Building Future Health and Well-Being of Thriving Toddlers and Young Children

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According to the World Health Organization, the early child period, i.e., from birth to 5 years of age, is considered the most important developmental phase throughout the lifespan.

This period of a child’s life is fundamental in building the foundation for physical growth, development, health, and social and emotional skills. In fact, the first 3 years of life, which include a good portion of toddlerhood, shapes a child’s brain structure in preparation for lifelong learning. The development of fine motor skills, language, and social and behavior skills are all categories that children, particularly toddlers, are seeking to master.

As it was stated in the 2018 Global Nutrition Report, although the number of children who are stunted decreased, millions of children are still affected by stunting and wasting (150.8 million [22.2%] and 50.5 million children under 5 years of age, respectively), while the number of children who are overweight is steadily rising (38.3 million children under 5 years of age). In such significant disparities, appropriate nutrition, stable, responsive, and nurturing caregiving, as well as safe and supportive environments are the 3 critical elements of healthy child development.

The 95th Nestle Nutrition Institute Workshop Building Future Health and Well-Being in Thriving Toddlers and Young Children, was the first NNI Workshop presented 100% virtually, and explored in some detail the current scientific research, challenges, and opportunities of cementing a healthy foundation for life in toddlers and young children.

The program brought together three outstanding experts in the areas of health care, public health, and developmental science. The first session, chaired by Prof. Atul Singhal (University College London), focused on the nutritional challenges in toddlers and young children across the globe, such as nutrient deficiencies as well as overweight/obesity, which can be especially detrimental during an important period of child development and growth. The theme of the second session, led by Prof. Maureen M. Black (RTI International and University of Maryland School of Medicine), elucidated the journey from infancy to toddlerhood and the role of nutrition in it. A large focus of the scientific debates was also given to social aspects, i.e., responsive, responsible, and nurturing caregiving.

The third session of the workshop on health behavior and the developing brain aimed to explain the steps of motor skill development and
the role of physical activities and nutrition in cognitive development and learning abilities of a child. This session, chaired by Prof. Charles H. Hillman (Center for Cognitive and Brain Health – Northeastern University), concluded this fascinating scientific forum.

The key issues provided by this 3-day workshop offer valuable insights for health care providers, policy makers, and researchers on how appropriate nutrition, nurturing caregiving, and environment can influence the development and health of children up to 5 years of age.

We gratefully acknowledge the three Chairpersons Atul Singhal, Maureen M. Black, and Charles H. Hillman, who assembled this outstanding scientific program. We would also like to thank all speakers and experts in the audience who have contributed to the content of the workshop and scientific discussions.

Finally, we express our gratitude to Dr. Tamara Lazarini, her team in Brazil, and the Nestlé Nutrition Institute team in Switzerland for their efforts to make this workshop happen during this challenging time of a world pandemic.

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Maureen M. Black

Toddlerhood, the period from 12 to 36 months, represents striking changes in children's development. Along with mastery of skills such as walking, talking, self-feeding, sleeping through the night, and bowel and bladder control, toddlers strive for autonomy. Toddlers' increasing autonomy impacts their feeding behavior and may increase or restrict their food exposures. Food preferences formed during toddlerhood often persist into adulthood, making toddlerhood an ideal time to increase children's dietary diversity [1]. Toddlers benefit from parenting that is responsive, while ensuring that their introduction to the family meal includes exposure not only to nutrient-rich food, but also to healthy mealtime behaviors.

Perspectives from Child Development

Child development is cumulative and dynamic during toddlerhood, building on skills acquired during infancy. Gross motor advances (crawling, walking, running, and climbing) enable toddlers to explore their physical environment as they engage in goal-directed behavior. Fine motor advances enable toddlers to pick up small objects, manipulate eating utensils, and self-feed. Oral motor and language developments enable toddlers to chew complex foods, to express themselves and communicate, and to negotiate. With enhanced cognition, toddlers can solve problems, recall the location of hidden objects, and play simple games. Toddler's social development includes prosocial skills, such as empathy and recognition of others' emotions, and self-regulation, such as controlling their thoughts or behavior in response to specific contexts and situations. These emerging skills bring increasing autonomy, often accompanied by impulsivity to satisfy their desires immediately. When combined with toddlers' changing nutritional needs, their increasing autonomy can present challenges to caregivers, especially during meals.
**Perspectives from Nutrition**

The World Health Organization recommends that children are exclusively breastfed until approximately 6 months of age and then transition to complementary feeding, defined as the period when breast milk alone is no longer sufficient to meet infants’ nutritional requirements. Guidelines for complementary feeding have focused primarily on toddlers’ nutrient requirements and advances in flavor and texture as their diet expands and begins to approximate the family diet.

Toddlers’ feeding behavior also changes. Baby-led weaning, sometimes referred to as baby-led eating, occurs in the context of complementary feeding. Children choose when and what food they will eat (from a choice of healthy options), the rhythm of the meal, and the amount of food that they will eat, while primarily feeding themselves [2]. Baby-led weaning is based on presumptions that young children have the motor skills to self-feed along with the regulatory skills to signal hunger and satiety. Two recent reviews [3, 4] found that baby-led weaning typically occurs in the context of the family meal, with the child consuming food that is softened and cut into bite sizes. Evidence on the nutrient intake and long-term impact of baby-led feeding on children’s nutrient intake and eating patterns is emerging.

Food neophobia, defined as refusal or fear to eat unfamiliar foods, is a normal developmental phase during toddlerhood. Food neophobia differs from selectivity or pickiness, defined as specific food preferences and dislikes regardless of familiarity. A recent systematic review and meta-analysis of neophobia and picky eating emphasized the relevance of considering the social context and bidirectional parent-toddler aspects of feeding, including factors at the cell, child, parent, and household levels [5].

Toddlerhood is a transitional period that can be both joyful and challenging, as children acquire new skills and assert their autonomy. Effective parenting practices include providing healthy food, age-appropriate settings and opportunities for toddlers to eat, reading toddler’s signals, and responding promptly, appropriately, and with nurturance [6]. This pattern is known as responsive parenting, or responsive feeding when applied to mealtimes. Responsive parenting ensures that toddlers receive the guidance and nurturant care that is needed to develop healthy feeding behavior and emotional well-being.
References


Global Landscape of Nutrient Inadequacies in Toddlers and Young Children

Alison L. Eldridge and Elizabeth A. Offord

Toddlers and young children need an adequate and diverse diet to provide all of the nutrients required for optimal growth and development. Unfortunately, undernutrition and inadequate intakes of vitamins and minerals are still identified by the World Health Organization (WHO) as major public health threats for young children along with growing overweight and obesity [1]. Organizations like WHO and the World Bank focus on iron, zinc, vitamin A, and iodine for children ≤5 years of age. Prevalence of anemia in children ≤5 years is highest in sub-Saharan Africa (59.9%) and South Asia (55.1%). Anemia, along with vitamin A deficiency and stunting, leads to an “alarmingly high” hidden hunger index in these regions [2].

