

A Review of Evidence to Support Why Young Eaters Need Veggies 'Early and Often'

# Yes, kids can learn to love veggies





## About Partnership for a Healthier America (PHA)

PHA's mission is to leverage the power of the private sector to transform the food landscape in pursuit of health equity. In 2010, PHA was created in conjunction with Former First Lady Michelle Obama's Let's Move! effort. PHA identifies, accelerates, and celebrates voluntary business practices that improve or increase choice or lead to new norms and behavior around food and physical activity.

## About the author

Emily A. Callahan, MPH, RDN is owner of EAC Health and Nutrition, LLC, which helps organizations evaluate and communicate research to educate stakeholders, shape environments, and advance policies to promote healthy eating, active living, and population health. Emily's core services include research evaluation and interpretation, science and technical writing and editing, and content creation for health professional, consumer, academic, and policymaker audiences. Previously, Emily managed a national nutrition initiative at the American Heart Association and was a Program Officer at the National Academies of Sciences, Engineering, and Medicine's Food and Nutrition Board. As a Registered Dietitian Nutritionist, Emily has also counseled patients and delivered numerous health and nutrition presentations to a variety of professional and consumer audiences. She earned an MPH in Nutrition and a certificate in Interdisciplinary Health Communication at the University of North Carolina at Chapel Hill, and a BS in Dietetics (*summa cum laude*) from Miami University in Ohio. Emily lives in the Washington, DC metro area with her family.





## **A review of evidence to support why young eaters need veggies ‘early and often.’**

Most young children fail to meet recommendations for vegetable intake, a regrettable fact given evidence suggesting that the early years are a unique window of opportunity to cultivate healthy taste preferences and dietary patterns. In addition, commercial baby and toddler vegetable products often fall short of their potential to support early vegetable acceptance. The Partnership for a Healthier America (PHA) has a vision to improve the food landscape for the nation’s youngest eaters through a veggie-forward approach.

PHA designed an education campaign called Veggies Early and Often in January 2021. The campaign is one strategy to pursue the PHA vision, which involves convening industry leaders, health professionals, and early education partners to consolidate evidence and outline an action agenda with the goal to raise a generation of veggie lovers. The campaign’s messages aim to educate parents, caregivers, health professionals, and

baby and toddler food makers about the importance of early, repeated exposure to vegetables for young eaters.

The primary purpose of this review paper is to present examples of research that underpin the campaign’s key and supporting messages to offer vegetables to young children early and often (particularly during the period of complementary feeding that lasts until 24 months of age). The evidence on how young children learn about food and eating behavior during the first two years of life is relatively limited (e.g., many feeding experiments that have been conducted had small numbers of participants), yet is supportive of the campaign messages. Moreover, PHA is aware of no evidence suggesting adverse effects of offering vegetables early and often. A second purpose of this review paper is to comment on the capacity of the current vegetable offerings in the U.S. mainstream retail baby and toddler food marketplace to facilitate increased vegetable acceptance.

# Veggies early and often are critical to a happy, healthy life

## Supporting Message 1a: Diets rich in fruits and vegetables can help prevent chronic diseases and support weight management.

The association between fruit and vegetable intake and prevention of chronic diseases is well-documented, particularly for cardiovascular disease (CVD).<sup>1,2</sup> According to the long-running Global Burden of Cardiovascular Diseases study, dietary risks (which include under-consumption of fruits and vegetables) are the second leading modifiable risk factor to which the global burden of CVD is attributed.<sup>3</sup> In studies that reported a reduced risk of death from CVD among individuals with higher intake of fruits and vegetables, average risk reduction was 4% for each additional daily serving of fruits and vegetables.<sup>4</sup> Among a large (n = 100,000+) cohort of female nurses and male health professionals, those who averaged 8 or more daily

servings of fruits and vegetables were 30% less likely to have a heart attack or stroke, and those consuming 5 daily servings were 12% less likely (compared with those who averaged <1.5 daily servings).<sup>5</sup> Green leafy vegetables such as lettuce, spinach, Swiss chard, and mustard greens were most strongly associated with decreased risk of CVD.

While overall fruit and vegetable intake did not decrease risk for developing cancer in the nurse and health professionals cohort,<sup>5</sup> certain fruits and vegetables and their components may protect against specific types of cancer. For example, associations have been reported between higher intakes of certain fruits and vegetables among women and lower risk of breast cancer.<sup>6,7</sup>

According to the World Cancer Research Fund and the American Institute for Cancer Research, there is probable evidence that non-starchy vegetables and fruit combined decrease risk of several types of cancers including mouth, pharynx and larynx; esophageal; lung; and stomach and colorectal cancers.<sup>8</sup>

The direct impact of fruit and vegetable consumption on weight outcomes is less well-studied than the impact on chronic disease outcomes, but available evidence suggests that eating fruits and vegetables may help manage weight.<sup>9</sup> Similarly, a systematic review of cohort studies that narrowed their focus to the impact of vegetables alone concluded that moderate quality evidence exists for an inverse association between vegetable





intake and weight-related outcomes in adults.<sup>10</sup> Notably, the total dietary context in which increased intake of fruits and vegetables occurs is an important influence on weight outcomes. Evidence suggests that coupling advice to increase fruit and vegetable intake with advice to decrease energy intake is a particularly effective strategy for weight management.<sup>11</sup>

The findings on fruit and vegetable intake and weight may be because fruits and vegetables in their natural

state have high water and fiber content and are low in energy density, and therefore could support weight loss when used to replace foods of higher energy density. This is one explanation for the different effects on weight that were observed in a study where weight loss was associated with increased intake of some fruits and vegetables (berries, apples, pears, soy, and cauliflower), but weight gain was associated with increased intake of others (potatoes, corn, and peas, which are starchier, more energy-dense

vegetables).<sup>12</sup> Further study is needed to explore relationships between specific types of fruits and vegetables and weight outcomes.

