Primary care interventions to reduce childhood obesity and sugar-sweetened beverage consumption: Food for thought for oral health professionals

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Abstract

Objectives: Childhood obesity remains a significant threat to America's children. Health care leaders have increasingly called upon oral health professionals to integrate healthy weight promotion and enhanced sugar-sweetened beverage counseling into their professional practices. The aim of this scoping review is to examine recent evidence regarding the effectiveness of primary care childhood obesity interventions that have potential for adoption by oral health professionals.
Methods: Medine, and PubMed were searched from 2010 to 2016 for review articles and studies reporting patient outcomes or policy outcomes relevant to primary care childhood obesity interventions for children ages 2–11 years. Additional articles were accessed through relevant websites, journals, and references. Our screening criteria included interventions that could be adopted by oral health professionals.
Results: Forty-two articles met inclusion criteria. Effective interventions fell into four domains: family-based programs, motivational interviewing, office-based practice tools, and policy interventions. Despite strong evidence linking the consumption of sugar-sweetened beverages to childhood obesity, our review did not find evidence of primary care programs effectively targeting and reducing childhood sugary drinks.
Conclusions: Effective primary care interventions for addressing childhood obesity have been identified, although only short-term effectiveness has been demonstrated. Dissemination of these practices as well as further research and advocacy are needed. Childhood obesity and poor oral health share many common risk factors. Additional research should focus on the benefits and feasibility of widespread interdisciplinary medical-oral health collaboration in addressing the two most prevalent diseases of childhood.

Introduction

America's high rates of childhood obesity are a serious concern for families, health care practitioners and the nation at large. Ogden et al. reported 31.8 percent of US children aged 2–19 had unhealthy weights as measured by the 2011–2012 National Health and Nutrition Examination Survey (NHANES) (1). The natural history of childhood obesity begins with excessive rates of weight gain occurring early in life and persisting into later childhood and adult years (2-4). Traditionally, medical primary care professionals (PCPs) have addressed this epidemic; however, these interventions are increasingly being questioned as ineffective without more

Table 1 Inclusion/Exclusion Criteria

Research question	Inclusion	Exclusion
Population	• Children under age 12 and/or their families	• Population of less than 100 patients/providers studied
Interventions	• Interventions performed by non-oral health professionals in community and professional settings with the potential for translation into clinical or community oral health practice, either by direct provision of the intervention or by referral	• Pharmacologic treatment or interventions primarily intended to address the cardiometabolic or other health outcomes of obesity
Outcomes	• Effectiveness as demonstrated by changes in BMI or in critical drivers of pediatric obesity, such as dietary, physical activity, or environmental changes relevant to obesity	• No available measurable outcomes for review

involvement of other health care and community partners (5-7).

The aim of this scoping review is to examine recent evidence regarding the effectiveness of primary care interventions to reduce childhood obesity. Our framework was to identify medical interventions, such as lifestyle counseling for sugar-sweetened beverages (SSBs) and routine health monitoring that had a potential for widespread adoption by the oral health community. We presented this review to the Healthy Futures Symposium, held in November 2016; the purpose of the Symposium was to address how the oral health community could be involved in reducing childhood obesity. This innovative convening of medical, dental, academic, and community partners gave our interdisciplinary group of authors the opportunity to view the medical literature with a novel perspective and review effective primary care interventions that oral health professionals could adopt if they choose to integrate healthy weight promotion into their professional practice.

Methods

We searched two relevant electronic databases (PubMed and MEDLINE) for English-language review articles dating from January 2010 to July 2016 to answer the following research question:

• What are non-oral-health professionals (e.g., physicians, nurse practitioners, and dietitians) in practice and in public health settings currently doing to effectively address childhood (under age 12) obesity and reduce consumption of SSBs?

We identified additional relevant articles by screening recent contents of major pediatric and childhood obesity journals, the Cochrane Library, ClinicalTrials.gov, and other obesity-related websites and reference lists. Using defined inclusion/exclusion criteria (Table 1), two members of the study group (DD, NM) performed title and abstract screening of 1,404 articles. In accordance with PRISMA guidelines, we subsequently performed independent review of 244 full-text articles for inclusion/exclusion criteria and relevance to the study question (8). Articles were grouped into effective domains; all authors independently extracted the data from the 42 identified articles within the effective domains (See Figure 1). Detailed information on the search strategy is available in the appendix.

Results

After review of the relevant studies, we identified four domains of effective primary care interventions used to address childhood obesity:

- Family-based programs
- Motivational interviewing
- Office-based practice tools
- Policy interventions

Because of the strong evidence that SSBs are unique contributors to childhood obesity, we also reviewed targeted clinical interventions to reduce childhood SSB consumption (9).

Family-based programs

Recent reviews of family-based interventions show participating families generally realize clinically significant improvements in the weight trajectory of their children (Table 2) (10-19). These programs for overweight or obese children and their families occur in health care settings, homes, or community settings and engage participants in a series of classes with an interactive curriculum focused on dietary changes, physical activity, and parenting support.

Berge et al. reviewed 20 family-based programs and found "70 percent of studies showed statistically significant moderate to large effect size changes in child BMI (body mass index)" (14). Secondary outcomes such as changes in screen time, diet, and unstructured and structured play were also improved. The most effective interventions included information as well as interactive learning in the areas of parenting skills, nutrition, and physical activity (15,16). Ling et al. reviewed 29 family-based interventions and found young children generally have greater improvements in weight than

