



Published in final edited form as:

J Acad Nutr Diet. 2018 March ; 118(3): 464–470. doi:10.1016/j.jand.2017.10.020.

Timing of Introduction of Complementary Foods to US Infants, National Health and Nutrition Examination Survey 2009–2014

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Abstract

Background—Although there has been inconsistency in recommendations regarding the optimal time for introducing complementary foods, most experts agree that introduction should not occur before 4 months. Despite recommendations, studies suggest that 20% to 40% of US infants are introduced to foods at younger than 4 months. Previous studies focused on the introduction of solid foods and are not nationally representative.

Objective—Our aims were to provide a nationally representative estimate of the timing of introduction of complementary foods and to describe predictors of early (<4 months) introduction.

Design—We conducted a cross-sectional analysis of 2009–2014 National Health and Nutrition Examination Survey data.

Participants—The study included 1,482 children aged 6 to 36 months.

Main outcome measures—Timing of first introduction to complementary foods (anything other than breast milk or formula) was analyzed.

Statistical analyses performed—Prevalence estimates of first introduction to complementary foods are presented by month. Logistic regression was used to assess characteristics associated with early (<4 months) introduction.

Results—In this sample, 16.3% of US infants were introduced to complementary foods at <4 months, 38.3% between 4 and <6 months, 32.5% between 6 and <7 months, and 12.9% at 7 months of age. In unadjusted analyses, early introduction varied by breastfeeding status; race/

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

FUNDING/SUPPORT

There is no funding to disclose.

Hispanic origin; Special Supplemental Nutrition Program for Women, Infants, and Children participation; and maternal age. In adjusted analyses, only breastfeeding status remained significant; infants who never breastfed or stopped at <4 months were more likely (odds ratio 2.27; 95% CI 1.62 to 3.18) to be introduced to complementary foods early than infants who breastfed 4 months.

Conclusions—Despite using a broader definition of complementary foods, this analysis found a lower prevalence of early introduction in this nationally representative sample than previous studies that included only solids. However, many young children were still introduced to complementary foods earlier than recommended. Strategies to support caregivers to adhere to infant feeding guidelines may be needed.

Keywords

National Health and Nutrition Examination Surveys; Complementary feeding; Infant feeding; Infant feeding decisions; Solid food introduction

In recent years, there has been some inconsistency in the recommended timing of the introduction of complementary foods to infants. The term *complementary foods* refers to anything other than breast milk and infant formula, both solids and liquids, that are needed when milk feeds alone are no longer sufficient to meet the nutritional requirements of infants.¹ The Dietary Guidelines for Americans (DGA) serve as federal level diet and nutrition guidance for the population 2 years of age; however, there is no federal guidance for children under 2 years.² The 2020–2025 DGA are expected to begin incorporating or releasing federal dietary guidelines for this age group.² Some groups that do have guidelines recommend infants be introduced to complementary foods between 4 and 6 months of age³ and others recommend waiting until about 6 months^{1,4,5}; however, most agree that introduction before 4 months is too early and introduction after 8 months is too late. Currently, the American Academy of Pediatrics recommends that infants be introduced to complementary foods at about 6 months of age.⁵ Early introduction has been found to be a risk factor for obesity, although the evidence for this is inconsistent.⁶ Both early and late introduction are thought to be risk factors for celiac disease and type 1 diabetes.⁷ Late introduction has been associated with allergies, micronutrient deficiency, and poor eating patterns at later ages.^{7,8}

Previous studies in the United States have reported that 20% to 40% of infants are introduced to complementary foods before 4 months.^{9–11} These studies were not nationally representative and focused on introduction to solid foods without consideration for liquids. In addition, two of these studies are more than 10 years old. The timing of when non-milk liquids are introduced is important to consider, as early introduction of non-milk liquids is thought to compromise adequate intake of nutrients that come from breast milk and infant formula, and reduce the duration of breastfeeding among breastfed infants.¹² One Canadian study that focused on the timing of introduction of liquids other than breast milk and infant formula found 45% of infants were introduced to other liquids before 6 months.¹³