In addition to effects on CVD and cancer outcomes, diets rich in fruits and vegetables are also associated with lower blood pressure,<sup>13,14,15</sup> a critical risk factor that hastens development of chronic diseases, particularly if left uncontrolled.<sup>16</sup>

## Supporting Message 1b: Infants, toddlers and preschoolers don't eat enough vegetables.

Most toddlers report eating vegetables on a given day,<sup>17</sup> but only about 10% of children consume the recommended amounts of vegetables. The Dietary Guidelines for Americans (2020-2025) recommend that toddlers (ages 12-23 months)<sup>a</sup> consume .66-1 cup of total vegetables per day,<sup>b</sup> but nearly 90% of toddlers fall short of that recommendation<sup>18</sup> (see Appendix for detailed information). On average, toddlers eat 0.56 cups of total vegetables per day, almost one quarter of which is white potatoes.<sup>19</sup>

For children ages 2-5, recommended total vegetable intake is 1-1.5 cups/day.<sup>20</sup> Average intakes in this age group are 0.7 cups/day.<sup>21</sup> Among all U.S. children and adolescents, the age

group with the highest percentage of individuals who have total vegetable intakes at or above recommended amounts is children 2-3 years—yet this designation applies to only 15% of boys and 13% of girls in this age group.<sup>22</sup>

Other surveys have also examined vegetable intake among young children, including the Feeding Infants and Toddlers Study (FITS) and the WIC Infant and Toddler Feeding Practices Study-2 (WIC ITFPS-2). These surveys, for which the most currently available data are reported below, include data that were collected among different samples of young children and during different years than the data reported above, for example. But overall, despite some differences in the reported percentages

of young children consuming vegetables, it is clear that young children fall short of vegetable recommendations in terms of both amount and variety.

According to FITS 2016, which examined dietary practices of children from birth up to 4 years (47.9 months) of age, the following percentages of 0-2-year-old children consumed any vegetable on the day of the study survey:

- 34% of 4-5.9-month-olds
- 72% of 6-11.9-month-olds
- 73% of 12-17.9-month-olds
- 71% of 18-23.9-month-olds

If white potatoes (the most commonly consumed category of vegetables among toddlers [12-23.9 months old])

<sup>a</sup> Who are no longer receiving human milk or infant formula

<sup>b</sup> Additional recommendations exist for weekly intakes of the five vegetable subgroups (see Appendix)

were excluded, the percentage of toddlers consuming any vegetable decreased to ~60%. Yet even if white potatoes were counted, 30% of toddlers still did not consume any vegetable servings on the day of the survey, and only 12-14% consumed dark green vegetables. The most commonly consumed vegetables were sweet potatoes, green beans, carrots, squash, and potato mixtures.<sup>23</sup>

FITS 2016 data indicate that 73% of older children (ages 24-47.9 months) consumed any vegetable on the day of the survey.<sup>c</sup> The most commonly consumed vegetables were (in descending order) fried potatoes, carrots, broccoli, green beans, potato

mixtures, and tomatoes.<sup>24</sup>

Compared with FITS 2016, similar proportions of participants in the WIC ITFPS-2 reported consuming vegetables, but not necessarily the most nutrient-dense options. About 60% of participants ages 11-24 months consumed vegetables on a given day; the highest proportion of vegetable consumption occurred among 11-month-old participants, of whom 66% reported consuming a vegetable.<sup>25</sup> Among children 7-13 months, less than half consumed deep yellow/orange vegetables on a given day, and fewer than 11% consumed dark green vegetables. By age 36 months, 63% of participants consumed any vegetables on a given day; 37% consumed none.

Tomatoes (including those cooked in sauces) and French fries or other fried potatoes were the most commonly consumed vegetables at both 24 and 36 months.<sup>26</sup>

The findings from FITS 2016 and WIC ITFPS-2 are similar to earlier estimates of young children's vegetable consumption. For example, 25-30% of infants and toddlers (6-23.9 months old) did not consume a vegetable on the day of the survey in both FITS 2002 and 2008.<sup>27</sup> Among older children, FITS 2008 reported that 30% of 2- and 3-year olds did not consume vegetables on the day of the survey.<sup>28</sup>

### **Supporting Message 1c: Because early childhood is a critical period for the development of taste preferences and healthy dietary patterns, it is a uniquely opportune time to cultivate vegetable acceptance.**

The first few years of life are a key period for establishing healthy taste preferences and dietary patterns, which are important supports for optimal growth and development as well as chronic disease prevention.<sup>29,30,31,32,33</sup> Dietary habits formed early in life track into childhood,<sup>34,35,36</sup> and childhood dietary patterns track to some degree into adolescence<sup>37,38</sup> and adulthood.<sup>39,40,41</sup> Reported dietary patterns and habits appear to be relatively stable after 3 to 4 years of

age, based on observed tracking of nutrient intakes in a small (n = 95) cohort of children between ages 3-4 and ages 7-8.<sup>42</sup> Overall, it is clear that the infant and toddler years are a critical and unique time window for influencing children's lifelong dietary patterns, which include vegetable intake habits.

An examination of the association between vegetable intake at 10.5 months of age and intake at age 6

found that children who ate vegetables less than once daily during late infancy had 2.4 times higher odds of eating vegetables less than once daily at age 6, compared with children who ate vegetables more frequently (2+ times per day) during late infancy.<sup>43</sup> This finding highlights the importance of encouraging regular vegetable intake from an early age.

