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Prevention and Management of Childhood Obesity and Its Psychological and Health Comorbidities

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Abstract

Childhood obesity has become a global pandemic in developed countries, leading to a host of medical conditions that contribute to increased morbidity and premature death. The causes of obesity in childhood and adolescence are complex and multifaceted, presenting researchers and clinicians with myriad challenges in preventing and managing the problem. This article reviews the state of the science for understanding the etiology of childhood obesity, the preventive interventions and treatment options for overweight and obesity, and the medical complications and co-occurring psychological conditions that result from excess adiposity, such as hypertension, nonalcoholic fatty liver disease, and depression. Interventions across the developmental span, varying risk levels, and service contexts (e.g.,

community, school, home, health care systems) are reviewed. Future directions for research are offered with an emphasis on translational issues for taking evidence-based interventions to scale in a manner that will reduce the public health burden of the childhood obesity pandemic.

Contents

1. INTRODUCTION

Influenced by genetics, biology, psychosocial factors, and health behaviors, overweight and obesity (OW/OB) in childhood is a complex public health problem affecting the majority of developed countries worldwide. The key contributors to obesity—poor diet and physical inactivity—are among the leading causes of preventable youth deaths, chronic disease, and economic health burden (Friedemann et al. 2012, Hamilton et al. 2018). Despite the urgent need to prevent childhood obesity and to intervene earlier to prevent excess weight gain in later developmental periods, few interventions have demonstrated long-lasting effects or been implemented at such a scale as to have an appreciable public health impact (Hales et al. 2018).

In this review, we describe the extent and nature of the childhood obesity pandemic, present conceptual and theoretical models for understanding its etiology, and take a translational-developmental perspective in reviewing intervention approaches within and across developmental

stages and in the various contexts in which childhood OW/OB interventions are delivered. We pay particular attention to co-occurring psychological conditions intertwined with OW/OB for children, adolescents, and their families as they relate to both development/etiology and to intervention. For this reason, our review begins with interventions aimed at prevention and moves to management and treatment options for obesity and its psychological and medical comorbidities. Then, we discuss the state of the science and expert recommendations for interventions to prevent and manage childhood OW/OB and the resources and methods needed to implement current evidence-based programs at scale. We end by discussing identified gaps in the literature to inform future directions for research and the translation of research findings to real-world practice that can curb the pandemic. For readability, we use the term "interventions for the prevention and management of childhood OW/OB" to capture an array of approaches referred to by a variety of monikers in the literature, including primary prevention, prevention of excess weight gain, weight loss intervention, weight management, and treatment.

2. EPIDEMIOLOGY OF CHILDHOOD OBESITY

Childhood OW/OB is determined by a child's height and weight to calculate body mass index (BMI), which is adjusted according to norms based on the child's age and gender. BMI between the 85th and 94th percentiles is in the overweight range, whereas BMI ≥95th percentile for age and gender is in the obese range (CDC 2018). In 2013, rates of obesity among children and adolescents in developed countries worldwide were 12.9% for boys and 13.4% for girls (Ng et al. 2014). In the United States from 1999 to 2016, 18.4% of children aged 2–19 years had obesity, and 5.2% had severe obesity, defined as BMI ≥120% of the 95th percentile for age and gender (Skinner et al. 2018). The prevalence of obesity increased between 2011–2012 and 2015–2016 in children aged 2–5 and 16–19 years (Hales et al. 2018). Being in the obese range during childhood or adolescence makes children and adolescents five times more likely to be obese in adulthood compared with peers who maintain a healthy weight (Simmonds et al. 2016). Compared with obesity, severe obesity is strongly linked to greater cardiometabolic risk, adult obesity, and premature death (Skinner et al. 2015).

OW/OB and its health consequences are disproportionately distributed across the United States with a higher prevalence among children of disadvantaged racial and socioeconomic backgrounds. Rates of OW/OB are significantly higher among non-Hispanic black and Hispanic children compared with non-Hispanic white children (e.g., Hales et al. 2018). Such disparities are particularly pronounced in severe obesity: 12.8% of African American children and 12.4% of Hispanic children have severe obesity compared with 5.0% of non-Hispanic white children (Hales et al. 2018). Youth in low–socioeconomic status (SES) households are more likely to develop OW/OB compared with their counterparts in high-SES households. In 2011–2014, 18.9% of children aged 2–19 living in the lowest-income group (≤130% of the Federal Poverty Level) had obesity, whereas 10.9% of children in the highest-income group (>350% of the Federal Poverty Level) had obesity (Ogden et al. 2018). Influences on multiple socioecological levels put racial/ethnic minority children of low SES at higher risk of developing OW/OB. Risk of OW/OB is further exacerbated by limited access to health services that can prevent excess weight gain and its sequelae.

3. ETIOLOGY OF CHILDHOOD OBESITY

Childhood OW/OB emerges from consuming more calories than expended, resulting in excess weight gain and excess body fat. Caloric imbalance is the result of, and can be further exacerbated

by, a range of obesogenic behaviors (i.e., behaviors that are highly correlated with excess weight gain). The most common obesogenic behaviors are high consumption of sugar-sweetened beverages and low-nutrient, high–saturated fat foods; low levels of physical activity and high levels of sedentary behaviors; and shortened sleep duration (see, e.g., Sisson et al. 2016). Diet, physical activity, screen time, and sleep patterns are influenced by a myriad of factors and interactions involving genetics, interpersonal relationships, environment, and community (see, e.g., Russell & Russell 2019, Smith et al. 2018c). Children living in the United States commonly consume the Western diet, which is high in calories, sugars, trans and saturated fats, salt, and food additives and low in complex carbohydrates and vitamins. Poor sleep patterns, characterized by short duration and late onset of sleep, can contribute to obesity through changing levels of appetite-regulating hormones and irregular eating patterns, such as late-night snacking (Miller et al. 2015). Children who experience shortened nighttime sleep from infancy to school age are at increased risk of developing OW/OB compared with same-aged children who sleep the average, age-specific numbers of hours (see, e.g., Taveras et al. 2014). Research indicates that children with higher rates of screen time also consume high levels of energy-dense snacks, beverages, and fast food and fewer fruits and vegetables, and screen time is hypothesized to affect food and beverage consumption through distracted eating, reduced feelings of satiety (i.e., fullness), and exposure to advertisements for junk food (sweet and salty, calorically dense foods) (Robinson et al. 2017). Screen time can also negatively affect children's sleeping patterns and is correlated with sedentary behaviors (e.g., watching television, playing video games) (Hale & Guan 2015).

3.1. Conceptual Models for Understanding and Addressing Childhood Overweight and Obesity

Childhood OW/OB develops through the interplay of genetic, biological, psychological, behavioral, interpersonal, and environmental factors (Kumar & Kelly 2017). OW/OB interventions are typically designed to account for these multilevel factors to assist children in meeting expert recommendations for physical activity and fruit and vegetable consumption while limiting sugar-sweetened beverage intake and screen time and regulating sleep patterns (Kakinami et al. 2019). Creating behavioral change requires an understanding of the multilevel interactions to identify opportunities for intervention to prevent excess weight gain in the long term. Numerous conceptual models exist to explain potential interactions and individual influences that lead to obesogenic behaviors and development of childhood OW/OB and to identify targets for improving health behaviors and routines. Basic science and conceptual models can be translated to develop effective, targeted intervention programs for prevention of excess weight gain.

