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Clinical interventions to increase vegetable intake in children

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Abstract

Purpose of review—Eating behaviors and dietary patterns begin in early childhood and persist into adolescence and adulthood, affecting lifelong acute and chronic disease risk. Vegetables provide a high density of necessary vitamins, minerals, and fiber. Dietary intake data show that children of all ages consume below the recommended range for vegetables. Pediatric providers are optimally positioned to promote vegetable intake in childhood. This review seeks to summarize lessons learned from behavioral interventions useful in the pediatric primary care setting to improve vegetable intake.

Recent findings—Ten published studies tested behavioral interventions in primary care to increase child vegetable intake. Strategies tested include teaching healthy eating behaviors and role modeling to parents of infants, and motivational interviewing paired with frequent office visits and reminders for families of older children and adolescents. Some strategies suggested positive change, despite study quality being limited by underpowered samples, heterogeneity of outcome measures, and statistical analytic approach.

Summary—Increased vegetable intake was achieved in infants through parental role-modeling when providers emphasized healthy dietary choices in parents. Older children increased their vegetable intake with motivational interviewing and frequent reminders from providers. Despite the high prevalence of inadequate vegetable intake among children, at present, there is only a modest body of literature to help guide pediatric providers in implementing practice-based interventions to improve vegetable intake in childhood, highlighting a need for high-quality research in this area.

Keywords

behavior change; diet; intake; pediatric; vegetable

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Conflicts of interest

There are no conflicts of interest.

INTRODUCTION

Poor diet is one of the leading causes of morbidity and mortality in the United States [1,2], and dietary patterns are established early in life [1,3,4]. Ninety percent of toddlers (12–23 months) eat less than the recommended daily intake of vegetables [5]. Over 40% of high school students [6] reported consuming vegetables less than once per day during the previous week, and only 2.1% of adolescents in the United States consume the recommended two to four cups of vegetables in a day depending on caloric intake [7]. Children ages 12–23 months should consume up to one cup of vegetables per day [5]. Although resources such as MyPlate (<https://www.myplate.gov/>) are available to provide dietary guidance, eating patterns persist into adulthood, with only 10% of adults meeting the daily vegetable intake recommendation of two-to-four-cup equivalents [8].

Inadequate vegetable intake is an independent predictor of higher systolic blood pressure, elevated triglyceride levels, and metabolic syndrome in adolescents [9,10]. Vegetables are an important component of the diet, providing a high density of vitamins, minerals, and fiber relative to the total number of calories. Greater daily consumption of vegetables may reduce the risk of constipation and dental caries in children [11–13]. Increased vegetable intake is associated with reductions in obesity and secondary comorbidities, including cardiovascular disease, and all-cause mortality from cancer [14–16].

Behavioral interventions designed to improve vegetable intake include nutrition education, motivational interviewing, the Transtheoretical Model (TTM), and additional techniques intended to modify patterns of behavior surrounding dietary choices and eating habits. TTM can help identify a patient's stage of readiness for behavior change, while motivational interviewing is a counseling technique that involves listening to and partnering with patients to modify unhealthy behaviors [17,18]. Previous interventions have been conducted in schools, communities, or laboratory settings and had limited success [19–22]. Interventions may not demonstrate significant improvement in vegetable intake because of the risk of bias, including performance, detection, and attrition bias [19]. Unintended consequences of behavioral interventions may include contamination from other techniques, such as exposure to different treatment arms in the same office and computer-based interventions or incentives that lose their effectiveness when no longer available [20,21]. Pediatricians see children regularly throughout childhood, are a trusted source of health information, and may be ideally positioned to improve child vegetable intake through interventions delivered within the patient-centered medical home. In this review, we aim to summarize data from behavioral interventions that measure child vegetable consumption to help guide pediatric primary care clinicians in evidence-supported clinical practice as well as highlight areas for future research.

REVIEW FINDINGS

Ten studies were identified that tested the effect on vegetable intake of behavioral interventions conducted on children of various ages in the pediatric primary care setting. Three studies found statistically significant increases in children's vegetable consumption (Table 1) [23,24,25]. Effective techniques in infancy and early childhood highlights

dietary guidance directed at parents and parental role modeling, whereas older children and adolescents saw the most benefit from motivational interviewing, programs such as 5210, and frequent follow-up. The techniques and observations described may be incorporated into pediatric office visits to help establish healthy eating behaviors [26]. More research is needed to identify additional evidence-based interventions and implementation strategies.