<sup>c</sup> It is notable that these estimates do not include the percentage of children who consumed vegetables as part of mixed dishes, which reportedly contribute up to one-quarter of vegetable intake in this age group, so the values from FITS 2016 may underestimate actual consumption.





# Through exposure early and often, kids can grow to love vegetables

**Supporting Message 2a: Children are born with preferences for sweet and salty tastes, but not for the bitter, umami, or even spicy tastes of many vegetables.**

Compared with adults, children have heightened preferences for sweet-tasting foods and greater rejection of bitter-tasting foods.<sup>44</sup> This is attributed to the age-related changes that occur in taste perception and preference, whereby the rewarding properties of sweet (and salty) tastes and the aversive properties of bitter tastes are more pronounced until mid-adolescence, when taste perceptions and preferences change to resemble adult patterns.<sup>33</sup> It has been suggested that infants' innate ability to detect sweet tastes (and their preferences for high levels of sweet tastes<sup>45</sup>), are present early in

life to attract them to the predominant taste quality of human milk. The inclination toward sweet tastes has also been hypothesized to be linked to the growing child's need for calories, which are relatively abundant in sweet-tasting foods.<sup>46</sup> Aversion to bitter tastes early in life may also occur as a survival mechanism, i.e., to help individuals avoid potentially toxic substances.<sup>33</sup>

Although inborn responses to basic tastes mean that childhood may be a time of heightened bitter sensitivity for many children—which may affect vegetable acceptance during the

early years—it has been said that “our biology is not necessarily our destiny.”<sup>33</sup> This statement is supported by a body of both experimental and observational evidence indicating that the senses underlying flavor perception are “plastic” in that they can be modified by early feeding experiences (examples of which are discussed in the remainder of this paper). This plasticity in the development of the chemical senses helps ensure that innate preferences and aversions to certain tastes do not restrict a child to a narrow range of foods.<sup>33</sup>

**Supporting Message 2b: Repeated exposure to vegetables in a positive environment is an effective way to encourage infants to accept new vegetables.**

A recent (2019) systematic review included 21 studies (19 controlled trials and 2 longitudinal cohorts) published between 1980 and 2017 that examined the effects of repeated exposure to single or multiple foods on acceptance of those or other foods among infants and toddlers ages 4-24 months.<sup>47</sup> Most of the studies examined exposures to vegetables; common vegetables examined in the studies included broccoli, green beans, peas, carrots, squash, and artichokes.

The authors concluded that moderate evidence indicates that tasting a single vegetable or multiple vegetables

1 food per day for 8-10 or more days is likely to increase acceptability of the exposed vegetables (indicated by an increase in intake or faster rate of feeding compared with the period before the exposure).

The authors also reported that the effect of repeated exposure on acceptability is likely to generalize to other foods within the same food category, but not to foods from a different food category. In other words, repeated exposure to a given vegetable is likely to improve acceptability of a different, new vegetable, but not necessarily a new fruit.





### **Supporting Message 2c: It can take 10 or more tastes for a child to accept a new vegetable.**

As stated above, a recent systematic review concluded that 8-10 or more exposures to vegetable(s) can increase acceptability to those or other vegetables among children ages 4-24 months.<sup>47</sup> The number of exposures in the included studies ranged from 6-47, but most studies provided 8-10 exposures which led to significant increases in acceptability. Some of the studies observed increases in vegetable acceptability as early as the first, third, fifth, or sixth exposure following initial exposure, although they weren't necessarily designed to determine the minimum number of exposures necessary to positively influence acceptability.

It is notable that exposures where young children simply look at a food are not sufficient to increase that food's acceptability; children must experience the flavor and taste of a food to learn to like it.<sup>48, 49</sup>

In addition to measuring children's intake of food and the rate at which they eat as indicators of acceptability, other measures that have been assessed include facial reactivity and maternal perceptions of the child's response to the food. For example, studies that used a scale for measuring facial expressions found that the expressions became less negative after repeated feeding experience with

a particular food, and in some cases, mothers perceived that their infants enjoyed the food more after multiple exposures.<sup>49, 50, 51</sup> However, because infants might initially display facial expressions of distaste in response to a new vegetable, caregivers might stop offering it prematurely. Caregivers should be encouraged to provide repeated opportunities for infants to experience vegetables and focus not only on their facial expressions but also their willingness to continue feeding.<sup>49</sup>

**Supporting Message 2d: The strategy to hide or mute vegetable flavors, such as by mixing them with more than 50% fruit puree, reduces a child's opportunities to learn and like vegetable flavors and could negatively reinforce a child's innate sweet taste preferences and contribute to long-term adverse health consequences.**

As indicated above, young children can learn to accept vegetables after repeated exposures to vegetables in their typical state; combining vegetables with fruit puree or seasonings, for example, was not imperative to acquire acceptance. One study that specifically examined this strategy found that repeated exposure to a new vegetable (artichoke) in its standard form was as effective at increasing acceptance as repeated exposure to the sweetened vegetable among infants 5-7 months old, suggesting that adding sweeteners is unnecessary.<sup>52</sup> Furthermore, it is likely

that minimizing children's exposure to very sweet-tasting foods during their early years could help avoid contributing to reinforcing their natural preferences for sweet tastes, though it does not appear that this theory has been specifically tested in young children.

