7] To date, the FDA does not distinguish between infant formulas designed for younger vs older infants; however, the product market does include transition formulas, which are formulas marketed for use by infants 9 months and older.[8,9] Because transition formulas include an age range that begins with <12 months, these products must also meet the FDA requirements set forth for infant formulas.

Some attributes by which the composition of infant formulas differ are the source and form of protein, carbohydrate, and fat. Specific to the form of protein, some studies have found that replacing milk ingredients in standard infant formula, such as nonfat milk, which mainly contains intact proteins,[10] with partial protein hydrolysate ingredients, which contain primarily smaller-sized proteins (molecular weight <5,000 Daltons[11]), may be beneficial for infants with fussiness, gas, or regurgitation.[12,13] Formulas composed of extensive protein hydrolysates, which are primarily free amino acids and peptides (molecular weight <3,000 Daltons[5,10,11,14]), are used for infants with allergies to intact protein (eg, cow's milk and soy).[14,15] Amino acid–based formulas (ie, only free amino acids[11]) are also hypoallergenic and intended for infants with severe protein allergies and other protein maldigestion disorders.[16,17]

Beyond the first year of life, infant formula and human milk consumption decreases, and consumption of cow's milk or cow's milk substitutes (also referred to as "other milks" or "milk alternatives") increases.[18,19] Cow's milk and cow's milk substitutes generally provide substantive amounts of key required nutrients in early childhood (eg, protein, carbohydrates, vitamin A, vitamin D, potassium, magnesium, and zinc).[20] The market of different types of infant formulas and milk products has changed[21] and, as such, the purpose of this study was to determine the types of milk (human milk, infant formula, and other milk) fed to US infants and toddlers in the past 12 years and to assess trends over time.

RESEARCH SNAPSHOT

Research Question: What are the types and prevalence of milk fed to infants and toddlers in the first 2 years of life in the United States?

Key Findings: The proportion of infants fed human milk only in the first year of life increased over the past decade. Among formula-fed infants, the types of formulas fed have changed, with a higher proportion of infants fed infant formulas containing partially hydrolyzed proteins. In the second year of life, most toddlers were fed unsweetened cow's milk, consistent with the 2020-2025 Dietary Guidelines for Americans.

METHODS

Study Design and Participants

Data from the National Health and Nutrition Examination Survey (NHANES), a cross-sectional and nationally representative survey of noninstitutionalized civilians in the United States conducted by the National Center for Health Statistics, were used for these analyses.[22] The National Center for Health Statistics Research Ethics Review Board approved the NHANES protocols. The sample (n = 3,079; Figure 1) consists of infants (0 to 11.9 months) and toddlers (12 to 23.9 months) within survey cycles from 2007-2008 through 2017-2018, with two 24-hour dietary recalls. In addition, secondary analyses were conducted in all infants and toddlers 0 to 23.9 months of age using only day one 24-hour dietary recall data (n = 3,597). To assess temporal trends over time, and for stability in estimates, cycles were combined into 2 intervals; 2007-2012 (n = 1,666) and 2013-2018 (n = 1,413).

Dietary Data

In brief, child proxies, of whom 89.6% were mothers (data not shown), were interviewed by trained examiners to obtain detailed information regarding the types and amounts of foods and beverages their infant or toddler was fed in the 24-hour period before the interview, using computer-assisted, multiple-pass dietary interview system.[23] The first dietary recall was collected in the mobile examination center and the second dietary recall was collected via telephone 3 to 10 days after the participant's visit at the mobile examination center.[23]

Milks fed to infants and toddlers were obtained from the NHANES individual food files (DR1IFF and DR2IFF). These files contain the 8-digit codes from the US Department of Agriculture's Food and Nutrient Database for Dietary Studies[24] for each food and beverage consumed. Each Food and Nutrient Database for Dietary Studies code is linked to a What We Eat in America major and sub-major food category.[25] Milks consumed were classified into a primary, secondary, and/or tertiary category, as applicable. In general, the primary milk type categories were constructed based on What We Eat in America sub-major food categories, the secondary milk type categories were classified according to product characteristics, and the tertiary milk type categories were constructed based on protein form (Figure 2). Two researchers (J.D., J.T.) independently assigned each milk reported to the applicable primary, secondary, and tertiary milk type category. Any discrepancies were discussed until consensus was reached.

More specifically, the primary milk type categories included "human milk," "infant formulas," "cow's milks and flavored cow's milks," and "cow's milk substitutes" (also described as "other milks" or "milk alternatives"). The What We Eat in America[25] category dairy drinks and substitutes was limited to cow's milk substitutes only because dairy drinks (eg, milk shakes) are more aligned nutritionally with dairy desserts. Because toddler milks are marketed for use by toddlers 12 months and older and are not subject to the requirements set forth by the FDA[26] for infant formulas, they were not categorized as infant formulas and, instead, a fourth primary milk type category, "toddler milks," was created for these products. A fifth category, ">1 primary milk type," was created to characterize infants and toddlers fed more than 1 primary milk type category (eg, human milk and infant formula, within a day or over the 2 days).

