Review Article

Challenges in the management of obesity in adolescents: an American perspective: a narrative review

Ethel Clemente, Maria Demma Cabral, Mackenna Senti, Dilip R. Patel

Department of Pediatric and Adolescent Medicine, Western Michigan University Homer Stryker MD School of Medicine, Kalamazoo, MI, USA

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Correspondence to: Dilip R. Patel, MD. Department of Pediatric and Adolescent Medicine, Western Michigan University Homer Stryker MD School of Medicine, 1000 Oakland Drive, Kalamazoo, MI 49008, USA. Email: Dilip.Patel@med.wmich.edu.

Background and Objective: Adolescent obesity is an increasingly concerning clinical problem with lifelong adverse impact on various adult health outcomes. Adolescence is characterized by growth and development in cognitive, physical, and psychosocial dimensions. Health-related behaviors are the most important underlying factors that increase the risk of obesity during adolescence. Preventive and treatment interventions for adolescent obesity should be considered within the context of adolescent growth and development. This discussion provides an overview of the challenges in the management of obesity in adolescents. Our objective is to provide a narrative review of specific developmental and behavioral considerations in the management of obesity in adolescents.

Methods: We searched the PubMed online database, limited to years from 2001 to 2020, English language, using search terms adolescent obesity, developmental and behavioral aspects of adolescent obesity, adolescent growth and development, obesity pharmacotherapy, bariatric surgery in adolescents, and adolescent obesity and depression or mental disorders. All article types were included for review. Articles with direct relevance to the developmental and behavioral aspects of management of obesity in adolescents were included for this narrative review. In addition, specific search was conducted to look at behavioral interventions in adolescent obesity. Since the application of behavioral interventions in the treatment of adolescent obesity has gained increased consideration in recent years, we looked at specific literation most recent 5 years, between 2015 and 2020. A search of English language peer-reviewed articles was performed using PubMed's online database. The following search terms were used to locate articles relevant to our study: *obese*, *overweight*, *pediatric*, *adolescent*, *cognitive behavioral therapy*, *family-based intervention*, *mindfulness*, *acceptance-based*, *sleep*, *health promotion*, *and stress management*. Variations of these search terms were used, and additional references cited in relevant articles were included in our literature study.

Key Content and Findings: This literature review contains discussion on adolescent obesity, its behavioral aspects, impact on adolescent growth and development, available treatments and interventions in adolescent obesity management. Obesity continues to be a hot topic with a breadth of information with ongoing updates to clinical practice. There is a wealth of available data on evidence-based approaches particularly in behavioral interventions to treating adolescent obesity.

Conclusions: The adolescent's level of cognitive and psychosocial development affects his or her adaptation of healthy lifestyle recommendations. The home environment and adolescent's peer and family relationships modulate treatment considerations. Behavioral treatment approaches, including cognitive-behavioral therapy, family-based interventions, mindfulness, and acceptance-based therapy have been shown to be useful components of comprehensive treatment plan for obesity in adolescents. Additional, large-scale research, specifically in behavioral management of adolescent obesity is needed. In clinical practice, the focus should be on prevention, based on the application of behavioral strategies that would promote adoption of healthy lifestyle by adolescents.

Keywords: Adolescent development; cognitive behavioral therapy; family-based intervention; acceptance-based therapy

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Introduction

Obesity is a preventable, yet costly disease, with an increasing incidence worldwide, with significant long-term implications for adverse health outcomes and burden on health care delivery systems (1-7). The lifetime medical cost is very high for a young child with obesity who in turn may suffer long-term health consequences in adulthood if not addressed early (8-16). The prevalence of obesity in the United States has doubled in the last two decades, with 1 in 5 adolescents aged 12 to 19 years old found to be obese (12). Most available published expert recommendations for treatment include a multidisciplinary approach with emphasis on diet, exercise and behavioral modification (13-16). In general, adherence to treatment guidelines is attainable; however, once puberty occurs, the obese adolescent will face an additional multitude of challenges affecting the physical, mental, and social aspects of health.

Our objective is to provide a narrative review of specific developmental and behavioral considerations in the management of obesity in adolescents. We present the following article in accordance with the Narrative Review reporting checklist (available at https://pm.amegroups.com/article/view/10.21037/pm-21-23/rc).

Methods

We searched the PubMed online database, limited to years from 2001 to 2020, English language, using search terms adolescent obesity, developmental and behavioral aspects of adolescent obesity, adolescent growth and development, obesity pharmacotherapy, bariatric surgery in adolescents, and adolescent obesity and depression or mental disorders (*Table 1*). All article types were included for review. Articles with direct relevance to the developmental and behavioral aspects of management of obesity in adolescents were included for this narrative review.

In addition, specific search was conducted to look at behavioral interventions in adolescent obesity. Since the application of behavioral interventions in the treatment of adolescent obesity has gained increased consideration in recent years, we looked at specific literation most recent 5 years, between 2015 and 2020. A search of English language peer-reviewed articles was performed using PubMed's online database. The following search terms were used to locate articles relevant to our study: *obese*, *overweight*, *pediatric*, *adolescent*, *cognitive behavioral therapy*, *family-based intervention*, *mindfulness*, *acceptance-based*, *sleep*, *health promotion*, *and stress management*. Variations of these search terms were used, and additional references cited in relevant articles were included in our literature study.