For children to learn to like vegetables, the flavors from the vegetables must be perceptible within the mixture. A quantitative analysis of the sensory properties of 21 commercial vegetable-containing infant foods reported that products that also contained fruit

were sweeter, higher in fruit flavors, and lower in vegetable flavors than products without fruit.<sup>53</sup> Sensory profiles tended to reflect the first ingredient in the product, but because few products featured dark green vegetables in this position, this flavor was not predominant in the category. The study authors suggested that the sensory profiles of the currently commercially available infant vegetables foods do not tend to facilitate increased acceptance of green vegetables.





# Early veggie variety is key to raising an adventurous, happy, healthy eater

**Supporting Message 3a: Variety is as important as quantity because each color of vegetable provides different nutrients.**

Variety within and among food groups is a cornerstone of dietary guidance and proper nutrition, because the nutrients that are essential to human health are distributed throughout major food groups. Eating a variety of foods provides more opportunities to consume a wide range of vitamins, minerals, and other food substances (e.g., antioxidants, probiotics, and other bioactive compounds) that contribute to good health.<sup>18</sup>

The various colors that occur in vegetables represent different phytonutrients, which is a broad name for a wide variety of compounds produced by plants to help protect the plants from insects, germs, and other threats.<sup>54</sup> Thousands of phytonutrients exist, but relatively few have been widely researched. A few examples of phytonutrients that occur in vegetables include beta-carotene (orange vegetables), lycopene (red vegetables),

phylloquinone (leafy green vegetables), and flavonoids (purple vegetables). Eating a variety of colorful vegetables provides the body with a diverse assortment of phytonutrients that offer different health benefits.<sup>55</sup>

**Supporting Message 3b: Between 4 and 7 months of age, infants appear to be highly receptive to variety in flavors and textures and generally require fewer exposures than older children to increase acceptance. Only a mouthful or two of food at each feeding attempt may be enough to acquire liking.**

Infants introduced to small tastes of vegetable flavors can learn to like vegetables relatively quickly. One small study (n = 39) of 4 to 7-month-old infants found that intake of a new vegetable nearly doubled (to 60 grams) after only one previous exposure to the vegetable.<sup>56</sup> This is in contrast to findings for older (i.e., 2 to 5-year-old) children who typically require multiple exposures of a new food before they significantly increase intake.<sup>48</sup>

Another study that explored the impact of feeding practices on food acceptance found that the earlier vegetables were introduced, the higher the acceptance of new vegetables. The average age at which solid foods were introduced in the study was 5 months. Furthermore, new food acceptance was significantly correlated with the number of different foods offered during the first two months of offering solids, particularly for fruits and vegetables.<sup>57</sup>

The Dietary Guidelines for Americans (2020-2025) recommend introducing infants to nutrient-dense complementary foods (which are intended to replace some calories from human milk or infant formula) at about 6 months of age.<sup>18</sup> During the time period leading up to this milestone (i.e., around 4-6 months of age), it has been suggested that it may be beneficial to introduce infants to tiny tastes of a variety of vegetables (offered one at a time) to build familiarity with their flavors, which may help promote vegetable acceptance in the months to come. This “flavor training” strategy can be implemented by regularly exposing an infant to a very small amount of pureed vegetable offered on a caregiver’s clean finger or a teaspoon. Flavor training is distinguished from complementary feeding in that it is not intended to replace human milk or infant formula, nor to count toward an infant’s calorie or nutrient needs.<sup>58</sup>

Because infants appear to be particularly receptive to new flavors and textures at the beginning of the complementary feeding period (as explained above), it has been suggested that vegetables—particularly less-sweet vegetables that are typically more difficult for young children to accept—should be a focus during this time, as a step toward increasing the likelihood of children eating these foods during childhood and beyond.<sup>59,60</sup>





**Supporting Message 3c: Offering a wide variety of vegetables when solid foods are introduced can help foster development of a broad palate and encourage baby's willingness to try diverse flavors during childhood.**

In addition to repeated exposures, a second type of feeding strategy that has been demonstrated to increase infants' acceptance of vegetables is providing a variety of flavors. Experiencing such a variety both within and between meals promotes willingness to eat other novel foods as well.<sup>33</sup> For example, infants who were repeatedly exposed to different vegetables ate more of the vegetables to which they were exposed, and they also ate more of the novel vegetables provided than infants who were repeatedly exposed to only one vegetable.<sup>61</sup>

In another study, offering infants a high variety of vegetables for 10 days at the beginning of complementary feeding increased acceptance of new foods, including vegetables, for up to 2 months (compared with infants offered no or low vegetable variety).<sup>62</sup> After following the same infants for 6 years, the authors found statistically significant evidence that those who had experienced high vegetable variety at the start of complementary feeding ate more vegetables, liked them more, and were more willing to taste vegetables than children in the no or low vegetable variety groups during

infancy.<sup>63</sup> Based on these findings, experience with flavor variety at the onset of complementary feeding appears to be one factor that can influence flavor preferences for vegetables into childhood.

In summary, complementary foods not only contribute to adequate nutrition but also provide exposure to different flavors, textures, and types of foods. This variety helps support complementary feeding's goal of establishing a healthy dietary pattern and transitioning an infant to a healthy family diet by 2 years of age.<sup>18</sup>

**Supporting Message 3d: Just as there are windows of opportunity to familiarize children with a wide variety of foods, there is also a period during which they are reluctant to try new foods—this period peaks as early as 24 months and typically fades throughout childhood and adolescence.**

Beginning in the second year of life, children typically become more selective or “fussy” about what they eat. This food neophobia (rejection of novel or unfamiliar foods) is minimal during infancy and strengthens as the child becomes more autonomous, peaking between 2-6 years of age.<sup>64,65</sup> The peak coincides with the time that children begin to explore their surroundings outside of parental guidance, suggesting that food neophobia may be present as an evolutionarily beneficial survival mechanism that operates when risk of consuming harmful foods is high.<sup>65</sup>

Food neophobia has been independently associated with lower fruit and vegetable intake at 2-6 years of age.<sup>66</sup> For example, one study reported that 24-month-old children with higher levels of food neophobia were likely to consume a lower quantity and variety of fruits and vegetables.<sup>67</sup> Fortunately, it is likely that food neophobia continues to decrease throughout childhood and adolescence.<sup>65</sup> Based on the evidence presented in this paper, it seems possible that food neophobia could be modified by repeated exposure to a wide variety of vegetables early in life.