3.1.1. Biopsychosocial model. The biopsychosocial model combines biological foundations in child development with environmental and psychosocial influences to identify and address mechanisms and processes to prevent and manage development of childhood OW/OB (Russell & Russell 2019). This model features biological factors (e.g., genetics) alongside environmental, psychosocial, and behavioral risk factors (e.g., family disorganization, parenting skills, feeding practices, child appetite, temperament) and the development of self-regulation. Such an approach can illustrate developmental processes interacting with biological underpinnings that can be targeted in prevention and management interventions for OW/OB. Intervening from a biopsychosocial model involves behavioral and cognitive behavioral therapy to reframe thoughts and replace unhealthy eating behaviors with new habits.

3.1.2. Ecological systems theory. Ecological systems theory (EST) embeds individual development and change within multiple proximal and distal contexts and emphasizes the need to

understand how an ecological niche can contribute to the development of specific characteristics and how such niches are embedded in more distal contexts (Davison & Birch 2001). For example, a child's ecological niche can be the family or school, both of which are embedded in larger social contexts, such as the community and society. Individual child characteristics (e.g., gender, age) interact within and between the family and community context levels, all of which influence development of OW/OB. The EST model presents various predictors of childhood OW/OB through identifying risk factors moderated by intraindividual child characteristics. The structure of the EST is present in various studies that examine the influence of community exposures and children's individual attributes on weight outcomes.

3.1.3. The Six C's model. The Six C's is a developmental ecological model that includes environmental (family, community, country, societal), personal, behavioral, and hereditary influences and a system for categorizing environmental influences, all of which can be adapted to each stage of child development from infancy to adolescence (Harrison et al. 2011). The Six C's stand for cell, child, clan, community, country, and culture, which respectively represent biology and genetics, personal behaviors, family characteristics, factors outside of the home including peers and school, state- and national-level institutions, and culture-specific norms. Each C includes factors that contribute to child obesity and that occur and interact simultaneously throughout child development. For example, among preschool-aged children, obesity-predisposing genes (cell), excessive media exposure (child), parent dietary intake (clan), unhealthful peer food choices (community), national economic recession (country), and oversized portions (culture) are all obesity-associated factors that can occur simultaneously and interact during this developmental stage.

3.1.4. The developmental cascade model of pediatric obesity. The model described in Smith and colleagues' (2018b) article offers a longitudinal framework to elucidate how the cumulative consequences and spreading effects of multiple risk and protective factors, across and within biopsychosocial spheres and phases of development, can propel children toward OW/OB outcomes. The cascade model of pediatric obesity (**Figure 1**) was developed using a theory-driven model-building approach and a literature review to identify empirically based paths and relationships in the model. The model allows for multiple pathways and interactions between different combinations of variables and constructs that contribute to pediatric obesity (equifinality), identifying multilevel risk and protective factors from the prenatal stage to adolescence. The model focuses on intra- and interindividual child processes and mechanisms (e.g., parenting practices) while acknowledging that individuals are embedded within broader ecological systems. On the basis of Smith and colleagues' (2018b) study, St. George et al. (2020) conducted a systematic review of the intervention literature to elucidate how the developmental cascade model of childhood obesity can inform and is informed by intervention approaches for childhood OW/OB.

3.2. Psychosocial Contributors

Consistent with a biopsychosocial perspective on childhood obesity, influences on OW/OB in childhood extend beyond genetics, metabolism, and other biological factors. Among the more proximal contributors to OW/OB in childhood are the mental and physical health of the biological mother; the mental health of the child; interactions with peers and family members that can result in stigmatization and bullying; and family functioning and the home environment, which include parenting, family management, and family health routines, among other factors.

3.2.1. Maternal mental and physical health. An emerging body of literature shows a significant relationship between higher levels of parental stress and youths' higher weight status and

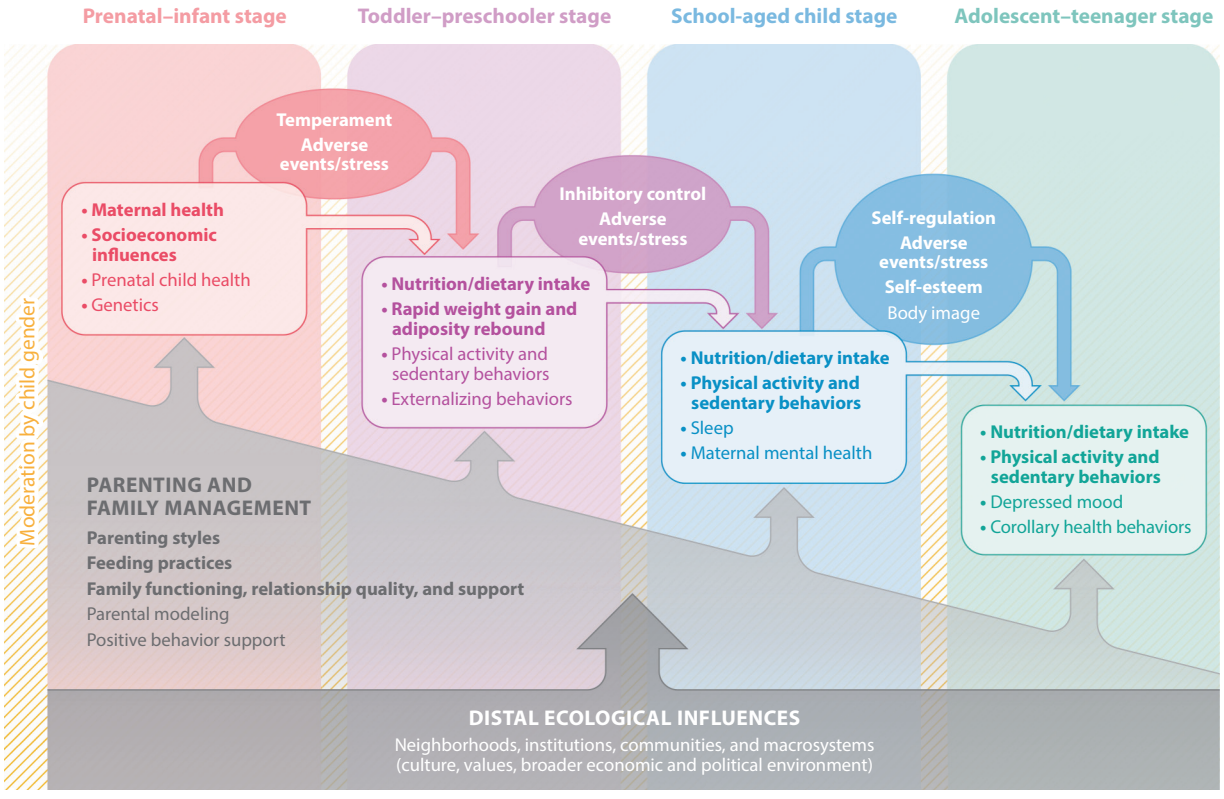

Figure 1

Developmental cascade model of pediatric obesity. Bold text indicates strongest support as indicated by a review of the literature. Figure adapted from Smith JD, Egan KN, Montaño Z, Dawson-McClure S, Jake-Schoffman DE, et al. (2018). A developmental cascade perspective of paediatric obesity: conceptual model and scoping review. *Health Psychol. Rev.* 12(3):271–93. Adapted with permission of the publisher (Taylor & Francis Ltd., **http://www.tandfonline.com**).

unhealthy lifestyle behaviors (Tate et al. 2015). In a prospective study, Stout et al. (2015) found that fetal exposure to stress, as evidenced by elevated maternal cortisol and corticotropin-releasing hormone, was related to patterns of increasing BMI during the first 24 months of life. Children whose mothers had experienced psychological distress and anxiety during pregnancy had higher fat mass, BMI, subcutaneous and visceral fat indices, liver fat fraction, and risk of obesity at age 10 years compared with children whose mothers had not (Vehmeijer et al. 2019). Early stress can have long-lasting effects; a nationally representative cohort study showed that postnatal maternal stress during the first year had a positive longitudinal relationship with children's BMI up to age 5 years (Leppert et al. 2018), and psychological distress at age 5 was associated with risk of obesity at age 11 in another nationally representative cohort (Hope et al. 2019). Isasi et al. (2017) found an increased likelihood of childhood obesity among Hispanic children and adolescents whose caregivers reported three or more chronic stressors compared with those whose parents reported no chronic stressors. In a systematic review assessing the impact of maternal stress on children's weight-related behaviors, S.G. O'Connor et al. (2017) found mixed evidence for the relationship specific to dietary intake; however, researchers found consistent evidence for the detrimental impact on youths' physical activity and an increase in sedentary behavior, which was often conceptualized as screen time. Highly stressed parents may rely more on convenient fast-food options

versus grocery shopping and preparing fresh and healthy meals and may not have the energy or wherewithal to support their children's physical activity or set limits on their children's screen time.

