



Mid-childhood fruit and vegetable consumption: The roles of early liking, early consumption, and maternal consumption



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ABSTRACT

Previous studies have shown that early liking, early consumption, and maternal consumption of fruits and vegetables (F&V) each predict children's F&V consumption, but no one has examined the independent contributions of these three correlated factors. We aim to examine the extent to which each of these 3 factors is associated with F&V consumption in mid-childhood after accounting for the other 2 in the analysis. We analyzed data from 901 mother-child dyads from Project Viva, a prospective pre-birth cohort study. Mothers reported their child's early liking and consumption of F&V at age 2 years and later consumption at mid-childhood (median age 7.7 years). They also reported their own consumption of F&V at 6 months postpartum. We used multivariable linear regression models to examine the independent associations of these 3 factors with mid-childhood consumption, adjusting for socio-demographic, pregnancy, and child confounders. At 2 years, 53% of the mothers strongly agreed that their child liked fruit and 25% strongly agreed that their child liked vegetables. F&V consumption was 2.5 (1.3) and 1.8 (1.1) times/d at age 2 y and 1.5 (1.1) and 1.3 (0.8) times/d in mid-childhood. Maternal F&V consumption was 1.4 (1.1) and 1.5 (1.0) times/d, respectively. Children's early consumption played the most predominant role. For every 1 time/d increment in children's early consumption of F&V, mid-childhood consumption was higher by 0.25 (95% confidence interval [CI]: 0.19, 0.30) times/d for fruits and 0.21 (95% CI: 0.16, 0.26) times/d for vegetables, adjusted for confounders plus the other 2 exposures. In conclusion, children's early F&V consumption has the most significant influence on children's later consumption.

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1. Introduction

Eating fruits and vegetables (F&V) is part of an overall healthful diet, and is recommended by the Dietary Guidelines for Americans. Despite the national guidelines, the consumption of F&V is well below the recommended amount in all age groups in the United States, including pre-pubertal school-age children (Go et al., 2013).

The first few years of life are a critical period for forming lifelong eating habits and taste preferences (Briefel, Reidy, Karwe, & Devaney, 2004). Long-term habits of eating F&V may start to develop as early as infancy.

Human beings innately prefer sweeter tastes and reject those that are sour and bitter (Birch, 1999). Many non-sweet vegetables have a bitter and/or sour taste, and thus are disliked by many children. There is growing research on how to promote consumption of F&V in early childhood. Early liking and acceptance of flavors are important in determining one's later consumption (Birch, 1999). Based on the culture, familial beliefs, and practices surrounding food and eating, young children learn from their environment what, when, and how much to eat (Savage, Fisher, & Birch, 2007; Schwartz, Scholtens, Lalanne, Weenen, & Nicklaus, 2011).

Abbreviations: F&V, Fruit and vegetable; R², R-squared; CFQ, child feeding questionnaire; Times/d, times per day.

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Previous research demonstrated that one of the best predictors of how much F&V children will eat is how much they like the taste of them (Resnicow et al., 1997). Besides environmental influences and cultural practices, genetics also play a role in determining one's taste preferences, as shown in a recent twin study that demonstrated genetic influences may explain our preferences and liking of vegetables, fruits, and protein (Fildes et al., 2014).

In addition, some studies show that young children's preferences and consumption patterns are largely the result of the food to which they have become familiar and accustomed, and thus early consumption predicts consumption later in life (Cooke, 2007). For example, in a small study of mother/child dyads ($n = 60$), the authors found that frequency of F&V consumption of 1-year-old children was significantly associated with F&V consumption when they turned 2 years of age (Gregory, Paxton, & Brozovic, 2011). Using a large longitudinal cohort of US children ($n = 1078$), Grimm and colleagues showed that infrequent consumption of F&V during infancy was associated with low consumption at 6 years of age (Grimm, Kim, Yaroch, & Scanlon, 2014).

Furthermore, parents not only create food environments for children's early experience, but they also influence their children's eating by modeling their own eating behaviors, taste preferences, and food choices. Prior research demonstrated that parental consumption of F&V is a strong predictor of F&V consumption of their children. For example, Hart, Raynor, Jelalian, & Drotar (2010) showed that fruit ($r = 0.54$, $p < 0.001$) and vegetable ($r = 0.42$, $p < 0.001$) consumption of infants and toddlers were significantly predicted by their mothers' intake. This association has also been observed in 2–6 year-old-children (Cooke et al., 2004; Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002).