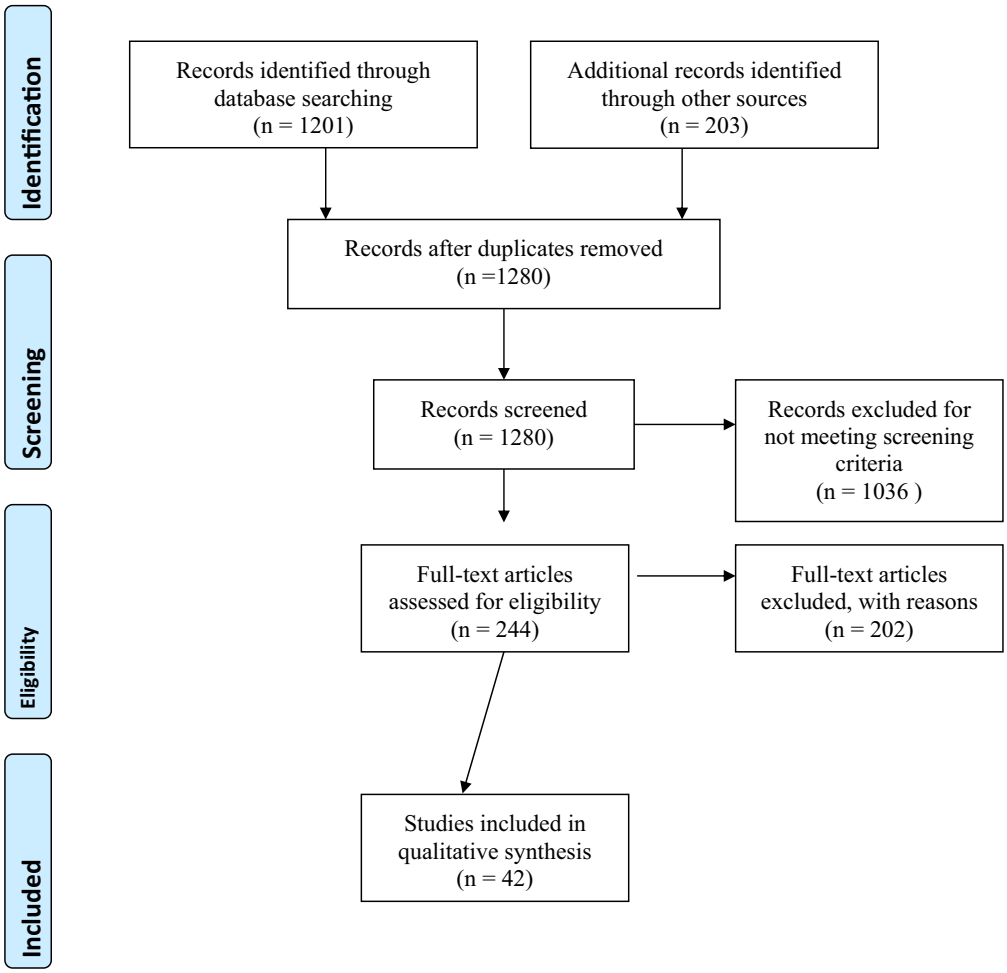

Figure 1 Selection process for articles chosen for pediatric childhood obesity scoping review.

older children (18). A systematic review on screening and treatment for childhood obesity performed by O'Connor showed behavior-based interventions had relative reductions in BMI z score of −0.2 or more (18). The reductions in BMI were relatively short-term in all programs; most programs did not show efficacy 6–12 months after the intervention ended.

Reported outcomes demonstrate that these programs effectively educate families and promote lifestyle changes. Although there is no standardized family intervention program proven to be most effective, parental satisfaction is generally high. Eighty-nine percent of parents participating in the Healthy Habits, Happy Homes program were satisfied or very satisfied with the program (19). Practitioners can refer families to local programs, however, programs presently have variable health care coverage and availability. A systematic review and meta-analysis of behavioral-based interventions for the United States. Preventive Services Task Force (USPSTF) concluded family-based programs with at least 26 contact hours were effective in reducing excess weight gain in children and adolescents after 6–12 months; the draft evidence review endorsed health insurance coverage of these programs as being an effective preventive health intervention (18).

Motivational interviewing

The review also demonstrated the effectiveness of motivational interviewing (MI), an intensive counseling style used by PCPs to encourage families to adopt healthier lifestyle habits (Table 3) (20-26). The 2007 Expert Committee recommended PCPs use MI as a tool in negotiating healthy lifestyle changes with families; however, the degree of efficacy of this technique in a clinical setting was unknown until recently (4). Borrello et al. performed a systematic review and meta-analysis of MI for parent-child health interventions, including studies targeting oral health in children, and concluded MI is associated with significant improvements in children's health behaviors (20). Large studies of childhood obesity MI programs conducted in multiple primary care settings have demonstrated short-term weight trajectory improvements as well

Table 2 Summary of Family-Based Intervention Articles

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
Berge (14)	2011	Varied	To conduct a meta-analysis of family-based interventions targeting childhood obesity in the last decade	1,545 families total	Reviewed studies 2000–2009, 20 childhood obesity intervention studies that targeted children and one or more family members. Did not require randomized controlled trials.	70% of studies showed statistically significant moderate to large effect size changes in child BMI. Of these, 50% showed statistically significant child weight loss change at 6-month, 1-year, and 2-year follow-up.	Meta-analysis of published articles.	8 weeks–2 years
Blake Lamb (15)	2016	Varied	To review existing and ongoing interventions from conception through age 24 months, identify gaps in current research and discuss conceptual frameworks and opportunities for future interventions.	Sample sizes varied from 43 to 17,626.	Systematic review of 26 completed studies and 47 ongoing interventions during pregnancy, through pregnancy and birth and after birth. 26 unique interventions. 1980–2014.	9 of 26 interventions demonstrated a beneficial effect on children's growth status. Family-based interventions and interventions conducted in the home most effective, but small number of studies.	RCTs, Cluster RCTs, Experimental trials	Varied
Colquitt (10)	2016	Varied	To assess the effects of diet, physical activity, and behavioral interventions for the treatment of overweight or obesity in preschool children up to the age of 6 years	Varied. Total population for 7 RCTs 923 overweight or obese preschool children	Review of 7 RCTs with multicomponent interventions and dietary interventions compared with no intervention, usual care, enhanced usual care or some other therapy.	Multicomponent interventions more successful than comparators in reducing BMI and body weight in preschool children and their parents. The effects were maintained 2 years after the start of the intervention.	RCTs	Follow-up 6 months–3 years post intervention
Haines (19)	2013	United States	To examine the effectiveness of a home-based intervention to improve household routines known to be associated with childhood obesity	121 low-income, racial/ethnic minority families with young children aged 2–5 years	6-month intervention promoting healthy household routines versus control subjects. Measured reported changes in behaviors, BMI, parent satisfaction.	Interventions participants had increased sleep, decreases in TV watching, BMI. Parents satisfaction rate 89% with the program.	Randomized trial	6 months
Janicke (12)	2014	Varied	To conduct a meta-analysis of RCTs examining the efficacy of comprehensive behavioral family lifestyle interventions for pediatric obesity	Sample sizes varied from 22 to 208	Systematic review and meta-analysis of comprehensive programs. Twenty studies. Review of comprehensive behavioral family lifestyle interventions targeting dietary intake, physical activity, and behavior strategies.	Overall effect size for improvement in zBMI was statistically significant. Only one study yielded a negative effect size. Effect size for change in caloric intake was not statistically significant.	RCTs	Varied

