FOCUS

Several behavioral and dietary patterns associated with childhood obesity are now recognized to begin in infancy

Ann Nutr Metab 2013;62(suppl 3):27–36

Lessons from the Feeding Infants and Toddlers Study in North America: What Children Eat, and Implications for Obesity Prevention

by Jose M. Saavedra et al.

Key insights

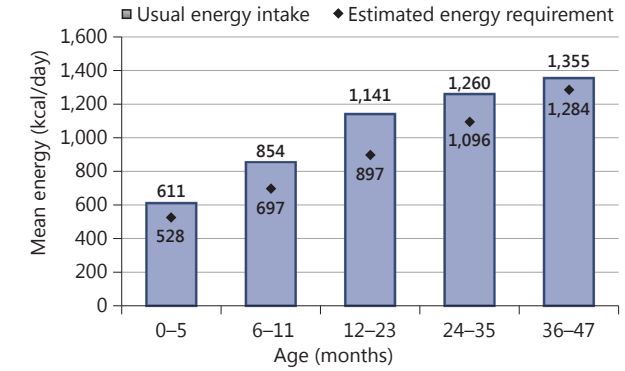
The Feeding Infants and Toddlers Study (FITS) is a long-term, comprehensive dietary survey that describes the feeding practices, nutrient intake and food consumption patterns of infants and young children in the US. The findings of this study underscore the higher than recommended intake of calories, protein, and saturated fats during infancy and the toddler years. These early dietary patterns not only mimic those of the family, but also set the path for suboptimal eating habits throughout later childhood and adolescence.

Current knowledge

One of the main goals of the FITS was to identify the dietary factors associated with early childhood overweight. Analysis of the data revealed several key findings. First, the average energy intake of young children was consistently greater than their estimated needs. Second, although the initiation of breastfeeding was acceptable, there was a significant decline in the duration of breastfeeding at 6 months and 1 year of age. Contrary to the recommendations of the American Academy of Pediatrics, 17% of infants younger than 1 year were fed cow's milk. Finally, the early introduction of solid foods, low consumption of fruits and vegetables, and high intake of sweetened food and beverages are important contributing factors to the prevalence of childhood obesity.

Practical implications

One means of improving diet quality is to replace energy-dense foods with fruits and vegetables. Between the ages of 9–18 months, an infant experiences major transitions in the diet. By the age of 2 years, the dietary patterns established during this period are set for life. The first 2 years therefore provide parents and caregivers with a critical window of opportunity in which to lay the foundation for healthy eating habits, improving the health of the next generation, and curbing the epidemic of obesity.



Results from the 2008 Feeding Infants and Toddlers Study (FITS) data indicate that the average energy intake of young children was consistently greater than their estimated needs. For further details, please refer to the article.

Recommended reading

Briefel RR, Kalb LM, Condon E, et al: The Feeding Infants and Toddlers Study 2008: study design and methods. J Am Diet Assoc 2010;110:S16–S26.

KARGER

© 2013 S. Karger AG, Basel

E-Mail karger@karger.com
www.karger.com/anm

Downloaded by:
University of Rhode Island
131.128.157.108 - 1/13/2015 6:05:53 PM

Annals of Nutrition & Metabolism

Ann Nutr Metab 2013;62(suppl 3):27–36
DOI: 10.1159/000351538

Published online: August 19, 2013

Lessons from the Feeding Infants and Toddlers Study in North America: What Children Eat, and Implications for Obesity Prevention

Jose M. Saavedra[a, c] Denise Deming[b] Anne Dattilo[a] Kathleen Reidy[b]

[a]Nestlé Nutrition, North America, and [b]Nestlé Nutrition Global R&D, Florham Park, N.J., and [c]Johns Hopkins University School of Medicine, Baltimore, Md., USA

Key Messages

- Caloric intake during infancy and toddler years appears excessive in young children in the US, beginning before 4 months of age.
- Major changes in the diet happen during 9–18 months and dietary patterns are set by 2 years of life.
- As children begin eating from the family table, their diets begin to mirror some of the unhealthy eating patterns often seen in older children and adults.
- The first 2 years of life are a critical time period where parents can and should intervene to establish healthy patterns that may well last a lifetime and could help curb the obesity trend.

Key Words

Infant · Diet · Dietary intake · Overweight · Obesity · Breastfeeding

Abstract

The latest exhaustive survey of dietary patterns in infants from the Feeding Infants and Toddlers Study (FITS) in North America documents and quantifies current trends in infant feeding. These include higher than generally recommended energy, protein, and saturated fat intakes. The majority of infants are bottle fed at some point in their first year of life, and their weaning diet often includes low intakes of fruits and vegetables, with high starchy, rather than green or yellow, vegetables. Early introduction of solids, use of cow's milk prior to 1 year of age, and high juice intake in the first 2 years – all less desirable diet practices – are improving, but are still prevalent. More preschoolers are likely to get sweets or sweetened beverages than a serving of fruit or a vegetable on a given day. These food intake patterns mimic the adult American diet and are associated with an increased risk of obesity in childhood and later life. But more importantly, these patterns appear to be set as early as 18 months of age, and by 20 months of age, they mimic the adult diet. Despite increase in total energy intake, and greater variety of foods, the basic characteristics of macronutrient intake distribution and food group contribution of energy to the diet before 2 years of age remain remarkably stable and similar to the family table. Obesity prevention needs to include specific targets in terms of breastfeeding and adequate formula feeding, as well as appropriate introduction of weaning foods with goals of changing the inadequate patterns documented in the FITS. These interventions will also require addressing parent and caregiver behaviors, including attending to hunger satiety cues (responsive feeding), and shaping early food preferences. This needs to be done starting at birth, in the first months of life. Early intervention offers a unique and potentially efficacious opportunity to shape the future dietary patterns of the next generation.