# Role model for kids— cook and eat a balanced, plant-forward diet

**Supporting Message 4a: Multi-generational approaches are most effective and sustainable in early interventions to increase vegetable consumption among children.**

Parents and caregivers influence children's eating behaviors in several ways, such as making food choices for the family, role modeling dietary choices and habits, and using feeding practices to shape eating patterns and behaviors that they consider appropriate.<sup>31</sup> In other words, caregivers are the gatekeepers of children's exposure to a variety of foods. Their decisions about what, when, and how to offer foods to children can have as much influence as biology on children's food preferences and acceptance.<sup>68</sup> For example, mothers' food preferences

may limit foods offered to children because foods disliked by mothers tend to not be offered.<sup>34</sup> A study of preschoolers found that greater maternal liking of fruits and vegetables was associated with their children's trying more fruits and vegetables, and mothers' likes also limited the number of fruits and vegetables that their children tried.<sup>69</sup>

Research suggests that parental fruit and vegetable intake is associated with young children's vegetable intake. For example, parental fruit and vegetable intake was positively related to their

children's fruit and vegetable intake in a population of preschoolers<sup>66</sup> as well as 5-year-old girls,<sup>70</sup> and for vegetables specifically, maternal modeling of healthy eating at 1 year predicted higher child frequency of vegetable consumption at 2 years.<sup>71</sup> It has been suggested that research on the effect of parental modeling on children's eating behaviors indicates that a "do as I do" approach has a stronger positive effect on children's food intakes than a "do as I say" approach.<sup>31</sup>

### Supporting Message 4b: Regular family-style mealtimes are positively associated with increased vegetable intake in children.

A 2014 review of family meal research concluded that greater family meal frequency is associated with children's increased intake of dietary components related to improved health (e.g., fruits, vegetables), but noted that the majority of family meal research has been conducted with older children and teens.<sup>72</sup> A 2020 systematic literature review with meta-analysis also found evidence of a positive association between family meal frequency and fruit and vegetable intake (when examined both separately and combined) among children ages 2-18.<sup>73</sup>

In terms of research specific to younger children, a survey of parents and caregivers of preschool children in London found that family mealtimes were associated with higher intake of vegetables,<sup>66</sup> whereas another study in the UK found that 2- to 5-year-old children's liking for vegetables and their vegetable consumption was predicted

by eating approximately the same food as their parents.<sup>74</sup> A U.S. study found a relationship between fruit and vegetable intake and frequency of family meals among preschoolers: the odds of low fruit and vegetable intake were greater for preschoolers who shared less than three evening family meals per week, compared with preschoolers who shared the evening meal with family every night.<sup>75</sup>

According to a poll of 1,000 U.S. adults conducted in August 2020, 94% reported cooking the same amount or more and 75% reported having the same amount or more family meals than before the COVID-19 pandemic.<sup>76</sup> Increased cooking at home during the pandemic has been an opportunity for households to promote vegetable acceptance among young children while they engage in more frequent family-style mealtimes.





**Supporting Message 4c: Familiarizing baby with diverse vegetable flavors and textures in the family's diet can help maintain vegetable consumption as the child fully transitions to the family table by age 2.**

The complementary feeding period (ages ~6-24 months) can be viewed as a continuous transition to diets that resemble family food patterns. By 2 years of age, children are consuming diets similar to those of their family members.<sup>18</sup>

However, commercial baby foods are not usually eaten beyond infancy and do not generally taste like the table foods to which infant will transition. For example, a small study (n=39) found that repeated exposure to commercial baby food (peas) did not generalize to homemade versions of the same food.<sup>56</sup>

In addition to the importance of regularly offering infants and toddlers a variety of vegetables, it is also critical that the family regularly eats a variety of vegetable types, flavors, and textures. The vegetables to which infants are exposed during the complementary feeding period should be part of the family's typical diet and food environment, so that when infants develop preferences for those vegetables, they continue to be exposed to them to maintain those preferences and even broaden preferences to more complex flavors and textures.<sup>33</sup>

**Supporting Message 4d: Producing and eating a plant-forward diet that emphasizes fruits and vegetables, whole grains, legumes, nuts and seeds, unsaturated plant oils, and herbs and spices positively impacts human and planetary health.**

The EAT-Lancet Commission developed global scientific targets in 2019 based on the best evidence available for healthy diets and sustainable food production.<sup>77</sup> According to the Commission, “healthy diets have an appropriate caloric intake and consist of a diversity of plant-based foods, low amounts of animal source foods, unsaturated rather than saturated fats, and small amounts of refined grains, highly processed foods, and added sugars.” The Commission suggests that a planetary health plate should consist by volume of approximately half a plate of vegetables and fruits,

and the other half primarily of whole grains, plant protein sources, unsaturated plant oils, and (optionally) modest amounts of animal sources of protein.<sup>78</sup>

Shifting to such diets by 2050 will require major shifts in dietary intake worldwide, (including more than a 100% increase in consumption of healthy foods such as nuts, fruits, vegetables, and legumes), but are expected to reap substantial benefits to human health. For example, shifting from current diets to healthy diets are projected to avoid about 10.8-11.6

million deaths annually.