LITERATURE SEARCH

The PubMed and Embase databases were searched in March 2022. Research articles that included an intervention and an outcome of vegetable consumption were identified through PubMed using the following search terms and Boolean operators: (*Vegetable**) AND (*pediatric** OR *infan** OR *child** OR *adolescen**) AND (“*office-based*” OR “*clinic-based*” OR “*practice-based*”). Criteria included an intervention initiated in a primary care setting for pediatric patients between the ages of 0 and 18 years and an outcome of vegetable and/or fruit consumption or a nutrition score that also reported vegetable consumption. Studies were included if the intervention included multiple visits to the primary care office or follow-up phone calls, but were excluded if the intervention included extensive educational sessions in the community setting. There were no search limitations on the year published or the geographic location of the study because of the scarcity of available studies. Titles and abstracts were screened for relevance, followed by the full text of appropriate articles.

EVIDENCE FOR INTERVENTIONS IN INFANCY

Three studies tested a behavioral dietary intervention in infants [24,27,28]. A pilot cluster randomized controlled trial (RCT) tested the effect of maternal role modeling as a strategy to help children develop positive eating patterns [24]. Mothers were encouraged by trained clinic providers, including physicians, nurses, or medical assistants, to consume regular meals and snacks, eat without the television on, increase fruit and vegetable intake, and limit soda and fast-food. Twelve months following the initial intervention visit, mothers reported that their infants consumed significantly more servings of vegetables and fruit compared with the Bright Futures control group [24]. A pretest/posttest study in Ireland demonstrated that a significant number of families increased their fruit and vegetable intake by at least four daily portions 3 months after being provided a handout on healthy nutrition and activity in infancy, as well as a brief discussion with a pediatrician on the infant’s weight. These interventions took place during the routine 13-month vaccination visits [28]. In contrast, a parallel cluster RCT in Norway found no difference in vegetable intake 2 years after public health nurses delivered a 10 min educational session to parents of 10-month-old infants. The session consisted of dietary advice, infant feeding, and role-modeling, with the aid of an in-office flip booklet [27].

EVIDENCE FOR INTERVENTIONS IN EARLY CHILDHOOD

Two studies included a clinical intervention for children in early childhood, ages 2–7 years, with neither study demonstrating significant impacts on vegetable intake [29,30]. The first study tested an office-based obesity prevention program using motivational interviewing in children ages 3–7 years with overweight or obesity (BMI-for-age-and-sex

85th percentile) or weight less than 85th percentile with one parent with obesity (BMI 30) [29]. Children assigned to an ‘intensive’ intervention were provided physician-led motivational interviewing followed by another motivational interviewing session with a registered dietitian 3 months later; those assigned to a ‘minimal’ intervention were provided physician-led motivational interviewing without the additional registered dietitian session. Both intervention groups received material on healthy eating patterns and physical activity and were shown a video that modeled healthy eating patterns. The ‘control’ group received the usual anticipatory guidance on diet and weight without motivational interviewing. Vegetable servings per day, measured using a youth and adolescent food frequency questionnaire, did not differ between the two intervention groups compared with standard care after 6 months. Participant attrition was notable with 50% for the ‘intensive’ care group, 32% for the ‘minimal’ care group, and 10% for the ‘control’ group [29].

Another study tested the High Five for Kids program in children ages 2–7 years who were at-risk for developing overweight or obesity, defined as child’s BMI at least 95th percentile or child’s BMI at least 85th to less than 95th percentile and one overweight parent (BMI 25 kg/m²) [30]. Children in the intervention group received four 25 min office visits separate from regularly scheduled pediatrician visits. These visits incorporated motivational interviewing and resources on local recreation and healthy recipes, three additional 15 min phone calls during the first year of the study, along with incentives for behavior change. The children in the control group received well child visits with a pediatrician or nutritionist and the same number of weight checks as the intervention group. Unfortunately, there was no difference in the change in fruit and vegetable intake after 2 years of study participation [30].

RECOMMENDATIONS FOR INFANCY AND EARLY CHILDHOOD

Studies with promising strategies to promote vegetable intake during infancy and early childhood focused on healthy parental diets, including motivational interviewing directed at the parents, and parental role modeling to influence young children to eat more vegetables [24■,29,30]. During the infants’ first 6 months of life, dietary counseling was directed at maternal dietary behaviors and encouraged parental role modeling; this approach was effective in increasing the infant’s vegetable intake at 12 months. Role modeling refers to parents demonstrating behaviors in front of their children, either intentionally or unintentionally, and subsequent adoption of the behaviors by the children [31■,32].