Table 2. Family Based Articles Continued

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
Ling (17)	2016	Varied	To examine the effects of prevention and management interventions on overweight/obesity among children aged 2–5 years, and explore factors that may influence intervention effects.	Sample sizes varied from 66 to 1,663	Systematic review of RCT of prevention and management interventions on overweight and obese children ages 2–5 years. 37 articles, 29 unique interventions. 12/29 showed significant weight changes.	Management interventions more effective than prevention interventions. Evidence shows that children with higher baseline BMI have greater weight loss, also greater weight loss with increasing intervention length. Effective interventions should focus on parents. Parents and children benefit from interactive education and hands-on experiences Children ages 4–7 years participating in lifestyle intervention have greater weight loss over 5 years than older children.	RCTs, Cluster RCTs	Varied
Loveman (11)	2015	Varied	To assess the efficacy of diet, physical activity and behavioral interventions delivered to parents only for the treatment of overweight and obesity in children aged 5–11 years.	Sample sizes varied from 9 to 457. Total sample size parents of 3,057 children.	Review of 20 RCTs comparing parent-only versus parent-child family intervention programs.	Both parent-only and parent-child interventions of programs have similar effects. Heterogeneous interventions studied with high risk of bias. Secondary outcomes reported inconsistently.	RCTs	Varied
O'Connor (18)	2016	Varied	To systematically review the benefits and harms of screening and treatment for obesity and overweight in children and adolescents	Varied. Total population studies 7,099	Review of 45 behavior-based interventions answering analytic framework developed with USPSTF. Included trials had a primary aim of reducing excess weight or maintaining previous reductions for overweight or obese children aged 2–18 years. Meta-analysis of studies meeting quality and review criteria.	Weight management interventions with 26 estimated contact hours were generally effective in reducing excess weight after 6–12 months.	RCTs, CCTs and cohort or case-control studies.	Weight outcomes to be reported at least 6 months post- baseline follow-up.

Table 2. Family Based Articles Continued

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
Sung-Chan (13)	2013	Varied	To examine the methodological rigor and treatment effectiveness of family-based interventions according to intervention types and theoretical orientations.	Sample sizes varied from 15 to 1,223	Review of 15 RCTs of family-based lifestyle interventions ages 2–19 years, 1975–2012. Used methodological quality rating scale to evaluate rigor and effectiveness of Rx.	Treatment effect of family-based models of intervention demonstrated. Behavior theory- based interventions did better than the family system theory therapy approach. Programs with focus on eating and exercise were most effective versus focusing on parenting, child management, and family therapy.	RCTs	Varied
Yavuz (16)	2015	Varied	To investigate the features related to the effectiveness of different types of obesity intervention programs involving parents and targeting young children (0–6 years).	Sample sizes varied from 17 to 1326	Meta-analysis of effectiveness of programs with parent involvement for children from birth through age 6 years that had intervention and control groups with random assignment. Published 2003–2013. Curriculum content included parenting skills, diet/nutrition education, physical activity/sedentary behaviors education.	Short-term follow-up of 50 studies showed small but significant effect of program within 3 months of the end of the intervention. Long- term follow-up showed no effectiveness with 26 studies. The most effective programs were (short-term): overweight/obese children, overweight/obese parents, 0–12 months, offered general parenting skills, or parenting skills with education. (long-term): toddler/preschool age, general parenting skills.	RCTs, Cluster RCTs	Varied

Table 3 Summary of Motivational Interviewing Articles

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
Borrello (20)	2015	Varied	Broad literature search of 6 MI studies 2007–2014.	Total participants: 1820. 56% White, 19% Black/AA, 17% Latino.	Description and results of selected studies of interventions with a MI component to change BMI in the treatment of overweight or obese children aged 2–11 years. Four studies used MI as described by Miller and Rollnick, 1 applied the principles of brief MI, 1 used a protocol based on theories and models of behavioral change	Three studies showed that MI intervention is more effective than the usual care for changing BMI. Reported results included changes in mean BMI and mean BMI%, parent satisfaction, secondary outcomes in obesity-related behaviors, waist circumference, and other anthropometric measures.	Varied	Duration varied from 14 weeks to 2 years
Broccoli (25)	2016	Italy	Determine whether the short-term (12-month) impact of family pediatrician-led MI for overweight children could be sustained for 24 months without other intervention	372 participants	Follow-up of Davoli study of Family Practice–led MI in Italy. Randomized ages 4–7 years, overweight. 89–91% participated in follow-up at 24 months.	Original study showed BMI differences between the original control and intervention groups at 12 months; in intervention group, relapse at 24 months after discontinuation of MI. Long-term changes remained in increased physical activity, fruit, decreased candies, sugar-sweetened beverages.	RCT	Follow-up performed 12 months after cessation of the intervention No further intervention performed.
Davoli (21)	2013	Italy	Evaluate the effect of family pediatrician-led MI on BMI of overweight children aged 4–7 years.	372 participants	Primary care intervention for overweight children ages 4–7 years. Both groups had baseline and 12-month visit to assess body mass index and lifestyle.	Significant difference between groups: Average increase in BMI for intervention group 0.49/control group 0.79 $P = 0.007$. Significant lifestyle changes intervention versus control – increased non-organized physical activity, decreased television time.	RCT	Usual-care group received information leaflet. Intervention group participated in 5 family meetings focused on MI. 12- month intervention.