The secondary milk type category describes product characteristics based on information found on the product label and/or manufacturers' websites, resulting in the following categories: "preterm infant formula," "term infant formula," "transition formula," "store brand or infant formula not

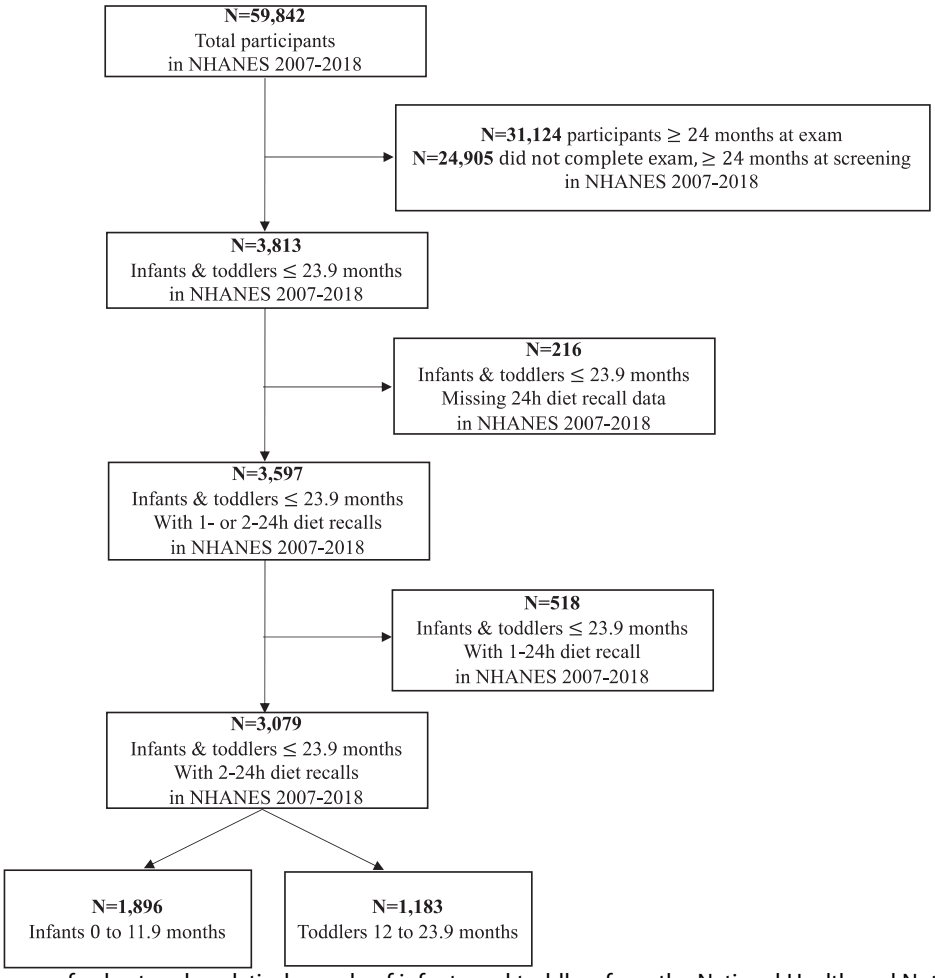

Figure 1. Flow diagram of cohort and analytical sample of infants and toddlers from the National Health and Nutrition Examination Survey (NHANES) 2007-2018, less than 24 months of age.

specified," "unsweetened cow's milk," "sweetened cow's milk," "unsweetened cow's milk substitutes," "sweetened cow's milk substitutes," and ">1 secondary milk type." Preterm formula included those formulated for premature and/or low-birth-weight infants. Term formula included those designated for full-term infants aged 0 to 12 months. Transition formula included those formulated for infants aged 9 months and older. Infant formula "not specified" or "store brand" included those that were reported without the details to categorize as preterm, term, or transition infant formula. Sweetened cow's milk and sweetened cow's milk substitutes were defined as containing >0 g of added sugar,

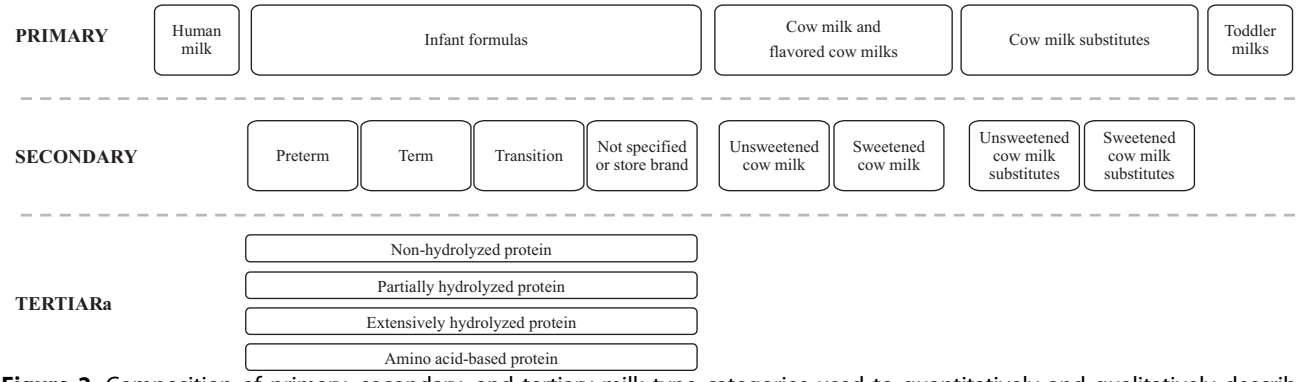

Figure 2. Composition of primary, secondary, and tertiary milk type categories used to quantitatively and qualitatively describe milks fed to infants and toddlers less than 24 months of age from the National Health and Nutrition Examination Survey 2007-2018.

as identified by the US Department of Agriculture's Food Patterns Equivalence Database.[27] Infants and toddlers fed more than 1 secondary milk type category within the respective primary milk type category were classified as ">1 secondary milk type."