Copyright © 2013 S. Karger AG, Basel

KARGER

E-Mail karger@karger.com
www.karger.com/anm

© 2013 S. Karger AG, Basel
0250–6807/13/0627–0027$38.00/0

Jose M. Saavedra, MD
12 Vreeland Rd.
Florham Park, NJ 07960 (USA)
E-Mail Jose.saavedra@us.nestle.com

Downloaded by:
University of Rhode Island
131.128.157.108 - 1/13/2015 6:05:53 PM

Introduction

The prevalence of childhood overweight has reached epidemic proportions worldwide [1]. Children are becoming affected with excess weight at young ages, and although socioeconomic and racial disparities exist, overweight and obesity rates for even the youngest populations are alarming and contribute to long-term health and economic hardships [2]. The United States National Health and Nutrition Examination Survey from 2009 to 2010 [3] identified that 9.7% of 0- to 2-year-olds reached ≥95th percentile weight for recumbent length (diagnostic of an 'obese' categorization) and 12.1% of children aged 2–5 years met the obesity criteria, defined as a body mass index (BMI) ≥95th percentile. Although data for overweight (identified by ≥85th percentile of BMI for age) are not available from this recent nationally representative study for children less than age 2 years, 26.7% of 2- to 5-year-olds were overweight, an increase in prevalence of 21.2% in 2007–2008 [4].

Childhood obesity has long been known as a strong predictor of adult obesity [5], and recent data indicate that the tracking of weight begins early in a child's life. Infant adiposity or increased BMI, as early as 2 weeks of age [6], through 24 months of age [7–9], has been associated with a significantly increased risk of overweight during toddler or preschool age years. Children who were obese at 9 or 24 months were 3 times more likely to retain an unfavorable obese weight at age 4, compared to non-obese children measured during their first 2 years of life. In contrast, children with a normal weight status at 9 months, who remained at a normal weight at 2 years, were much more likely to have a normal weight at age 4 (84.8%) than to become overweight (8.9%), or obese (6.3%) [7]. Attention to weight status in the first years of life may be the most critical time for overweight prevention.

Antecedents of early childhood obesity are clearly multifactorial, and associations of varying strength have been documented for genetic, biologic, dietary, environmental, social, and behavioral factors. Multiple potentially modifiable dietary and parent feeding practices have been demonstrated to correlate with weight status in children, even those as young as infant age [10]. Feeding choices, such as breastfeeding, along with a healthy diet quality and appropriate quantity during the first few years of life are paramount in setting the stage for establishing food intake patterns that could halt the obesity epidemic and provide opportunity for healthy growth. Recognition that food preferences and intake patterns emerge prior to 24 months of age, and tend to track through the first few years of life, offers opportunities for health care practitioners to intervene and provide direction for policy makers to consider. The Feeding Infants and Toddlers Study (FITS) is one of the most comprehensive dietary intake surveys that describes the infant feeding practices, nutrient intakes, and food consumption patterns of infants and young children living in the US. FITS surveys have been conducted in 2002 and 2008. It is the aim of this paper to use FITS data to describe what is known about the early dietary intake of infants and young children, with a focus on dietary factors associated with early childhood overweight, during the first 24 months of life and through the toddler age.

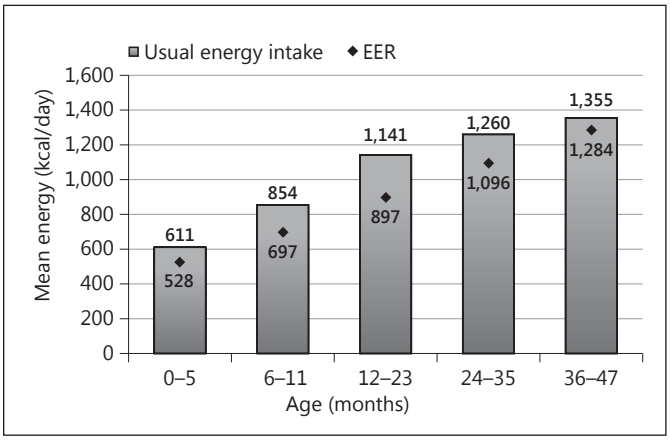


Fig. 1. Mean energy intake (kcal/day) of children aged 0–47 months from the FITS 2008 and EER estimated from Center for Disease Control and Prevention growth charts using median body weights (adapted from Butte et al. [14] and Kuczmarski et al. [13]).

Methods

The FITS is a cross-sectional dietary intake survey of a national random sample of parents and caregivers of infants and young children living in the US. The FITS was designed to obtain information on the diets and feeding practices of US infants, toddlers, and preschoolers from birth to 47 months, i.e. up to age 4 years. The FITS 2008 consisted of up to three telephone interviews between June 2008 and January 2009. A recruitment interview to collect household and child characteristics, and a dietary interview using a 24-hour dietary recall and questions on breastfeeding, the introduction of foods, and dietary supplement use on the recall day (n = 3,273), were utilized. Details of the design, dietary data collection, analysis methods, and study limitations have been described elsewhere [11]. Some data are compared to the FITS 2002 data, which used a similar methodology described by Devaney et al. [12]. Information about total energy intake, intake distribution of macronutrients, breastfeeding, and food consumption patterns are provided below.

Ann Nutr Metab 2013;62(suppl 3):27–36
DOI: 10.1159/000351538

Downloaded by:
University of Rhode Island
131.128.157.108 - 1/13/2015 6:05:53 PM

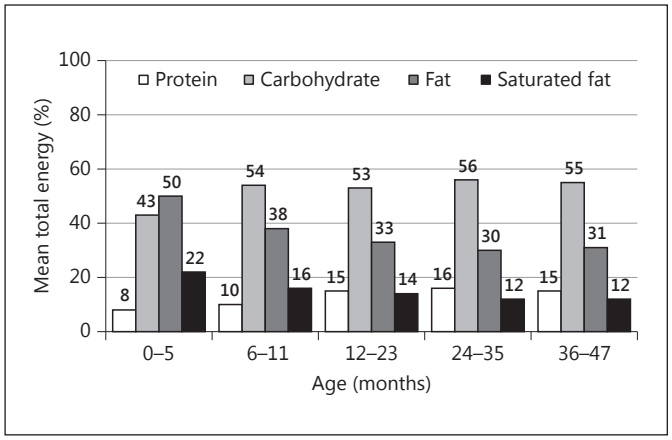


Fig. 2. Mean intake of protein, carbohydrate, total fat, and saturated fat as a percentage of total energy of children aged 0–47 months from the FITS 2008 (adapted from Butte et al. [14]).