The objective of this study was to examine the timing of first introduction of complementary foods (including both solids and liquids other than breast milk and infant formula) among a

nationally representative sample of US children. In addition, breastfeeding status and the sociodemographic predictors of early (<4 months) introduction are described. These data may be relevant to the development of the DGA for this age group.²

METHODS

Data Source and Study Sample

This study used data from the 2009–2014 continuous National Health and Nutrition Examination Survey (NHANES). NHANES is conducted in 2-year cycles by the Centers for Disease Control and Prevention's National Center for Health Statistics. Each 2-year cycle obtains nationally representative data on the health and nutrition status of the non-institutionalized civilian population in the United States and uses a complex, stratified, multistage probability design to select participants. Respondents participate in both a household interview and a physical examination at the Mobile Examination Center; only data from the household interview questionnaires were used for this study. The unweighted response rate for the included NHANES survey years ranged from 82.2% to 88.8% for children aged <1 year and 79.0% to 90.4% for children aged 1 to 5 years.¹⁴ The National Center of Health Statistics Research Ethics Review Board approved NHANES protocol and all participants in NHANES provide written informed consent or by proxy for those who are <7 years of age.

The dietary behavior and nutrition questionnaire asks participants 0 to 6 years of age questions pertaining to infant feeding. A proxy, typically the child's parent, responds to these questions. The survey asks how old the infant was when he or she "was first fed anything other than breast milk or formula," including "juice, cow's milk, sugar water, baby food, or anything else that [the infant] might have been given, even water." The sample was limited to children who were reportedly first fed complementary foods before 12 months of age, as it is unlikely a child would receive only breast milk or formula beyond 12 months of life. Breastfeeding status was based on the following questions: "Was [name of the infant/child] ever breastfed or fed breast milk?" and "How old was [name of the infant/child] when [he/she] completely stopped breastfeeding or being fed breast milk? Breastfeeding was categorized as those who received breast milk for 4 or more months or those who did not (ie, never breastfed or stopped breastfeeding before 4 months). For both timing of complementary food introduction and breastfeeding duration, respondents could have answered in days, weeks, or months. NHANES then standardized these variables into days using the conversion factors: 7 days/week, 30.4 days/month, and 365 days/year.

Information on age; sex; race/Hispanic origin; participation in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC); poverty-to-income ratio; maternal age; and maternal smoking were collected during the in-home interview.¹⁵ Race and Hispanic origin were based on answers to questions on race and Hispanic origin and were reported in the following categories: non-Hispanic white, non-Hispanic black, and Hispanic. Estimates from the Other race/ethnicity category are not presented as a separate group for race/Hispanic origin specific estimates; however, these data are included in all analyses. WIC status was based on child's participation in WIC within the past 12 months and poverty-to-income ratio data; a poverty-to-income ratio 1.85 was used to determine

WIC income eligibility.¹⁶ WIC status was reported as not income-eligible, eligible-received, and eligible-not received. Maternal age was categorized as ≥ 25 years and < 24 years and maternal smoking during pregnancy was categorized as no or yes.

Two sets of analyses were completed, one including children who were 6 to 24 months of age at the time of the NHANES interview and one including children who were 6 to 36 months of age at the time of the NHANES interview. Results were similar between the narrower and expanded age groups, suggesting recall bias was not greater when including slightly older children. Therefore, in order to increase sample size, the expanded age group (6 to 36 months) was used as the analytic sample. The sample was limited to children at least 6 months of age as participants younger than 6 months of age may not yet be receiving complementary foods. In addition, the sample was limited to children no older than 36 months of age, as reporting of timing of introduction of foods and beverages may be less accurate among older children due to the potential for recall bias.