Table 3. Motivational Interviewing Articles Continued

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
Resnicow (22,23)	2013 2015	United States	Test the efficacy of MI delivered by providers and registered dietitians to parents of overweight children aged 2–8 years.	457 participants had a 2-year follow-up BMI. 645 eligible baseline children. Final cohort 60% White, 22% Latino, 7% Black/AA, 6% Asian.	42 practices from American Academy of Pediatrics practice- based research network.	Significant decrease in BMI% for option 3 versus 1. 2-year follow-up: BMI percentile adjusted for co-factors: Usual care – decreased 1.8, MI primary care professional decreased 3.8, MI PCP + registered dietitian decreased 4.9.	Cluster-randomized, 3-group intervention trial with clinical practices serving as the unit of randomization and analysis.	Group 1 (Usual care) versus Group 2 practitioner- delivered 4 MI to parents over 2 years versus Group 3 practitioner and registered dietician – delivered 4 MI plus 6 MI RD. 2-year intervention.
Rifas-Shiman (26)	2016	United States	Examine 2-year changes in age- and sex-specific BMI z-scores and obesity-related behaviors after an intensive 1-year intervention followed by a less intensive 1-year maintenance period.	441 overweight or obese children aged 2–6 years at enrollment.	1-year intervention (4 in-person visits, 2 phone calls. MI + educational modules targeting TV, fast food, SSBs.) versus usual care. Followed by in-person intervention visits during the 1-year maintenance period.	Did not appreciably improve BMIz scores or obesity-related behaviors compared with children not receiving the intervention. Intervention involved only the primary care setting and not children's communities or environment. Adherence to intervention activities was low during the 1-year maintenance period.	Cluster randomized trial in 10 pediatric practices.	2-year follow-up of High Five for Kids Study.
Woo Baidal (24)	2013	United States	Identify correlates of parental perceptions of helpfulness of and satisfaction with a MI-based pediatric obesity prevention intervention.	Parents of 253 children ages 2–6 years who participated in the High Five for Kids Study.	Parent satisfaction rates for primary care-based randomized controlled trial. Telephone survey at baseline and 1 year after enrollment.	Parents born outside United States, with decreased income and/or higher BMI, more likely to perceive MI-based visits as helpful in improving obesity-related behaviors. Parents of black and Latino, children had lower satisfaction with intervention AOR black 0.43, Latino 52. No description of MI standardization, training, Spanish interpreters, or competency of practitioners.	Data analysis of parent perceptions and demographics of program satisfaction. Surveys of parents following first year of High Five for Kids Study.	1-year intervention (4 in-person visits, 2 phone calls. MI + educational modules targeting TV, fast food, SSBs versus usual care.

as changes in secondary moderators of weight, such as caloric intake, television watching, and physical activity. These programs are often co-located in the medical office setting and may involve a PCP meeting with the family to set feasible goals, followed by a registered dietitian or nurse practitioner assisting the family at home or in the office with the chosen goals. Consistent with the methods of Miller and Rollnick, trained practitioners use non-directive questioning and reflective listening to establish agreement with families that change needs to occur (27).

Office-based practice tools

Our review contained 11 articles demonstrating that electronic health systems and office-based practice tools improve care and communication for PCPs addressing childhood obesity (Table 4) (28-38). Shaikh et al. documented that adoption of electronic provider prompts and reminders in a teaching clinic resulted in a significant increase in diagnosis and follow-up for overweight and obese pediatric patients (30). In a point-of-care study of clinical decision support by Taveras et al., obese children seen in a clinic using more advanced EHR capabilities had less increase in their BMI than those in usual care (31). Bronder et al. outlined further potential capacities of EHR systems, including provision of self-management support, linked patient education, and prompts for community and programmatic referrals, but noted few currently adopted EHR systems presently have these capabilities (32).

The reviewed literature also showed promise that widespread adoption of improved communication tools with families with limited English proficiency (LEP) and/or low health literacy would enhance clinical interventions in childhood obesity. This area of inquiry is critically important since family LEP and low health literacy status both correlate with increased rates of childhood obesity and decreased parental care satisfaction (33). Studies showed strong evidence that use of language interpreters and partnering patients with physicians that speak their language improve outcomes and care for LEP adult diabetic patients (34-36). Using tools to confirm patient comprehension, such as the teach-back method was also demonstrated to assist adult patients avoid misunderstandings of health concepts. As reported by Porter and Zoellner, teach-back methods improved the ability of adult patients to complete self-monitoring diaries and resulted in a decrease in SSB consumption among low health literate patients (37,38).

Interventions to influence policy

Many authors in our review noted that childhood obesity preventive measures taken on a broad policy level would likely be more effective than clinical interventions after obesity develops. Our review of nine articles with policy interventions (Table 5) showed that health care practitioners could be the crucial link between community-based prevention efforts and individual treatment follow-up. However as pointed out by Vine et al. "Many health care providers continue to see themselves primarily as clinical practitioners and not as health educators or advocates in the broader community." (39) Boyle et al. reported that 88 percent of surveyed providers thought health care practitioners should advocate for policies to reduce obesity, improve local environments, and expand insurance coverage for obesity prevention. The authors concluded that health care practitioners could effectively mobilize community members and influence policymakers, but need time, training, resources, and institutional support to improve their ability to communicate obesity-prevention messages as policy advocates (40).

Reviewed authors identified multiple opportunities for health care professionals to initiate preventive policy changes close to home. The importance of establishing healthy local vending policies was highlighted by Craddock et al. in a study reporting significant declines in student soda consumption when Boston high schools restricted the sale of SSBs from vending machines (41). Lawrence et al. reported that sodas comprise the greatest percentage of beverages, and candy was the most frequently offered food in the vending machines of local health facilities (42). Wocjicki and Grech et al. described numerous vending strategies for altering marketing, availability or pricing of unhealthy drinks and foods in hospital vending machines, and concluded that changes in hospital food policies can be a model for community health reforms (43,44).

A significant body of articles also presented evidence regarding the impact of food and beverage industry funding on professional organizations and research. Bes-Rastrollo et al. studied published reviews of the medical literature on the relationship between SSB consumption and weight gain; they found that reviews with financial conflicts of interest were five times more likely to determine no impact of SSB on weight gain compared to reviews without food-industry funding (45). Analysis of sugar industry influence on federal policies and research by Kearns et al. revealed that historical documents from the 1960s showed that the sugar industry successfully developed relationships with federal policymakers and prominent researchers to minimize the true harms of sugar intake; the resulting policies significantly impacted priorities for the subsequent National Caries Program and research regarding the hazards of added sugar on cardiovascular health (46,47).