Energy Intake and Macronutrient Distribution

Compared to estimated energy requirements (EER), based on Center for Disease Control and Prevention median weights and heights of US children [13], results from the 2008 FITS data indicated that average energy intakes were consistently in excess of estimated needs (fig. 1). For example, the mean energy intake of infants <6 months of age was approximately 14% greater (83 kcal/day) than estimated needs; from 6 to 11 months, the energy differential between actual intake and EER rose to 157 kcal/day (18.4%), and at 1–2 years of age, children on a given study day were consuming an additional 244 kcal (21.4%), relative to EER. Discrepancies between the EER and reported energy intake may reflect various factors [14]; nevertheless, caloric content of infants' and toddlers' diets is likely contributing, in some degree, to the prevalence of overweight and obesity in young children.

Small variations in intake in early infancy can make a big difference. Assuming energy intake from the FITS compared to the EER for ages 0–5 months, and applying the first law of thermodynamics in its simplest form, after 6 weeks of 83 additional kcal/day, an estimated 0.45 kg excess weight gain would be possible, and after only 6 months, an additional 2.0 kg of weight could be predicted. Utilizing an average weight of 8.2 kg for a 6-month-old infant boy, the weight differential of 2.0 kg corresponds to the difference between a weight for age between the 50th and the 95th percentile.

Holding energy intake constant, there is a dearth of literature comparing young children's macronutrient distribution to weight gain. It has been hypothesized that the observed higher growth rates among formula-fed versus breastfed infants may be related to higher protein intake [15], which was suggested to contribute to an enhanced release of growth-promoting hormones [16]. In a double-blind, randomized controlled trial, growth measures were followed for 2 years among infants fed lower- and higher-protein formulas in the first year of life [17, 18]. Small, but statistically significant higher measures of growth were reported among infants fed the higher-protein formulas. It is unclear whether the effects of protein intake per se persist and are related to a risk of obesity later in life [19]; nevertheless, judiciously lowering protein intake in formula-fed infants, closer to that of breastfed infants, seems a reasonable potential approach.

Agostoni et al. [20] suggested that when dietary protein approximates 16% of total energy intake in 12- to 24-month-old children, an association with later overweight is more likely than when the percentage of energy from protein is <15% of total calories. The percentage of energy from protein at 1–2 years of age has been positively associated with BMI at 5 years of age, and negatively associated with age of adiposity rebound in young children [21, 22], a reported risk factor for later obesity [23].

It is unclear whether protein intake during the transition to the family diet is a critical point for overweight risk among young children. The FITS data showed that mean protein intake sharply increased from approximately 8–10% of calories from birth to 11 months, to 15% of energy at 1 year (fig. 2). Moreover, the mean percentage of energy from protein remained at 15–16% through toddlerhood to age 4 years. It is noteworthy that as US infants advance their diet from breast milk (approximately 7% of calories from protein in mature milk) [24] or infant formula (approximately 8% of calories from protein) to whole cow's milk (approximately 20% of energy from protein for 3.7% fat milk) [25] at 12 months of age, a concomitant increase in total energy from protein is seen. Thus, it appears the switch to cow's milk from breast milk or formula is a major indicator of protein intake among

Judiciously lowering protein intake in formula-fed infants, closer to that of breastfed infants, seems a reasonable potential approach.

Downloaded by:
University of Rhode Island
131.128.157.108 - 1/13/2015 6:05:53 PM

young children aged 1–3 years (see discussion on milk, below).

Beginning at 1 year of age, overall, the percentage of macronutrient distribution is in line with the percent energy recommendation by the Institutes of Medicine; however, mean saturated fat intake at 2 years of age was elevated to 12% compared to the 10% recommended by the Dietary Guidelines for Americans [26]. Since patterns for macronutrient intake emerge at approximately 12 months and begin to track with relatively minor changes from age 1–4 years, just prior to 1 year of age may be an optimal time to adopt patterns of energy intake consistent with healthy growth. By replacing more energy-dense foods with foods such as fruits and vegetables, which are generally high in fiber and low in protein, typically devoid of saturated fat and also relatively low in calories, diet quality will naturally improve. Such an alteration in macronutrient contribution and energy intake may be an effective approach to decreasing early childhood risk of overweight.

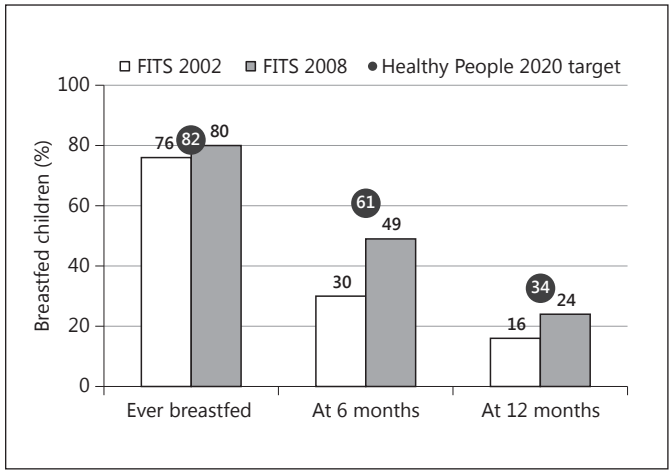


Fig. 3. Breastfeeding rates of infants from the FITS 2002 and 2008 compared with Healthy People Objectives for 2020 (adapted from Siega-Riz et al. [32] and Healthy People 2020 [33]).