A systematic review of this topic found that parental role modeling of healthy food intake was positively associated with healthy food intake by their children in 28 of 31 studies [31■]. Pediatric clinicians should begin promoting healthy dietary behaviors as early as possible in early infancy and should emphasize to caregivers the importance of parental role modeling in influencing their young children to improve vegetable intake as they age. Other studies described testing motivational interviewing directed at the child’s behaviors in early childhood, but were found to be less impactful on child vegetable intake [29,30].

EVIDENCE FOR INTERVENTIONS IN LATE CHILDHOOD

Three studies evaluated primary care-based interventions among children ages 5–12 years [25,33,34]. The first trial studied children ages 4–18 years with BMI between the 85th and less than 95th percentile who received motivational interviewing and set goals in accordance with the 5210 Program. Results demonstrated significantly increased fruit and vegetable intake compared with the control group after 12 months (Table 1). The 5210 Program establishes the daily goals of at least five servings of fruits and vegetables, no more than 2 h of screen time, at least 1h of physical activity, and zero sugar-sweetened beverages [25]. Servings were defined as roughly the size of the child's palm. The intervention group completed a readiness ruler and a goal-setting worksheet and received three individualized motivational interviewing sessions with a clinic nurse and prescheduled phone calls over 6 months. The standard care group received a BMI chart print-out, handouts on healthy weight management, and referrals for dietary evaluations as appropriate [25].

Another study evaluated the effect of motivational interviewing with overweight Italian children, ages 4–7 years [33]. Children in the intervention group received five pediatrician-led motivational interviewing sessions (1–2 months apart) in which one mutually agreed dietary and one mutually agreed physical activity objective were reinforced. The usual care group only received a booklet with information for the parents on obesity prevention and advice typically given during a well child visit. Although vegetable intakes did not differ between the intervention and control groups at 12 months following the intervention, there was an increase in consumption of vegetable soups ($P=0.023$) [33].

TTM was also studied to identify readiness for behavior change and create tailored health counseling in children ages 4–10 years [34]. Both intervention and control children completed a baseline survey and chose a topic for health counseling; however, the intervention group received counseling before the end of the study and the control group received counseling after the study. Health counseling consisted of a printed handout with messages on a health topic tailored to the child's stage of readiness. The intervention group reported an increase in vegetable intake of borderline significance compared with the control group ($P=0.05$) [34].

EVIDENCE FOR INTERVENTIONS IN ADOLESCENCE

Two studies by Patrick *et al.* [35,36] tested the Patient-centered Assessment and Counseling for Exercise + nutrition (PACE+) program for adolescents, described below.

The initial feasibility study tested the effect of the PACE+ program on long-term behavior change among healthy adolescents ages 11–18 years [36]. All participants completed an initial computerized assessment on health habits and were asked to choose one nutrition and one physical activity habit to target for behavior change, which were then discussed with their healthcare provider. Participants were randomly allocated into four intervention groups with increasing frequency of mail or telephone contact versus a control group receiving no additional contact outside the primary care office. Mailings included healthy habit tip sheets and strategies for behavior change, while phone calls (<10 min) included brief counseling

or a reminder. All participants in the intervention groups improved their fruit and vegetable intake over time ($P=0.002$) [36].

The subsequent RCT tested the effect of the PACE+ program in adolescents ages 11–15 years [35]. The intervention group completed the initial computer assessment on health habits and received provider counseling, followed by regular telephone calls and mailings by research staff to teach and reinforce healthy behaviors. Unlike the initial feasibility study, the control group in the RCT received the same intervention steps except the given guidance was on sun protection, rather than nutrition or physical activity guidance. Females in the intervention group increased their daily servings of fruit and vegetables relative to those in the control group but not significantly. Males in both groups increased their fruit and vegetable intakes by 20%. Dietary recalls were analyzed by trained analysts and converted to servings per day. Adolescents in the intervention group who were reached less than nine times by phone over the 12-month study period were less likely to meet the recommendation of five or more daily servings of fruit and vegetables compared with those who were reached at least nine times by phone [RR 1.5; 95% confidence interval (CI) 1.02–2.03] [35].

RECOMMENDATIONS FOR LATE CHILDHOOD AND ADOLESCENCE

Techniques to increase vegetable intake in older children and adolescents were often directed at the child by identifying the child's stage of readiness for behavior change using the TTM before providing tailored motivational interviewing [25,33,36]. Motivational interviewing resulted in increased vegetable intake in older children [25] but not in younger children [29]. Identifying stage of change and providing motivational interviewing for increasing vegetable intake should initially be directed at the caregivers of children younger than 4 years. The provider should then transition to directing these techniques toward the older child, especially during late childhood and adolescence. Several of the interventions that included frequent contact with older children through mailings or phone calls reported improved vegetable intake [25,36].