Lack of clinical interventions to reduce SSB consumption

Despite evidence of strong links between SSB consumption in children and unhealthy weight gain, our review did

Table 4 Summary of Office-Based Practice Tools Articles

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
Bronder (32)	2015	United States	To describe the prevalence of obesity-related EHR functions in clinical practice and analyze characteristics associated with increased obesity-related EHR sophistication	1,507 PCPs	Docstyle survey done with PCPs practicing June 2013. Response rate 74%. 88% had EHR.	Reviewed capability of EHRs to perform basic functions to support obesity diagnosis and counseling. Found that 17% do not capture BMI, 89% had obesity-screening functions, 57% had self-management support, 36% had decision support, 51% calculated BMI %.	Survey	PCPs practicing June 2013
DeCamp (54)	2013	United States	To compare language services use by US pediatricians in 2004 and 2010 and examine variations in use in 2010.	Results of 1,391 national surveys of pediatricians in 2004 and 2010.	American Academy of Pediatrics National Periodic Survey of pediatricians seeing patients with LEP. Used bivariate analyses to examine changes in methods of communication use with LEP patients. Multivariate logistic regression performed.	Increased rates of interpreter use 2004–2010: 49.7% versus 55.8%. Most respondents reported using family members to communicate. States with reimbursement for language service use had twice the odds of formal interpreter use. Less than half of pediatricians in high-LEP states reported any formal interpreter use.	Cross-sectional, observational study	Analyzed surveys completed by pediatricians April–October 2004, and June-November 2010.
Fernandez (36)	2011	United States	To assess the association between limited English proficiency and glycemic control and whether this association is modified by having a language-concordant physician.	6,738 adult patients with diabetes in the Kaiser Northern California Diabetes registry	White, Latino-English-speaker and Latino patients with LEP were assessed for English proficiency, physician language concordance and last A1C test.	LEP Latinos more likely to have poor glycemic control versus English-speaking Latinos. Patients with physician language discordance more likely to have poor control versus English-speaking Latinos (odds ration [OR] 1.76). LEP-discordant patients more likely to have poor control versus concordant (adjusted OR 1.98).	Cross-sectional, observational study	Patients responded to surveys and received care 2005–2006

Table 4. Practice-Based Tools Continued

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
Hacker (35)	2012	United States	To determine whether the amount and type of language services received during primary care visits had an impact on diabetes-related outcomes (hospitalization, emergency room utilization, glycemic control) in limited English proficient patients.	1,425 limited English proficient patients in the Cambridge Health Alliance diabetes registry	Patients receiving usual care categorized into 7 groups based on the amount and combination of language services received at primary care visits during a 9-month period. Bivariate analyses and multiple logistic regression were used to determine relationships between language service categories and outcomes in the subsequent 6 months.	Patients who received 100% of their primary care visits with language concordant providers were least likely to have diabetes-related emergency department visits compared to other groups ($P < 0.001$) in the following 6 months.	Cohort Study	NA
Karliner (34)	2007	Varied	To determine if professional medical interpreters have a positive impact on clinical care for limited English proficiency (LEP) patients.	28 studies met inclusion criteria	Systematic review of articles comparing at least two language groups, and contained data about professional medical interpreters. Each study was evaluated for the effect of interpreter use on four clinical topics that were most likely to either impact or reflect disparities in health and health care.	In all four areas examined, use of professional interpreters is associated with improved clinical care more than is use of ad hoc interpreters, and professional interpreters appear to raise the quality of clinical care for LEP patients to approach or equal that for patients without language barriers.	Systematic review focused on clinical topics – communication (errors and comprehension), utilization of clinical care, clinical outcomes, and satisfaction with clinical care.	Varied
Moyce (29)	2015	United States	To examine associations between weight	9,835 office-based provider visits	2007 expert committee recommended universal	Increased counseling reported for children with increased weight.	Data analysis of nationally representative survey of	Results of 3 years of this survey

Table 4. Practice-Based Tools Continued

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
			classification and receipt of weight-related screening and counseling from the pediatric provider.		assessment of BMI regardless of weight class, with dietary and exercise-related counseling to all children. Used Medical Expenditures Panel Survey 2008–2011 ages 6–17 years with office-based practitioner visits in the past year to determine if documented counseling occurred for physical activity and diet with visit.	Co-variates for decreased counseling: low to moderate income, special health care needs, and maternal education less than 12 years. Increased counseling: urban setting, usual source of care. Linear regression model showed that receipt of counseling, and child's BMI correlated with year 2 obesity rates.	parents of children less than age 6	
Porter (36)	2016	United States	To assess differences, by health literacy status and behavioral condition, in the ability of low-income adults in Virginia to self-monitor behaviors relevant to physical activity or SSB consumption using data from a teach-back call.	301 adults in rural Virginia participating in the Zoellner study.	Described the performance and perceptions of participants in completing a diary and answering behavioral question after a Teach- back call intended to address low health literacy.	Low-health-literacy participants were less accurate in diary completion, recalled fewer behavioral messages correctly, needed more rounds of Teach-back to identify and calculate SSB consumption.	Cross-sectional study	6-month intervention
Shaikh (30)	2015	United States	To assess the impact of EHR-based clinical decision support in improving the diagnosis and management of pediatric obesity	574 provider visits of overweight/obese children	Medical record review. Implemented enhanced EHR tools to alert for elevated BMIs, give checklist of interventions, standardized documentation	Use of enhanced clinical decision support resulted in significant increases in the diagnoses of obesity, ordering labs for the condition, scheduling follow-up appointments.	Data analysis of medical record review.	9 months

Table 4. Practice-Based Tools Continued

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
					templates. Reviewed visits in control period of 9 months followed by intervention period of 9 months.			
Smith (28)	2013	Varied	To review the effect of health IT (electronic health records [EHRs], telemedicine, text message or telephone support) on patient outcomes and care processes in pediatric obesity management.	Varied. Patient population included overweight and obese children.	13 studies using IT to deliver obesity screening or treatment to children aged 2 to 18 from January 2006 to April 2012. The majority of included studies were small and/or of poor methodological quality.	EHR use was associated with increased BMI screening rates in five of eight studies. Telemedicine counseling was associated with changes in BMI percentile similar to that of in-person counseling and improved treatment access in two studies. Text message or telephone support was associated with weight loss maintenance in one of three studies.	Systematic review of controlled trials, before-and-after studies, and cross-sectional studies	Varied
Taveras (31)	2015	United States	To examine the extent to which computerized clinical decision support with or without individualized family coaching improved BMI and quality of care.	Study of 10 practices randomized to two intervention arms and 4 practices in control group	Comparative study of 3 arms of pediatric care for childhood obesity. 5 practices implemented clinical decision support and family interventions for self-guided behavior change, 5 practices implemented clinical decision support and individualized family coaching, 4 practices usual care. Obese children presented for a well-child visit ages 6–12.9 years.	Practices using clinical decision support and family intervention and clinical decision support with individualized coaching had lower BMI increase versus clinical decision support with coaching and usual care.	Cluster-randomized, 3-arm clinical trial	9-month intervention with 1 year follow-up after intervention