In addition to the data from these organizations, individual-level food consumption surveys are needed to provide a fuller picture of food and nutrient intakes in different countries. However, these surveys are generally available in higher-income countries and are less common in low- and middle-income countries in regions such as Africa, Eastern Europe, and Southeast Asia [3]. Even among countries with a food consumption survey, not all collect data on young children. In Europe, only about two-thirds of the countries report energy and nutrient intakes for children ≤5 years [4]. National surveys in the USA (National Health and Nutrition Examination Survey, NHANES) and Australia (National Nutrition and Physical Activity Survey, NNPAS) start only from the age of 2 years. Some national surveys also lack data on the full complement of nutrients required in the diet.

To help fill these gaps, several studies have been done to focus specifically on young children. The South East Asian Nutrition Survey (SEANUTS) conducted studies in Indonesia, Malaysia, Thailand, and Vietnam. The Feeding Infants and Toddlers Study (FITS) is a series of cross-sectional studies in the USA, starting in 2002 with subsequent
surveys collected in 2008 and 2016. FITS provides comprehensive nutrient intake data for more than 5,000 toddlers and young children. It has also been used as a model to analyze national survey data on toddlers and young children from other countries, including China, Mexico, Russia, and the Philippines [5].

Where detailed dietary intake studies are available, we find wide ranges in energy intakes for 2- to 3-year-old children, with lower intakes in the Philippines (839 kcal/day) and Indonesia (965 kcal/day), and higher intakes in Brazil (1,650 kcal/day), the USA (1,379 kcal/day), and Mexico (1,367 kcal/day). Energy intakes were intermediate in Russia (1,243 kcal/day), Germany (1,075 kcal/day), and China (1,189 kcal/day). Energy intakes corresponded with higher rates of stunting in the Philippines, and higher rates of overweight and obesity in Brazil, North America, and Europe [2]. The distribution of energy from protein, fat, and carbohydrates also differs by country, with higher carbohydrate and lower fat intakes in Southeast Asia (Fig. 1).
Table 1. Dietary fiber and micronutrient inadequacies (mean values per day and percentages below EAR) in young children from selected countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Fibers, g/day</th>
<th>Vitamin A</th>
<th>Vitamin C</th>
<th>Vitamin D</th>
<th>Vitamin E</th>
<th>Calcium</th>
<th>Iron</th>
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<td>µg % &lt;EAR</td>
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<td>mg % &lt;EAR</td>
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<td>EAR/AI</td>
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<td>Brazil [6]</td>
<td>15.5 924 0.7 312.9 0 5.3 93.6 5.4 15.1 807 12.6 13.4 0.4 9.7 0</td>
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<td>China [7]</td>
<td>5.9 587 19.7 76.1 34.6 – – 12.4 6.0 646 48.4 15.2 12.7 7.6 –</td>
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<td>Indonesia [8]</td>
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<td>Philippines [9]</td>
<td>3.5 365 41 23.1 35 2.3 – 2.0 &gt;90 421 66 5.2 75 5.0 46</td>
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<td>USA [10]</td>
<td>12.0 603 4.2 80 0 6.8 80 7.3 32 961 6.4 11.0 4.1 7.7 0.4</td>
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<td>Mexico [11]</td>
<td>14.2 595 3.5 107.1 0.4 8.4 71.4 13.6 12.0 814 21.6 11.0 2.9 8.7 0.3</td>
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<td>Germany [12, 13]</td>
<td>12.3 646 25.4 68.6 – 1.1 – 5.7 43.2 609 35.2 6.3 12.5 5.1 7.4</td>
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<td>Russia [14]</td>
<td>7.9 357 65.2 33.5 67.8 – – – – 554 78.8 8.6 63.7 – –</td>
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EAR, estimated average requirement; AI, adequate intake level (National Academies of Sciences, Engineering, and Medicine 2019; https://doi.org/10.17226/25353); EARs are available for all vitamins and minerals listed; AI is used for fiber. Inadequacy was compared to US EAR values, except for Indonesia and Russia, which were compared to their locally recommended dietary allowances.

Dietary fiber and vitamin D intakes are generally below recommendations for toddlers and young children (Table 1). Other nutrient gaps differ by country and are related to food availability and local dietary habits. Toddlers in the USA, for example, regularly consume dairy products, and fewer than 10% fall below recommendations for calcium intakes. In the Philippines, however, where consumption of dairy foods is rare, 66–84% of 2- to 4-year-old children are below recommendations. For vitamin E, we see relatively low levels of inadequacy in China (6%), moderate inadequacy in the USA (32%), and high levels of inadequacy for the Philippines (>90%).

Detailed dietary intake studies complement global monitoring of nutritional issues by WHO and the World Bank. They help to identify the foods and beverages most relevant to alleviate nutrient gaps and improve dietary intakes of toddlers and young children around the world.

References


Nutrition-Related-Practices in Brazilian Preschoolers: Identifying Challenges and Addressing Barriers

Mauro Fisberg and Lais Duarte Batista

Early life nutrition is essential for achieving long-term health benefits in adulthood. Identifying challenges and addressing barriers related to this issue is primordial to encourage healthy eating habits and to fight malnutrition.

The scenario regarding nutrition in Brazil, as in many other parts of the world, is alarming. As a middle-income country, it has faced important challenges over the past decades. Inadequate intakes of essential nutrients associated with high rates of malnourished children were unresolved problems in the country. Changes in dietary intake and feeding habits switched the scenario from undernutrition to increased rates of overweight and obesity (Fig. 1). The prevalence of obesity among school children reached 16.6% in boys and 11.8% in girls. Moreover, 1 in every 3 children (about 30%) presented excess weight in 2010 [1]. However, changes in the nutritional status did not decrease malnutrition in Brazil. Not only undernourished but also overweight and obese children face hidden hunger. Important deficiencies, e.g., in iron and vitamin A, are still common. A systematic review found a 53% prevalence of anemia in Brazil, with rates reaching over 70% in some socially vulnerable regions [2].

This phenomenon is related to changes in lifestyle and eating habits. Brazilian preschoolers consume low amounts of meat, fruits, and vegetables, and prefer high and early intake of fried foods, soft drinks, salty snacks, and sweets [3]. In the context of children with feeding difficulties, there is an excessive daily protein intake from milk-based supplements, reducing the consumption of non-milk-based foods. Milk intake alone satisfies 80–138% of daily protein demands [4]. Therefore, children consume poor diets that do not meet current recommendations. Food intake is related to obesity and malnutrition not only in terms of diet quality. Dietary patterns and the volume ingested are also important. Besides the
poor quality and composition of children's diet, there is an increase in food portion sizes in Brazil. Skipping important meals, such as breakfast, is also a common eating habit.

To solve this complex problem, integrated policies and division of responsibilities are needed. Actions involve families, schools, the government, and the food industry (Fig. 2). Barriers to healthy eating that deserve the government’s attention are the aggressive marketing of energy-dense and nutrient-poor foods and beverages, as well as the quality of food directed at children. Even with the intention of the food industry to provide adequate milk substitutes during feeding transition, people still choose to feed their toddlers with cow’s milk based on price. Therefore, knowledge alone does not seem to change eating habits. People are educated regarding adequate food choices, but the socioeconomic reality in Brazil is still a challenge.