A systematic review of pediatric primary care-based behavioral interventions to improve BMI found interventions were more promising when motivational interviewing techniques, such as goal setting and behavior reinforcement, were accompanied by more frequent office visits, treatment sessions, pediatrician contact, and longer follow-up duration [37]. On the other hand, potential reasons for frequent contact being ineffective may have been one-way modes of contact, such as mailings instead of text messages, or delayed follow-up. Vegetable intake may be improved with multicomponent interventions, which have been shown to improve outcomes [35,38,39]. Multicomponent interventions take place in various settings, such as a combination of the primary care office and the school setting. Collaboration with local schools and community centers to increase kids' awareness of vegetables would serve to reinforce the messaging provided in the primary care office [40]. Regular text messaging, use of health apps, or games that teach parents and children about vegetables also may be very beneficial [41,42]. Providing older children with specific dietary guidance may improve self-efficacy during a stage of life when children are starting to make their own food choices outside the home and can cognitively appreciate that certain foods are consistent with health [43].

PROVIDER CONFIDENCE TO DELIVER INTERVENTIONS

Providers need further training in providing dietary advice and using tools such as motivational interviewing to create effective behavior change. Furthermore, the abilities of physician associates, nurse practitioners, physical therapists, dietitians, and nurses have been under-utilized toward the effort of pediatric behavior change [44,45]. The ability of providers to deliver nutrition and behavior change counseling has been noted to be insufficient to meet patients' needs. At one large academic medical center, 82% of pediatric and medicine–pediatric physicians agreed that there is a lack of obesity supportive services, including referrals for dietitians or weight management specialists [46]. Only 51% of the physicians surveyed felt comfortable discussing nutrition with families, and only 37% felt confident in providing motivational interviewing [44]. There is an increasing need for providers to confidently deliver nutrition and behavior change interventions; hence, improved provider training and confidence are important first steps.

DISPARITIES IN AVAILABLE DATA

There is a major gap in the literature describing interventions to increase vegetable intake in low income and minority populations. Only one study [24] was conducted in a predominantly black population. All other studies reported results in predominantly white populations or did not report racial or ethnic demographic data at all. In a cross-sectional study examining dietary intake survey data by race and ethnicity, Guerrero and Chung [47] found that over 70% of Spanish-speaking Latino households and non-English speaking Asian families reported consuming fewer than two servings of vegetables the previous day. They also found that lower caregiver education was associated with higher odds of children consuming less than two servings of vegetables per day [47]. These data highlight the need to identify strategies to increase vegetable intake in diverse populations of children who may be at greater risk.

STRENGTHS AND LIMITATIONS

This current review has several strengths. Strategies have been identified for providers to increase vegetable intake in all pediatric age groups, which has the potential to slow the rising rates of diet-preventable chronic disease seen in adulthood [1,48]. Additionally, several studies delivered clinical interventions in early infancy and adolescence, both important windows for the development of dietary habits [49]. Several limitations also exist. The databases were searched with relatively broad search terms, so relevant studies may have been missed. Although the goal of the review was to identify behavioral interventions that would lead to increased vegetable intake, 7 of the 10 included studies did not differentiate between fruits and vegetables, or types of vegetable. Therefore, it cannot be determined if the increased intake was primarily vegetables or fruit, or if the vegetables consumed were leafy greens or starchy potatoes. Vegetables and fruits can have significantly different nutrient composition and support different aspects of health [50]. In addition, the differences in vegetable intake reported may not reflect a meaningful clinical change, as only two studies reported average increases in vegetable intake that were greater than or equal to one serving per day; the definition of a serving across studies also differed [25,36]. Six

studies reported higher than expected attrition, while some had small sample sizes, which may impact the validity of statistical significance. Finally, the quality of the evidence was not formally assessed in the studies we included in this review. Despite these limitations and the challenges inherent in measuring the effects of behavioral interventions to increase vegetable intake, early conversations about healthy dietary habits are likely to have a positive impact across a child's lifetime.

CONCLUSION

The pediatrician's office is an excellent place to begin conversations with families to emphasize the importance of healthy dietary behaviors. Interventions in infancy and early childhood should focus on parental dietary habits and parental role modeling of healthy eating behaviors, while interventions for older children and adolescents should include motivational interviewing, programs with simple and effective messaging such as 5210, and frequent follow-up. Although this review suggests a paucity of data on interventions to improve vegetable intake in the pediatric clinical setting, it also highlights important opportunities for clinicians to design and test their own clinical interventions. With new social communication technology and platforms, there are many more tools today that can be used to educate and motivate children, teens, and their families to make positive dietary changes.