Table 4. Practice-Based Tools Continued

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
Zoellner (37)	2016	United States	To assess the effectiveness of a behavioral intervention targeting SSB consumption among adults in a medically-underserved rural community.	Study of 1056 adults in rural Virginia with high SSB consumption.	Used Talking Health curriculum to compare outcomes for SSB versus physical activity intervention. Patients had three small group classes, 1 live Teach-back call, 11 interactive voice response calls.	SSB consumption was significantly reduced an average of 227 kcal/day in SSB class versus PA class reduction 53 kcal/day.	Type 1 effectiveness-implementation hybrid RCT	6 month effects measured.

not find evidence of targeted clinical interventions for children that significantly reduced SSB consumption (Table 6) (9,48-53). A systematic review by Lane et al. concluded that child- and adolescent-focused SSB intervention studies are not providing enough information to determine best practices for nutrition researchers and practitioners (49). The reviewed studies primarily identified correlates of SSB consumption, such as Mazarello Paes et al. who reported that children's preference for SSBs, time spent viewing television or other screens, and snack consumption were positively associated with SSB consumption; parental modeling of healthy drinks was associated with lower SSB consumption. They also found that studies using a behavior change theory and addressing multi-level determinants of SSB consumption had proven short-term efficacy (50). School interventions addressing SSB consumption provided some evidence of the types of messaging effective at changing behavior. As reported by Cunha et al., nutritionists delivering educational sessions on SSB consumption to students, parents and teachers found significant reduction in daily SSB consumption but no reduction in BMI gain (51).

Discussion

Our review of the relevant literature identified four domains of effective clinical practices and policy interventions available to PCPs to reduce childhood obesity: family-based programs, motivational interviewing, office-based practice tools, and policy interventions.

Evidence of efficacy was most significant in family-based interventions and motivational interviewing, with systematic reviews consistently finding short-term effectiveness compared to usual care. The benefits of these interventions to families and children include statistically significant reductions in BMI z scores as well as increased physical activity, reduced screen time, and reduced consumption of sugary drinks and foods. The improvements are generally clinically modest, however, and do not show evidence of sustained effects beyond the intervention period, usually 6–12 months (18,25,26). Future research should focus on sustaining the benefits of these programs. We concluded that the evidence supports widespread dissemination of these programs into clinical practice and pre-doctoral curriculum, since they demonstrate efficacy greater than that seen in the current brief, primary care interventions for pediatric weight management (54).

The use of enhanced office-based practice tools also showed promising evidence for improved provider effectiveness in addressing childhood obesity. Electronic health systems with provider prompts and decision support tools demonstrated improved childhood obesity documentation, however, only one study reviewed showed improved clinical outcomes. Further work needs to be done in this promising

Table 5 Summary of Interventions to Influence Policy Articles

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
Bes-Rastrollo (45)	2013	United States	Examined whether financial industry funding or the disclosure of potential conflicts of interest influence the results of published systematic reviews conducted in the field of sugar-sweetened beverages and weight gain or obesity.	17 Systematic Reviews	Systematic review of published systematic reviews (SRs) published before August 31, 2013 on the association between SSB consumption and weight gain or obesity. Association between stated conflicts of interest and the articles conclusions assessed using Poisson regression analysis.	SRs with financial conflicts of interest were five times more likely to present a conclusion of no positive association between SSB consumption and obesity than those without them.	Systematic Review	Inception of PubMed, the Cochrane Library, and Scopus databases to August 31, 2013.
Boyle (40)	2009	United States	To describe how health care providers address obesity prevention in clinical practice and to assess health care providers' level of readiness to advocate for policies to prevent childhood obesity.	248 health care providers included in survey. 56 participants in qualitative interviews.	Study included two data-collection methods: (1) a self-administered survey to health care providers (physicians, dietitians, nurses, nurse practitioners, medical assistants, and community health workers). (2) stakeholder interviews with health care facility administrators, health department staff, and health insurance representatives.	65% of health care providers usually or always discussed the importance of physical-activity, reducing soda consumption, and breastfeeding during clinical pediatric visits. >90% of providers perceived home or neighborhood environments and parental resistance to their efforts to prevent childhood obesity in clinical practice. >75% of providers reported not having engaged in any policy/advocacy activities related to obesity-prevention. 88% stakeholders thought health care professionals should advocate for policies to reduce obesity.	Observational Study	Data collection occurred in 2006

Table 5. Policy Articles Continued

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
Cradock (41)	2011	United States	To determine whether high school students' consumption of sugar-sweetened beverages declined after Boston public schools restricted sale of SSBs in schools in 2004.	2033 Boston High school students	Compared the results of 2 questions to assess total consumption of SSBs in the Boston Youth Survey among students in grades 9–12, 2004 and 2006. Observed changes in intake were compared with national trends by using NHANES data.	Boston public high school student consumption of SSBs showed significant decline from 2004 to 2006, from an average of 1.71 servings daily to 1.38 servings. No significant nationwide change in adolescents' consumption of SSBs occurred between 2003– 2004 and 2005–2006.	Quasi-experimental evaluation	2004, 2006
Grech (44)	2015	United States	To determine the efficacy of nutrition interventions in vending machines in eliciting behavior change to improve diet quality or weight status of consumers.	12 studies – RCTs, Cluster RCTs, pre-test/post-test trial, Quasi-experimental controlled trial.	Systematic literature search and synthesis conducted for nutrition interventions that aim to improve the nutritional quality of food and beverages selected by vending machine consumers. Articles assessed for risk of bias using the Evidence Analysis Manual.	The review found consistent evidence that pricing and availability strategies are effective at improving the nutritional quality of foods and beverages purchased from vending machines.	Systematic Review	Not applicable
Kearns (46)	2015	United States	To explore the sugar industry's interaction with the National Institute of Dental Research (NIDR) to alter research priorities of the National Caries Program (NCP).	319 archived internal sugar industry documents	Examined internal cane and beet sugar industry documents from 1959 to 1971, and sources related to the NIDR through searches of PubMed and WorldCat, and contacted sources directly to analyze industry actions related to setting research priorities for the National Caries Program.	Findings reveal an alignment of research agendas between the NIDR and the sugar industry in the early 1970s and suggest the NCP was a missed opportunity to develop a scientific understanding of how to restrict sugar consumption to prevent tooth decay. The documents show that the sugar industry knew that sugar caused dental caries as early as 1950 and did not attempt to	Case Study	From 1959 to 1971