Data were available for 1,747 children 6 to 36 months of age. Children were excluded from analyses if they were reported to have been introduced to complementary foods after 12 months of age ($n=109$), had not yet been introduced to complementary foods ($n=16$), refused to answer the question pertaining to complementary food introduction or did not know when the participant was introduced to complementary foods ($n=5$), or were missing data on breastfeeding status or key sociodemographic variables ($n=135$). This resulted in a final analytic sample of 1,482.

Statistical Analysis

The distribution of the percentage of infants with reported first introduction to complementary foods is described by month of age. NHANES reported both age of introduction and duration of breastfeeding in days. For this study, age in days was converted to age in months; 1 month was defined by NHANES as 30.4 days. Because of small sample sizes, infants introduced to complementary foods at 0 to < 2 months were collapsed into one category, as were infants introduced at ≥ 9 months.

Logistic regression was used to assess whether breast-feeding status and any demographic characteristics predicted early (< 4 months) complementary food introduction. Odds ratios were adjusted for all included variables (breastfeeding status, sex, race/Hispanic origin, WIC status, maternal age, and maternal smoking during pregnancy). All analyses were conducted using SAS software¹⁷ survey procedures to account for NHANES complex sampling design. A 6-year interview sample weight was created to account for the complex survey design, survey nonresponse and post-stratification as recommended by the National Center for Health Statistics; weighted estimates are presented.¹⁸

RESULTS

Table 1 illustrates the breastfeeding status and selected sociodemographic characteristics of the 1,482 children included in the study. The mean age of the children was 16.4 months (standard deviation 7.8 months). Less than half of the children were still receiving breast milk at 4 months of age (43.3%) and just over half of the children were male (51.7%). More

than half of the children (52.4%) were non-Hispanic white, 12.5% were non-Hispanic black, and 26.3% were Hispanic. Among children in the study, 50.4% were not eligible for WIC, 42.1% were eligible for and received WIC in the past 12 months, and 7.5% were eligible but not receiving WIC. More than half of the children were born to mothers ≥ 25 years of age (69.6%) and most were born to mothers who did not report smoking (90.5%).

The distribution of the percentage of children aged 6 to 36 months and their reported age of first introduction to complementary foods is presented in the Figure. Among US children 6 to 36 months of age, 16.3% were introduced to complementary foods early (<4 months) and 38.3% were introduced to complementary foods between 4 and <6 months. Overall, 54.6% of infants were introduced to complementary foods before 6 months of age and 32.5% were introduced between 6 and <7 months. Introduction (≥ 7 months) occurred in 12.9% of infants.

In bivariate analyses, the odds of being introduced to complementary foods early (<4 months) were higher among infants never breastfed or breastfed <4 months (odds ratio [OR] 2.46, 95% CI 1.84 to 3.30) compared to infants breastfed for 4 months or longer (Table 2). In addition, the odds of being introduced to complementary foods early were higher among non-Hispanic black infants (OR 1.67, 95% CI 1.08 to 2.57) compared to non-Hispanic white infants, among infants receiving WIC (OR 1.38, 95% CI 1.01 to 1.89) compared to infants not eligible for WIC, and among infants born to mothers ≥ 24 years of age (OR 1.61, 95% CI 1.16 to 2.22) compared to infants born to mothers 25 years of age or older. After adjusting for covariates, only breastfeeding status remained significant (OR 2.27; 95% CI 1.62 to 3.18).