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REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:

■ of special interest

■ ■ of outstanding interest

1. Craigie AM, Lake AA, Kelly SA, et al. Tracking of obesity-related behaviors from childhood to adulthood: a systematic review. *Maturitas* 2011; 70:266–284. [PubMed: 21920682]
2. Murray CJL, Mokdad AH, Ballestros K, et al. The state of US Health, 1990-2016: burden of diseases, injuries, and risk factors among US States. *JAMA* 2018; 319:1444. [PubMed: 29634829]
3. Perrin EM, Jacobson Vann JC, Benjamin JT, et al. Use of a pediatrician toolkit to address parental perception of children's weight status, nutrition, and activity behaviors. *Acad Pediatr* 2010; 10:274–281. [PubMed: 20554259]
4. Nicklaus S. Complementary feeding strategies to facilitate acceptance of fruits and vegetables: a narrative review of the literature. *Int J Environ Res Public Health* 2016; 13:1160. [PubMed: 27869776]
5. U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2020 – 2025. [DietaryGuidelines.gov](https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf). December 2020: Available at: https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf [Accessed 26 February 2022]

6. Merlo CL, Jones SE, Michael SL, et al. Dietary and physical activity behaviors among high school students — youth risk behavior survey, United States, 2019. *Morb Mortal Wkly Rep Suppl* 2019; 69:64–76.
7. Moore L v, Thompson FE, Demissie Z. Percentage of youth meeting federal fruit and vegetable intake recommendations, Youth Risk Behavior Surveillance System, United States and 33 states, 2013. *J Acad Nutr Diet* 2017; 117:545.e3–553.e3. [PubMed: 27988220]
8. Lee SH, Moore LV, Park S, et al. Morbidity and mortality weekly report adults meeting fruit and vegetable intake recommendations-United States. 2019. Available at: <https://www.myplate.gov/eat-healthy/fruits> 2022. [Accessed 8 March 2022]
9. Mellendick K, Shanahan L, Wideman L, et al. Diets rich in fruits and vegetables are associated with lower cardiovascular disease risk in adolescents. *Nutrients* 2018; 10:136. [PubMed: 29382069]
10. Collese TS, Nascimento-Ferreira MV, de Moraes ACF, et al. Role of fruits and vegetables in adolescent cardiovascular health: a systematic review. *Nutr Rev* 2017; 75:339–349. [PubMed: 28475799]
11. Yen CE, Huang YC, Hu SW. Relationship between dietary intake and dental caries in preschool children. *Int J Vitam Nutr Res* 2013; 80:205–215.
12. Asakura K, Masayasu S, Sasaki S. Dietary intake, physical activity, and time management are associated with constipation in preschool children in Japan. *Asia Pac J Clin Nutr* 2017; 26:118–129. [PubMed: 28049271]
13. Andreoli CS, Vieira-Ribeiro SA, Fonseca PCA, et al. Eating habits, lifestyle and intestinal constipation in children aged four to seven years. *Nutr Hosp* 2019; 36:25–31.
14. Miller V, Mente A, Dehghan M, et al. Fruit, vegetable, and legume intake, and cardiovascular disease and deaths in 18 countries (PURE): a prospective cohort study. *Lancet* 2017; 390:2037–2049. [PubMed: 28864331]
15. Wang X, Ouyang Y, Liu J, et al. Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies. *BMJ* 2014; 349: g4490. [PubMed: 25073782]
16. Liu W, Hu B, Dehghan M, et al. . PURE-China Investigators. Fruit, vegetable, and legume intake and the risk of all-cause, cardiovascular, and cancer mortality: a prospective study. *Clin Nutr* 2021; 40:4316–4323. [PubMed: 33581953]
17. Resnicow K, McMaster F. Motivational Interviewing: moving from why to how with autonomy support. *Int J Behav Nutr Phys Act* 2012; 9:19. [PubMed: 22385702]
18. Woo S, Park KH. Motivating children and adolescents in obesity treatment. *J Obes Metab Syndr* 2020; 29:260–269. [PubMed: 32843587]
- 19■■. Hodder RK, O'Brien KM, Tzelepis F, et al. Interventions for increasing fruit and vegetable consumption in children aged five years and under. *Cochrane Database Syst Rev* 2020; 5:CD008552. [PubMed: 32449203] This is a living systematic review that evaluates the most recent evidence for increasing fruit and vegetable intakes in young children. The analysis includes a comprehensive assessment of the quality of evidence.
20. DeCosta P, Møller P, Frøst MB, Olsen A. Changing children's eating behaviour - a review of experimental research. *Appetite* 2017; 113:327–357. [PubMed: 28286164]
21. Hamel LM, Robbins LB. Computer- and web-based interventions to promote healthy eating among children and adolescents: a systematic review. *J Adv Nurs* 2013; 69:16–30. [PubMed: 22757605]
22. Holley CE, Farrow C, Haycraft E. A systematic review of methods for increasing vegetable consumption in early childhood. *Curr Nutr Rep* 2017; 6:157–170. [PubMed: 28596931]
23. Doorley E, Young C, O'shea B, et al. Is primary care prevention of childhood obesity by education at 13-month immunisations feasible and acceptable? results from a general practice based pilot study. *Ir Med J* 2015; 108:13–15. [PubMed: 25702347]
- 24■. French GM, Nicholson L, Skybo T, et al. An evaluation of mother-centered anticipatory guidance to reduce obesogenic infant feeding behaviors. *Pediatrics* 2012; 130:e507. [PubMed: 22891225] This study found significant increases in vegetable intake in infancy after a behavioral dietary intervention was directed at a diverse sample of mothers. Included in the review.
25. Tucker SJ, Ytterberg KL, Lenocho LM, et al. Reducing pediatric overweight: nurse-delivered motivational interviewing in primary care. *J Pediatr Nurs* 2013; 28:536–547. [PubMed: 23531463]