Table 5. Policy Articles Continued

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
						deny the causative role of sucrose in tooth decay, but instead, through trade associations, adopted a strategy to deflect attention to public health interventions that would reduce the harm of sugar consumption, rather than restricting intake.		
Kearns (47)	2016	United States	A historical analysis of internal sugar industry documents relating to coronary heart disease research	Number of documents not reported	Examined Sugar Research Foundation internal documents, historical reports, and statements relevant to early debates about the dietary causes of coronary heart disease and assembled findings chronologically into a narrative case study.	Study suggests that the sugar industry sponsored its first coronary heart disease research project in 1965 to downplay early warning signals that sucrose consumption was a risk factor in coronary heart disease.	Case Study	From 1950's to 1960's
Lawrence (42)	2009	United States	To assess the healthfulness of foods sold in health care facility vending machines as well as how health care organizations are using policies to create healthy food environments.	96 vending machines assessed in 19 California health care facilities that serve children.	Food and beverage assessments were conducted of items sold in vending machines and interviews conducted for information on vending policies. Analyses examined the types of products sold and the healthfulness of these products.	Hospitals averaged 9.3 vending machines per facility. Sodas comprised the greatest percentage of all beverages offered for sale. 23% of beverages in hospitals met standards for healthy beverages adhered by California schools. Candy comprised the greatest percentage of all foods offered in vending machines.	Quasi-experimental evaluation	Data collection occurred in 2006
Vine (39)	2013	United States	To update the most recent reviews of literature on the primary care role in obesity prevention and treament published from	96 peer-reviewed articles	Conducted a review of clinic- and community-based interventions with a primary care component to identify evidence of effective	Study demonstrates that PCPs are increasingly being included in childhood obesity interventions, consistent with current	Systematic Review	Articles published from 2005 to 2012

Table 5. Policy Articles Continued

Author	Year of publication	Country	Aims	Study size	Methods	Outcome behavior	Type of intervention	Duration of intervention
			2005 to 2012, address 2012 recommendations that emphasize both a clinical and community advocacy role for PCPs, and incorporates multisector interventions and community advocacy-specific interventions involving PCPs.		roles of primary care in addressing the obesity epidemic.	recommendations from scientific and professional organizations.		
Wojcicki (43)	2013	United States	To discuss the role of hospitals in limiting the amount of unhealthy foods and beverages on their campuses.	Numerous examples of hospitals with healthy vending policies	Describes US and international policies regarding hospital food and beverage offerings.	Hospitals should be a model for health care reform in their communities and removing SSBs is a necessary first step	Commentary	Examples from 2012

area as well as the use of primary care language support tools to address childhood obesity. The low levels of use of interpreters in primary care has been documented by many authors; a national survey of the American Academy of Pediatrics fellows in 2010 showed that less than half of responding pediatricians working in states with a high-LEP population reported any formal interpreter use. The majority of pediatricians surveyed used family members, including the child patient, to communicate with parents, a practice correlated with communication errors and compromised quality of care (55).

Most practitioners and researchers call for a multi-sector approach to address childhood obesity and dental caries, in which broader societal, economic, and community factors are addressed along with individually oriented clinical efforts. Our review identified a link between reducing the availability of soda in school vending machines and student soda consumption, and evidence that vending environments in many hospitals do not model healthy dietary recommendations. Reviewed studies also identified important issues to be addressed such as the potentially pernicious influence of food-and-beverage-industry funding on governmental policies, and professional research. We concluded that health care practitioners have unleveraged potential to reduce childhood obesity rates by taking a more active role in creating healthy environments for children. Researchers should also increase their study of the impact of PCP advocacy efforts on issues such as local vending environments and professional conflict of interest policies.

Our review noted a significant gap in primary care tools addressing childhood obesity – the lack of effective clinical interventions to reduce childhood SSB consumption. There is a great need for research in this area, since SSBs are a major source of sugar in children's diets. The American Heart Association recommends that children and adolescents limit sugar consumption to less than 25 grams daily, yet between 2009 and 2012 children 2–19 years of age consumed on average of 80 grams, or 20 teaspoons of added sugars daily (56). Studies have shown a significant relationship between soda consumption and higher rates of weight gain and obesity in children aged 2 and above (52,57,58). Researchers should prioritize developing practical, sustainable interventions for SSB reduction; these could be available either in clinical or community settings. Similar to smoking cessation programs, a step-wise method of reducing consumption of sugary drinks would assist families in understanding the risks of SSBs, documenting their intake of SSBs and support interested families in making lifestyle changes. It would also help families identify which childhood drinks contain sugar and deliver a clear message that these drinks are unhealthy. Though a personal, highly tailored office or community-based intervention may be proven effective, altering school and community

Table 6 Summary of Sugar-Sweetened Beverage Intervention Articles

Author	Year of Publication	Country	Aims	Study Size	Methods	Outcome Behavior	Type of Intervention	Duration of Intervention
Avery (53)	2015	United Kingdom	Explore the interventions that aim to reduce consumption of SSBs in children and determine whether they lead to subsequent changes in body fatness.	Eight studies met inclusion criteria	A systematic review of interventions that aimed to help reduce consumption of sugar-sweetened beverages in children leading to changes in body fatness.	Six interventions achieved significant ($p<0.5$) reductions in SSB consumption, although this was not always sustained. In the two interventions providing replacement drinks, significant differences in body mass index (BMI) (12 or 18 month follow-up) were reported ($p=.001$ and .045)	Replacement drinks, school-based education, school-based environmental change, and web-based modules.	Only intervention control trials 6 months or longer in duration were included.
Cunha (51)	2013	Brazil	Evaluate the effectiveness of a randomized school-based intervention involving families and teachers that aimed to promote healthy eating habits in adolescents; the ultimate aim of the intervention was to reduce the increase in body mass index (BMI) of the students.	559 students participated in the study (intervention: 10 classes with 227 participants; control: 10 classes with 282 participants).	Paired cluster randomized school-based trial conducted with a sample of fifth graders.	There was a major reduction in the consumption of SSBs and cookies in the intervention group; students in these groups also consumed more fruit. Intention-to-treat analysis showed that changes in BMI were not significantly different between the two groups ($\beta=0.003$, $p=0.75$).	Nutrition-education sessions delivered by trained nutritionists to students, parents, and teachers. Positive messaging related to the intake of water, fruits, rice, beans, and an emphasis on reducing SSBs and cookies.	Students attended 9 nutritional education sessions during the 2010 school year.
de Ruyter (52)	2012	Netherlands	Examine the effect on weight gain of masked replacement of SSBs with non-caloric, artificially sweetened beverages.	Enrolled and randomly assigned 641 children, stratified according to school, sex, age, and intial BMI.	Doubled-blind, randomized, controlled trial (RCT) involving schoolchildren living in the community ages 4 years 10 months to 11 years 11 months.	In the full cohort of 641 children, the mean BMIz score increased by 0.02 ± 0.41 SD units in the sugar-free groups and by 0.15 ± 0.42 SD units in the sugar group. The mean difference of 0.13 SD units was significant.	Provided experiment group with 1 can per day of a masked replacement of SSBs with non-caloric artificially sweetened beverages.	18 months