One of the few studies that used a longitudinal design did not replicate the relationship between high parental stress and lower levels of youth physical activity, but the relationship held for high levels of parental stress and increased fast-food consumption (Baskind et al. 2019). This study observed an interaction effect on the relationship between high parental stress and childhood obesity only in low-income households and among ethnic minority children—specifically, non-Hispanic black children—explaining the way in which the interaction between parental stress and SES contributes to health disparities for childhood obesity rates in the United States. In another study using a large, prospective cohort, Shankardass et al. (2014) found a significant effect of parental stress on BMI. The researchers also observed a significantly larger effect among Hispanics versus the total sample population and further noted that the relationship was weaker and not statistically significant among non-Hispanic children. Because of the salient role of caregiver stress on child health behaviors, interventions for childhood OW/OB should incorporate stress reduction strategies for parents while simultaneously focusing efforts on reaching racial/ethnic minority families and the economically disadvantaged.

Maternal mental health, most commonly assessed in terms of depressive symptoms and diagnosis of depression, is related to children's risk of OW/OB. In a study by Benton et al. (2015), the longitudinal effects of postnatal maternal depressive symptoms predicted obesity risk in preschool-aged children as well as less healthful lifestyle behaviors, such as high television-viewing time and low levels of physical activity. In another study, children of mothers with severe depression were more likely to be obese compared with children of mothers with fewer symptoms (Marshall et al. 2018). Maternal mental health also may negatively affect child-feeding behaviors; for instance, elevated depressive symptoms in low-income mothers have been associated with increased use of feeding to soothe children (Savage & Birch 2017). To date, few interventions for childhood obesity have specifically targeted caregiver depression, but some protocols have provided guidance to engage caregivers in services to manage depression and related stressors (Smith et al. 2018b).

3.2.2. Child mental health. Poor self-regulation and related constructs such as reactivity and impulsivity are prospective obesogenic risk factors (Bergmeier et al. 2014, Smith et al. 2018c). A child's temperament describes behavioral tendencies in reactivity and self-regulation. Negative reactivity is characterized by a quick response with intense negative affect and is difficult to soothe. Infants and children with negative reactivity are at high risk of excess weight gain and of obesity later on, and toddlers with low self-regulation and inability to control impulses or behavior are at increased risk of obesity and rapid weight gain over the subsequent 9 years compared with toddlers with higher self-regulation abilities (Graziano et al. 2013). Poorer emotional self-regulation at age 3 is an independent predictor of obesity at age 11 (Anderson et al. 2017). In contrast, the ability to delay gratification at age 4 is associated with lower BMI 30 years later (Schlam et al. 2013). It is possible that parents of children with difficult temperament experience challenges effectively managing their children's behaviors and setting limits, leading to irregular health routines and increased obesity risk (Bergmeier et al. 2014, Smith et al. 2018c). Further, some parents overuse food and feeding to soothe children (Anzman-Frasca et al. 2012). Throughout childhood, emotional regulation deficits and other mental health disorders continue to predict obesity and weight gain. Emotional regulation in conjunction with stress during childhood is highly linked to low physical activity, emotional eating, irregular and disrupted sleep, and later development of obesity (Aparicio et al. 2016). A longitudinal study examining emotional psychopathology in preadolescence saw that boys diagnosed with a social phobia, panic disorder, or dysthymia (persistent depressive disorder)

had higher waist circumference and/or BMI, and girls diagnosed with dysthymia had increased waist circumference at 3-year follow-up (Aparicio et al. 2013). In a prospective study, overweight children who reported binge eating at ages 6–12 years gained 15% more fat mass during a period of 4 years compared with overweight children with no binge eating (Tanofsky-Kraff et al. 2006). The presence of mental health problems can be costly and burdensome as they exacerbate physical health conditions and subsequent comorbidities. Children with obesity-related health conditions (e.g., type 2 diabetes, metabolic syndrome) and a comorbid psychiatric diagnosis (e.g., depressive mood disorder, bipolar disorder, attachment disorder) have higher health care utilization and costs per year compared with children without a comorbid psychiatric diagnosis (Janicke et al. 2009a).

There is an association between OW/OB and depression in childhood and adolescence, but there is mixed evidence of the directionality of this effect among children and adolescents. In a review of high-quality studies, Mühlig et al. (2016) found that among nine studies examining the influence of depression on weight status, six showed no significant influence. Of the studies that reported significant associations, one study saw effects only among female adolescents, another showed effects only for male adolescents, and a third showed effects of adolescent depressive symptoms on adult obesity at age 53 years only in women. Conversely, OW/OB status can have a significant influence on risk of low self-esteem and depressive symptoms and/or diagnosis in adolescence, as discussed in Section 6.2.1.

3.2.3. Stigma and bullying. Weight-related stigma is subtle or overt discrimination against individuals with obesity. When directed toward children with obesity, this stigma can impair quality of life and contribute to unhealthy behaviors that can worsen obesity, such as social isolation, decreased physical activity, and avoidance of health care services (Pont et al. 2017). Unfortunately, stigma is widespread and tolerated in society, furthering the reach of negative harm. Children with obesity face explicit weight bias and stigma from multiple environments including from parents, obesity researchers, clinical settings, and school. Parents demonstrate not only implicit bias against childhood obesity but also implicit and explicit biases against children with obesity (Lydecker et al. 2018). Even among obesity researchers and health professionals, significant implicit and explicit antifat bias and explicit antifat attitudes increased between 2001 and 2013 (Tomiyama et al. 2015). Exposure to stigma and weight bias can have damaging psychosocial effects on children, such that stigma can mediate the relationship between BMI, depression, and body dissatisfaction (Stevens et al. 2017).

Weight stigma can also prompt bullying and weight-related teasing, which can have serious psychological consequences among children, such as depression, further weight gain, and decreased motivation to change. A nationally representative sample of children aged 10–17 years saw that OW/OB adolescents were at higher odds of being victims of bullying as well as higher odds of perpetrating bullying and victimizing others (Rupp & McCoy 2019). The children at higher odds of engaging in bullying or of being bullied were also at significantly higher odds of having depression, difficulty making friends, and conduct problems compared with OW/OB adolescents who were not bullies or victims of bullying. The relationship between obesity and bullying needs to be addressed through bullying engagement and development of coping skills for victimization to prevent and manage associated behavioral and depressive symptoms.