26. Hackell JM, Abularrage JJ, Almendarez YM, et al. 2021 recommendations for preventive pediatric healthcare. *Pediatrics* 2021; 147:e2020049776. [PubMed: 33593848]
27. Holmberg Fagerlund B, Helseth S, Andersen LF, et al. The use of a communication tool about diet at the child health centre: a cluster randomized controlled trial. *Nurs Open* 2020; 7:1217. [PubMed: 32587742]
28. Doorley E, Young C, O'shea B, et al. Is primary prevention of childhood obesity by education at 13-month immunisations feasible and acceptable? Results from a general practice based pilot study. Available at: <http://www.rcpch.ac.uk/child-health/research-projects/uk-who-growth-charts/uk-who-growth-chart-resources-0-4-years/uk-who-0> (2004).
29. Schwartz RP, Hamre R, Dietz WH, et al. Office-based motivational interviewing to prevent childhood obesity: a feasibility study. *Arch Pediatr Adolesc Med* 2007; 161:495–501. [PubMed: 17485627]
30. Taveras EM, Gortmaker SL, Hohman KH, et al. Randomized controlled trial to improve primary care to prevent and manage childhood obesity: the High Five for Kids study. *Arch Pediatr Adolesc Med* 2011; 165:714–722. [PubMed: 21464376]
31. Yee AZH, Lwin MO, Ho SS. The influence of parental practices on child promotive and preventive food consumption behaviors: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act* 2017; 14:47. [PubMed: 28399881] This systematic review evaluated the effects of promotive versus restrictive parental modeling practices on children's food intake. Concluded that praise for healthy food intake is more effective in younger children under six years, and rules and restrictions for unhealthy foods are more effective in older children.
32. Scaglioni S, de Cosmi V, Ciappolino V, et al. Factors influencing children's eating behaviours. *Nutrients* 2018; 10:706. [PubMed: 29857549]
33. Davoli AM, Broccoli S, Bonvicini L, et al. Pediatrician-led motivational interviewing to treat overweight children: an RCT. *Pediatrics* 2013; 132: e1236–e1246. [PubMed: 24144717]
34. Wright JA, Whiteley JA, Watson BL, et al. Tailored communications for obesity prevention in pediatric primary care: a feasibility study. *Health Educ Res* 2018; 33:14. [PubMed: 29112721]
35. Patrick K, Calfas KJ, Norman GJ, et al. Randomized controlled trial of a primary care and home-based intervention for physical activity and nutrition behaviors: PACE+ for adolescents. *Arch Pediatr Adolesc Med* 2006; 160:128–136. [PubMed: 16461867]
36. Patrick K, Sallis JF, Prochaska JJ, et al. A multicomponent program for nutrition and physical activity change in primary care: PACE+ for adolescents. *Arch Pediatr Adolesc Med* 2001; 155:940–946. [PubMed: 11483123]
37. Mitchell TB, Amaro CM, Steele RG. Pediatric weight management interventions in primary care settings: a meta-analysis. *Health Psychol* 2016; 35:704–713.
38. Rajjo T, Mohammed K, Alsawas M, et al. Treatment of pediatric obesity: an umbrella systematic review. *J Clin Endocrinol Metab* 2017; 102:763–775. [PubMed: 28359101]
39. Jørgensen TS, Rasmussen M, Aarestrup AK, et al. The role of curriculum dose for the promotion of fruit and vegetable intake among adolescents: results from the Boost intervention Health behavior, health promotion and society. *BMC Public Health* 2015; 15:1–12. [PubMed: 25563658]
40. Kim SA, Grimm KA, May AL, et al. Strategies for pediatric practitioners to increase fruit and vegetable consumption in children. *Pediatr Clin North Am* 2011; 58:1439–1453. [PubMed: 22093861] This review highlights several key strategies for pediatric providers to promote vegetable intake in children at the level of the individual, social and physical environment, and the healthcare facility and community.
41. Power JM, Bersamin A. A text messaging intervention (Txt4HappyKids) to promote fruit and vegetable intake among families with young children: pilot study. *JMIR Form Res* 2018; 2:e13. [PubMed: 30684412]
42. Thompson D, Bhatt R, Vazquez I, et al. Creating action plans in a serious video game increases and maintains child fruit-vegetable intake: a randomized controlled trial. *Int J Behav Nutr Phys Act* 2015; 12:1–10. [PubMed: 25592201]
43. Fleary SA, Joseph P, Pappagianopoulos JE. Adolescent health literacy and health behaviors: a systematic review. *J Adolesc* 2018; 62:116–127. [PubMed: 29179126]