Table 6. Sugar-Sweetened Beverage Articles Continued

Author	Year of Publication	Country	Aims	Study Size	Methods	Outcome Behavior	Type of Intervention	Duration of Intervention
Lane (49)	2016	United States	Systematic review to examine the extent to which studies reported internal and external validity indicators defined by the reach, effectiveness, adoption, implementation, and maintenance (RE-AIM) model and assess reporting differences by socio-ecological level.	There were 55 eligible studies accepted, published in English between 2004 and 2015, targeting children and adolescents (ages 3-18 years). Among those reporting participation rate (25 studies), the median number of participants per study was 675 ± 1,331, with an average participation rate of 66%±31%.	Systematic review conducted in six major databases to identify studies meeting inclusion criteria. Interventions were categorized by socio-ecological level, and data were extracted using a validated RE-AIM protocol. One-way analysis of variance assessed differences between levels.	Adoption, implementation, and maintenance reporting did not vary among levels. Interventions to reduce SSB consumption in children and adolescents across the socio-ecological spectrum do not provide the necessary information for dissemination and implementation in community nutrition settings.	Study designs included experimental or quasi-experimental designs where pretest- posttest data were presented.	NA
Mazarello Paes (50)	2015	United Kingdom	Systematic review of systematic reviews of quantitative and qualitative evidence on determinants of obesogenic behaviors in young children	A total of 46,876 papers were identified by searching 8 electronic databases.	Evidence from intervention (n=13), prospective (n=6), and cross- sectional (n=25) studies on correlates/determinants for SSB was quality assessed and synthesized.	The results of this comprehensive review show that SSB consumption in young children is influenced by factors operating at individual, interpersonal, and environmental levels, consistent with the socio-ecological theory.	Reports from 13 intervention studies were identified. Children's age ranges varied from early-infancy to 4–6 years old. Seven intervention studies used a behavior change theory, four of which showed a significant positive effect in favor of the intervention. Eight intervention studies targeted multi-level determinants of SSB consumption, of which four reduced SSB consumption. No interventions exclusively targeted child determinants of SSB consumption.	Duration of interventions varied from 8 weeks to 4 years, and post- intervention follow- up was either immediate (n=11), 6 months (n=1), or 4 years (n=1).

environments in conjunction with counseling and education would produce the most lasting and meaningful effects.

Widespread dissemination of the clinical interventions identified in this review would require mobilizing both health care and community partnerships. Although motivational interviewing and family-based programs are initiated in the primary care setting, expansion of these programs would require additional support outside of daily clinical practice. Authors reported that lengthy health practitioner training, additional staff to recruit and motivate families, large group spaces, and interdisciplinary collaboration were all critical to demonstrating program effectiveness. They also noted that incentives and convenient scheduling were needed to motivate families to participate (22,24). Studies of enhanced EHR and communication tools cited barriers such as cost of implementation, difficulty obtaining reimbursement for services, and the additional time required for their access and use (29-32). Similarly, authors advocating for enhanced advocacy role for health care practitioners noted that PCPs would need time, training, resources, and institutional support to become more effective policy advocates (40).

Our review's intent was to identify effective childhood obesity interventions that could potentially be adopted by interested oral health professionals. Health care leaders have increasingly called on oral health professionals to take a role in addressing childhood obesity, similar to their efforts to address hypertension, diabetes, and tobacco use. Childhood obesity and poor oral health share common risk factors and disproportionately impact a population of at-risk children from low-income families and certain racial/ethnic groups (59,60). However the framework of a medical-oral health effort to address these diseases remains unclear and barriers would need to be addressed, such as the lack of integrated EHRs and interpreter services in many oral health settings and reimbursement for enhanced interventions. Further research is needed regarding the feasibility and impact of this collaboration (5).

Multi-disciplinary professional partnerships could enhance advocacy efforts for policy changes, such as healthy vending machines, and efforts to address SSB marketing and influence on research. Practitioners working with families to encourage the formation of healthy lifelong habits are in a position to effectively advocate on broad policy matters, such as access to healthy foods and water. Oral health professionals could partner with medical providers to ensure that professional organizations adopt strong conflict-of-interest standards to limit the influence of industry on research and policy-making. By disseminating identified effective practices more widely and working together, practitioners and policymakers have significant potential to create healthier futures for the children and families in our care.

Our review documents the effectiveness of multiple domains for primary care providers to address childhood obesity in their offices and professional practice. Strengths of this review include the comprehensive search and the novel framework of using inclusion criteria developed by a multi-disciplinary team of authors to view primary care interventions that might be integrated into oral health practice. The review has several limitations, including the use of English-language articles only, our inability to assess bias and the dependence upon many review articles that cited duplicating primary references.

Conclusion

- This scoping review provided evidence of effective primary care interventions to reduce childhood obesity including family-based programs, motivational interviewing, office-based practice tools, and interventions to influence local, community and professional policies.
- The review identified a lack of effective clinical programs targeting reduced consumption of SSBs by children and their families. Further research on effective programs is critically important.
- The widespread dissemination of the identified evidence-based practices by PCPs has the potential to significantly reduce rates of childhood obesity. Barriers would need to be addressed in order for sustainable programs to be widely available to patients.
- Research is needed to identify programs that demonstrate sustained reduction of unhealthy weights in children.
- Further research is also needed on the impact of language interpreters, EHR clinical decision support and low-literacy communication methods in addressing childhood obesity.
- Childhood obesity and poor oral health share many common risk factors and disproportionately impact a shared population of at-risk children. Many of the effective interventions for childhood obesity, such as motivational interviewing, office-based practice tools, and policy initiatives to support healthier environments have potential for widespread adoption within the oral health community.
- Health care practitioners from various disciplines have the potential to work together to influence societal issues impacting both childhood obesity and poor oral health and create healthier futures for children.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article.