The tertiary milk type category was based on protein form (ie, degree of protein hydrolysis). Using information found on the product label and/or manufacturer's websites, infant formulas were assigned to the following categories: "nonhydrolyzed protein," "partially hydrolyzed protein," "extensively hydrolyzed protein," "amino acid-based," ">1 tertiary milk type," and "not specified or store brand." Nonhydrolyzed formula included those formulated with intact protein sources, such as nonfat milk, milk protein isolate, and/or soy protein isolate. Partially hydrolyzed formula included those composed of partially hydrolyzed nonfat milk, enzymatically hydrolyzed whey protein concentrate, and/or enzymatically hydrolyzed soy protein isolate. Extensively hydrolyzed formula included those formulated with extensively hydrolyzed protein, often labeled as hypoallergenic, such as casein hydrolysate. Amino acid–based formula included those composed of free amino acids only. Similar to the primary and secondary milk type categories, a combination category was created if infants were fed products with different protein forms. Not specified or store brand included those that were reported as only infant formula without the details needed to categorize the tertiary milk type.

Examination of data found that some participants consumed 1 type of primary milk on day 1 (eg, infant formula) and a different type of primary milk on day 2 (eg, human milk), therefore, 2 days of recall were selected as the primary analyses to account for intra-individual variability in milk type and increase the accuracy of infant milk type categorization. Secondary analyses were repeated in all infants and toddlers using only day 1 of dietary recall.

Statistical Analysis

The primary analyses included those with two 24-hour dietary recalls and, therefore, the WTDR2D variable[28] for each survey cycle was used, along with strata and primary sampling units, to account for the complex survey design, nonresponse, and post-stratification adjustments to replicate US Census Bureau population counts.[29] Secondary (sensitivity) analyses included all infants and toddlers using only the day one 24-hour dietary recall and used the WTDR1D variable[28] instead. Preliminary descriptive analyses of primary milk type frequencies were conducted on all subjects regardless of the number of days of dietary recall compared with only subjects with 2 days of dietary recall. Weighted cumulative percentages were used to report sociodemographic characteristics and the proportion of subjects fed each milk type category by age group (0 to <6 months, 6 to <12 months, 12 to <18 months, and 18 to <24 months) and by survey cycle intervals (eg, 2007-2012 and 2013-2018). Differences in subject characteristics by age group were assessed using binary or multinomial logistic regression. All estimates were examined for stability on the basis of guidance from National Center for Health Statistics Data Presentations for Proportions.[30] Estimates identified as unreliable due to nominal or effective sample size or relative CI width were identified.[30] All analyses were performed using *Stata IC*, version 15.1[31] using $\alpha = .05$.

RESULTS

A total of 3,597 infants and toddlers younger than 24 months had either 1 or 2 days of dietary intake data. Preliminary descriptive data review (n = 3,597) revealed that some participants were fed more than 1 primary milk type category within the same day and/or across 2 days. With respect to the latter, because subjects could be characterized differently based on day 1 or day 2 of dietary intake data, only those participants with 2 days of dietary intake data (n = 3,079) were included in these analyses. Sociodemographic characteristics by age group for subjects with 2 days of dietary intake are provided in Table 1. Secondary analyses of sociodemographic characteristics by age group for all subjects with 1 day of diet recall are provided in Table 2 (available at jandonline.org). There were no differences in sociodemographic characteristics by age group.

The proportion of infants fed each milk type category (primary, secondary, and tertiary) by age group and by survey cycle intervals are provided in Table 3. Secondary analyses of milk type categories by survey cycle intervals for all subjects with 1 day of diet recall are provided in Table 4 (available at jandonline.org). As shown in Table 3, the percentage of infants aged 0 to <6 months fed human milk only was 23.8% in 2007-2012 and 35.3% in 2013-2018. Among infants aged 6 to <12 months, 10.8% and 22.4% were fed human milk only in 2007-2012 and 2013-2018, respectively. Among infants aged 0 to <6 months in 2007-2012 and 2013-2018, 60.2% and 44.8% were fed "infant formula only," respectively. Similarly, 63.3% of infants aged 6 to <12 months in 2007-2012 and 54.0% in 2013-2018 were fed "infant formula only." Among infants aged 0 to <6 months in 2007-2012 and 2013-2018, 42.7% and 25.9% were fed a nonhydrolyzed protein formula and 9.2% and 11.0% were fed a partially hydrolyzed protein formula, respectively.

The proportions of toddlers fed each milk type category (primary, secondary, and tertiary) by age group and by survey cycle intervals are provided in Table 5. Results of secondary analyses of milk type categories by survey cycle intervals for all subjects with 1 day of diet recall are provided in Table 6 (available at jandonline.org). As shown in Table 5, 77.6% and 66.7% of toddlers aged 12 to <18 months were fed "cow's milk and flavored cow's milk" only in 2007-2012 and 2013-2018, respectively. Within cow's milk and flavored cow's milk, 74.1% and 62.6% of toddlers aged 12 to <18 months were fed unsweetened cow's milk in 2007-2012 and 2013-2018, respectively. Similarly, 75.1% and 70.5% of toddlers aged 18 to <24 months were fed unsweetened cow's milk in 2007-2012 and 2013-2018, respectively.