3.2.4. Family functioning and home environment. Evidence suggests links among general family functioning, parent–child relationships, communication, and use of positive behavior support strategies and childhood OW/OB (see Smith et al. 2017a). Influence of general parenting styles, as opposed to the more specific feeding styles, has been extensively studied and linked to children's diet, physical activity, and weight (Shloim et al. 2015). Children raised with an

authoritative (warm and demanding) parenting style had healthier diet, higher physical activity levels, and lower BMI than those raised with the other styles (Sleddens et al. 2011). Parents' proactive structuring of home environments to support and positively reinforce healthy dietary and physical activity behaviors also plays a key role in children's healthy lifestyles (Smith et al. 2017b). Exposure to less supportive environments (characterized by family stress, father absence, maternal depression, confinement, and unclean home environments) at 1 year of age has been associated with high BMI at age 21 (Bates et al. 2018). Taken together, family participation and development of positive parenting skills can play a salient role in the prevention of childhood OW/OB (Pratt & Skelton 2018, Wen et al. 2011).

4. PREVENTION AND MANAGEMENT OF OVERWEIGHT AND OBESITY

This section discusses the state of the science in childhood OW/OB prevention and management along with salient factors related to the implementation of prevention and management strategies in varied health care delivery systems. The current climate is being shaped by the position of the American Medical Association. In 2013, the American Medical Association voted to classify obesity as a disease that requires medical attention. This classification aimed to emphasize health risks of obesity, remove individual blame, and create new implications and opportunities for intervention. This classification can help to further (*a*) a broader public understanding of the obesity condition and associated stigma, (*b*) prevention efforts, (*c*) research for treatment and management, (*d*) insurance reimbursement for intervention, and (*e*) medical education (Kyle et al. 2016). In primary health care settings specifically, the US Preventive Services Task Force (USPSTF) gave childhood obesity screening and family-based intervention a B grade for evidence of effectiveness (USPSTF 2017), which was sufficient to open new insurance reimbursement streams for activities related to the prevention and management of childhood OW/OB. Reimbursement has been a significant barrier to uptake of effective interventions, and the impact of the USPSTF in removing this impediment is not yet fully known.

A number of high-quality systematic reviews and meta-analyses have been published in recent years; these publications, which provide the most contemporary perspective on the effectiveness of interventions for prevention and management, also reveal wide variability and inconsistent findings. For example, Peirson et al. (2015a) observed that prevention interventions were associated with slightly improved weight outcomes compared with control groups in mixed-weight children and adolescents. However, intervention effects were not consistent among each intervention strategy tested. This finding suggests that specific characteristics of the interventions, such as setting, participants, dose, and tailoring, should be examined to determine what is and is not effective in achieving desired outcomes.

Intervention strategies for the prevention and management of child OW/OB occur in various contexts and within, and in coordination with, multiple service delivery systems. This is due in large part to the risk factors inherent to familial, school, and community/societal levels. For prevention in particular, there is some correspondence between the sample being targeted and the context, such that community- and school-based interventions are far more likely to be universal (sample does not consider weight status) or selective (target sample is overweight or specifically targeted because of obesity risk—e.g., ethnic minority, low income) compared with the indicated (majority of target sample is in the obese range) models more commonly found in primary and specialty health care systems. The specific intervention targets and behavior change strategies align with the context and approach (St. George et al. 2020).

4.1. Community Interventions

Community interventions incorporate policies and strategies to reduce the population risk of obesity through legislation, modifications to the built environment, provision of accessible resources, changes in economic incentives, reduced pricing, and food subsidies (Bleich et al. 2013). Community interventions can involve the use of media, businesses (e.g., restaurants), community health services, community gardens, community or recreational centers, city planning, and local governments (Karacabeyli et al. 2018). Interventions delivered in community settings can provide high degrees of access and exposure to strategies and programs to racial/ethnic minority, low-income children, who are at the highest risk of OW/OB. Interventions delivered in community settings can be effective, but the impact could be diminished through the lower likelihood of intervention completion due to living in lower socioeconomic circumstances and other obstacles (Fagg et al. 2015).

In a recent review, Bleich et al. (2018) found that fewer studies were conducted at the community level compared with other settings, such as the school or family level. This difference may be due to the numerous challenges and complications involved in building community capacity and engaging community leaders, stakeholders, community agencies, and city organizations. Alternatively, it could reflect a greater focus to date on other contexts and intervention targets, which we discuss in the following sections. To address effectiveness and sustainability, a combined clinical and community intervention could hold promise, especially for racial/ethnic minority children living in low-income communities, who are most at risk. A study by Hoffman et al. (2018) showed that an integrated clinic–community model is feasible and improves physical activity and quality of life compared with multidisciplinary treatment provided only in clinical care settings.

To summarize, there is promise in community-based interventions that involve either the health clinic and community partnerships or community and school partnerships. Interventions using a community-based participatory approach and a strong quasi-experimental design could achieve the long-term goals of reducing both child BMI and the prevalence of OW/OB in childhood and achieving obesity remission in children (Economos & Hammond 2017).

4.2. School-Based Interventions

School-based interventions take place during school hours or after-school hours for children in kindergarten through high school and are focused exclusively in the school or delivered primarily in the school setting with secondary settings of family/home, primary care, or the community (Bleich et al. 2018). Considering that the majority of children spend a significant amount of their day in school, many preventive interventions have leveraged schools as an entry point to improve the obesogenic environment by, for instance, promoting more physical activity in physical education classes and recess, improving school playgrounds and nutritional options in school cafeterias, and providing healthy lifestyle education in classes (Ickes et al. 2014). Previous reviews (e.g., Wang et al. 2015) have recommended using multicomponent interventions targeting two or more health behaviors (e.g., physical activity, dietary outcomes, sedentary behavior) to improve adiposity outcomes compared with single-component interventions. Well-designed, school-based studies are effective in improving dietary behavior but typically do not show statistically significant differences in child BMI between intervention and control schools, except among children who are already in the obese range (Bogart et al. 2016). While increasing fruit, vegetable, and water consumption is important, these health behavior modifications are not sufficient for significant long-term obesity management. One way to address this issue is through partnerships between schools and community-based interventions that also engage parents. In a review, Ickes et al. (2014) found that less than half of childhood obesity interventions incorporated parents; of those studies involving parents, 75% demonstrated positive outcomes in reducing BMI or weight status. In a synthesis

of systematic reviews and meta-analyses of school-based interventions, long-term interventions with a combination of diet and physical activity components and family or parental involvement significantly reduced weight among children (Khambalia et al. 2012). Bleich et al. (2018) found that, consistent with previous research, school-based interventions that used a multicomponent approach of both physical activity and nutrition with some intervention with families in the home had the largest effects. A systematic review and meta-analysis by Wang et al. (2015) observed that strength of evidence of obesity prevention programs for children aged 2–18 years was dependent on intervention type and delivery setting(s). Strength of evidence was high for physical activity–only interventions delivered in school settings with home involvement and also for combined diet and physical activity interventions delivered in school settings with home and community involvement. Wang et al. also found moderately strong evidence in support of combined interventions in school-based settings alone, in schools with a home or community component, or in the community with a school component.

Bleich et al. (2018) reviewed a smaller number of preschool interventions and found some promise in both single-component interventions (focusing solely on physical activity) and multicomponent interventions. Two other reviews evaluating early child care center–based interventions both found promising evidence for multicomponent interventions and multiple levels influencing the child, parent, teachers/staff, and class (Sisson et al. 2016, Ward et al. 2017). In an exemplar study, Natale et al. (2017) conducted an early childhood multilevel obesity intervention that included menu modifications at the child care center, a nutrition and physical activity educational curriculum for preschoolers, and a healthy meal preparation and role modeling curriculum for parents. At 2-year follow-up, the researchers observed significantly less increase in BMI percentile among the intervention group versus controls. Overall, strong obesity prevention interventions in early care and education settings were associated with healthy eating and anthropometric outcomes, which were further improved by parental engagement. In sum, the preschool and school contexts hold promise for improving weight-related behaviors and adiposity outcomes; however, the evidence is clear that parents should be engaged in the process of supporting and reinforcing their children's health behaviors for these programs to be maximally effective (Ward et al. 2017).