Transitions in Food Consumption Patterns

Breastfeeding

Several observational studies, meta-analyses, and systematic reviews have examined the role of breastfeeding in relation to childhood and adulthood obesity [27–29]. Although some earlier results are inconsistent, the vast majority of studies showed some protective role of breastfeeding from risk of obesity, and more recent trials have reported that breastfeeding duration and/or exclusivity has been inversely associated with rate of weight gain or weight measures during infancy, adiposity or risk of overweight and obesity in toddler and preschool-age children [30, 31]. Despite the well-documented health benefits to mothers and infants, rates of breastfeeding, particularly exclusive breastfeeding, are discouragingly low.

The FITS data from 2002 and 2008 indicated some positive trends between these years in the incidence and duration of breastfeeding among US women (fig. 3). However, in 2008, although nearly 80% of infants initiated (any) breastfeeding, only 49.4% were still breast fed at 6 months, and far less (24.2%) were provided breast milk at 12 months of age [32]. Data from the 2008 survey demonstrated that although initiation rates of breastfeeding were acceptable toward the 2020 US Government's Healthy People Objective of 82%, there was a frank disparity between the duration goal of 61% breastfeeding prevalence at 6 months of age, and 34% at 1 year [33].

The mechanisms by which breastfeeding could decrease the risk of overweight or obesity remain unclear, but it has been suggested that breastfed infants develop a feeding style that allows a stronger self-regulation of intake compared to when they are bottle fed. For example, when infants were fed only human milk from a bottle, they gained significantly more weight (88.8 g/month) than infants that were fed directly from the breast [34]. The act of bottle feeding may affect a caregiver's reading and interpretation of hunger and satiety cues that are not typically disrupted with the finely regulated supply-and-demand relationship present in breastfeeding [35]. Energy intake, often dictated by feeding practices and adequate recognition of hunger satiety cycles, independent of formula composition, may be a critical modifiable dietary factor for obesity prevention, particularly in bottle-fed infants.

By replacing more energy-dense foods with foods such as fruits and vegetables, which are generally high in fiber and low in protein, typically devoid of saturated fat and also relatively low in calories, diet quality will naturally improve.

Downloaded by:
University of Rhode Island
131.128.157.108 - 1/13/2015 6:05:53 PM

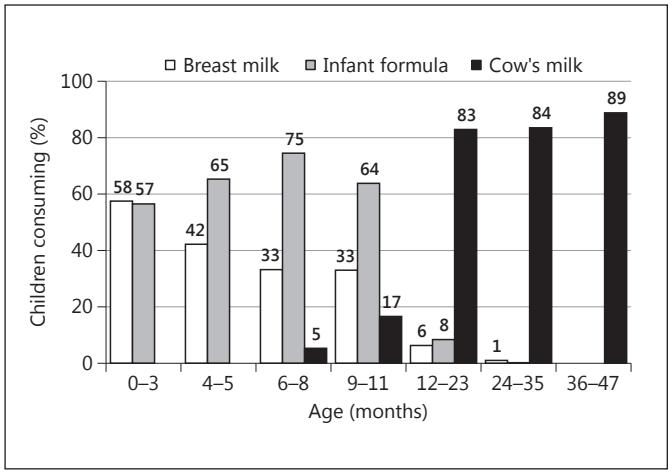


Fig. 4. Mean percentage of children aged 0–47 months who consumed breast milk, infant formula, or cow's milk on the day of the dietary survey (FITS 2008) (adapted from Siega-Riz et al. [32] and Fox et al. [44]).

Breastfeeding, compared to formula feeding, has also been associated with other desirable parental feeding practices related to a decreased risk of overweight development, such as the delayed introduction of complementary foods until at least 4 months and less frequent offering of high-sucrose or high-fat foods at 1 year of age [36, 37]. In addition, a vast array of flavors derived from foods, spices, and beverages ingested by the mother are provided to the infant from breast milk, which, in turn, may influence an infant's subsequent acceptance and preference of these flavors in foods at weaning. For example, infants whose mothers consumed carrot juice during the first 3 months of breastfeeding showed enhanced preference for carrot-flavored cereal at weaning, compared to infants whose mothers did not drink carrot juice or eat carrots [38]. These early experiences with flavor compounds in breast milk can modify later flavor and food acceptance [39] and may explain findings that breastfed infants are less 'picky eaters' and more willing to try new foods [40, 41] compared to formula-fed infants not provided an early exposure to a multitude of flavors.

Milks

Transitions in milk consumption patterns among children age 0 through 47 months from FITS 2008 are shown in figure 4. Similar percentages of infants consumed some breast milk (58%) or infant formula (57%) from birth to 3 months of age. However, infant formula was the most common source of milk in the infant diet consumed by >60% of 4- to 11-month-olds. Breast milk consumption declined after age 3 months, and about a third of infants continued to consume breast milk throughout infancy. By the age of 12 months, the major milk source in the diet shifted dramatically from infant formula to cow's milk with >80% of 1- to 3-year-olds consuming cow's milk in a day.

These early experiences with flavor compounds in breast milk can modify later flavor and food acceptance and may explain findings that breastfed infants are less 'picky eaters' and more willing to try new foods.

Seventeen percent of 9- to 11-month-olds in the FITS were fed cow's milk [32], which is not in line with the American Academy of Pediatrics (AAP) recommendation to delay cow's milk before 1 year of age [42]. For the second year of life, the AAP recommends feeding whole cow's milk to support the need for rapid growth and development of children in this age group, and using lower-fat milks for 1- and 2-year-old infants with a family history of obesity, lipid disorders or cardiovascular disease. This guideline is in contrast to the American Heart Association recommendation of lower-fat milk to *all* children aged 1 year and older [43]. The FITS data show that 60–68% of children aged 12–23 months consumed whole milk, but up to a third consumed reduced fat milks (fat-free, 1–2%) [32]. While FITS showed that there was a shift to lower-fat milks by the age of 2 years, most 2- and 3-year-olds still consumed whole or reduced-fat (2%) milk and very few consumed fat-free or low-fat (1%) milks [44]. As mentioned above, both energy and saturated fat intakes are above desirable in US infants. Changing the type of milk that a young child consumes in a day could have a significant impact on the total calorie and saturated fat intake in the diet described earlier. If a 2-year-old child consumed 2 cups of milk, the calorie reduction to moving from whole to fat-free or low-fat (1%) milks would be 90–130 kcal and 6–9 g of saturated fat [25].