44. van Horn L, Lenders CM, Pratt CA, et al. Advancing nutrition education, training, and research for medical students, residents, fellows, attending physicians, and other clinicians: building competencies and interdisciplinary coordination. *Adv Nutr* 2019; 10:1181. [PubMed: 31728505]
45. Nicholson LM, Schwirian PM, Klein EG, et al. Recruitment and retention strategies in longitudinal clinical studies with low-income populations. *Contemp Clin Trials* 2011; 32:353–362. [PubMed: 21276876]
46. Campoverde Reyes KJ, Perez NP, Czepiel KS, et al. Exploring pediatric obesity training, perspectives, and management patterns among pediatric primary care physicians. *Obesity (Silver Spring)* 2021; 29:159–170. [PubMed: 33184987]
47. Guerrero AD, Chung PJ. Racial and ethnic disparities in dietary intake among California children. *J Acad Nutr Diet* 2016; 116:439–448. [PubMed: 26433453]
48. Micha R, Peñalvo JL, Cudhea F, et al. Association between dietary factors and mortality from heart disease, stroke, and type 2 diabetes in the United States. *JAMA* 2017; 317:912–924. [PubMed: 28267855]
49. Gur K, Erol S, Kadioglu H, et al. The impact on adolescents of a Transtheoretical Model-based programme on fruit and vegetable consumption. *Public Health Nutr* 2019; 22:2500–2508. [PubMed: 31171047]
50. Sharma S, Sheehy T, Kolonel L. Sources of vegetables, fruits, and vitamins A, C and E among five ethnic groups: results from the Multiethnic Cohort Study. *Eur J Clin Nutr* 2014; 68:384. [PubMed: 24398639]

KEY POINTS

- Pediatric providers see children and adolescents throughout their development and are well positioned to provide brief in-office interventions to encourage regular vegetable intake.
- Strategies such as teaching parents to role model vegetable intake for their infants and young children are promising strategies for younger age groups.
- Strategies such as motivational interviewing and frequent follow-up are promising for older children and adolescents toward increasing vegetable intake.
- Well designed and well powered studies that test clinical behavioral interventions to increase vegetable intake in the primary care setting are needed.

Table 1. Interventions in pediatric primary care with statistically significant impacts on child fruit and vegetable consumption