4.3. Family-Based Interventions

The home environment (e.g., family routines, limit setting, household chaos, crowding) has long been considered one of the most powerful influences on children's healthy behaviors and OW/OB outcomes (Bates et al. 2018). Playing an integral role in physical activity, diet, screen time, and sleep, parents can exhibit positive parenting practices (e.g., limit setting, role modeling) and provide a healthy, supportive environment (e.g., providing fresh fruits and vegetables), thereby shaping their children's lifelong habits and preventing the onset of childhood obesity (for a review, see Smith et al. 2018c). Family-based interventions may involve either passive or active parental involvement, often with parents viewed as the primary or sole agents of change (Sung-Chan et al. 2013). Active parental involvement entails repeated engagement, such as participation in workshops, counseling, or educational sessions; passive involvement (e.g., reading brochures or newsletters) does not integrally involve the parent or guardian.

In a review evaluating family-based interventions for OW/OB prevention, Ash et al. (2017) found a significant increase in the number of family-based intervention studies: Just 6 studies were published in 2008 compared with 35 studies in 2013. The majority of studies employed rigorous randomized controlled trial (RCT) study designs (73%), but almost two-thirds of the studies were short-term and implemented for less than a year. A fraction of studies occurred in multiple settings, and over half targeted multiple components beyond diet and physical activity,

such as screen time or sleep. Many preventive studies targeting young children (prenatal to 5 years) tended to use home or primary care–based settings with parental involvement, whereas interventions targeting older children tended to take place in community- and school-based settings. These findings are consistent with the review of St. George et al. (2020), which showed a decrease in parental involvement and family-based intervention strategies with child age. This result dovetails with the conclusions of Kothandan (2014) that family-based interventions demonstrated effectiveness for children younger than 12 years but that for children aged 12 and older, school-based interventions were most effective in the short term.

Regarding preventive interventions specifically, most interventions have been tested among low-SES families and predominantly white families (Ash et al. 2017). Hispanics/Latinx have been well represented in US intervention studies compared with other ethnic minorities (i.e., African Americans, Asians, and indigenous groups). Latinx are particularly well suited to participate in family-based interventions given their cultural emphasis on familial values; however, a recent meta-analysis noted diminishing intervention effects with a higher proportion of Hispanic children (Ling et al. 2016). This finding was attributed to a lack of culturally competent interventions to address language barriers and dietary preferences. In addition to incorporating other ethnic minorities and culturally appropriate interventions, Ash et al. (2017) suggested that preventive family-based interventions should account for nontraditional families and their different needs and family dynamics.

Regarding family dynamics and interactions, poor family functioning has been linked to increased risk of obesity, obesogenic behaviors, and adverse health outcomes (see, e.g., Pratt & Skelton 2018). Family-based care for childhood OW/OB involves targeting dietary and physical activity behaviors along with the rules of the family unit, family health routines, communication, and dynamics (Pratt & Skelton 2018). Existing protocols involve family counseling for diet and physical activity change in the home environment; some approaches also target more general parenting and family management skills that have been found to affect children's OW/OB status (Smith et al. 2017b, 2018a,b). Interventions including both parents and children have shown more positive short- and long-term effects on child weight compared with parent-only interventions and controls in some studies (Yackobovitch-Gavan et al. 2018), whereas other studies have found comparable effects for parent-only and child-involved family-based approaches (Boutelle et al. 2017). Further, parent-only interventions have been shown to be more cost-effective (Janicke et al. 2009b). In a meta-analysis evaluating comprehensive behavioral family lifestyle interventions treating pediatric obesity, Janicke et al. (2014) found an overall standardized effect size (ES) of 0.47, which indicates a small to moderate effect on BMI. The dose of treatment (i.e., number of intervention sessions, minutes spent in treatment) was positively related to the treatment effect, which suggests that more intense and longer interventions are associated with better outcomes, a conclusion also made by Whitlock et al. (2010). In addition, age was a significant moderator for weight outcomes: Older children had larger and more beneficial intervention effects than younger children.

Specifically, family-based interventions targeting positive behavior support have been used to address key mechanisms of change specific to promoting children's healthy lifestyle behaviors (Smith et al. 2017b). Positive behavior support has been identified as a way to reduce weight gain through improving the caregiver's ability to support and work with the child toward a healthier diet and improved physical activity. A long-term prevention trial using a family-based intervention to target positive behavior support found that children randomized to the intervention had lower BMI in the years following participation (Smith et al. 2015). This finding was particularly promising because these trials did not explicitly focus on child weight in any way; prevention of childhood OW/OB was a spillover effect.

Given the various ways in which individual, interpersonal, and family health behaviors contribute to child obesity, a tailored family-based intervention could be effective in identifying specific family needs and providing appropriate resources. In a family-based tailored intervention, Taylor et al. (2015) found that the children of families randomized to the tailored treatment had significantly lower BMI compared with families in the usual care group. Children in the tailored treatment also had better dietary behaviors and were more physically active than children in the treatment-as-usual group. Smith et al. (2018b) adapted the highly effective and well-known, individually tailored, family-based prevention program called the Family Check-Up (Dishion et al. 2008) to specifically target obesogenic behaviors with the aim of preventing obesity and excess weight gain in children aged 2–12 years. This adaptation, referred to as the Family Check-Up 4 Health, is being tested in two large RCTs in coordination with pediatric primary care (Smith et al. 2018a) and with community-based family resource centers, public schools, and primary care (Berkel et al. 2019b) in low-income neighborhoods with racially/ethnically diverse families at highest risk for childhood OW/OB.

4.4. Primary Health Care

Primary care interventions are health promotion or weight management programs that are conducted within or in close coordination with the primary health care system. Primary care is viewed as an ideal, real-world environment for weight management interventions because of accessibility and frequency of visits (i.e., routine well-child visits) (Davis et al. 2007). In a meta-analysis evaluating weight management interventions delivered in primary care settings, Mitchell et al. (2016) found an overall ES of 0.26, which indicates a small treatment effect—smaller than has been found in broader meta-analytic reviews (e.g., Janicke et al. 2014, Whitlock et al. 2010). The dose–response relationship was significant: The number of treatment contacts, length of treatment in months, and number of visits with the pediatrician were associated with larger treatment effects.

In a systematic review examining RCTs targeting obesity management in children aged 2–5 years, five of six interventions, all in ambulatory health care settings, had significant decreases in child weight, with sustained intervention effects through follow-up (Ling et al. 2016). The effective interventions actively involved parents in health education, group meetings, physical activity sessions, and/or behavioral therapy.

4.5. Interventions by Developmental Period

In a review of interventions of OW/OB from birth to age 18 years, St. George et al. (2020) identified 74 distinct interventions reported across the 141 included articles. The interventions were categorized based on the child's age at entry into the intervention: prenatal/infancy (<2 years; $n = 4$), early childhood (2–5 years; $n = 11$), childhood (6–11 years; $n = 38$), early adolescence (12–15 years; $n = 18$), and late adolescence (16–18 years; $n = 3$). Developmental stage has also been found to align with the strategy, such that interventions in the prenatal and infancy periods are nearly all universal, whereas during childhood and adolescence, compared with early childhood, the burden of disease is larger, and intervention strategies more often target selected and indicated samples with greater intensity (St. George et al. 2020).