Iron-Fortified Infant Cereal

Early introduction of solids (<4 months of age) has been associated with increased risk for childhood overweight [45, 46]. The FITS survey in 2002 documented that 26% of infants were introduced to solid foods before 4 months of age [37] and the FITS 2008 survey indicated

Ann Nutr Metab 2013;62(suppl 3):27–36
DOI: 10.1159/000351538

Downloaded by:
University of Rhode Island
131.128.157.108 - 1/13/2015 6:05:53 PM

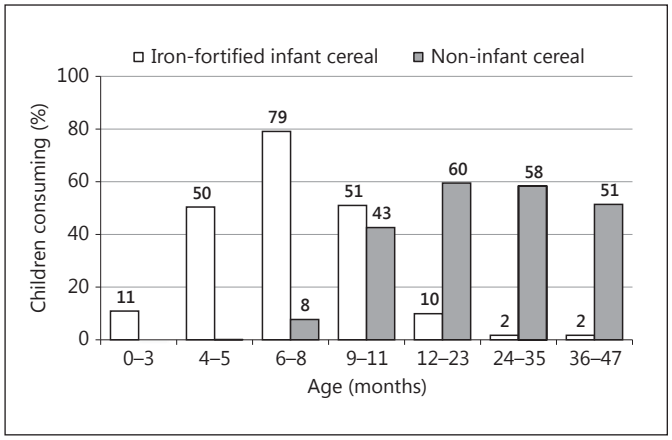


Fig. 5. Mean percentage of children aged 0–47 months who consumed infant cereal and non-infant cereal on the day of the dietary survey (FITS 2008). Non-infant cereal included ready-to-eat cereals and hot cereals (adapted from Siega-Riz et al. [32] and Fox et al. [44]).

that approximately 10% of infants were introduced to complementary foods prior to 4 months of age, indicating an improvement in this practice compared to the 2002 survey [32].

Introduction of iron-rich foods is recommended around the age 4–6 months [42, 47]. The AAP recommends iron supplementation for all exclusively or partially breastfed infants at 4 months of age, and that supplementation may be discontinued if an infant is fed infant formula or iron-containing complementary foods [48].

In the US, infant cereal is the most common first solid food introduced. Iron-fortified infant cereals are a major source of iron in the infant diet, yet the FITS data reveal some concerns related to cereal consumption and iron intake. In 2008, the percentages of infants who consumed iron-fortified infant cereal decreased from 79% among 6- to 8-month-old infants to 51% among 9- to 11-month-old infants (fig. 5). A significant drop in iron-fortified infant cereal consumption in 2008 was also reported among infants aged 4–5 months and 9–11 months compared to the same-age infants in the 2002 survey [32]. While less infant cereal consumption at 4–5 months is in line with some recommendations that advocate no complementary food before 6 months [42], the lower consumption of iron-fortified infant cereal among 9- to 11-month-olds is a concern (particularly in exclusively breastfed infants who receive less additional iron than formula-fed infants), given the inadequate iron intakes reported among older infants in 2008. Twelve percent of children 6–11 months old had intakes below the estimated average requirement in 2008 versus 7% in 2002 [14].

Reduced dietary iron is consistent with a lower consumption of baby food meats after age 8 months in the FITS. It is also plausible that the inadequate iron intakes among older infants are influenced by the replacement of infant cereals with non-infant cereals in the diets of older infants. In 2008, the prevalence of non-infant cereals, primarily ready-to-eat cereals, increased from 8% among 6- to 8-month-olds to 43% among 9- to 11-month-olds (fig. 5). While the ready-to-eat cereals are useful to encourage the development of fine motor feeding skills, these cereals provide up to 50% less iron on a weight basis than infant cereals [25, 49]. Encouraging the use of iron-fortified infant cereals through 12 months of age will help provide adequate iron intake in early life.

Fruits and Vegetables

Children with a high consumption or availability of fruit and/or vegetables consume less total energy and this is associated with a more desirable body composition or body weight during preschool years [31, 50, 51]. The FITS data show troubling concerns regarding fruit and vegetable consumption patterns among US infants and young children. Substantial proportions of older infants and toddlers, aged 9–23 months, did not consume any fruit, in any amount, on the day of the survey – 24–35% of children in 2002 [52] and 16–27% in 2008 [32]. A similar lack of fruit consumption was reported among 2- and 3-year-olds in FITS 2008 [44], and among most Americans aged 2 years and above [53, 54]. FITS data show that apples, bananas, pears, and peaches are the most popular fruits and consumed most often as baby food among infants [32]. From the age of 1–3 years, fresh fruit was most commonly consumed, and apples, bananas, grapes, and strawberries ranked as the most popular [32, 44].

In addition to lack of vegetable consumption, the data show a major shift in the consumption of different types of vegetables in figure 6. Sweet potatoes, carrots, and squash were the most frequently consumed vegetables among infants aged 6–8 months. Yet, the consumption of white potatoes and corn, as well as green beans, became more common with age. By the age of 9 months, mashed potatoes were as common as sweet potatoes, and after the first year, it is striking to see that French fries surpassed the sweet potato as the most popular vegetable. Moreover, the proportions of children who consumed fried potatoes (French fries) almost doubled those who consumed mashed potatoes or corn by the age of 2 years.