DISCUSSION

The percentage of infants fed human milk only was higher in 2013-2018 compared with 2007-2012. These data are in line with guidance from the DGA, underscoring the importance of human milk feeding as the preferred source of nutrition[1] and consistent with the Centers for Disease Control and Prevention Breastfeeding Report Card, which showed the

Table 1. Sociodemographic characteristics of infants and toddlers aged <24 months with 2 days of dietary recall (n = 3,079) from the National Health and Nutrition Examination Survey (2007-2018), by age group

Characteristic	Age Groups				*P* value[a]
	0 to <6 mo (n = 933)	6 to <12 mo (n = 963)	12 to <18 mo (n = 652)	18 to <24 mo (n = 531)	
	←——————————%——————————→				
Weighted[b]	25.5	27.1	25.4	22.0	
Infant sex					.1355
Male	51.2	49.7	55.3	52.7	
Female	48.8	50.3	44.7	47.3	
Infant race/ethnicity					.6657
Non-Hispanic White	51.5	53.6	49.4	47.6	
Non-Hispanic Black	13.9	13.1	13.3	13.7	
Mexican American	19.5	18.3	19.0	18.3	
Other Hispanic	6.9	8.0	7.9	11.3	
Other race and/or multiracial	8.3	7.1	10.5	9.2	
Head of household education[c]					.2062
Less than high school	22.3	19.8	20.0	23.6	
High school/GED[d]/some college	50.1	47.8	57.4	50.0	
College graduate	27.7	32.4	22.8	26.4	
Head of household marital status[e]					.5194
Married/living with partner	81.5	83.7	79.5	81.6	
Widowed/divorced/separated	9.4	6.8	10.8	10.1	
Never married	9.1	9.5	9.6	8.3	
Annual household income[f]					.8508
<$35,000	38.9	40.0	39.9	38.5	
$35,000—$75,000	31.5	28.1	31.4	29.7	
>$75,000	29.6	31.9	28.7	31.9	

[a]Differences in subject characteristics by age group were assessed using binary or multinomial logistic regression.
[b]Two-day dietary recall weights (WTDR2D)[28] for each survey cycle were used to account for the complex survey design, nonresponse, and post-stratification adjustments to replicate US Census Bureau population counts.[29]
[c]Percentages do not include participants with missing data, n = 514 missing.
[d]GED = General Educational Development test.
[e]Percentages do not include participants with missing data, n = 553 missing.
[f]Percentages do not include participants with missing data, n = 117 missing and n = 89 with reported income more than $20,000 and could not be categorized).

percentage of US infants exclusively breastfed at 6 months has increased from 11.3% in the 2007 Breastfeeding Report Card[32] to 25.6% in the 2020 report.[6] Similarly, the percentage of infants fed any human milk at 6 months has increased from 41.5% in the 2007 Breastfeeding Report Card to 58.3% in the 2020 Breastfeeding Report Card.[6]

With respect to the tertiary milk types of infant formulas, although nonhydrolyzed protein formulas continue to be fed to most infants, the percentage of infants in these analyses and in previous NHANES analyses (2003-2010)[33] suggest that the percentage of infants fed partially hydrolyzed protein formula increased from 2007-2012 to 2013-2018 in infants younger than 12 months. These data suggest that the types of infant formulas (ie, form of protein) fed to US infants is changing and partial protein hydrolysate formula use may be increasing. Infant formulas containing partially hydrolyzed protein ingredients have been proposed to reduce fussiness,[12,34] gas, vomiting, spitting up, and nighttime awakening[34]; however, not all studies are consistent[13] and additional research is needed to determine the clinical benefits of feeding partially hydrolyzed formulas, as well as caregiver motivation for selecting these formulas. Differences in degree of protein hydrolyzation between products, as evidenced by different concentrations of free amino acids,[10,35] may be a factor in the inconsistent clinical outcomes.

Table 3. The proportion of infants aged <12 months with 2 days of dietary recall (n = 1,896) from the National Health and Nutrition Examination Survey (2007-2018), fed each primary, secondary, and tertiary milk type category, by age group and survey cycle

	Age Groups			
	0 to <6 mo		6 to <12 mo	
Milk type category fed[a]	2007-2012 (n = 495)	2013-2018 (n = 438)	2007-2012 (n = 523)	2013-2018 (n = 440)
	←——————————% (95% CI)[b]——————————→			
Human milk only	23.8 (18-29.6)[c]	35.3 (28.5-42.2)	10.8 (6.8-14.9)[c]	22.4 (16.8-28.0)[c]
Infant formulas only	60.2 (53.6-66.8)	44.8 (39.2-50.4)	63.3 (57-69.7)[d]	54.0 (48.6-59.4)
Premature infant formulas only	1.3 (0.3-5.0)[d]	1.7 (0.7-4.0)[d]	0 (0-0.3)	0.3 (0-1.6)[d]
Term infant formulas only	55.6 (49.9-61.4)	41.4 (36.1-46.7)	55.1 (48.5-61.7)	44.6 (37.6-51.6)
Nonhydrolyzed protein	42.7 (35.2-50.5)	25.9 (21.5-30.8)	44.5 (38.1-51.1)	28.2 (22.7-34.4)
Partially hydrolyzed protein	9.2 (5.4-15.2)[d]	11.0 (7.5-15.9)[c]	7.3 (4.3-12.2)[c]	13.1 (8.0-20.7)
Extensively hydrolyzed protein	0.3 (0-1.3)[d]	3.6 (1.6-7.7)[d]	1.2 (0.5-2.7)[d]	2.1 (1.1-4.2)[d]
Amino acid—based protein	0.5 (0-3.3)[d]	None reported	None reported	0.2 (0-0.1)[d]
Tertiary milk type, combination	2.9 (1.5-5.9)[d]	1.0 (0.4-2.4)[d]	2.1 (0.9-4.8)[d]	0.9 (0.4-2.1)[d]
Transition infant formulas only	0.2 (0-1.0)[d]	None reported	None reported	0.6 (0-0.4)[d]
Store brand or infant formulas not specified	1.8 (0.3-3.4)[d]	1.3 (0.1-2.5)[d]	5.6 (1.5-9.8)[d]	4.3 (1.5-7.2)[d]
Secondary milk type, combination	1.3 (0-2.6)[d]	0.4 (0-0.9)[d]	2.6 (0.2-0.6)[d]	4.2 (1.1-7.3)[d]
Cow's milk and flavored cow's milk only	None reported	None reported	3.9 (1.4-6.5)[d]	2.0 (0.5-3.5)[d]
Unsweetened cow's milk	None reported	None reported	3.7 (1.3-6.2)[d]	2.0 (0.5-3.5)[d]
Sweetened cow's milk	None reported	None reported	None reported	None reported
Secondary milk type, combination	None reported	None reported	0.2 (0-1.1)[d]	None reported
Cow's milk substitute only	None reported	None reported	None reported	0.1 (0-0.2)[d]
Unsweetened cow's milk substitute	None reported	None reported	None reported	None reported
Sweetened cow's milk substitute	None reported	None reported	None reported	0.1 (0-0.2)[d]
Secondary milk type, combination	None reported	None reported	None reported	None reported
Primary milk type, combination	16.0 (11.8-20.2)[c]	19.8 (13.4-26.3)[c]	21.3 (17-25.7)[c]	21.6 (16.7-26.4)[c]