Some progress has been made to overcome malnutrition in the country. A healthy eating policy in school feeding, iron and folate fortification of food, and iron and vitamin A supplementation for groups at risk are some ongoing interventions. Affordable and fresh foods should be offered to disadvantaged groups. One outstanding experience related to that practice is the project “Favela Orgânica” (http://favelaorganica.com.br/english/). The initiative seeks to teach creative cooking skills in a socially

![Fig. 1. Food patterns in Brazilian schools.](image)
vulnerable community. Using the variety of fruits and vegetables available in the country, the project encourages the full use of foods and thus aims to avoid waste while promoting healthy eating habits. Beyond the family level, the parenting style is another focus for interventions. The availability of nutrient-dense foods, encouraging cooking skills, and active involvement in child feeding are responsibilities that caregivers should take. Public and safe spaces for practicing physical activity are also important to change the lifestyle. A favorable environment promoting the accessibility of healthy food and the dearth of inadequate food is essential to improve children’s eating habits. Therefore, interventions must go much further than nutritional education to ensure healthy eating habits and to overcome malnutrition.

**Fig. 2.** Multisectoral division of responsibilities to promote healthy feeding habits in children.

**References**

Growth Faltering: Underweight and Stunting

Andrew M. Prentice

The great majority of attention on growth faltering concentrates on the first “1,000 days” of life with a much lesser focus on toddlers and young preschoolers. The rationale for this is understandable since the first 1,000 days cover the period of most rapid growth and changes in body composition, the period of breastfeeding, and the complex transition from breastfeeding and weaning to complementary feeds, and then shifting to the family/adult diet. There has also been a strong perception that once a child has become stunted or wasted in the first 2 years of life, there is little hope of recovery – an assumption we address below.

Global Distribution of Stunting, Wasting, and Underweight

It is self-evident that, with the exception of certain rare clinical conditions or inappropriate parenting behaviors, stunting, wasting, and the consequent underweight are largely confined to the poorer populations of low-income countries. As countries emerge from poverty and pass through the economic transition, malnutrition rates fall sharply and soon resemble those in first-world nations (Fig. 1); a corollary is that obesity rates rise rapidly as will be discussed elsewhere in this symposium.

Timing of the Development of Stunting and Wasting

There are 3 critical periods in the development of stunting. The first relates to the generations before a child is even conceived. There is clear evidence for generational influences on population height. Intergenerational influences can be mediated through a mother’s small body size that can impart effects through numerous possible mechanisms such as uterine constraints. Much less certain is whether there can be so-called transgenerational effects (i.e., effects not mediated by the direct influence of a mother’s diet or body size). Transgenerational effects would require some
method (e.g., epigenetic programming marks that survive erasure in the very early embryo) that would convey a signal that would effect stunting; we have some evidence that this can occur [1], but much more research is needed. The second critical period is in utero, and it has been shown that a substantial proportion of childhood stunting and wasting has its origins during fetal life. The third critical window is in the early postnatal period. Recent evidence from our own very detailed studies of growth trajectories suggests that the channels that will steer later growth are established surprisingly early in postnatal life.

**Can Toddlers and Young Preschoolers Recover from Stunting and Wasting?**

In most poor communities from low- and middle-income countries, there is a precipitous drop-off in average height-for-age $Z$-scores compared to the WHO growth reference. This seems to be caused, in large part, by exposure to infections and highly unhygienic living conditions.

![Fig. 1. Childhood stunting is predominantly a problem of low-income countries and resolves rapidly with economic advancement. Data compiled from Demographic Health Surveys since 2005. GDP, gross domestic product; PPP, purchasing power parity.](image-url)
Analysis of aggregate data from many such countries suggests that there is little evidence for a later recovery [2]. However, our own very detailed studies of poor rural Gambian children show that they achieve catchup of almost 1 $Z$-score between 2 and 5 years of age (Fig. 2). We interpret this as due to the fact that their immune systems have finally developed a resilience against all the prevalent infections. We have also emphasized that there can be a second period of catchup in adolescence [3].

**Diets for Toddlers and Young Preschoolers in Low-Income Countries**

In developed countries, there are many foods designed to meet the energy and nutrient needs of growing and active toddlers; such foods are rarely available in very poor populations, and toddlers usually join the *family food bowl* and share the adult diet. The implications of this for growth will be examined.
References


Obesity in Toddlers and Young Children: Causes and Consequences

Atul Singhal

The rapid rise in obesity in toddlers and young children is a major concern for public health globally. In 2016, the WHO estimated that 41 million children under the age of 5 years were overweight or obese with nearly half of these living in Asia. Understanding risk factors for obesity in the early years is therefore fundamental to guiding parents, carers, educators, and health care professionals looking after young children and to developing preventive strategies.

Of particular importance to the development of obesity in young (preschool) children is exposure to an unhealthy obesogenic environment such as the easy availability and affordability of highly palatable, energy-dense foods. However, many children exposed to such an environment do not become overweight and so the social, commercial, and biological factors that determine a child’s response to this environment are critical in the development of obesity [1]. Most research has focused on biological risk factors for obesity, which can be broadly categorized as genetic predisposition, poor diet (and the behaviors that influence excessive food intake), insufficient physical activity, and developmental factors acting in early life that impact on long-term health.

Whilst genes strongly influence an individual’s risk of becoming overweight, they cannot account for the rapid rise in the population prevalence of obesity. Nutritional factors leading to a positive energy balance are without doubt important risk factors for adiposity, but there is surprisingly little evidence that intakes of energy, fats, or carbohydrates are causally related to obesity in young children [2]. However, the concurrent rise in obesity over the last 50 years with increases in both sugar intake (particularly sugar-sweetened drinks [3]) and portion size of food servings suggests that these are both possible causal factors for childhood obesity.

On the other side of the energy balance equation, insufficient physical activity and excessive sedentary behaviors are consistently associated with obesity in young children in observational studies. However, whilst physical activity has many health benefits, a causal link with obesity has
not been established. For instance, a recent Cochrane systematic review on the prevention of obesity found that interventions that focused on physical activity alone were not effective in children aged 0–5 years [4]. Similarly, insufficient sleep is consistently associated with obesity in young children (possibly via effects on appetite regulation), although there is little evidence of a causal link. Overall, although more physical activity, less sedentary behaviours, and adequate sleep have huge health benefits in their own right, the scientific consensus is that the rise in childhood obesity is mostly driven by changes in food consumption rather than declines in physical activity [1].

More recently, there is much interest in the role of developmental factors in the early years and their impact on long-term trajectories of weight gain [5]. For instance, the early years may be critical for establishing dietary preferences and patterns, and eating habits that influence long-term health, while a high protein intake leading to faster weight gain has been shown to be associated with a greater risk of later obesity in toddlers (as in younger infants) [5].

Understanding the causes of obesity in preschool children is particularly important in view of the long-term detrimental consequences of obesity in this age group. In rich countries, at least, there is evidence to suggest that most excess weight at adolescence is gained before the age of 5 years. Childhood obesity is also strongly linked to long-term obesity and independently associated with cardiometabolic disease in later life [1]. Interventions to prevent long-term weight gain from the first years of life are therefore likely to have huge health and economic benefits for populations, individuals, and the wider society.