5. EXPERT RECOMMENDATIONS

5.1. Youth Health Behaviors

It is recommended that children and adolescents aged 6–17 years achieve ≥60 minutes of physical activity each day (Piercy et al. 2018). The 2015–2020 *Dietary Guidelines for Americans* recommend

consuming a variety of fruits and vegetables, whole grains, proteins, and low-fat dairy products and limiting intake of sodium, solid fats, and added sugars beginning at age 2 years (DeSalvo et al. 2016). Unfortunately, only 21.6% of children aged 6–19 years reach the recommended 60 minutes of physical activity at least 5 days per week (NPAPA 2018). Dietary quality affects weight gain and OW/OB, and it is estimated that the obesity epidemic has largely contributed to statistics showing a declining life expectancy, which occurred in 2015 for the first time in 30 years (Ludwig 2016).

The American Academy of Pediatrics (AAP) recommends that children under 18 months have no screen time aside from video chatting; children aged 2–5 years may watch high-quality programs with parents for 1 h/day. Children aged 6 and above should have limited media exposure ($\leq$2 h/day), which should not interfere with sleep, physical activity, or other health behaviors. The AAP recommends that families should have "media-free" time together and should establish "media-free" locations, such as the dining room or bedroom, to avoid interfering with meals and sleep duration (Am. Acad. Pediatr. Counc. Commun. Media 2016). The World Health Organization, which asserts that screen time brings no benefit to children, recommends that infants younger than 1 year have no electronic screen exposure and that children aged 2–4 years have no more than 1 h/day of "sedentary screen time." In recent years, the portability of screen devices has led to an overall increase in screen time, with the majority of US youth exceeding screen time guidelines by a wide margin (averaging more than 7 h/day) (Barnett Tracie et al. 2018).

The most recent AAP guidelines recommend that children aged 1–2 years sleep 11–14 h per 24 h, children aged 3–5 sleep 10–13 h, children aged 6–12 sleep 9–12 h, and teenagers aged 13–18 sleep 8–10 h (Paruthi et al. 2016). Certain behaviors, such as a regular routine, avoiding large meals close to bedtime, being physically active during the daytime, and eliminating electronic devices in the bedroom, are associated with better sleep (Irish et al. 2015). According to the Centers for Disease Control and Prevention (CDC), 60% of middle schoolers and 70% of high schoolers do not meet regular sleep recommendations.

5.2. Behavioral Intervention

Family-based intervention is recommended by the National Academy of Medicine, the AAP, and the Endocrine Society, among others, as the preferred approach for the management of OW/OB from infancy to adolescence. Based on a systematic review, the USPSTF concluded that lifestyle-based weight loss interventions (not necessarily family-based) consisting of 26 or more hours of intervention engagement are likely to assist children and adolescents in weight management (E.A. O'Connor et al. 2017). Recommendations from a number of expert committees and task forces support targeting the following behaviors for prevention and management of childhood OW/OB: limiting consumption of sugar-sweetened beverages, consuming daily recommended fruit and vegetables, limiting screen time, increasing physical activity, eating breakfast, limiting eating out at restaurants, encouraging family meals, and limiting portion sizes. The majority of existing interventions target multiple behaviors, but some have been designed for discrete behaviors.

5.3. Pharmacologic Intervention

Orlistat is the only US Food and Drug Administration–approved medication for treating obesity in pediatric patients aged 12 years and older. Side effects in the gastrointestinal area are common in children, and further clinical trials are needed to evaluate medication risk and benefits among pediatric patients (Chao et al. 2018). Expert opinion indicates that orlistat, in conjunction with lifestyle changes, leads to modest weight loss and could benefit children in the indicated age range with obesity, but tolerability limits its use (Kelly & Fox 2018). Furthermore, results

are not unequivocal. In a meta-analysis looking at primary care–based interventions, Peirson et al. (2015b) found a medium effect (standardized ES = −0.54) favoring behavioral interventions compared with orlistat plus behavioral intervention components (ES = −0.43). Additional research is needed on both effectiveness and tolerability in youth. New pharmacologic options continue to be developed and tested and could reach the market in the next few years if approval is granted (Kelly & Fox 2018).

5.4. Surgical Intervention

The American Society for Metabolic and Bariatric Surgery Pediatric Committee's best practice guidelines selection criteria are based on systematic reviews of comorbidities, risks and outcomes, important team members, and patient selection. The guidelines recommend that adolescents being considered for a bariatric procedure should have a BMI of $\geq$35 kg/m^2 with major comorbidities such as type 2 diabetes mellitus, moderate to severe sleep apnea, or severe nonalcoholic steatohepatitis (Michalsky et al. 2012). Data show that bariatric surgery in morbidly obese adolescents can greatly influence weight loss and attenuate or resolve associated chronic disease. However, adolescents undergoing bariatric surgery should be assessed for their capability to adhere to follow-up care regimens to ensure proper nutrition intake and care. The committee also recommends a multidisciplinary team for adolescents undergoing bariatric surgery, which could include an experienced bariatric surgeon, pediatric specialist, registered dietitian, mental health specialist, care coordinator, and exercise physiologist.

6. CLINICAL IMPLICATIONS OF CO-OCCURRING MEDICAL AND PSYCHOLOGICAL CONDITIONS

6.1. Co-Occurring Medical Conditions

The proinflammatory disease nature of obesity and contributing health behaviors affects normal physiology and metabolism and can cause many associated diseases (González-Muniesa et al. 2017). If left untreated, obesity can lead to serious health conditions including type 2 diabetes, cardiovascular disease, asthma, obstructive sleep apnea (OSA), high blood pressure/hypertension, nonalcoholic fatty liver disease (NAFLD), hepatocellular carcinoma, and psychosocial problems (see, e.g., Nobili et al. 2015). Recent research indicates that being in the obese BMI range in childhood or adolescence is associated with increased risk of cardiovascular disease incidence, morbidity (ischemic heart disease, stroke), and mortality in adulthood (Sommer & Twig 2018). Obesity prevention and management interventions in childhood are imperative for averting the burden of associated comorbidities.

6.1.1. Type 2 diabetes. Children with obesity are four times as likely to develop type 2 diabetes compared with children with a normal BMI (Abbasi et al. 2017). Ethnic minority children of low income are at increased risk and have limited maintenance and glycemic control, furthering the probability of developing additional health complications down the line (Pulgaron & Delamater 2014). Metformin is the main treatment for type 2 diabetes in youth and adults, though emerging evidence implicates a role in treating children with obesity and a family history of type 2 diabetes (see, e.g., Warnakulasuriya et al. 2018). Exercise and lifestyle interventions have had significantly positive health effects in adults, but trials evaluating effects in youth with type 2 diabetes are limited. Given the data from adult trials, the American Diabetes Association recommends that youth with type 2 diabetes meet the goal of 1 h/day of physical activity to manage symptoms and decrease health risks (Colberg et al. 2016).

6.1.2. Obstructive sleep apnea. OSA is disrupted breathing due to partially or completely blocked upper airways during sleep (Narang & Mathew 2012). Obesity confers the most significant risk for OSA. As many as 60% of children and adolescents with obesity have OSA or some sort of disrupted breathing during sleep (Narang & Mathew 2012). Obesity and OSA have additional comorbidities and impairments including excessive daytime sleepiness, neurocognitive function, reduced physical activity, cardiovascular burden, and hypertension, further complicating quality of life for children with obesity (Blechner & Williamson 2016). Obesity management strategies such as increased physical activity and a healthy diet are recommended for OSA treatment, as are surgical procedures when appropriate.