Downloaded by:
University of Rhode Island
131.128.157.108 - 1/13/2015 6:05:53 PM

	Mean percentage of children consuming vegetables				
Rank	6–8 months	9–11 months	12–23 months	24–35 months	36–47 months
1	16% baby food sweet potatoes	11% mashed potatoes[1]	15% French fries[1]	19% French fries[1]	18% French fries[1]
2	14% baby food mixed vegetables	10% baby food sweet potatoes	14% cooked green beans[1]	11% cooked broccoli[1]	10% cooked corn[1]
3	11% baby food carrots	8% cooked broccoli	10% mashed potatoes[1]	11% mashed potatoes[1]	10% cooked green beans[1]
4	10% baby food peas	7% cooked green beans[1]	10% cooked carrots[1]	10% cooked green beans[1]	8% cooked broccoli[1]
5	9% baby food squash	7% baby food green beans	10% cooked corn[1]	9% cooked corn[1]	7% cooked mixed vegetables[1]

Fig. 6. Most frequently consumed vegetables (ranked 1–5) consumed by children aged 6–47 months from the FITS 2008. Values are the mean percentage of children who consumed the vegetable on the day of the survey (adapted from Siega-Riz et al. [32] and Fox et al. [44]). [1] Non-baby food vegetables.

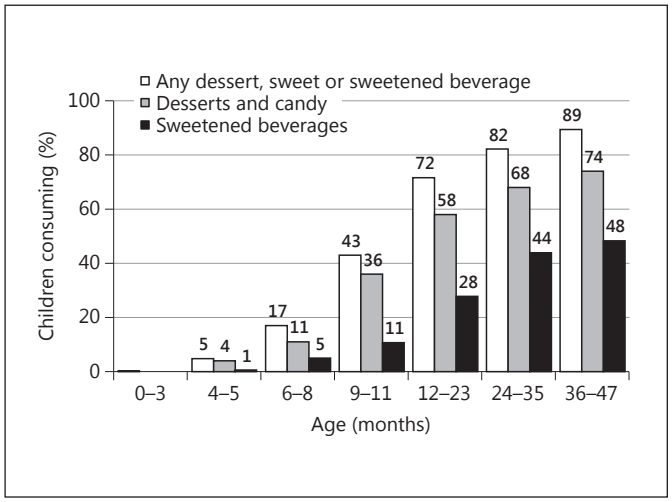


Fig. 7. Mean percentage of children aged 0–47 months who consumed any dessert, sweet, or sweetened beverage on the day of the survey (FITS 2008) (adapted from Siega-Riz et al. [32] and Fox et al. [44]).

Fruit and vegetable consumption by 18 months mirrors the adult American diet, in which only approximately 10% of energy comes from fruits and vegetables. FITS also showed that about half of the calories from vegetables derive from white potatoes; and this is also consistent with the typical adult American diet, in which calories available from white potatoes are about half (2.7%) of total calories available from vegetables (4.7%) [49]. Importantly, it is also during this transition that the consumption of commercially prepared baby food vegetables declined and cooked and raw vegetables, typically those from the family table, become the major form consumed [32]. Boiled white potato and broccoli contribute 116 and 28 kcal/100 g, respectively, to the diet. Thus, small changes that, for example, encourage green and yellow vegetables versus starchy vegetables can make significant differences. More importantly, the energy contribution of each food group to total calories becomes fixed and stable after 18 months of age, already mimicking the adult diet, in which <10% of energy comes from fruits and vegetables. Thus, 'early intervention' to set adequate eating patterns needs to start before 2 years of life.

More children consumed whole fruit than 100% fruit juice [32, 44], which is in line with feeding recommendations to encourage fruit intake from whole fruit rather than juice [26], and to limit fruit juice intake among infants and young children aged 1–6 years [55]. In fact, FITS data show significantly fewer children who consumed 100% fruit juice from age 6–11 months in 2008 compared to 2002 [32]. Yet, it is important to note that in 2008, 100% fruit juice consumption increased progressively during infancy, peaked after 11 months, and more than half of 1- to 3-year-olds consumed 100% fruit juice in a given day [32, 44].

Downloaded by:
University of Rhode Island
131.128.157.108 - 1/13/2015 6:05:53 PM

Sweets and Sweetened Beverages

A significant cause for concern is the early introduction and rapid rise in the consumption of low-nutrient, energy-dense sweets (e.g. desserts, cookies, and candy) and sweetened beverages among infants and young children. The consumption of sugar-sweetened beverages and energy-dense foods has been identified as a dietary risk factor for childhood obesity [56, 57]. In FITS 2008, these foods continued to appear in the infant diet as early as 4–5 months of age and by the age of 9–11 months. Forty-three percent of infants consumed some type of dessert, sweet or sweetened beverage at least once in a day (fig. 7). This percentage increased to 72% among toddlers, characterized by a progressive rise from the age of 12–14 months up to 21–23 months [32], and driven by the increased consumption of desserts (including cakes, pies, and cookies), and candy (58%) and sweetened beverages (28%).

Decreasing discretionary calories and increasing vegetable and fruit intake not only is necessary, but it is critical to do this starting at 4–6 months of age.

The pattern of increasing consumption of sweets and sweetened beverages continued among young preschoolers in FITS 2008. Over 80% of 2- and 3-year-olds consumed one or more of such foods in a day, and for almost all of the foods considered, the percentages of children consuming them was higher for 3-year-olds than for 2-year-olds [44]. For example, 68% of 2-year-olds and 74% of 3-year-olds consumed desserts and candy at least once in a day and 44 and 48% consumed sweetened beverages, respectively (fig. 7). Perhaps more troubling is that by the age of 2 years, a sweet was more commonly consumed than either a vegetable or a fruit. More young preschoolers (82–89%) consumed any type of dessert, sweet, or sweetened beverage in a day than distinct portions of vegetables (68–72%) or of fruits (71–73%) [44]. A 3-year-old who consumed 8 ounces of a fruit-flavored drink (117 kcal) and 3 sandwich cookies (159 kcal) in a day would greatly exceed the discretionary energy allowance of 171 kcal for that age [58]. It is clear that the current intake of sweets and sweetened beverages greatly exceeds the allowance for discretionary calories in most infants and toddlers. Decreasing discretionary calories and increasing vegetable and fruit intake not only is necessary, but it is critical to do this starting at 4–6 months of age.