DISCUSSION

This is the first nationally representative report describing the timing of the introduction of complementary foods to US infants. Contrary to previous studies that found 20%⁹ to 40%¹⁰ of infants are being introduced to solids before 4 months of age, this study found that 16.3% are introduced to complementary foods before 4 months and 54.6% of infants are being introduced to complementary foods before the recommended 6 months. Consistent with existing literature, earlier introduction to complementary foods was associated with infants who had not received breast milk or had received it for <4 months.^{10,19,20} In one analysis that explored reasons for early introduction of complementary foods by milk feeding type, mothers of infants who were formula fed at the time of complementary food introduction were more likely to report that a doctor or other health professional had said that their baby was ready to begin eating solid foods.¹⁰ Infants with a longer duration of breastfeeding (ie, 4 months or longer) may be delaying food introduction as a result of the American Academy of Pediatrics recommendation to breast-feed exclusively through 6 months.²¹

Guidelines for complementary food introduction have changed dramatically over the last 60 years. In 1958, guidelines were released that recommended infants be introduced to solids in the third month,²² in the 1970s, guidelines began recommending solid introduction be delayed until after 4 months of age, and it was not until the 1990s that guidelines began specifying that solids not be introduced until 6 months of age.²³ Most recently, in 2017,

guidelines were released that recommend infants at high risk for developing allergies be introduced to peanut-containing foods as early as 4 to 6 months to reduce the risk of developing peanut allergy.²⁴ Given these variations, it is not surprising that studies that have focused on the timing of the introduction of solid foods have found a general lack of adherence to current professional guidelines.

The 2002 cross-sectional Feeding Infants and Toddlers Study (FITS) found that among toddlers 12 months and older, 29% were introduced to infant cereal and pureed foods before 4 months of age.¹¹ Another example is the 2005–2007 Infant Feeding and Practices Study II (IFPS II), a longitudinal study of children through 12 months of age, which reported 40% of infants were introduced to solid foods before the age of 4 months.¹⁰ Lastly, the US Department of Agriculture's WIC ITFPS-2 (Special Supplemental Nutrition Program for Women, Infants, and Children's Infant and Toddler Feeding and Practices Study), which began in 2013, found that 20% of low-income infants enrolled in WIC were introduced to infant cereals, fruits, vegetables, or meats before 4 months.⁹

There are several potential reasons why the timing of food introduction varied across studies. Studies were conducted at different time points (ie, 2002, 2005–2007, and 2013) and the method for assessing the timing of food introduction has varied across studies. For example, FITS was a cross-sectional survey, and parents of children 12 to 24 months of age were asked about the introduction of specific foods (infant cereal and pureed foods) and reported the timing of introduction in weeks or months.¹¹ However, IFPS II was a longitudinal study with approximately monthly data collection. The age of introduction to solid foods was calculated at the midpoint between the child's age when the mother reported no solid food consumption and when she first reported that her child had consumed solid foods in the previous 7 days.¹⁰ Therefore, if a child was receiving no complementary foods at 4 months, but reported receiving complementary foods in the previous 7 days at 5 months, the child would be considered to have received solid foods at 4.5 months. WIC IFPS-2 is also a longitudinal study and assessed the timing of when a child was first fed various foods at each data collection point, including months 1, 3, 5, 7, 9, 11, and 13 months.²⁵ It is not known how these different methodologies impact the reported percentages of children's introduction to complementary foods. An assessment between studies on how parents report food introduction (either specific foods or any foods or beverages) and the timing of food introduction (eg, days, months, mid points) may provide more details on the magnitude of these differences, but was beyond the scope of this study. Lastly, the study populations were not always similar. For example, women in FITS were identified from a child-level commercial vendor and were more likely to be white and of higher socioeconomic status.²⁶ Similarly, women in IFPS II were identified from a consumer panel and were more likely to be white, of higher socioeconomic status, able to read English, and have a stable mailing address.²⁷ However, women in WIC ITFPS-2 were drawn from national WIC sites and are representative of children participating in WIC.²⁵

This study had several limitations. Measurement error could have occurred from the diet behavior and nutrition interview data, as they rely on accurate memory of when foods or liquids were first introduced. There is also potential for bias related to the desire to be perceived as following best practices or recommendations. A further limitation is that

NHANES does not provide data on what foods are first introduced, the amount, or frequency of introduction. In addition, NHANES has limited data on maternal characteristics.

Strengths of this study include that NHANES is a nationally representative data source and therefore findings are generalizable across the United States and interviews were conducted in person by a trained interviewer.