6.1.3. Asthma. Asthma is one of the most common chronic diseases among children and adolescents: 10.1% of children aged 5–14 years had asthma in 2016 (NCHS 2019). Although both obesity and asthma rates have been increasing, obesity does not appear to have contributed to the increased asthma prevalence rate (Akinbami et al. 2018). This does not discount the risks of obesity on asthma and its unique effects on asthma symptoms. OW/OB children have a higher prevalence of asthma compared with normal-weight children and may have exacerbations as early as preschool age (Lang et al. 2018). OW/OB children also have reported distinct asthma symptoms, such as greater shortness of breath, reduced airway hyperresponsiveness, and loss of asthma control, compared with normal-weight children (Lang et al. 2015). The relationship between asthma and OW/OB should be further investigated.

6.1.4. Hypertension. Hypertension, like obesity, has been increasing among youth and is associated with increased cardiovascular disease risk throughout the lifetime (May et al. 2012). The greatest risk factor for pediatric hypertension is elevated BMI (Falkner et al. 2006). About 3% of children in the general population have hypertension compared with about 25% of obese children (Shatat & Brady 2018). In a meta-analysis examining cardiovascular risk factors, systolic blood pressure was higher by 4.54 mm Hg ($n = 12{,}169$; 8 studies) in overweight children and by 7.49 mm Hg ($n = 8{,}074$; 15 studies) in obese children compared with normal-weight children (Friedemann et al. 2012). A study examining childhood hypertension and OW/OB in schoolchildren found that 2.2% of the sample had hypertension, and 37% of those cases could be attributed to OW/OB status (Chiolero et al. 2007). According to a review by Wuhl (2019), children with obesity-related hypertension are at increased risk of cardiovascular morbidity and mortality. Between 3.8% and 24.8% of children with OW/OB have hypertension, though the actual prevalence could be higher because of inconsistencies and challenges with diagnoses (Flynn et al. 2017). The risks of hypertension on children's lifetime health indicate the importance of preventing obesity early on.

6.1.5. Nonalcoholic fatty liver disease. NAFLD is the leading cause of liver disease and is associated with shorter life expectancy due to associated comorbidities; one such comorbidity, nonalcoholic steatohepatitis, is projected to be the leading indication for pediatric liver transplant by 2025 (Charlton et al. 2011). Epidemiological studies consistently show associations between NAFLD and adiposity, unhealthy diet, and sedentary behavior (Dunn & Schwimmer 2008). Prevalence of NAFLD is especially high in young people who have obesity: 22.5–52.8% of children with obesity have NAFLD compared with 2.6% of all children (Anderson et al. 2015). Child obesity is the greatest risk factor for the development of NAFLD during childhood (Hays & McGinnis 2018). In a longitudinal study, in which participants aged 3–18 years were followed for 31 years, child OW/OB was associated with increased risk of adult NAFLD (Cuthbertson et al. 2019). The associated risk was removed if participants obtained a normal-range BMI by adulthood—a finding

that emphasizes the salient role of weight management. The high prevalence of NAFLD among children with obesity and the effectiveness of weight change in treating this condition indicate the need for prevention and management of obesity. Smith et al. (2017a) found that among children who had NAFLD, poorer family functioning was significantly related to higher BMI, cholesterol (LDL but not HDL), HbA1c, and glucose levels. Their study exposed the critical role of family functioning on child health and the importance of using targeted interventions to prevent and manage obesity and associated diseases using a family-centered approach. Because weight is the most modifiable factor, the mainstay of NAFLD treatment is lifestyle behavior modifications aimed at weight loss (Marchesini et al. 2016).

6.2. Co-Occurring Psychological Conditions

The literature shows that in addition to co-occurring medical conditions, psychological conditions can result from excess weight in childhood. The most predominant of these in childhood are low self-esteem, depression, and eating disorders.

6.2.1. Low self-esteem and depression. Children with OW/OB are more likely to experience low self-esteem and develop depressive symptoms during adolescence compared with normal-weight peers (see, e.g., Mühlig et al. 2016). This relationship can be attributed to multilevel factors including health behaviors, parenting styles, and family functioning. A review by Hoare et al. (2014) suggested that obesogenic risk factors, such as infrequent physical activity, sedentary behavior, poor diet quality, and adiposity, are associated with depressive symptoms in adolescents. Conversely, healthier eating patterns are associated with decreased depressive symptoms. Child eating disorder pathology, emotionally manipulative parenting style, and lower child social status have been associated with depressive symptomatology among children with OW/OB (Sheinbein et al. 2019). Children in poorly functioning families with low self-esteem participating in weight loss interventions have been observed to have poor 6-month outcomes; this finding suggests that multiple social-ecological factors need to be addressed when targeting depressive symptoms in children with OW/OB (Taylor et al. 2017). Further, negative psychological experiences more generally, such as trauma and stigma, can trigger emotional eating and lead to an ongoing obesity–depression cycle (Milaneschi et al. 2019).

6.2.2. Eating disorders. Children with OW/OB have a high prevalence of disordered eating attitudes and behaviors, which can increase risk of developing eating disorders in adulthood. A high proportion of adolescents with restrictive eating disorders report a history of OW/OB (Lebow et al. 2015), and it is estimated that over a quarter of youth with OW/OB have binge and loss-of-control eating (He et al. 2017). Adolescent girls with OW/OB experiencing overvaluation of weight—that is, being so concerned with weight that self-evaluation is influenced—are at higher risk of starting to binge eat weekly 2 years later, tend to have more severe depressive symptoms, and are more likely to engage in continuous overvaluation (Sonneville et al. 2015). The bidirectional relationship of obesity and eating disorders, including eating disorder psychopathology, should be properly evaluated during treatment planning.

7. IMPLEMENTATION AND RESEARCH TRANSLATION CHALLENGES

One major challenge for the field is the translation and implementation of effective interventions to the real-world service delivery systems that can reach those most in need. This so-called research–practice gap is pronounced in obesity prevention and management because of the preponderance of untested, usual care approaches currently in use; the persistence of debunked

myths about causes and effective intervention approaches (e.g., fad diets); and the incongruence between what is being developed by experts and what is acceptable, feasible, and sustainable in existing systems given the constraints of the workforce, space, and funding. An additional challenge concerns the absence of the perspectives and preferences of consumers of evidence-based interventions, who historically have had only cursory involvement in the design and deployment of interventions. This gap has contributed to low engagement rates and high attrition from more intensive OW/OB interventions (Hampl et al. 2011). Raising public and caregiver concern about the risks posed by OW/OB in childhood and adolescence would also facilitate engagement and retention. Currently, many parents of children with obesity underestimate their children's weight (Lydecker & Grilo 2016) and are thus unlikely to seek intervention or to follow through after receiving a referral for intervention. Given this issue as well as the stigma in society surrounding obesity and the shame parents experience concerning their children's weight, traditional approaches to care will likely continue to be underused.

While many of the aforementioned conceptual models encapsulate the multiple levels contributing to childhood obesity, researchers are trying to elucidate which combination of levels and service contexts has the greatest effectiveness and which implementation strategies best address the complexity at the levels of the community, school, family, and primary care. Implementation strategies are the methods or techniques used to enhance the adoption, implementation, and sustainability of a clinical program or practice (Proctor et al. 2013). They are the actions taken on agents in the system of care itself and rarely only on the patient or client who is the recipient of the clinical program or practice. The first iteration of the CDC's Childhood Obesity Research Demonstration (CORD) Projects, CORD 1.0, examined multisector intervention implementation in schools, community centers, early care and health centers, and pediatric primary care practices. The three projects around the United States identified the facilitators of and barriers to implementing multisetting interventions targeting levels of the socioecological model in racially diverse, lower-income communities (Dooyema et al. 2017). CORD 1.0 projects identified common implementation barriers in schools, rural communities, and community centers including staff turnover, limited resources, and competing needs for existing requirements (such as standardized testing in schools) (Chuang et al. 2016, Ganter et al. 2017). Interventions in rural communities and multiple settings benefited from engaging parents and obtaining support from organization members and leadership (Chuang et al. 2016, Ganter et al. 2017). Facilitators of school interventions included using the principal as a champion and using students to engage other students (Blaine et al. 2017). In low-income primary care settings, only about 27% of referred patients enrolled in the intervention (Barlow et al. 2017). Such knowledge assists in the design of future studies to develop effective, accessible, and acceptable interventions for those who need it most.