Conclusion

Several behavioral and dietary patterns associated with childhood obesity are now recognized to begin in infancy [10]. Therefore, in considering approaches to prevention, addressing these at an early age is critical. Too many infants and young children have diets that provide an excessive number of calories, starting with bottle feeding and weaning into diets that are low in fruits and vegetables and high in sweets and sweetened beverages, and saturated fat. As children begin eating from the family table, their diets begin to mirror some of the unhealthy eating patterns often seen in older children and adults; thus, it is ultimately the family table that needs to be improved. However, early intervention may allow for shaping the diet, food intake, and food preferences of children. Potential interventions through the first 2 years of life include: education prior to birth, breastfeeding, responsive feeding practices, including adequate bottle feeding education, and attending to hunger and satiety cues, as well as appropriate food choices and portion size selection. Such an approach may ultimately lead to both healthy eating, as well as improved growth patterns. Taking advantage of the learning plasticity of infants and the opportunities for early life programming is a potentially efficacious approach to childhood obesity prevention. And perhaps, through teaching parents about a healthy diet for their young child, at a time when young families may be open to change, we may improve the quality of the family table and the healthfulness of the family's diet.

Disclosure Statement

All authors are employed by Nestlé Nutrition.

References

1 International Obesity Task Force: Global childhood overweight. http://www.oecd.org/ (accessed February 15, 2013).
2 Hammond RA, Levine R: The economic impact of obesity in the United States. Diabetes Metab Syndr Obes 2010;3:285–295.
3 Ogden CL, Carroll MD, Kit BK, Flegal KM: Prevalence of obesity and trends in body mass index among US children and adolescents, 1999–2010. JAMA 2012;307:483–490.

Downloaded by:
University of Rhode Island
131.128.157.108 - 1/13/2015 6:05:53 PM

4 Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal KM: Prevalence of high body mass index in US children and adolescents, 2007–2008. JAMA 2010;303:242–249.
5 Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH: Predicting obesity in young adulthood from childhood and parental obesity. N Engl J Med 1997;337:869–873.
6 Winter JD, Langenberg P, Krugman SD: Newborn adiposity by body mass index predicts childhood overweight. Clin Pediatr (Phila) 2010;49:866–870.
7 Moss BG, Yeaton WH: US children's preschool weight status trajectories: patterns from 9-month, 2-year, and 4-year Early Childhood Longitudinal Study-birth cohort data. Am J Health Promot 2012;26:172–175.
8 Stettler N, Iotova V: Early growth patterns and long-term obesity risk. Curr Opin Clin Nutr Metab Care 2010;13:294–299.
9 Taveras EM, Rifas-Shiman SL, Belfort MB, Kleinman KP, Oken E, Gillman MW: Weight status in the first 6 months of life and obesity at 3 years of age. Pediatrics 2009;123:1177–1183.
10 Dattilo AM, Birch L, Krebs NF, Lake A, Taveras EM, Saavedra J: Need for early interventions in the prevention of pediatric overweight: a review and upcoming directions. J Obes 2012;2012:1–18.
11 Briefel RR, Kalb LM, Condon E, et al: The Feeding Infants and Toddlers Study 2008: study design and methods. J Am Diet Assoc 2010;110:S16–S26.
12 Devaney B, Kalb L, Briefel R, Zavitsky-Novak T, Clusen N, Ziegler P: Feeding Infants and Toddlers Study: overview of the study design. J Am Diet Assoc 2004;104:s8–s13.
13 Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, et al: CDC growth charts: United States. Adv Data 2000;1–27.
14 Butte NF, Fox MK, Briefel RR, et al: Nutrient intakes of US infants, toddlers, and preschoolers meet or exceed dietary reference intakes. J Am Diet Assoc 2010;110:S27–S37.
15 Alexy U, Kersting M, Sichert-Hellert W, Manz F, Schoch G: Macronutrient intake of 3- to 36-month-old German infants and children: results of the DONALD Study. Dortmund Nutritional and Anthropometric Longitudinally Designed Study. Ann Nutr Metab 1999;43:14–22.
16 Axelsson I: Effects of high protein intakes. Nestle Nutr Workshop Ser Pediatr Program 2006;58:121–129.
17 Grote V, von Kries R, Closa-Monasterolo R, et al: Protein intake and growth in the first 24 months of life. J Pediatr Gastroenterol Nutr 2010;51(suppl 3):S117–S118.
18 Koletzko B, von Kries R, Closa R, et al: Lower protein in infant formula is associated with lower weight up to age 2 y: a randomized clinical trial. Am J Clin Nutr 2009;89:1836–1845.
19 Kalhan SC: Optimal protein intake in healthy infants. Am J Clin Nutr 2009;89:1719–1720.
20 Agostoni C, Scaglioni S, Ghisleni D, Verduci E, Giovannini M, Riva E: How much protein is safe? Int J Obes (Lond) 2005;29(suppl 2):S8–S13.
21 Rolland-Cachera MF, Deheeger M, Akrout M, Bellisle F: Influence of macronutrients on adiposity development: a follow up study of nutrition and growth from 10 months to 8 years of age. Int J Obes Relat Metab Disord 1995;19:573–578.
22 Scaglioni S, Agostoni C, Notaris RD, et al: Early macronutrient intake and overweight at five years of age. Int J Obes Relat Metab Disord 2000;24:777–781.
23 Rolland-Cachera MF, Deheeger M, Bellisle F, Sempe M, Guilloud-Bataille M, Patois E: Adiposity rebound in children: a simple indicator for predicting obesity. Am J Clin Nutr 1984;39:129–135.
24 Raiha NRC: Protein content of human milk, from colostrum to mature milk; in: Protein Metabolism during Infancy. NNI Workshop Series, vol 33. New York, Raven Press, 1994, pp 87–99.
25 USDA Agriculture Research Service: National nutrient database for standard reference. http://ndb.nal.usda.gov/index.html (accessed March 5, 2013).
26 USDA Center for Nutrition and Policy Promotion: Dietary guidelines for America 2010. http://www.cnpp.usda.gov/dietaryguidelines.htm (accessed March 8, 2013).
27 Arenz S, Ruckerl R, Koletzko B, von Kries R: Breast-feeding and childhood obesity – a systematic review. Int J Obes Relat Metab Disord 2004;28:1247–1256.
28 Harder T, Bergmann R, Kallischnigg G, Plagemann A: Duration of breastfeeding and risk of overweight: a meta-analysis. Am J Epidemiol 2005;162:397–403.
29 Owen CG, Martin RM, Whincup PH, Smith GD, Cook DG: Effect of infant feeding on the risk of obesity across the life course: a quantitative review of published evidence. Pediatrics 2005;115:1367–1377.
30 Durmus B, van Rossem L, Duijts L, et al: Breast-feeding and growth in children until the age of 3 years: the Generation R Study. Br J Nutr 2011;105:1704–1711.
31 Griffiths LJ, Smeeth L, Hawkins SS, Cole TJ, Dezateux C: Effects of infant feeding practice on weight gain from birth to 3 years. Arch Dis Child 2009;94:577–582.
32 Siega-Riz AM, Deming DM, Reidy KC, Fox MK, Condon E, Briefel RR: Food consumption patterns of infants and toddlers: where are we now? J Am Diet Assoc 2010;110:S38–S51.
33 US Department of Health and Human Services: HealthyPeople.gov. http://www.healthy people.gov/2020/default.aspx (accessed February 15, 2012).
34 Li R, Magadia J, Fein SB, Grummer-Strawn LM: Risk of bottle-feeding for rapid weight gain during the first year of life. Arch Pediatr Adolesc Med 2012;166:431–436.
35 Taveras EM, Rifas-Shiman SL, Scanlon KS, Grummer-Strawn LM, Sherry B, Gillman MW: To what extent is the protective effect of breastfeeding on future overweight explained by decreased maternal feeding restriction? Pediatrics 2006;118:2341–2348.
36 Grummer-Strawn LM, Scanlon KS, Fein SB: Infant feeding and feeding transitions during the first year of life. Pediatrics 2008;122(suppl 2):S36–S42.
37 Hendricks K, Briefel R, Novak T, Ziegler P: Maternal and child characteristics associated with infant and toddler feeding practices. J Am Diet Assoc 2006;106:S135–S148.
38 Mennella JA, Jagnow CP, Beauchamp GK: Prenatal and postnatal flavor learning by human infants. Pediatrics 2001;107:E88–E93.
39 Beauchamp GK, Mennella JA: Flavor perception in human infants: development and functional significance. Digestion 2011;83(suppl 1):1–6.
40 Galloway AT, Lee Y, Birch LL: Predictors and consequences of food neophobia and pickiness in young girls. J Am Diet Assoc 2003;103:692–698.
41 Sullivan SA, Birch LL: Infant dietary experience and acceptance of solid foods. Pediatrics 1994;93:271–277.
42 American Academy of Pediatrics: Pediatric Nutrition Handbook. Elk Grove Village, IL, American Academy of Pediatrics, 2009.
43 Gidding SS, Dennison BA, Birch LL, et al: Dietary recommendations for children and adolescents: a guide for practitioners. Pediatrics 2006;117:544–559.
44 Fox MK, Condon E, Briefel RR, Reidy KC, Deming DM: Food consumption patterns of young preschoolers: are they starting off on the right path? J Am Diet Assoc 2010;110:S52–S59.
45 Huh SY, Rifas-Shiman SL, Taveras EM, Oken E, Gillman MW: Timing of solid food introduction and risk of obesity in preschool-aged children. Pediatrics 2011;127:e544–e551.
46 Schack-Nielsen L, Sorensen TI, Mortensen EL, Michaelsen KF: Late introduction of complementary feeding, rather than duration of breastfeeding, may protect against adult overweight. Am J Clin Nutr 2010;91:619–627.
47 Butte N, Cobb K, Dwyer J, Graney L, Heird W, Rickard K: The Start Healthy Feeding Guidelines for infants and toddlers. J Am Diet Assoc 2004;104:442–454.
48 Baker RD, Greer FR: Diagnosis and prevention of iron deficiency and iron-deficiency anemia in infants and young children (0–3 years of age). Pediatrics 2010;126:1040–1050.