[a]Primary milk type categories were constructed based on What We Eat in America sub-major food categories,[25] secondary milk type categories were classified according to product characteristics, and tertiary milk type categories were constructed based on protein form. See Methods section for details. Primary milk type categories sum to 100% within each age group (column). Secondary milk type categories further describe each primary milk type category and sum to the primary milk type category within each age group (column). Tertiary milk type categories further describe each secondary milk type category and sum to the secondary milk type category within age group (column).

[b]Cumulative percent within each column may not add to 100% due to rounding.

[c]Estimate may be statistically unreliable because the relative CI width is >130% of the proportion.

[d]Estimate may be statistically unreliable because the nominal or effective sample size is <30.

Furthermore, it appears that a small proportion of infants aged 6 to <12 months were introduced to milks other than human milk or infant formula (ie, cow's milk and flavored cow's milk). By 6 to <12 months of age, although more than two-thirds of infants were fed infant formula only or human milk only as the primary milk type, the introduction of cow's milk and flavored cow's milk was present. These data are consistent with a recent report that 20% to 22% of US infants aged 6 to 11 months were fed any cow's milk or toddler milk.[36] This is of concern, given that the American Academy of Pediatrics,[37] the Healthy Eating Research Expert Panel,[38] and the most recent DGA[1] all discourage the introduction of milks other than human milk or infant formula before a child's first birthday,[1] as cow's milk and cow's milk substitutes fail to provide appropriate amounts of key nutrients required for infants aged 0 to <12 months. One possible explanation is that the marketing of toddler milks often uses branding, packaging, and labeling that make it difficult for caregivers to distinguish toddler milks from infant formulas,[39] and some caregivers may be unintentionally providing toddler products to infants.

Focusing on milks beyond the first year of life, only a small percentage of toddlers continued to be fed human milk only or infant formula only, and a small percentage were fed cow's

Table 5. The proportion of toddlers aged 12 to <24 months with 2 days of dietary recall (n = 1,183) from the National Health and Nutrition Examination Survey (2007-2018), fed each primary, secondary, and tertiary milk type category, by age group and survey cycle

	Age Groups			
	12 to <18 mo		18 to <24 mo	
Milk type category fed[a]	2007-2012 (n = 353)	2013-2018 (n = 299)	2007-2012 (n = 295)	2013-2018 (n = 236)
	←——————————% (95% CI)[b]——————————→			
Human milk only	3.1 (1.1-8.1)[c]	2.7 (1.4-5.4)[c]	0.6 (0.1-2.6)[c]	3.0 (0.9-7.2)[c]
Infant formulas only	2.5 (1.3-4.8)[c]	4.6 (2.0-10.3)[c]	3.1 (0.8-11.2)[c]	None reported
Premature infant formulas only	None reported	None reported	None reported	None reported
Term infant formulas only	1.7 (0.8-3.5)[c]	4.2 (1.6-9.8)	1.3 (0.2-7.9)[c]	None reported
Nonhydrolyzed protein	1.3 (0.5-3.3)[c]	2.1 (0.8-5.0)	0 (0-0.5)[c]	None reported
Partially hydrolyzed protein	0.2 (0-1.0)[c]	0.2 (0-0.7)	None reported	None reported
Extensively hydrolyzed protein	None reported	1.8 (0.3-10.4)	1.2 (0.2-8.3)[c]	None reported
Amino acid-based protein	None reported	None reported	None reported	None reported
Tertiary milk type, combination	0.2 (0-1.3)[c]	0 (0-0.7)	None reported	None reported
Transition infant formulas only	0.5 (0-3.3)[c]	None reported	None reported	None reported
Store brand or infant formulas not specified	0.2 (0-1.7)[c]	0.2 (0-1.6)[c]	1.8 (0.3-11.1)[c]	None reported
Secondary milk type, combination	0.1 (0-0.9)[c]	0.3 (0-2.5)[c]	None reported	None reported
Cow's milk and flavored cow's milks only	77.6 (71.9-82.4)	66.7 (58.3-74.2)	83.0 (76.6-87.9)	76.7 (68.4-83.4)
Unsweetened cow's milk	74.1 (68.9-78.8)	62.6 (54.6-69.9)	75.1 (68.6-80.7)	70.5 (61.8-77.9)
Sweetened cow's milk	0.4 (0-2.0)[c]	0.7 (0-4.8)[c]	1.1 (0.3-3.4)[c]	1.0 (0.2-3.9)[c]
Secondary milk type, combination	3.1 (1.9-5.0)[c]	3.5 (1.3-8.8)[c]	6.8 (3.9-11.8)[c]	5.2 (2.6-10.3)[c]
Cow's milk substitutes only	2.9 (1.0-8.0)[c]	1.8 (0.4-7.1)[c]	1.7 (0.5-5.5)[c]	6.7 (3.2-13.7)[c]
Unsweetened cow's milk substitute	None reported	0.2 (0-0.9)[c]	0.9 (0.1-6.4)[c]	0.3 (0-1.9)[c]
Sweetened cow's milk substitute	2.9 (1.0-8.0)[c]	1.6 (0.4-6.4)[c]	0.8 (0.3-3.4)[c]	3.9 (1.4-10.6)[c]
Secondary milk type, combination	None reported	None reported	None reported	2.6 (1.0-6.7)[c]
Primary milk type, combination	12.1 (8.0-17.9)[d]	23.0 (16.1-31.9)[d]	8.5 (5.5-12.9)[d]	7.2 (5.3-12.0)[d]
No milk reported	1.8 (0.6-5.7)[c]	0.9 (0.3-3.1)[c]	3.1 (1.5-6.4)[c]	5.1 (3.0-9.2)[c]