**References**

Transition from Breastfeeding and Complementary Feeding to Toddler Nutrition in Child Care Settings

Lorraine D. Ritchie, Danielle L. Lee, Elyse Homel Vitale, and Lauren E. Au

In the USA, obesity is at an all-time high and is projected to rise unless substantial efforts are undertaken to improve what and how Americans eat [1]. Dietary risk factors for obesity begin in infancy, when energy intakes already exceed recommendations, most are bottle-fed at some point in the first year of life, complementary foods are introduced earlier than recommended, and inadequate amounts of fruits and vegetables but excess amounts of foods and beverages with added sugars are consumed [2, 3]. By toddlerhood, food preferences and dietary patterns have largely established [3]. Despite the importance of early nutrition for subsequent nutrition and health, the evidence-based recommendations for the nation, the dietary guidelines for Americans, do not yet include guidance for children 0–2 years of age.

Child care is the largest institutional setting in the USA for improving nutrition among young children. Concurrent with rates of parental employment, use of child care has also risen. Over one-third of all young children spend much of their day and consume up to two-thirds of their daily nutrition in organized, licensed child care (as opposed to informal care with family, friends, and neighbors) [4]. Outside of the federal Child and Adult Care Food Program (CACFP), which provides reimbursements to licensed child care facilities that follow specific meal and snack patterns, there are few nutrition requirements to which licensed child care facilities are subject. In the USA, licensed facilities can vary from small, family child care homes with a single provider and a few children, to large centers or preschools with a director, multiple teachers, and several hundred children. There is concern that nutrition standards may be especially costly or difficult for family child care homes to implement. Family child care homes are independently operated businesses in the homes of providers who often are low-income women with limited time, resources, and opportunities to obtain nutrition information and training. Further, nutrition practices in family child care homes tend to be less optimal than
# Table 1. Child care nutrition standards for infants (0–12 months)

<table>
<thead>
<tr>
<th>What foods should be served</th>
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</table>
| **Vegetables**              | Offer pureed, mashed, or whole vegetables for infants 6–12 months  
  Vegetables can be fresh, frozen, or canned (all with no added salt, fat, or sugar) for infants 6–12 months  |
| **Fruits**                  | Offer unsweetened whole, mashed, or pureed fruits for infants 6–12 months  
  Fruit can be fresh, frozen, or canned (all with no added sugars) for infants 6–12 months  |
| **Proteins**                | Offer proteins such as soft cooked egg, beans, meat, poultry, and fish without bones for infants 6–12 months  
  Serve protein foods with no added salt for infants 6–12 months  
  Offer natural cheese ≤1–2 times per day; choose low-fat or reduced-fat cheese but do not serve cheese food/spread for infants 6–12 months  
  Offer yogurt ≤1 time per day, must have <23 g sugar per 6 oz for infants 6–12 months  |
| **Grains**                  | Offer iron-fortified infant cereals for infants 6–12 months  
  Do not serve grains with added sugars  |

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<th>How foods should be served</th>
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| **Breast milk and other beverages** | Support and encourage breastfeeding  
  Offer only breast milk and/or iron-fortified infant formula (as beverage besides water)  
  While breast milk and formula are the best sources of water, begin using a cup for additional drinking water at 6–9 months  
  No cow’s milk, unless a doctor’s note  
  Do not serve 100% juice, juice drinks, or any other beverages  |

| Introducing solid foods | At about 6 months, introduce developmentally appropriate solid foods in age-appropriate portion sizes  
  Start with iron-fortified infant cereals or pureed meats, then pureed vegetables and fruits, and then other protein-rich foods  
  Introduce foods gradually, one at a time, and wait for at least 3–5 days, watch for allergic reactions such as diarrhea, rash, or vomiting  
  At 9 months, begin self-feeding with finger foods then transition to foods served at the table as developmentally appropriate  
  Encourage older infants to self-feed with their fingers and drink from a cup with assistance  
  Offer solid foods at regular meal and snack times for infants 6–12 months  
  Avoid choking hazards (e.g., by cutting grapes into smaller pieces)  
  Include older infants at family style meals where provider and children eat together  |

| Self-regulation | Feed younger infants on demand by recognizing feeding cues (e.g., rooting and sucking)  
  Ensure that infants are guided by own feelings of hunger and satiety and are not pressured to eat all that is offered  
  Minimize distractions at mealtime (e.g., no TV, toys, phones, or video games)  |
### Table 2. Child care nutrition standards for toddlers (≥1 year old)

| What foods should be served |  |
|----------------------------|  |
| **Vegetables** | Offer vegetables ≥2 times per day  |
| | Offer dark green, orange, red, or deep-yellow vegetables once per day  |
| | Do not serve deep-fried or prefried baked vegetables  |
| **Fruits** | Offer fruit ≥2 times per day  |
| | Offer only fruit that is fresh, frozen, or canned in water (all with no added sugars)  |
| **Proteins** | Do not serve processed meat or deep-fried or prefried meat or fish  |
| | Offer lean protein ≥2 times per day, such as seafood, fish, lean meat, poultry, eggs, beans, peas, soy products, tofu, or unsalted nuts/seeds  |
| | Offer yogurt ≤1 time per day, must have <23 g sugar per 6 oz  |
| | Offer natural cheese ≤1–2 times per day; choose low-fat or reduced-fat cheese; do not serve cheese food/spread  |
| **Beverages** | Do not serve sugar-sweetened beverages  |
| | Rarely or never offer 100% fruit juice  |
| | When offered, give ≤1 age-appropriate serving of 100% fruit juice per day  |
| | Ensure that water is easily available for self-serve indoors and outdoors and actively offered with meals and snacks and at other times as appropriate  |
| | Offer unflavored whole milk ≥2 times per day for children 12–24 months  |
| | Offer unflavored fat-free (also called nonfat or skim) or 1% (also called low-fat) milk ≥2 times per day for children >24 months  |
| | Offer only nondairy milk substitutions (e.g., soy milk) that are nutritionally equivalent to milk1  |

| Sugar, sodium, and fat |  |
|------------------------|  |
| Do not serve foods with added sugar or sugar equivalents (e.g., high-fructose corn syrup, fructose, corn syrup, cane sugar, evaporated cane juice, or sucrose) listed as the first or second ingredients or having a combination of ≥3 kinds of sugar/sugar equivalents  |
| Do not serve low-calorie sweeteners or items containing low-calorie sweeteners (e.g., diet foods or diet beverages)  |
| Do not serve high-salt foods (>200 mg sodium per snack item or >480 mg sodium per entrée)  |
| Do not add salt at the table  |
| Use only liquid nontropical vegetable oils instead of solid fats  |

| How foods should be served |  |
|----------------------------|  |
| **Eating frequency** | Offer ≥1 meal and 1 snack for care <8 h  |
| | Offer ≥2 meals and 2 snacks for care ≥8 h  |
| | Provide meals and snacks every 2–3 h at regularly scheduled times  |
| **Meal and snack times** | Serve family-style meals and snacks; providers teach children to serve themselves age-appropriate portion sizes with assistance as needed  |
| | Use dishware and utensils that are sized appropriately  |
| | At least 1 childcare provider sits with children at a table and eats the same meals and snacks  |
| | Allow enough time to eat  |
| | Provider models healthy eating and does not consume other items in front of the children  |
| | Offer a variety of culturally relevant items  |
| **Self-regulation** | Do not use foods or beverages as reward or punishment or for comfort  |
| | Ask children if they are full before removing plates and ask if they are hungry before serving seconds  |
| | Expect young children to eat a lot of some meals and very little of others and to be messy; it may take months or years to accept new foods  |
| | Expect children to not eat everything offered and to change likes/dislikes  |
| | Minimize distractions while eating (e.g., no TV, toys, phones, or video games)  |
| | When food is provided at celebrations or fundraisers offer only healthy items, such as fruit, vegetables, and water  |

1 Information on soy equivalents to milk can be accessed at: https://wicworks.fns.usda.gov/wicworks/Learning_Center/FP/soybeverage.pdf.
in centers [5]. Developing nutrition standards that are both evidence-based and feasible for implementation in child care settings is an important first step towards laying the groundwork for improving the nutrition environment for young children.