Downloaded by:
University of Rhode Island
131.128.157.108 - 1/13/2015 6:05:53 PM

49 USDA Agriculture Research Service: Economic research service food availability data system. http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx (accessed March 5, 2013).
50 Hendy HM, Williams KE, Camise TS, Eckman N, Hedemann A: The Parent Mealtime Action Scale (PMAS). Development and association with children's diet and weight. Appetite 2009;52:328–339.
51 Leahy KE, Birch LL, Rolls BJ: Reducing the energy density of multiple meals decreases the energy intake of preschool-age children. Am J Clin Nutr 2008;88:1459–1468.
52 Fox MK, Pac S, Devaney B, Jankowski L: Feeding Infants and Toddlers Study: what foods are infants and toddlers eating? J Am Diet Assoc 2004;104:s22–s30.
53 Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM: Most Americans eat much less than recommended amounts of fruits and vegetables. J Am Diet Assoc 2006;106:1371–1379.
54 Krebs-Smith SM, Guenther PM, Subar AF, Kirkpatrick SI, Dodd KW: Americans do not meet federal dietary recommendations. J Nutr 2010;140:1832–1838.
55 American Academy of Pediatrics: Bright Futures Nutrition. Elk Grove Village, IL, The American Academy of Pediatrics, 2011.
56 American Dietetic Association, Evidence Analysis Library: Evidence-based pediatric weight management nutrition practice guideline. http://www.adaevidencelibrary.com (accessed February, 2013).
57 Barlow SE: Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. Pediatrics 2007;120(suppl 4):S164–S192.
58 Dwyer JT, Butte NF, Deming DM, Siega-Riz AM, Reidy KC: Feeding Infants and Toddlers Study 2008: progress, continuing concerns, and implications. J Am Diet Assoc 2010;110:S60–S67.

Downloaded by:
University of Rhode Island
131.128.157.108 - 1/13/2015 6:05:53 PM