[a]Primary milk type categories were constructed based on What We Eat in America[25] sub-major food categories, secondary milk type categories were classified according to product characteristics, and tertiary milk type categories were constructed based on protein form. See Methods section for details. Primary milk type categories sum to 100% within each age group (column). Secondary milk type categories further describe each primary milk type category and sum to the primary milk type category within each age group (column). Tertiary milk type categories further describe each secondary milk type category and sum to the secondary milk type category within age group (column).

[b]Cumulative percent within each column may not add to 100% due to rounding.

[c]Estimate may be statistically unreliable because the nominal or effective sample size is <30.

[d]Estimate may be statistically unreliable because the relative CI width is >130% of the proportion.

milk substitutes only. A recent report found that per-capita consumption of dairy milk as a beverage in US households has declined steadily since 1975.[40] Furthermore, although more than three-quarters of US households reported regularly consuming dairy milk, 38% report consuming only plant-based beverages and 16% report consuming plant-based and other dairy alternatives.[40] However, research on milk consumption in infants and toddlers is limited, and future research should focus on cow's milk substitute consumption in younger age groups.

The American Academy of Pediatrics and DGA recognize plain cow's milk and unsweetened milk alternatives (eg, soy milk and almond milk) as acceptable components of the toddler diet[1,3] and, consistent with these recommendations, unsweetened cow's milk was the only milk fed to nearly three-quarters of toddlers aged 12 to <18 months and 18 to <24 months. The DGA[1] and the American Heart Association[41] recommend that added sugars should not be introduced before 2 years of age, yet flavored cow's milk and cow's milk substitutes have been reported to be among the top 8 sources

of added sugars in the diets of US infants and toddlers from 2011 to 2016.[42] Avoiding milks that contain added sugars (eg, toddler milks, flavored cow's milks, and sweetened cow's milk substitutes) is important in the first 2 years of life, as this is a sensitive period in flavor development and preference,[43-45] and may contribute to setting the palate for a preference for sweetness and other poor health outcomes related to diet later in life.[46]

A strength of this study is the use of a nationally representative data set in which sample weights were applied, resulting in findings that are generalizable to the US infant and toddler population. However, this study is not without limitations. Due to the small sample size, many estimates were not stable, however, the CIs provide context for the estimate. Because infants and toddlers are unable to complete dietary recalls independently, researchers are dependent on caregivers to serve as a proxy, and research in younger pediatric populations has found that adults are suitable proxies.[47] Research has found that the 24-hour dietary recall is an appropriate method of measuring dietary intake in infants[48]; however, this study is limited to the fact that there are only 2 days of dietary data available in NHANES data. Because these analyses focus on the occurrence of milk types in the diet (ie, presence or absence) as opposed to amounts of each milk type, this reduces potential error. Another limitation is the lack of specific information on some reported formula types (eg, store brand, infant formula not specified). This led to the creation of a separate category for these reported formulas and thus other categories may be underestimated. It should be noted that store brand and infant formula not specified contributed to 2.4%, on average, of formulas reported.

CONCLUSIONS

In summary, the milk-based diet of infancy and early toddlerhood transitions from primarily human milk and infant formulas, eventually to cow's milk and flavored cow's milks, cow's milk substitutes, and toddler milks. These data demonstrate shifts in the proportion of infants fed human milk and infant formula, as well as transitions in the types of infant formulas fed. In the second year of life, most toddlers were fed unsweetened cow's milk. One unexpected finding from these data was the proportion of infants and toddlers receiving different combinations of primary milk types in both infancy and toddlerhood. Future research should qualitatively describe these combinations in milk types.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

J. C. Trabulsi consults on clinical trial design for ByHeart, Inc. No potential conflict of interest was reported by the remaining authors.

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AUTHOR CONTRIBUTIONS

J. E. Decker, S. M. Robson, and J. C. Trabulsi conceptualized the study. J. E. Decker, M. T. Delahanty, A. Davey, and J. C. Trabulsi imported and analyzed the data. All authors contributed to the writing and critical review of the manuscript.