As such, the purpose of this paper is to describe a process whereby evidence-based nutrition standards for young children in child care were developed and refined so that they would be actionable and achievable in most child care settings in the USA, including family child care homes. Starting with current guidelines from authoritative bodies, standards were refined by both nutrition and child care experts. The nutrition standards include not only what foods and beverages to serve but also how to feed infants (Table 1) and toddlers (Table 2). Finally, the standards were pilot tested by family child care providers over a 3-month period to assess adherence and challenges in implementation. Results suggest that nutrition standards are well accepted and can be feasibly implemented by child care providers. Larger, longer-term and more rigorous studies are warranted to determine the impact of implementing nutrition standards in child care settings on infants as they transition to toddler nutrition. Further, the process whereby the standards were developed may be adapted to establish or refine nutrition standards for child care settings in other countries.

Infant standards include recommendations for vegetables, fruits, proteins, grains, breast milk, and other beverages. Also included are recommendations for bottle feeding, introducing complementary foods, and promoting self-regulation in response to hunger and satiety. Toddler standards are expanded to address the frequency as well as types of food groups and beverages, and include guidance on sugar, sodium, and fat. Feeding practices for toddlers include meal and snack frequency, feeding style, and how to promote self-regulation of intake.

**References**

Children 1–3 years of age are among the most nutritionally understudied population. Most recent studies, especially on minerals, have used stable isotopes to assess nutrient absorption and metabolism [1]. This methodology relies on the incorporation of an orally administered iron isotope (often given with an enhancer of iron absorption such as vitamin C or with a meal) into red blood cells at 14–28 days. For zinc, calcium, and magnesium, the preferred technique is the dual tracer study in which one isotope is administered orally and a second is given intravenously with primary analysis being done of the ratio of the recovered isotopes in the urine.

**Iron and Zinc**

The requirements for iron have been set using a factorial approach in which the mean need of toddlers is about 0.6 mg absorbed iron per day and the 97th percentile of requirement is 1.2 mg/day. The US Dietary guidelines then used an approximate absorption fraction of 18% to calculate an estimated average requirement (EAR) of 3 mg/day and a recommended dietary allowance (RDA) of 7 mg/day.

Comparing these values to usual intakes on a global basis, it appears that the mean intake of iron in the USA, Mexico, Europe, and Australia is about 7–10 mg/day, consistent with most children in these locations being well above the EAR. In contrast, lower intake with a mean of about 5 mg/day was reported in the Philippines. Of concern is that the prevalence of anemia remains very high globally with large differences between regions ranging from about 20 to nearly 70% (Table 1) [2, 3].

The EAR for zinc has been set as 2.5 mg/day in the USA/Canada and the equivalent value of 3.6 mg/day in Europe. The RDA for zinc has been set for this age group at 3 mg/day in the USA/Canada and 4.3 mg/day for Europe. Regardless of the exact EAR recommended, the EAR is well below the usual intakes in the USA and Mexico of about 6–8 mg/day.
Calcium, Vitamin D, and Magnesium

Dietary requirements of calcium have largely been set in childhood based on the usual rate at which the skeleton accretes calcium. Estimates based largely on bone mass data suggest this rate in toddlers is about 100 mg/day on average. The EAR in the USA and Canada is 500 mg/day and the RDA 700 mg/day in this age group. Usual intakes in the USA are well above both of these values [4]. Key issues related to vitamin D are the use of national strategies related to food fortification and/or supplementation strategies. These may be most likely considered in countries in which 20% of the population at risk has a 25-OHD level below 30 nmol/L and/or a >1% prevalence of rickets [5]. This is consistent with a Cochrane review suggesting that supplementation of deficient children (< approximately 35 nmol/L) may be useful. The persistence of clinical rickets in many parts of the world is consistent with careful vigilance. The importance of magnesium is increasingly recognized in all age groups. We found that an intake of about 100 mg/daily led to a net calcium retention of about 20 mg/daily in toddlers. However, it is likely that 20 mg/day slightly exceeds the average typical magnesium retention in this age group. The EAR for magnesium was set at 65 mg and the RDA of 80 mg/day before our study. The 1st percentile of usual intakes is 80 mg/day, and the median intake is 180 mg/day. These data suggest limited population-based concern in the USA related to magnesium dietary sufficiency.

Table 1. Summary of key current considerations for minerals in toddlers

- In industrialized countries, iron intake for most small children matches published requirements. This is less true for nonindustrialized countries, and significant shortfalls and anemia persist in all locations.
- Generally, zinc intakes are well above recommendations for most toddlers. As with iron, this is truer in industrialized settings. The likely average physiological need is about 300–400 mg/day.
- Calcium requirements are easily achieved with diet that includes dairy or fortified plant-based or other beverages. Breastfed toddlers should have adequate solid food or other dietary sources of calcium.
- Related to bone health, there is a low but definite persistence of severe vitamin D deficiency in this age group in most countries, since dietary intakes are low in many populations.
- Magnesium-deficient intake is likely relatively uncommon with mixed diets and difficult for clinicians to assess.
References

You Are What Your Parents Eat: Parental Influences on Early Flavor Preference Development

Catherine A. Forestell

Children consume fewer fruits and vegetables than recommended, and their diets are high in saturated fat, sugar, and salt. For example, in the USA, more than 25% of infants and toddlers do not consume a single serving of fruit or vegetables on any given day [1]. Children’s preference for simple sugars and energy-dense foods over nutrient-rich alternatives has a variety of serious health consequences, such as a heightened risk of obesity, type 2 diabetes, and cardiovascular diseases.

Unhealthy dietary preferences are partially a reflection of children’s basic biology. Children are predisposed to like sweet-tasting foods and to reject bitter-tasting foods, such as leafy green vegetables. While preferences for sweet tastes likely evolved to attract children to sources of high energy during periods of maximal growth, bitter rejection may have evolved to protect against poisoning, because many toxic substances are bitter and distasteful. Consequently, preferences for bitter foods (e.g., dark-green vegetables) are largely learned through early sensory experiences.

Sensory experiences begin before birth with the emergence of the chemosensory system. As shown in Figure 1, during gestation, the fetus is exposed to flavors from their mother’s diet in the amniotic fluid. Infants who are breastfed continue to experience these flavors in breast milk. Through these early sensory experiences, infants learn to like a variety of flavors that are characteristic of the culinary traditions of their family and of the foods their mother will later feed them.