Despite the finding of F&V consumption during early childhood predicting later consumption, Grimm and colleagues' study was not able to tease out the influence of children's taste preferences or environment, such as parental F&V consumption, on this association. These 3 factors – early liking (preference), early consumption, and maternal consumption of F&V – have been studied individually in previous research to predict children's F&V consumption later in life. These 3 factors, however, are often correlated with each other, and the independent contribution of each of these factors remains unclear. Determining the independent contributions is important because it provides insight into designing more effective strategies to help young children develop sustainable healthy eating habits. Therefore, the objective of our study is to examine the extent to which each of these 3 factors is associated with F&V consumption in mid-childhood after accounting for the other 2 in the analysis.

2. Material and methods

2.1. Subjects

Study participants were from Project Viva, a longitudinal pre-birth cohort of mother-offspring pairs enrolled between April 1999 and July 2002 from Atrius Harvard Vanguard Medical Associates, a multi-site group medical practice in eastern Massachusetts. All mothers in the study signed informed consents, and the study protocols were approved by the institutional review board of Harvard Pilgrim Health Care. Details on recruitment and data collection have been published elsewhere (Oken et al., 2015). Exclusion criteria included non-singleton pregnancy, planning to relocate before delivery, unable to answer questions in English, and gestational age >22 completed weeks at initial prenatal visit. Mothers and children attended in-person visits at 6 months after delivery and in mid-childhood (median age 7.7 years). At 2 years after delivery, mothers completed mailed questionnaires updating

their child's feeding practices, including liking and consumption of F&V.

Briefly, among 2128 women with live births, 1167 had child F&V intake data at mid-childhood, among whom 901 also had data on maternal F&V intake at 6 months and infant feeding practices at 2 years. Compared with the excluded sample, the 901 women in our analytic sample were slightly older [mean age, 32.7 vs. 31.2 y] and leaner [mean BMI, 24.3 vs. 25.3 kg/m²]. Mothers in our analytic sample also showed a higher proportion of identifying as racially white (76.6 vs. 59.0%), were more educated (76.6 vs. 55.7% college graduates), and had lower rates of smoking during pregnancy (7.7 vs. 16.3%).

2.2. Measurements

Main Exposures – Child's liking and consumption of F&V at age 2 y and maternal consumption of F&V (6 months postpartum).

We measured children's liking of F&V at 2 years after birth by 2 questions on a mailed questionnaire: "Does your child like vegetables?" and "Does your child like fruits?" Mothers responded to the questions using 4-point Likert-type scales ranging from strongly agree to strongly disagree. We used responses to these questions as ordinal variables in the data analysis: strongly disagree (score = 1), disagree (score = 2), agree (score = 3), strongly agree (score = 4).

We measured children's usual (in the past month) frequency consumption of F&V at 2 years by a validated semi-quantitative food frequency questionnaire that included 93 items (Blum et al., 1999). The fruit items included oranges or grapefruit, bananas, apples or apple sauce, grapes, peaches or plums, strawberries or other berries, cantaloupe, watermelon, pears, and raisins or prunes. The vegetable items included corn, peas, tomatoes, peppers, carrots, broccoli, green beans, spinach, squash, sweet potatoes or yams, cabbage, coleslaw or cauliflower, and lettuce salad. Response categories included: "Never", "Less than once per week", "Once per week", "2–4 times per week", "Nearly daily or daily", and "2 or more times per day".

We also collected maternal dietary consumption at 6 months postpartum, using a brief dietary questionnaire called PrimeScreen, which has been validated against a full-length food frequency questionnaire and plasma biomarkers (Rifas-Shiman et al., 2001). The women were asked how often, on average, they consumed citrus fruits (e.g., orange juice or grapefruit juice, oranges, grapefruit), other fruits (e.g., apples or pears, bananas, berries, grapes, melons), dark green leafy vegetables (e.g., spinach, romaine lettuce, kale, turnip greens, bok choy), broccoli, cauliflower, cabbage, brussels sprouts, carrots and other vegetables (e.g., peas, corn, green beans, tomatoes, squash). Response categories included: "Never", "Less than once per week", "Once per week", "2–4 times per week", "Nearly daily or daily", and "2 or more times per day". We assumed that the dietary patterns of mothers did not change much over time, and 6 months postpartum F&V consumption is an approximate measure of consumption when their children were age 2 y (Olson, 2005).

2.3. Outcome measures – mid-childhood F&V consumption

Our main outcomes were F&V consumption (times/d) during mid-childhood (median age 7.7 y), which we collected using PrimeScreen questionnaire (Oken et al., 2015). To assess F&V consumption, mothers indicated the frequency with which their children ate each F&V over the past month, and were given the response options of: "Never", "Less than once per week", "Once per week", "2–4 times per week", "Nearly daily or daily", and "2 or more times per day". The fruit items included citrus fruits (e.g.,

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