Author(s), year, location; study design	Age	Population	Demographics and clinical characteristics (SD or range)	Sample size	Study design; intervention, control, study visits; duration	Vegetable intake outcome; measure of intake	Additional outcomes	Results on vegetable intake mean (SD) where applicable
Infancy								
Doorley E, Young C, O'Shea B, <i>et al.</i> 2015, urban clinics in Ireland	13 months	Healthy children being seen for 13-month vaccination visit	Study Site 1: Toddlers at least 91st percentile for weight at baseline; 33% Parental age of leaving education: 16 years Private patients: 11% Deprivation index: 10 (maximum) Study Site 2: Toddlers at least 91st percentile for weight at baseline; 20% Parental age of leaving education: 22 years Private patients: 86% Deprivation index: 7	<i>n</i> total: 39	Design: pretest, posttest Intervention (1) Healthy eating and activity information sheet, discussion of child's weight - Interventionist: general practitioner Control: No control group Study visits: one 13-month visit, follow-up phone call 3 months later Study duration: 3 months	Proportion consuming at least four servings of fruit and vegetables per day.	Intake of unhealthy snacks, sugar-sweetened drinks, fruit juice; more than 2 h screen time; more than 30 min exercise daily.	Increase in proportion of participants consuming at least four servings of fruit and vegetables per day. Baseline: 20.5% Postintervention: 28.5%
French GM, Nicholson L, Skybo T, <i>et al.</i> 2012; Columbus Ohio	0–6 months	Healthy mother–infant pairs	Mother's BMI: 62% overweight or obese Mother's race: - Black: 61% - White: 24% - other: 15% CES-D10 score > 11: 73.1% Mother's education: high school or less: 66%	<i>n</i> (total pairs): 292 <i>n</i> (MOMS): 98 <i>n</i> (OP): 95 <i>n</i> (BF): 99	Design: pilot cluster RCT Intervention: (1) Maternal-focused dietary intervention (MOMS): participants were instructed to model healthy eating habits, which included eating three meals a day, not eating with the TV on, consuming at least five servings fruits and vegetables daily. (2) Ounce of Prevention (OP): taught infant-guided feeding, introducing new foods, interpreting infant satiety cues. Interventionists for both groups: trained pediatricians, nurses, and medical assistants Control: Bright Futures (BF; usual care) included traditional anticipatory guidance on breast-feeding,	No primary outcome reported	Infant feeding practices (vegetable servings/day, fruit oz/day), measured by infant feeding questionnaire; maternal and child anthropometrics, eating behaviors, food security.	Significantly higher infant vegetable intake in MOMS group (servings/day) compared with BF control ($P < 0.05$). MOMS: 1.41 (0.11) BF control: 1.03 (0.10) Ounce of Prevention: 1.20 (0.11)

Author(s), year, location; study design	Age	Population	Demographics and clinical characteristics (SD or range)	Sample size	Study design; intervention, control, study visits; duration	Vegetable intake outcome; measure of intake	Additional outcomes	Results on vegetable intake mean (SD) where applicable
Tucker SJ, Ytterberg KL, Lenoch LM, et al. 2013, Midwestern Academic Medical Center in the United States	4–18 years	Children with BMI 85th to 95th percentile	Child ethnicity: Caucasian: 80% Asian: 4% Black/African American: 6% Hispanic/Latino: 2% Parent: Race/ethnicity: Caucasian: 81% Asian: 4% Black/African American: 6% Hispanic/Latino: 2% Education level: At least high school or GED: 14% College degree: 41% Household annual gross income: \$80001+: 37%	n total: 96 n intervention: 44 n control: 52	Design: nonrandomized quasi-experimental trial Intervention (52/10 program): Registered nurse (RN) training in MI RN-led 30 min MI session (with readiness ruler and goal-setting worksheet), weekly phone calls, follow-up MI, and a booster MI at 6 months, based on the 52/10 program: at least five servings fruits and vegetables per day, at least 1 h physical activity per day, 2 h or less screen time per day, 0 sugar-sweetened beverages per day; Interventionist: registered nurse Control: Given a BMI chart print-out, handouts on healthy weight management, and referrals for dietary evaluations as appropriate	Behavior change (including increase in servings/day of fruits and vegetables, measuring by healthy habits questionnaire) BMI, BMI percentile, and parent, child, and provider satisfaction with MI intervention	Significant difference in fruit/vegetable consumption ($P < 0.001$). 6-month outcomes: Intervention: increase from 2.8 (1.3) to 4.0 (1.4) Control: increase from 2.6 (1.4) to 2.9 (1.6) 12-month outcomes: Intervention: increased from 2.8 (1.3) to 3.8 (1.1) Control: increased from 2.6 (1.4) to 3.0 (1.4). Additional findings: proportion eating five servings of fruits/vegetables per day ($P = 0.021$): - Intervention: 30% Control: 10%	
CES-D 10; Center of Epidemiologic Studies Depression Scale; FV, fruits and vegetables; GED, General Educational Development Test; MI, motivational interviewing; PACE+, patient-centered assessment and counseling for exercise + nutrition; RCT, randomized control trial; SD, standard deviation; WC, waist circumference; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.					introduction of new foods, and avoidance of hazards Study visits: 2, 4, 6, 9, and 12 months Study duration: 12 months			
					Study visits: 6 months (baseline, 1, and 6 months) Study duration: 12 months			