Worldwide consumption of the healthy diet described by the Commission is also expected to benefit planetary health and reduce environmental risks by reducing greenhouse-gas emissions, nitrogen and phosphorus pollution, biodiversity loss, and water and land use. Transformation to food production methods that promote planetary stability will likewise require major shifts from current food production practices as well as large reductions in food loss and waste.





## **The shortcomings of vegetable offerings in the U.S. commercial baby and toddler food marketplace.**

Parent and caregiver efforts to provide veggie-forward diets to young children can be either supported or hampered by the offerings in the baby and toddler food marketplace. Much room exists to improve the U.S. mainstream retail baby and toddler food marketplace so it includes affordable products that support veggie-forward diets for the nation's youngest eaters.

### Many commercial baby and toddler food product lines lack sufficient variety to facilitate young children's acceptance of veggies.

A 2018 survey of commercial baby food products in the United States reported that the products examined did not provide caregivers with a sufficient variety of single-vegetable products or products containing dark green vegetables to facilitate children's subsequent acceptance of these vegetables.<sup>79</sup> Specifically, only 52 out of 548 vegetable products identified were single-vegetable products, and none featured dark green vegetables or beans/peas. Dark green vegetables were found only as mixtures with fruit or sweeter vegetables, yet evidence suggests that specific vegetable flavors must be perceptible within a product for the liking of those vegetables to be learned.<sup>53</sup>

### Commercial baby food products hide or mask the flavor of veggies even when veggies are on the ingredient list.

A descriptive analysis that quantitatively profiled the sensory properties of 21 commercial vegetable-containing infant foods found that products containing fruit were sweeter than products that did not contain fruit, and were also higher in fruit flavors and lower in vegetable flavors.<sup>53</sup> Furthermore, a product's sensory profiles were driven by its first ingredient. Few products had dark green vegetables as a first ingredient, therefore that vegetable flavor was not prevalent in this sample of foods. The authors suggested that the sensory profiles of commercially available infant vegetable foods may not be adequate to facilitate increased acceptance of green vegetables, because prior research has demonstrated that children must experience the flavor and taste of a food to learn to like it.<sup>48,49</sup>

Further research is needed to clarify whether specific combinations of foods and the relative prominence of singular vegetable flavors lead to different outcomes in preference and intake of specific vegetables.<sup>60</sup> Such research could inform the practice of mixing vegetables with other foods, which appears to be a common method that is presumably intended to mask their taste.

### Parents cannot trust that products marketed as having vegetables actually have vegetables in significant amounts.

A survey of infant and toddler foods found that products containing vegetables were more commonly packaged in pouches (50%) than in other packages (25%) or jars/packs (25%). Pouches were more likely to contain vegetable/fruit blends, whereas jars/packs were more likely to contain single-vegetable or multi-vegetable blends, and "other" packages were more likely to be combinations of vegetables and other ingredients such as grains and/or dairy. Pouches are popular, convenient, and widely available, but may not represent the vegetable profiles and nutritional qualities that parents want and are expecting.<sup>80</sup>

### There is an opportunity to reformulate existing commercial baby food products and/or create new products with an optimal composition to facilitate increased acceptance of veggies.

Manufacturers of baby and toddler foods could help promote young children's acceptance of veggies by providing products that support better-for-you and culturally-specific efforts by parents and caregivers to provide them with repeated exposures to a variety of vegetables. An expert group in the UK suggested that small (~20 gram) "taster" packs of a variety of vegetables, as well as larger meal-sized vegetable-based products that are not sweet in taste, could support this objective.<sup>60</sup>





## Conclusion

The early years of a child's life are an opportune time to promote vegetable acceptance within efforts to foster healthy taste preferences and healthy dietary patterns. Although the biological development of human taste preferences does not predispose children to favor diets that are low in sugar and salt and rich in vegetables, it is encouraging that taste preferences are malleable and can be shaped and modified by early dietary experiences. Therefore, it is important to include in young children's diets, varied and positive exposures to the taste, flavors, and textures of a variety of vegetables in order to help cultivate a lifetime of healthy, plant-based dietary patterns, improve planetary health, and reduce the likelihood of developing obesity and other chronic diseases. Innovative approaches to introduce and sustain the consumption of a variety of vegetables that children accept and enjoy should be a high priority for baby and toddler food manufacturers, health professionals, early childhood education providers, and parents and caregivers.

## Appendix – Data on Recommended and Actual Intakes of Vegetables for Young Children

**Table 1**

Healthy U.S.-Style Dietary Pattern for Vegetables for Toddlers Ages 12 Through 23 Months Who Are No Longer Receiving Human Milk or Infant Formula, With Daily or Weekly Amounts From Food Groups, Subgroups, and Components

Calorie Level of Pattern <sup>a</sup>	700	800	900	1,000
<b>Food Group or Subgroup<sup>b,c</sup></b>	<b>Daily Amount of Food From Each Group<sup>d</sup></b> (Vegetable and protein foods subgroup amounts are per week)			
<b>Vegetables (cup eq/day)</b>	<b>2/3</b>	<b>3/4</b>	<b>1</b>	<b>1</b>
	Vegetable Subgroups in Weekly Amounts			
Dark-Green Vegetables (cup eq/wk)	1	1/3	1/2	1/2
Red and Orange Vegetables (cup eq/wk)	1	1 3/4	2 1/2	2 1/2
Beans, Peas, Lentils (cup eq/wk)	3/4	1/3	1/2	1/2
Starchy Vegetables (cup eq/wk)	1	1 1/2	2	2
Other Vegetables (cup eq/wk)	3/4	1 1/4	1 1/2	1 1/2

SOURCE: Dietary Guidelines for Americans, 2020-2025 (Table 2-1).