Opportunities to develop healthy flavor preferences do not end with gestation or breastfeeding. After the introduction of solid foods, parents continue to play a powerful role in shaping children’s flavor preferences by determining which foods will be made available to their children, and how they will be prepared and flavored. Continued exposure to flavors of a variety of healthy foods, such as fruit and vegetables, during
complementary feeding promotes familiarization of their sensory properties and in turn enhances acceptance of these foods as well as acceptance of novel foods. It is important to note that the process of familiarizing infants with these healthful foods may require patience. Although children will easily accept energy-dense foods and beverages that are high in sugar and salt upon initial presentation, 8–10 exposures to vegetables may be required in order to overcome children's inherent dislike for vegetables [2]. The ease with which children accept new foods will also depend on their age, as new foods are more readily accepted by infants than toddlers.

As young children advance into their second year of life, food preferences and acceptance become influenced by social determinates. For example, parents influence children's eating habits through modeling their own eating behaviors. Research shows that children try new foods more quickly and like healthy foods better when consumption of those

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**Fig. 1.** Depiction of the young child’s feeding environment within the context of the family, which is influenced by various community and societal characteristics.
foods is modeled by a parent [3]. Children will also learn to associate foods with emotional tone of social interactions during feeding. For example, repeated opportunities to taste a vegetable in a positive context with a parent increases its acceptance [4].

From an early age, children learn how and what to eat, and develop expectations about how foods should taste [5]. This learning occurs as a result of the interplay between children's biological predispositions, the food environment provided by their parents, and the community and culture in which they live. Parents vary dramatically in the food environment that they provide their children, which in turn is determined in part by their demographic and cultural background (as depicted in Figure 1). Developing strategies that empower parents from all backgrounds to provide children healthy foods in a supportive feeding environment is critical for promoting the development of preferences for healthy foods.

References
Introducing Hard-to-Like Foods to Infants and Toddlers: Mothers’ Perspectives and Children’s Experiences about Learning to Accept Novel Foods

Susan L. Johnson and Kameron J. Moding

The period of complementary food introduction is increasingly conceived to be an important period for building lifelong food preferences. While the majority of young children consume vegetables and fruit during the introduction of complementary foods [1], vegetable intake is reported to fall when children begin to eat foods of the family table [2]. Food acceptance is influenced by multiple inputs, including (1) individual child traits, (2) environmental inputs, including familial practices and environments, and (3) repeated opportunities for learning and interaction with new foods (Fig. 1) [3]. Previously conducted studies utilizing repeated exposure strategies have proven effective in positively influencing children’s acceptance of novel foods and, to a lesser extent, consumption of such foods [4, 5]. Thus, for many children, barriers to their intake of harder-to-like foods appear to be related to which foods are provided and the persistence with which unaccepted foods continue to be offered, even when they are first rejected.

Through the Good Tastes Study, we have recently explored early experiences of the mother and child with offering a hard-to-like bitter green vegetable (kale). Our aim was to capture transactions during the complementary feeding period which could illuminate the nature of difficult feeding experiences from both mother and child perspectives. Caregivers of infants and toddlers (n = 106; 6–24 months of age) were video-recorded offering up to 8 tastes of pureed kale. Trained researchers coded videos for (1) successful tastes, (2) positive (e.g., reaching for the spoon, playing with the food) and negative child behaviors (e.g., expelling the food, avoiding the spoon, crying), and (3) the avidity with which children accepted the kale offers. Caregivers were queried regarding their
perceptions of their child's liking for the food and the likelihood that they would re-offer the food in the future (a proxy for caregiver persistence). A brief interview was conducted with each participant to gain insights into caregivers’ knowledge of repeated exposure, how they handle food rejections, and what influences their willingness to continue to offer a rejected food.

Children’s refusal increased across the infancy to toddler age span ($p = 0.000$). Toddlers exhibited more avoidant behaviors ($p = 0.000$) and a lower rate of acceptance ($p = 0.000$) than younger infants. Maternal perceptions of children’s liking for kale and their intentions to re-offer the kale were highly correlated ($r = 0.63, p = 0.000$). Moreover, the mothers’ perceptions of child liking and their intention to re-offer kale were negatively associated with child avoidant behaviors ($p < 0.001$); especially when the child expelled the kale ($p < 0.000$). In agreement with previous studies, caregivers’ intention to re-offer was highly related to the amounts children consumed and how avidly it was eaten. Thus, the more difficult the feeding, the less mothers intended to persist in offering the disliked food. Accomplishing the goals of getting children to eat and avoiding stressful feedings take priority over building food acceptance.

During interviews, the majority of mothers revealed knowledge of repeated exposure concepts, but intentions to persist in offering rejected foods differed substantially. Some reported a firm conviction to "never
give up” on rejected foods stating children should “eat what we eat,” while others reported being influenced by their child’s resistance and food dislikes, and having a focus on ensuring their children eat enough. Mothers suggested re-offering a rejected food after “a break.” Intervals for “breaks” varied from days to months to years.

Our findings suggest a “sweet spot” for the introduction of complementary foods that occurs between 6 and 12 months of age. Difficulties in child feeding during toddlerhood may benefit from promoting self-feeding skills rather than the introduction of novel foods. Future research is needed to translate repeated exposure paradigms into practical methods that can assist caregivers to persist in offering difficult-to-like foods.

References

Dietary Sugars: Not as Sour as They Are Made Out to Be?

Dennis M. Bier

Sugars may be Mother Nature’s most essential nutrient since, in the course of evolution, humans have retained the ability to synthesize every sugar needed for metabolic functions while, at the same time, humans lost the ability to make 9 amino acids and 2 fatty acids required for life. During the same evolutionary period, Mother Nature iterated to preferring glucose as the almost sole fuel of the brain and the fetus. Human infants are born with sweet taste receptors, and sugars constitute approximately one-third of the energy supply of human milk. Moreover, complex carbohydrates, half or more of the energy content of human diets, are assimilated only after being broken down to simple sugars whose absorption is enhanced by other fuels serving as the energy source for enterocyte metabolism. If sugars are as unhealthful as many postulate, has Mother Nature been trying to fool us all these eons?

More recently, observational studies have reported repeatedly that consumption of dietary sugars is associated with various adverse consequences, including an increased risk of cardiovascular diseases and mortality [1]. It is important to realize that such observational studies can only find associations (i.e., uncover new hypotheses, not answers) and can never, no matter how extensive, prove causality [2]. “Big data” techniques have now demonstrated unequivocally that there are a huge number of correlation interdependencies among unmeasured and uncontrolled “exposome” variables that make it impossible to attribute causality to individual dietary components themselves (e.g., sugars) [3]. Nonetheless, causal implications of this kind are prevalent throughout both the scientific literature as well as media reports. Importantly, a significant number of such studies fail to control for equivalent total energy intakes. In fact, a meta-analysis of sugar studies commissioned by the WHO concluded that the apparent effects of sugar intake were likely the consequence of increased energy intake [4]. Additionally, the bulk of observational studies have been graded of low quality (including those used by the WHO for its recommendations). Furthermore, many of the reported small-effect
sizes are, arguably, within the propagated “noise” level of the observational methods themselves.