Table 2. Sociodemographic characteristics of infants and toddlers aged <24 months with day 1 of dietary recall (n = 3,597) from the National Health and Nutrition Examination Survey (2007-2018), by age group

	Age Groups				
Characteristic	**0 to <6 mo (n = 1,034)**	**6 to <12 mo (n = 1,127)**	**12 to <18 mo (n = 760)**	**18 to <24 mo (n = 676)**	***P* value**[a]
	←——————————%——————————→				
Weighted[b]	24.3	27.0	25.2	23.6	
Infant sex					.7083
Male	51.1	50.7	53.0	52.4	
Female	48.9	49.3	47.0	47.6	
Infant race/ethnicity					.5433
Non-Hispanic White	51.4	54.0	50.0	49.3	
Non-Hispanic Black	13.9	13.0	12.7	12.6	
Mexican American	19.4	17.6	17.8	18.2	
Other Hispanic	6.4	7.7	8.6	10.7	
Other race and/ or multiracial	8.9	7.6	11.0	9.2	
Head of household education[c]					.4419
Less than high school	21.9	19.9	20.2	21.3	
High school/GED[d]/some college	50.7	49.4	56.5	50.4	
College graduate	27.4	30.7	23.3	28.3	
Head of household marital status[e]					.0342
Married/living with partner	81.6	83.5	79.2	82.0	
Widowed/divorced/separated	9.3	6.4	11.6	10.4	
Never married	9.2	10.1	9.2	7.7	
Annual household income[f]					.8779
<$35,000	39.0	40.3	38.4	38.8	
$35,000—$75,000	30.6	27.6	31.9	28.9	
>$75,000	30.4	32.1	29.6	32.3	

[a]Differences in subject characteristics by age group were assessed using binary or multinomial logistic regression.
[b]Two-day dietary recall weights (WTDR2D)[28] for each survey cycle were used to account for the complex survey design, nonresponse, and post-stratification adjustments to replicate US Census Bureau population counts.[29]
[c]Percentages do not include participants with missing data, n = 597 missing.
[d]GED = General Educational Development test.
[e]Percentages do not include participants with missing data, n = 632 missing.
[f]Percentages do not include participants with missing data, n = 148 missing and n = 111 with reported income >$20,000 and could not be categorized).

Table 4. The proportion of infants aged <12 months with day 1 of dietary recall (n = 2,161) from the National Health and Nutrition Examination Survey (2007-2018), fed each primary, secondary, and tertiary milk type category, by age group and survey cycle

	Age Group			
	0 to <6 mo		6 to <12 mo	
Milk type category fed[a]	2007-2012 (n = 551)	2013-2018 (n = 483)	2007-2012 (n = 606)	2013-2018 (n = 521)
	← % (95% CI)[b] →			
Human milk only	24.4 (18.7-30.0)[c]	32.5 (26.7-38.3)	11.5 (7.6-15.5)[c]	22.5 (17.6-27.4)[c]
Infant formulas only	59.3 (52.9-65.8)	46.5 (40.4-52.5)	63.2 (57.3-69.2)	56.3 (51.3-61.2)
Premature infant formulas only	1.8 (0-3.7)[d]	1.4 (0.2-2.6)[d]	0.1 (0-0.2)[d]	0.3 (0-0.7)[d]
Term infant formulas only	54.0 (48.6-59.3)	42.3 (37.2-47.3)	56.8 (50.6-62.9)	48.5 (41.8-55.1)
Nonhydrolyzed protein	42.2 (34.8-49.7)	27.8 (23.4-32.2)	45.0 (39.2-50.8)	29.5 (23.4-35.7)[c]
Partially hydrolyzed protein	8.1 (3.8-12.5)[c]	11.5 (7.8-15.1)[c]	7.8 (3.7-11.9)[c]	14.5 (8.7-20.4)[c]
Extensively hydrolyzed protein	0.6 (0-1.4)[d]	2.2 (0.6-3.8)[d]	2.2 (1.0-3.5)[d]	3.2 (1.2-5.2)[d]
Amino acid–based protein	0.5 (0-1.4)[d]	None reported	None reported	0.2 (0-0.6)[d]
Tertiary milk type, combination	2.5 (0.7-4.4)[d]	0.9 (0-1.7)[d]	1.8 (0.2-3.3)[d]	1.0 (0.3-1.7)[d]
Transition infant formulas only	0.1 (0-0.4)[d]	0.2 (0-0.5)[d]	0.1 (0-0.2)[d]	0.8 (0-1.9)[d]
Store brand or infant formulas not specified	1.9 (0.6-3.3)[d]	2.2 (0.5-3.8)[d]	4.6 (1.5-7.6)[d]	4.0 (1.4-6.5)[d]
Secondary milk type, combination	1.5 (0.1-2.8)[d]	0.5 (0-1.1)[d]	1.8 (0.4-3.1)[d]	2.8 (1.1-4.5)[d]
Cow's milk and flavored cow milks only	None reported	0.1 (0-0.3)[d]	3.8 (1.7-5.9)[d]	1.7 (0.6-2.7)[d]
Unsweetened cow's milk	None reported	0.1 (0-0.3)[d]	3.7 (1.7-5.8)[d]	1.7 (0.6-2.7)[d]
Sweetened cow's milk	None reported	None reported	None reported	None reported
Secondary milk type, combination	None reported	None reported	0.1 (0-0.3)[d]	None reported
Cow's milk substitutes only	None reported	None reported	None reported	0.1 (0-0.2)[d]
Unsweetened cow's milk substitute	None reported	None reported	None reported	None reported
Sweetened cow's milk substitute	None reported	None reported	None reported	0.1 (0-0.2)[d]
Secondary milk type, combination	None reported	None reported	None reported	None reported
Primary milk type, combination	16.3 (12.4-20.2)[c]	20.9 (14.7-27.2)[c]	21.1 (17.1-25.2)[c]	19.4 (15.1-23.7)[c]