- a = Calorie level ranges: Energy levels are calculated based on median length and body weight reference individuals.
- b = Definitions for each food group and subgroup and quantity (i.e., cup or ounce equivalents) are provided in Chapter 1 and are compiled in Appendix 3 of the 2020-2025 Dietary Guidelines for Americans.
- c = All foods are assumed to be in nutrient-dense forms and prepared with minimal added sugars, refined starches, or sodium. Foods are also lean or in low-fat forms with the exception of dairy, which includes whole-fat fluid milk, reduced-fat plain yogurts, and reduced-fat cheese. There are no calories available for additional added sugars, saturated fat, or to eat more than the recommended amount of food in a food group.
- d = In some cases, food subgroup amounts are greatest at the lower calorie levels to help achieve nutrient adequacy when relatively small number of calories are required.

**Table 2**

Healthy U.S.-Style Dietary Pattern for Vegetables for Children Ages 2 through 8 Years, With Daily or Weekly Amounts From Food Groups, Subgroups, and Components

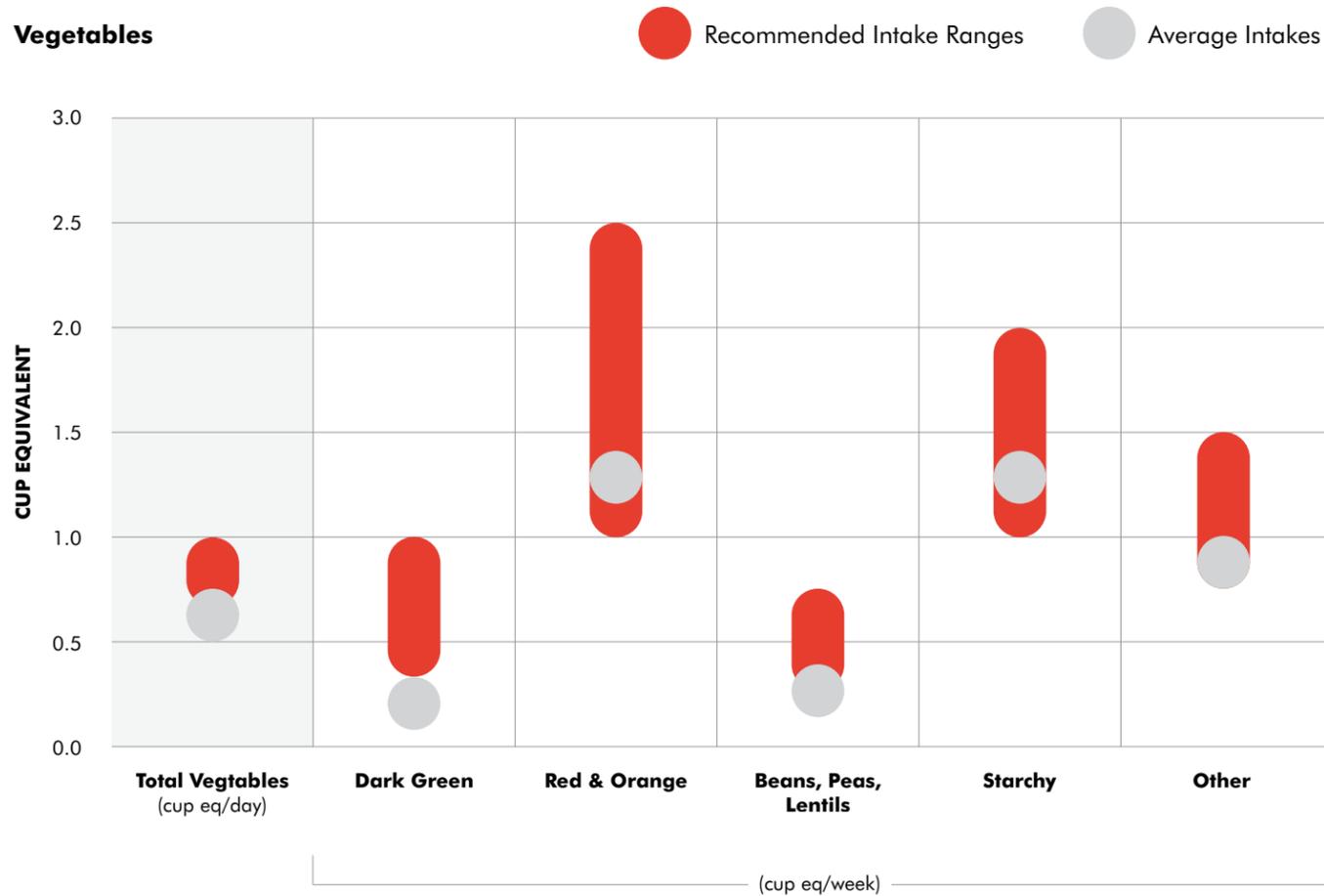
Calorie Level of Pattern <sup>a</sup>	1,000	1,200	1,400	1,600	1,800	2,000
<b>Food Group or Subgroup<sup>b,c</sup></b>	<b>Daily Amount of Food From Each Group<sup>d</sup></b> (Vegetable and protein foods subgroup amounts are per week)					
<b>Vegetables (cup eq/day)</b>	<b>1</b>	<b>1 1/2</b>	<b>1 1/2</b>	<b>2</b>	<b>2 1/2</b>	<b>2 1/2</b>
	Vegetable Subgroups in Weekly Amounts					
Dark-Green Vegetables (cup eq/wk)	1/2	1	1	1 1/2	1 1/2	1 1/2
Red and Orange Vegetables (cup eq/wk)	2 1/2	3	3	4	5 1/2	5 1/2
Beans, Peas, Lentils (cup eq/wk)	1/2	1/2	1/2	1	1 1/2	1 1/2
Starchy Vegetables (cup eq/wk)	2	3 1/2	3 1/2	4	5	5
Other Vegetables (cup eq/wk)	1 1/2	2 1/2	2 1/2	3 1/2	4	4

SOURCE: Dietary Guidelines for Americans, 2020-2025 (Table 3-1).