Relatively consistently, the detrimental consequences of increased sugar intake have been limited to the consumption of sugar-sweetened beverages (SSB), not to the consumption of food sugars. In this case, one must question whether the apparent uniqueness of SSB is due to methodological rather than biological distinction. For instance, is the apparent significance due to the fact that one can tally cans or bottles of sodas more accurately and precisely than one can estimate food sugars by dietary intake methods, leading to a statistically significant effect size for the former due merely to less error of the estimate? Additionally, “artificially sweetened” beverages containing no sugar (i.e., the null-sugar control) also often show an apparent, albeit usually less strong, association with detrimental noncommunicable disease outcomes. These findings are often interpreted by creatively constructed “plausible” causal metabolic mechanisms while the most parsimonious explanations deal with recognition of the role of “reverse causality” and acknowledgement of the fact that the “negative sugar control” (i.e., the non-SSB) effect size is simply an indication of the extent of the methodological “noise” of dietary intake methods.

On the other hand, with several notable exceptions, an extensive body of meta-analytical data of randomized controlled sugar reports (including those of sucrose and fructose) that controlled for total energy consumption have failed to confirm the causal implications of the observational data. Likewise, reports of authoritative committees (e.g., the UK Scientific Committee on Nutrition) that evaluated this issue comprehensively over many years also failed to confirm the widely postulated detrimental effects of sugar consumption per se [5]. These points will be discussed.

References

Despite widespread health campaigns to improve health and wellness among youth, most children are not adequately physically active to derive the full health benefits. In fact, less than 24% of school age children engage in the recommended 60+ min of daily moderate-to-vigorous physical activity (MVPA) [1]. Further, many school districts have obviated physical activity (PA) from the school day. Although it may seem counterintuitive that spending less time in the classroom and more time engaged in PA might serve to improve cognition and learning, there is a growing literature detailing the benefit of PA for brain health, cognition, and academic performance.

Early childhood is a critical period of physical and mental development. PA has been shown to improve health outcomes in children; however, PA has seldom been a topic of research in children younger than 6 years. Considering the importance of this period of rapid growth, investigating the potential effects of PA on cognition and brain health is imperative. PA for children under 2 years can include rolling over and learning to sit up, crawl, and walk. Although the connection between PA and cognition in children under 2 years remains unknown, it is generally thought that novel experiences that promote motor skills, movement, and exploration enhance neuroplasticity and further cognitive growth. In children aged 3–5 years, the most prevalent form of PA is active play. Given that active play is naturally unstructured, standardization of PA measures in this age group is challenging to obtain. However, children who spend more time in MVPA during play demonstrate higher executive functioning, which has important implications for academic achievement [2].

Since PA decreases throughout the lifespan, critical populations of interest include preadolescent and adolescent children. Recently, research in preadolescent children has moved towards understanding the cognitive and brain benefits associated with PA. For example, as seen in Figure 1, an afterschool
PA program was associated with larger benefits to executive functioning and the underlying neural processes assessed via different neuroimaging tools [3]. Overall, findings suggest that PA is an important lifestyle factor for cognitive, academic, and brain health during preadolescent childhood.

Relative to research in younger children, the relationship between adolescent cognitive performance and brain outcome in response to PA is unexplored. Cross-sectional studies in adolescents suggest PA during extracurricular leisure time was related to better performance on verbal, numeric, and reasoning abilities [4]. Similar findings were observed in adolescent females who reported actively commuting to school (e.g., walking or biking), compared to nonactive commuters (e.g., by car or bus) [5]. These cross-sectional studies provide a framework for further investigation and are suggestive of a positive relationship between PA and cognition. However, there remains a need for randomized controlled trials to assess the causal effects of PA on adolescent brain and cognition.

Collectively, the importance of PA on cognitive and brain health in children is evident. Data suggest a beneficial relationship between the amount of time preschool children spend in MVPA through active play and improvements in executive functions. PA interventions in preadolescent children have demonstrated benefits to executive functioning (and the neural underlying indices) and academic performance. Cross-sectional adolescent research has further demonstrated that greater amounts of PA are related to better verbal, numeric, and reasoning outcomes. Accordingly, PA is important to consider when evaluating and promoting the health and development of all children. Recently, many school districts have focused their curriculum toward spending more time in the classroom and less time engaged in PA. However, evidence suggests this may be counterintuitive, as PA positively promotes brain health, cognition, and academic performance. Restructuring the school day to include regular bouts of PA is recommended to improve cognitive and brain health.

Fig. 1. Data from the FITKids and FITKids2 trials illustrating cognitive and brain changes stemming from a 9-month PA intervention compared to a wait list control group in preadolescent children. a Topographic scalp plots demonstrating mean change in P3 amplitude during modified flanker and switch tasks for each group [3]. b Response accuracy for the modified flanker task, and the homo- and heterogeneous conditions of the switch task for each group and time point [3]. c Topographic scalp plots depicting the mean change in error-related negativity amplitude during the modified flanker task for each group [6]. d Topographic scalp plots demonstrating an initial contingent negative variation amplitude for each group and time point [7]. e The ratio of fractional anisotropy (FA) and radial diffusivity (RD) for the genu of the corpus callosum for each group and time point [8]. f Mean percent change in the blood oxygen level-dependent signal for the right anterior prefrontal cortex (PFC) and incongruent flanker task response accuracy for each group and time point [9].
References


Nutrition Effects on Childhood Executive Control

Nathaniel Willis and Naiman A. Khan

Longitudinal studies suggest that greater abilities for cognitive control have long-term benefits for children’s academic and vocational success, as well as quality of life in adulthood. Therefore, lifestyle approaches with the potential to support cognitive control in childhood stand to have long-term implications not only for physical but also for cognitive health. Nutrition plays a fundamental role in brain structure and function and has the potential to influence cognitive abilities [1]. Emerging evidence provides preliminary support for the importance of particular nutrients (e.g., water, dietary fibers, carotenoids, and choline) typically studied in the context of physical health but not cognitive function. Understanding the cognitive implications of such nutrients has become increasingly important as the nutrient priorities of individuals expand beyond avoiding deficiencies and increasingly focus on optimization of cognitive function. This article represents a brief narrative review that aims to highlight knowledge on key nutrients (i.e., water, choline, lutein, and fiber) with the potential to promote childhood cognitive function. Literature on the cognitive influence of overall diet quality suggests that greater adherence to the recommended dietary guidelines of Americans and other composite indices is associated with superior cognitive control among school-age children [2]. Recent work has even demonstrated this relationship in children as young as 4 years, suggesting that the influence of diet quality on cognitive abilities is evident in early childhood [3]. Similar relationships have been observed between cognitive control abilities and the habitual consumption of key nutrients known to characterize higher quality diets including water, choline, lutein, as well as dietary fiber [4]. It is likely that these nutrients could impact cognitive function via multiple mechanisms, including modulation of the gastrointestinal microbiota, reducing stress and risk for metabolic impairments, as well as providing neuroprotection to enhance sensory perception and/or cognitive processing. However, much of this work has only recently emerged in child populations, and several limitations are worth acknowledging such as the scarcity of
randomized, controlled trials as well as the heterogeneity of cognitive tasks employed. Additionally, the specific mechanisms that directly or indirectly link the specific nutrients to cognitive control are unclear and should be a goal of future studies. Nevertheless, emerging cross-sectional evidence, accompanied with limited data from clinical trials, points to the potential of these key nutrients in supporting cognitive control in children. Certainly, additional research is needed to continue developing the evidence base for dietary patterns and nutrients that preferentially support cognitive control during childhood. This is an important goal given that nutritional recommendations for children’s cognitive function are absent from the US dietary guidelines [5], making the endeavor to develop the evidence base for dietary patterns and nutrients that preferentially support cognitive control during childhood all the more important.