[a]Primary milk type categories were constructed based on What We Eat in America sub-major food categories,[25] secondary milk type categories were classified according to product characteristics, and tertiary milk type categories were constructed based on protein form. See Methods section for details. Primary milk type categories sum to 100% within each age group (column). Secondary milk type categories further describe each primary milk type category and sum to the primary milk type category within each age group (column). Tertiary milk type categories further describe each secondary milk type category and sum to the secondary milk type category within age group (column).

[b]Cumulative percent within each column may not add to 100% due to rounding.

[c]Estimate may be statistically unreliable because the relative CI width is >130% of the proportion.

[d]Estimate may be statistically unreliable because the nominal or effective sample size is <30.

Table 6. The proportion of toddlers aged 12 to <24 months with day 1 of dietary recall (n = 1,436) from the National Health and Nutrition Examination Survey (2007-2018), fed each primary, secondary, and tertiary milk type category, by age group and survey cycle

	Age Group			
	12 to <18 mo		18 to <24 mo	
Milk type category fed[a]	2007-2012 (n = 415)	2013-2018 (n = 345)	2007-2012 (n = 389)	2013-2018 (n = 287)
	←——————————% (95% CI)[b]——————————→			
Human milk only	3.2 (0.1-6.3)[c]	2.6 (0.7-4.5)[c]	0.5 (0-1.2)[c]	2.1 (0.1-4)[c]
Infant formulas only	3.8 (1.8-5.9)[c]	3.9 (1.8-6.0)[c]	2.3 (0-5.2)[c]	None reported
Premature infant formulas only	None reported	None reported	None reported	None reported
Term infant formulas only	2.9 (1.2-4.7)[c]	2.7 (1.3-4)[c]	1.0 (0-2.9)[c]	None reported
Nonhydrolyzed protein	2.6 (0.9-4.2)[c]	1.9 (0.7-3)[c]	0.1 (0-0.2)[c]	None reported
Partially hydrolyzed protein	0.2 (0-0.6)[c]	0.2 (0-0.5)[c]	None reported	None reported
Extensively hydrolyzed protein	None reported	0.5 (0-1.3)[c]	0.9 (0-2.8)[c]	None reported
Amino acid-based protein	None reported	None reported	None reported	None reported
Tertiary milk type, combination	0.1 (0-0.4)[c]	0.1 (0-0.4)[c]	None reported	None reported
Transition infant formulas only	0.4 (0-1.3)[c]	None reported	None reported	None reported
Store brand or infant formulas not specified	0.4 (0-1.0)[c]	0.8 (0-1.9)[c]	1.3 (0-3.6)[c]	None reported
Secondary milk type, combination	0.1 (0-0.3)[c]	0.4 (0-1.1)[c]	None reported	None reported
Cow's milk and flavored cow's milks only	77.0 (70.7-83.2)	66.2 (59.2-73.2)	82.7 (77.9-87.4)	76.5 (70.2-82.8)
Unsweetened cow's milk	72.0 (65.9-78.2)	62.9 (55.9-69.9)	75.8 (70.6-81.1)	71.2 (65.2-77.3)
Sweetened cow's milk	0.7 (0-1.6)[c]	0.5 (0-1.6)[c]	1.3 (0-2.7)[c]	0.7 (0-1.8)[c]
Secondary milk type, combination	4.2 (1.6-6.9)[c]	2.7 (0-5.6)[c]	5.5 (2.5-8.6)[c]	4.5 (1.3-7.7)[c]
Cow's milk substitutes only	2.2 (0.9-3.6)[c]	1.5 (0-3.5)[c]	1.6 (0-3.3)[c]	6.4 (1.8-11.0)[c]
Unsweetened cow's milk substitute	2.2 (0.9-3.6)[c]	0.2 (0-0.6)[c]	0.3 (0-1.0)[c]	0.3 (0-1.0)[c]
Sweetened cow's milk substitute	None reported	1.3 (0-3.0)[c]	1.2 (0-2.9)[c]	3.6 (0-7.4)[c]
Secondary milk type, combination	None reported	None reported	None reported	2.5 (0-4.9)[c]
Primary milk type, combination	12.3 (7.0-17.6)[d]	24.8 (18.2-31.4)[d]	8 (4.7-11.3)[d]	8.6 (5.0-12.3)[d]
No milk reported	1.5 (0-2.9)[c]	0.9 (0-2.0)[c]	5 (2.9-7.1)[c]	4.9 (1.9-7.8)[c]

[a]Primary milk type categories were constructed based on What We Eat in America sub-major food categories,[25] secondary milk type categories were classified according to product characteristics, and tertiary milk type categories were constructed based on protein form. See Methods section for details. Primary milk type categories sum to 100% within each age group (column). Secondary milk type categories further describe each primary milk type category and sum to the primary milk type category within each age group (column). Tertiary milk type categories further describe each secondary milk type category and sum to the secondary milk type category within age group (column).

[b]Cumulative percent within each column may not add to 100% due to rounding.

[c]Estimate may be statistically unreliable because the nominal or effective sample size is <30.

[d]Estimate may be statistically unreliable because the relative CI width is >130% of the proportion.