- a = Calorie level ranges: Ages 2 through 4, Females: 1,000-1,400 calories; Males: 1,000-1,600 calories. Energy levels are calculated based on reference height (median) and reference weight (healthy) corresponding with a healthy body mass index.
- b = Definitions for each food group and subgroup and quantity (i.e., cup or ounce equivalents) are provided in Chapter 1 and are compiled in Appendix 3 of the 2020-2025 Dietary Guidelines for Americans.

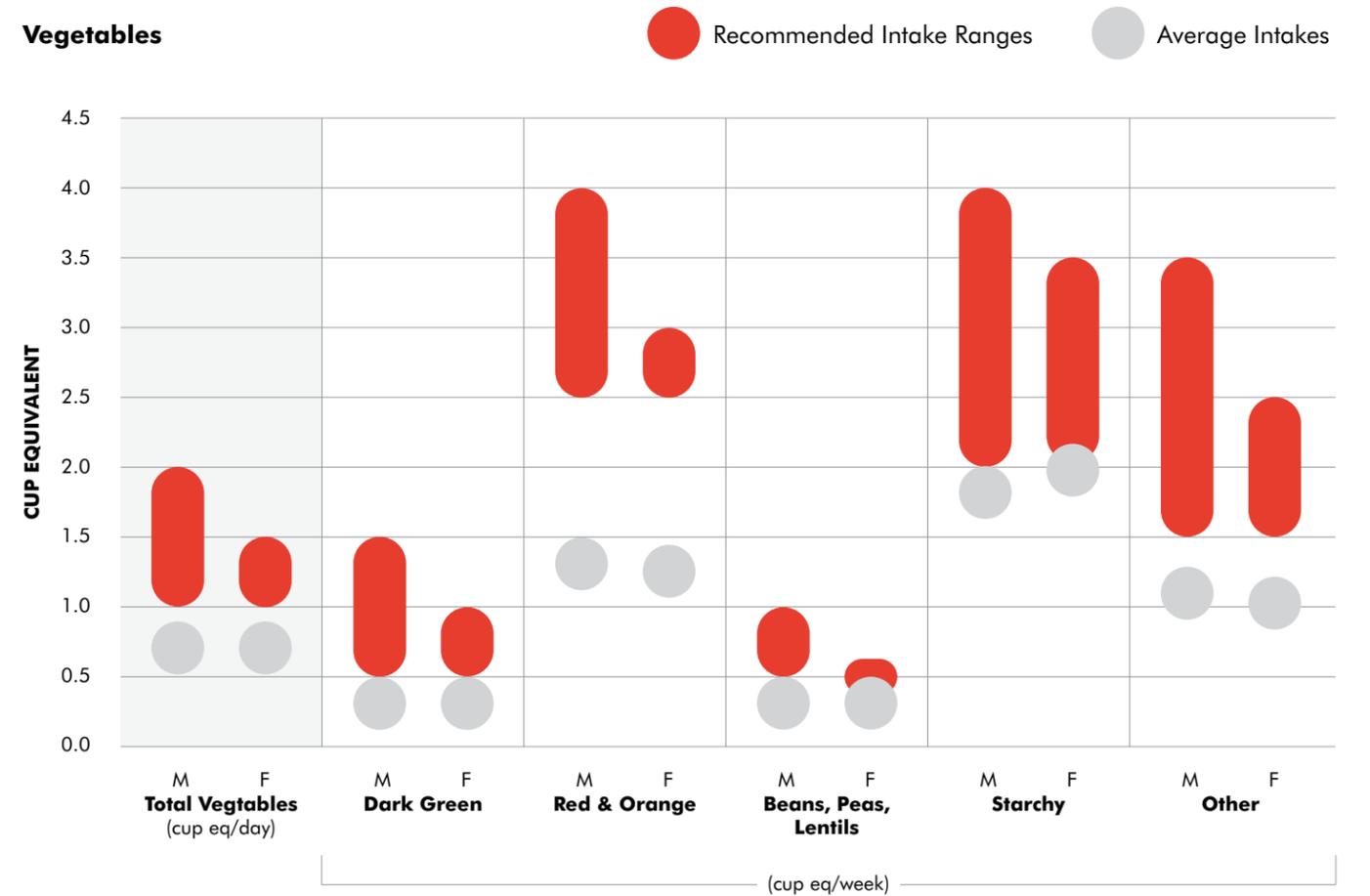
## Appendix – Data on Recommended and Actual Intakes of Vegetables for Young Children

**Figure 1**  
Average Intakes of Subgroups Compared to Recommended Intake Ranges: Ages 12 Through 23 Months



SOURCE: Dietary Guidelines for Americans, 2020-2025 (Figure 2-3).

**Figure 2**  
Average Intakes of Subgroups Compared to Recommended Intake Ranges: Ages 2 Through 4 Years



SOURCE: Dietary Guidelines for Americans, 2020-2025 (Figure 3-3).

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