References

The Importance of Motor Skills for Development

Karen E. Adolph and Justine E. Hoch

Motor skills are important for development. Everything infants do involves motor skills – postural, locomotor, and manual actions; exploratory actions; social interactions; and actions with artifacts. Put another way, all behavior is motor behavior, and thus motor skill acquisition is synonymous with behavioral development. Age norms for basic motor skills provide useful diagnostics for “typical” development, but cultural differences in child-rearing practices influence skill onset ages. Whenever they emerge, motor skills lay the foundation for development by opening up new opportunities for learning. Postural control brings new parts of the environment into view and into reach; locomotion makes the larger world accessible; manual skills promote new forms of interactions with objects; and motor skills involving every part of the body enhance opportunities for social interaction. Thus, motor skills can instigate a cascade of developments in domains far afield from motor behavior – perception and cognition, language and communication, emotional expression and regulation, physical growth and health, and so on. Finally, motor skill acquisition makes behavior increasingly functional and flexible. Infants learn to tailor behavior to variations in their body and environment and to discover or construct new means to achieve their goals.

People typically think of motor development as the items on a standard milestone chart (Fig. 1). But milestone charts do not represent the scope of motor development. All behavior is motor behavior. Thus, to the extent that behavior is important, motor skills are important. Moreover, behavior develops. So, motor development is really behavioral development. From day to day, new skills enter and exit infants’ repertoires, and frequently used skills continually improve [for reviews, see 1, 2].

Motor skills provide a window into development. Generally, motor development is age related (Fig. 1). Thus, age norms for skill onset provide a useful diagnostic tool, and when infants’ onset ages fall beyond the normative range, clinicians and caregivers have cause for concern. The World Health Organization even published “standards” (prescriptive age
bands rather than descriptive norms) for infants’ postural and locomotor milestones [3].

However, age norms must be interpreted with caution. Motor skill acquisition is not a direct readout of neuromuscular maturation – experience trumps age as the key predictor of skill emergence and improvement [for reviews, see 1, 2]. Moreover, because cultural differences in child-rearing practices affect infants’ motor experiences, age norms should reflect worldwide diversity in child-rearing practices, but they do not. In cultures that consider motor development as the result of exercise, caregivers deliberately train skills such as sitting and walking (Fig. 2a), and infants achieve those milestones earlier than would be expected based on western age norms and the WHO standards [for reviews, see 1, 2, 4].
Conversely, in cultures where caregivers constrain infants’ movements (Fig. 2b), infants’ skills are delayed.

Motor skills lay the foundation for psychological development. Each motor achievement unlocks new parts of the environment for exploration and alters infants’ interactions with objects, people, and places [5]. New opportunities for learning, in turn, cascade into developments far afield from motor behavior [for reviews, see 1, 2, 4, 5]. For example, the transition from crawling to walking allows infants to see more, go farther, play more, and interact more (Fig. 2c). Accordingly, the onset of independent
walking is related to increases in infant joint engagement, autonomy, and improvements in receptive and productive language.

Perhaps most important, the development of motor skills makes behavior more functional and flexible [for reviews, see 1, 2, 4]. Function is critical for the activities of daily living, and behavioral flexibility is imperative because bodies and environments are continually in flux. For behavior to be functional and flexible, infants must tailor action to changes in local conditions [for reviews, see 1, 2, 4]. They must select, modify, and, in many instances, create appropriate actions on the fly. Perception and cognition are required to guide actions adaptively. Infants must perceive what is out there and decide what to do about it.

For example, when infants first begin crawling and walking, they do not perceive possibilities for locomotion. In laboratory experiments, they plunge headlong over the brink of impossibly steep slopes and high drop-offs. Over weeks of crawling and walking, infants learn to perceive possibilities for locomotion with impressive precision (Fig. 2d). Infants can even update their assessments to take experimentally induced changes in their bodies into account (e.g., lead-weighted shoulder packs and Teflon-soled shoes that decrease their ability to walk down slopes). Moreover, infants can create new means to cope with novel tasks – learning in the moment to slide down steep slopes in a sitting or backing position, and so on. How do they do it? Through massive amounts of everyday, time-distributed, variable practice, and by generating the requisite perceptual information through exploratory actions [for reviews, see 1, 2, 4].

References

The Importance of Providing Opportunities for Health Behaviors during the School Day

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Globally, full-day preschool and an increased academic focus are rapidly becoming the norm, thus depriving children of opportunities to engage in physical activity (PA) [1]. Children are spending their time outside of the home in the school environment, which presents an opportunity for schools, administrators, teachers, and child care providers to educate children about the importance of participating in PA and making healthy eating choices. One such approach is called Whole School, Whole Community, Whole Child (WSCC) [2]. Figure 1 provides a framework to provide opportunities for 60 min of moderate-to-vigorous PA per day [3].

WSCC is ideal because it intertwines the desired outcome of academic success and prevalence of healthy behaviors, such as being regularly physically active and eating healthy. Particularly for youth, multicomponent approaches that include both school and family or community involvement have the most significant potential to make meaningful differences in the rate of PA participation [4]. Further, The Healthy Foods and Beverages in Schools campaign (Fig. 2) identifies smart snacks in school settings and opportunities in schools where healthy eating can be explained and practiced (classroom celebrations, events, and nonfood rewards).

Overall, successful school interventions intended to increase PA and healthy eating include the following evidenced-based practice:

- Supportive administrators who are invested in improving student health
- Content-specific and ongoing professional development that increases teacher knowledge on PA and nutrition
- Effective use of school and classroom environment to engage students in PA opportunities across the school day
- Intentional teaching practices that embed routine PA across the school day
- Teacher champions that organize, support, and encourage a sustained culture of health
Fig. 1. The Whole School, Whole Community, Whole Child collaborative approach to learning and health [2].

- Engaging youth in health leadership opportunities that provide them with a say and a voice
- Parental engagement that reinforces healthy eating and PA at home
- Community partnerships that support and extend the shared culture of health
- Evidenced-based curricula and data-driven instructional methods that support health behavior change in youth (i.e., SPARK, CATCH)
Ample resources for teachers (PA break options GoNoodle, Hip Hop Public Health, Snap-ED, etc.)

Social-ecological modes and theories like the Self-Determination Theory provide a framework for social systems supporting opportunities for children to build autonomy, relatedness, and competence. For example, during the school day, upper elementary school children before dancing to music in the classroom can predict how many steps per minute that they will take, whereas the same activity in early childhood might focus on having the child notice that their heart beats faster when dancing over sitting. Healthier children are better learners, because of the cognitive benefits and improved brain health from individual PA sessions and regular PA participation over time [5], both structured and unstructured play, movement, physical education, recess, and sport should be integrated into
the daily lives of children. Finally, the Centers for Disease Control and Prevention recommend that schools implement policies and practices to create a nutrition and PA environment that supports students in making healthy choices. When a school offers appealing, nutritious foods and opportunities to be physically active, children not only learn about the importance of making healthy choices but also reduce health risks and improve readiness for learning.

References

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