The timing of when complementary foods are first introduced to infants has implications for public health, as early (before 4 months) and late (after 8 months) introduction has been associated with both short- and long-term adverse health outcomes.²⁸ To develop strategies to improve adherence to complementary feeding guidelines, it is important to understand not just who is introducing early, but why. Clayton and colleagues¹⁰ found mothers most commonly reported reasons for introducing early were that they wanted to feed their baby something in addition to breast milk or formula, a doctor or health care provider recommended they begin feeding solids, the baby seemed hungry a lot of the time, and to help the baby sleep longer at night.

The recommended timing of first introduction to complementary foods has been controversial and varied and historically span the 4- to 6-month time period.^{3-5,24} The current guidelines from American Academy of Pediatrics state that infants should first be introduced to complementary foods at about 6 months of age.⁵ Efforts to support caregivers, families, and health care providers may be needed to ensure that US children are achieving recommendations on the timing of food introduction. Inclusion of children <2 years in the 2020–2025 DGA may promote consistent messaging of when children should be introduced to complementary foods.

CONCLUSIONS

These findings provide a national estimate of the timing of first introduction of complementary foods to young children. These data indicate that 16% of US children are introduced to complementary foods too early (before 4 months) and one in two children are introduced to complementary foods before 6 months of age.^{1,5} Future research could explore which foods and beverages are introduced first and the reasons for variation in early introduction by milk feeding type.

Acknowledgments

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Author contributions: C. M. Barrera contributed to the analytic study design, conducted the analysis, and drafted and revised the final manuscript. C. G. Perrine contributed to the analytic study design and provided critical review of the manuscript. H. C. Hamner contributed to the analytic study design and provided critical review of the manuscript. K. S. Scanlon contributed to the analytic study design and provided critical review of the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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RESEARCH SNAPSHOT

Research Question

When are infants in the United States first being introduced to complementary foods?

Key Findings

Among US children 6 to 36 months of age in 2009-2014, 16.3% were introduced to complementary foods too early (<4 months). An additional 38.3% were introduced between 4 and <6 months and 32.5% were introduced at the recommended 6 to <7 months of age. The remaining 12.9% were introduced to complementary foods at 7 months.

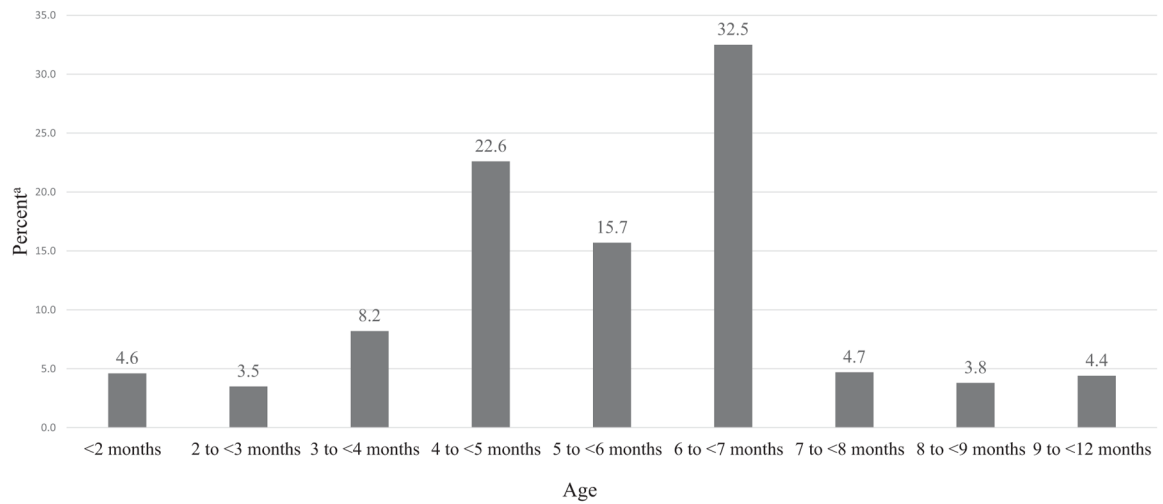


Figure.