These implementation challenges are not unique to childhood obesity, but the complexity of the problem will require more rapid translation of discoveries in research with bidirectional input from successes and failures in practice back to researchers. Last, improving the packaging of evidence-based programs can provide potential implementers with a ready-off-the-shelf product that requires less involvement by the intervention developers [a primary contributor to the high cost of adopting new programs (Jordan et al. 2019)] and can arguably aid implementers in delivering interventions with fidelity. This is the goal of the CDC's CORD Project 3.0 (**https://www.cdc.gov/obesity/strategies/healthcare/cord3.html**). However, the scale-up penalty—reduced effects as interventions are widely disseminated and adopted—has been shown in the childhood obesity literature to decrease efficacy to about 75% of that shown in pre–scale-up efficacy and effectiveness studies (McCrabb et al. 2019). Implementation scientists have argued for dynamic adaptation that retains effectiveness while also increasing sustainability (see, e.g., Chambers et al. 2013). This is an area in need of attention as interventions are taken to scale.

8. RECOMMENDATIONS FOR FUTURE RESEARCH

Reviews of interventions for childhood OW/OB show variability in effectiveness—interventions often change health behaviors but not weight—thus exposing the difficulties of addressing and managing this public health crisis. There are a number of directions for future research to improve outcomes and address the challenges of wide-scale implementation.

1. **Interventions need to be integrated across systems.** Given the multifaceted, multilevel, and interrelated nature of OW/OB development, if interventions are to be maximally effective, there needs to be an integration of multiple service systems (primary care, schools, communities, child care, the home) for the delivery of multicomponent interventions that use behavioral, structural, environmental, policy, and biomedical approaches.
2. **There is no one-size-fits-all approach.** More complex, individual child and family interventions need to be tailored in terms of both content and implementation strategy to best align with the personal needs of those involved. This requires flexible, adaptive, or modularized intervention protocols addressing the cadre of potential health behaviors and related individual and familial risk factors of OW/OB present and getting interventions to families in a manner that is engaging, accessible, and wide-reaching.
3. **Implementation considerations need to come earlier.** Researchers developing interventions for childhood OW/OB ought to consider the interventions' implementability from the beginning using the framework of designing for accelerated translation (Ramsey et al. 2019), which considers the capacities, needs, and preferences of the end users (service delivery systems, children/families, funding mechanisms) during design and testing. Another method for speeding translation is to adapt existing programs for new service contexts and new populations rather than following the traditional pipeline of treating something different as new and having to establish efficacy and effectiveness before moving to implement. This concept has been referred to as "scaling out" (Aarons et al. 2017) and has been applied in childhood OW/OB prevention and management (Smith et al. 2018b). Scaling out is a critical method for implementation research to address the health inequities and disparities of childhood obesity (McNulty et al. 2019).
4. **Scalability and sustainability result from community engagement efforts.** Berkel et al. (2019a) engaged a diverse group of stakeholders, including payers, in the adaptation and delivery processes of a recent trial of the Family Check-Up 4 Health as a means of increasing the likelihood of sustained adoption beyond the funded trial. Economos & Hammond (2017) suggested that community-level research should employ novel techniques of systems mapping and causal loop diagramming, which can help stakeholders visualize the interrelated processes and elements that are relevant to the intervention. They also suggested using agent-based modeling and other simulation methods to help encapsulate the complex dynamics involved in implementing successful community-based interventions. Tailoring strategies to local communities and deepening engagement holds promise in enhancing sustainability and scalability of community-based interventions.
5. **There is a need to balance research rigor and scale-up.** Future research should address the shortcomings of less rigorous study designs, which inherently increase the risk of confounding and present challenges in attributing changes in the outcome to intervention effects, although as research translation moves toward scaling up after establishing effectiveness, this tradeoff is both expected and encouraged to increase external validity. Additional research is needed to determine the appropriate length and dosage of interventions; clear reporting of outcomes, consistency of measures, and long-term follow-ups are also necessary (Bleich et al. 2018, Ickes et al. 2014, St. George et al. 2020). Echoing Karacabeyli et al.

(2018), we recommend collecting process evaluation and outcome data to understand the complex causal chain and to help bolster inferences regarding the effectiveness and implementation of the intervention using hybrid designs.

6. **Engaging families remains a critical challenge.** Large community trials in particular often suffer high attrition rates because of mobile populations who move to different residences, which can affect the ability to track and communicate with participants. This issue relates to effectiveness: Children completing >75% of a community-based intervention program experienced beneficial change in BMI as well as associated health behaviors (physical activity, screen time, unhealthy food consumption) compared with children completing <75% of the program (Hardy et al. 2015). A way to attenuate attrition in research on community-level interventions could be through adjusting study intervention design. The majority of community-based interventions used quasi-experimental designs, which are often associated with practicality and sustainability (Bleich et al. 2018, Karacabeyli et al. 2018). Interestingly, less rigorous study designs (e.g., quasi-experimental versus RCTs) demonstrated significant reductions in child weight (Karacabeyli et al. 2018). By removing randomization, Karacabeyli et al. reported that communities with the resources, engagement/buy-in, and capacity could be selected to participate, which optimized community support for the obesity intervention efforts through both sustainable partnerships and buy-in from the community and its champions. This participatory approach could potentially lead to lasting positive health changes that extend beyond the study period. In addition, Karacabeyli et al. (2018) described the benefits of a quasi-experimental design that lends itself to selecting at-risk communities that could greatly benefit from intervention efforts. For example, researchers might use a stepped wedge or randomized rollout trial design where all at-risk communities selected would eventually receive the intervention at different time periods and none would serve as nonintervention controls (see Landsverk et al. 2017).

9. CONCLUSION

There are signs that progress is being made in stemming the tide of childhood obesity, and evidence-based interventions are available across development and for various contexts and systems that affected and at-risk children routinely encounter. Tremendous challenges remain in connecting the dots between etiology, development, and intervention targets as well as when and where to intervene. There needs to be a push to scale up effective interventions because even small changes in weight can yield significant impact on multiple cardiometabolic indices (Lloyd-Jones et al. 2010) that can improve quality and length of life. Clinical health psychologists are ideally suited to conduct research on this complex problem, but transdisciplinary teams will be needed to move the dial further.

SUMMARY POINTS

1. Childhood obesity is a complex, multidetermined, preventable chronic disease that increases risk of premature death and psychological problems.
2. Evidence-based interventions for obesity are available for all stages of development from birth to 18 years.
3. Specific interventions can be delivered in community, school, home, and health care settings depending on the type of strategy and risk level of the targeted population.

4. Associated co-occurring medical and psychological conditions of childhood obesity present an opportunity for clinical and health psychology researchers and practitioners.

FUTURE ISSUES

1. Future research ought to focus on translational considerations from the start and ways to scale up delivery of effective interventions.
2. Research is needed on interventions and their implementation to more effectively reach minority and underserved populations at greatest risk of obesity.
3. Increasing engagement and retention in childhood obesity interventions is a promising area of focus for future research.

DISCLOSURE STATEMENT

J.D.S. is codeveloper of the Family Check-Up 4 Health intervention for childhood obesity. Apart from this, the authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

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