The distribution of the percentage of children 6 to 36 months and their reported age of introduction to complementary foods, National Health and Nutrition Examination Surveys, 2009–2014 (n=1,482). ^aData are weighted to account for survey sampling design.

Table 1

Breastfeeding status and selected demographic characteristics of US children 6 to 36 months of age,^a National Health and Nutrition Examination Surveys, 2009–2014 (n=1,482)

Characteristic	n	Mean–SD ^b
Age, mo	1,482	16.4±7.8
		% ^c (95% CI)
Breastfeeding status		
4 mo	558	43.3 (39.0–47.5)
Never or <4 mo	924	56.7 (52.5–61.0)
Sex		
Male	755	51.7 (47.9–55.5)
Female	727	48.3 (44.5–52.1)
Race/Hispanic origin^d		
Non-Hispanic white	479	52.4 (46.4–58.5)
Non-Hispanic black	287	12.5 (10.2–14.9)
Hispanic	562	26.3 (20.3–32.2)
WIC^e status		
Not income-eligible	546	50.4 (46.6–54.2)
Eligible-received	828	42.1 (38.0–46.3)
Eligible-not received	108	7.5 (5.6–9.3)
Maternal age		
25 y	946	69.6 (66.4–72.8)
24 y	536	30.4 (27.2–33.6)
Maternal smoking during pregnancy		
No	1,335	90.5 (88.0–93.0)
Yes	147	9.5 (7.0–12.0)

^aAt time of interview.

^bSD=standard deviation.

^cData are weighted to account for survey sampling design.

^dRace/Hispanic origin subanalyses are limited to participants who report being non-Hispanic white, non-Hispanic black, or Hispanic.

^eWIC=Special Supplemental Nutrition Program for Women, Infants, and Children.

Table 2

Prevalence and odds ratios of introduction to complementary foods before 4 months of age by breastfeeding status and demographic characteristics among children 6 to 36 months of age,^a National Health and Nutrition Examination Surveys, 2009–2014

Variable	% ^b	Unadjusted	Adjusted ^c
←— odds ratio (95% CI) —→			
Total	17.3		
Breastfeeding status			
4 mo	9.9	Reference	Reference
Never or <4 mo	21.2	2.46 (1.84–3.30)	2.27 (1.62–3.18)
Sex			
Male	17.9	Reference	Reference
Female	14.5	0.77 (0.54–1.11)	0.75 (0.54–1.06)
Race/Hispanic origin^d			
Non-Hispanic white	15.7	Reference	Reference
Non-Hispanic black	23.7	1.67 (1.08–2.57)	1.40 (0.87–2.24)
Hispanic	15.8	1.01 (0.71–1.44)	0.94 (0.63–1.40)
WIC^e status			
Not income-eligible	13.9	Reference	Reference
Eligible-received	18.1	1.38 (1.01–1.89)	0.97 (0.67–1.41)
Eligible-not received	22.1	1.77 (0.83–3.77)	1.60 (0.76–3.37)
Maternal age			
25 y	14.2	Reference	Reference
24 y	21.0	1.61 (1.16–2.22)	1.22 (0.85–1.74)
Maternal smoking during pregnancy			
No	15.5	Reference	Reference
Yes	24.1	1.74 (0.88–3.42)	1.38 (0.64–2.97)

^aAt the time of interview.

^bData are weighted to account for survey sampling design.

^cEach adjusted odds ratio was adjusted for all other variables presented in the table.

^dRace/Hispanic origin subanalyses are limited to participants who report being non-Hispanic white, non-Hispanic black, or Hispanic.

^eWIC=Special Supplemental Nutrition Program for Women, Infants, and Children.