Discussion

The primary care physician (PCP) is recognized to effectively guide obesity prevention strategies (17,18). However, adolescents seek medical attention for acute illness more frequently than preventive care, seem less interested in health investment, and are less likely to adhere to physician treatment recommendations (19,20). Addressing concerns about overweight and its impact, in addition to the recommended clinical preventive care services, during yearly maintenance visits, will not suffice. It has been suggested that addressing specific needs should be considered for every medical visit (20). There are several identified causes of obesity such as primary (genetic and syndromes) and secondary (neurologic, endocrine, psychological, and drug induced) causes (21-26). However, with adolescents attaining autonomy during this period of transition, there are modifiable risks that change precipitously. Their lifestyle choices, with reference to impact on health, may contribute to obesity. Key considerations in formulating a plan of management for adolescent obesity include adolescent growth and development, pubertal changes, dietary habits, level of physical activity, interpersonal and family relationships, and mental health (*Table 2*).

Developmental perspective

Adolescence is best described as a period of psychosocial transition from childhood into adulthood. This rapid

Table 1 The search strategy summary

Items	Comment
Date of Search	1/1/2001–12/31/2020
Databases and other sources searched	PubMed online database
Search terms used	Adolescent obesity, developmental and behavioral aspects of adolescent obesity, adolescent growth and development, obesity pharmacotherapy, bariatric surgery in adolescents, and adolescent obesity and depression or mental disorders
Timeframe	2001–2020
Inclusion and exclusion criteria	English publications
Selection process	Conducted independently

Table 2 Key developmental-behavioral considerations in formulation of plan of management

Category	Comment
Adolescent development	An understanding of adolescent cognitive, psychosocial and physical develop is essential in developing developmentally appropriate plan of management
Puberty	Onset, tempo and progression of puberty with underlying biological and physiological changes interplay with weight gain, and body fat distribution
Diet	Multiple societal and family factors affect adolescent's dietary habits and need consideration
Physical activity	Technological advances and social media use contribute to reduced engagement in physical activity
Relationships	Adolescence is complicated by varying relationships with family, school system, and the community Interpersonal relationships evolve during progression from early to late adolescence
Mental health	Adolescence is a time of psychological and psychosocial transition that may be contributory to added stress and influence lifestyle choices, behavior and coping

transition could result in specific disease patterns and unusual clinical presentations posing the ever-difficult challenge of communicating with the young patient. In providing medical care to adolescents, understanding the developmental milestones at each phase is essential in delivering appropriate care, especially for those with chronic illness or obesity (27,28). *Table 3* summarizes the differences at each phase of adolescent development.

Being at a specific developmental phase entails a unique type of challenge. For example, an 11-year-old boy may not fully comprehend the cardiovascular risks that obesity poses, but would likely focus more on its impact to the present situation, such as the short term pleasures of dessert foods. This is in contrast to a 20-year-old who might have more insight to the unfavorable consequences of the disease to overall wellbeing. It is important for the physician to provide the adolescent with information appropriate to his or her level of cognitive ability, using language that is adaptable and easily understandable, and not discounting the feelings associated with the diagnosis of obesity (28).

Changes during puberty

In healthy individuals, maturation of the hypothalamic-pituitary-gonadal axis leads to normal pubertal progression. About half of the adult weight is attained during this period of growth (29). Known body composition changes take place as directed by the presence of sex steroids. Estrogen stimulates lipogenesis, resulting in distribution of fat in the lower body; whereas, androgens have the opposite effect promoting more muscular development. These hormonal effects bring about increased body fat in girls and increased lean body mass in boys (29). Early maturing girls were found to have lower self-image and disordered eating compared to peers (30).

The physical development should be noted with accurate sexual maturity rating assessment. The Centers for Disease Control and Prevention recommends using

Table 3 Key characteristics of adolescence

Characteristics	Early adolescence	Middle adolescence	Late adolescence
Age (in years)	10–13	14–17	18–21
Question asked	"Am I normal?"	"Am I liked?"	"Am I loved?"
Level of education	Middle school	High school	College or 4 years after high school
Pubertal changes	Heightened preoccupation with physical changes	General acceptance of body	Less to no preoccupation at all
Cognitive changes	Concrete thinking established	Abstract thinking begins	Abstract thinking well established
Parental involvement	Less interested in parental activities	Peak of parental conflicts	Accepts and values parental advice
Sense of independence	Beginnings of emancipation	Independence-dependence conflicts	Independent; defined role as an adult
Understanding of disease processes	Not established due to lack of time perspective (i.e., long-term consequences)	Affected by "individuation" (i.e., seeking self-identity)	Progressive acceptance of conditions

the calculated body mass index (BMI in kg/m^2) that is age- and sex-specific in screening an adolescent for overweight (85–95th percentiles) and obesity (>95th percentiles) (31,32). This number is actually not diagnostic and should be interpreted with caution (33). It is important to plot measurements on the standardized growth charts and follow trends overtime. Many adolescents and their parents lack accurate perception of weight status, so it is imperative that the clinician educates them and include in the discussion the associated health risks at higher BMI levels (18,34).

The role of increasing prevalence of obesity in the early onset of puberty is a subject of debate, which is based on observations of early puberty development frequently associated with overweight and obesity, particularly in girls (35-38). Several hypotheses have been postulated looking into how adiposity influences pubertal timing and development. The action of leptin and other adipokines on the hypothalamic-pituitary-gonadal axis and its influence on insulin resistance provides additional understanding on this matter (39-41). Some studies suggest a relationship between parental obesity and the tempo of pubertal development.

The "Teen Diet"

Recommendations for dietary intake have been consistent with emphasis on increased consumption of the low calorie healthy foods (fruits, vegetables, fiber) and a reduced intake of the calorie dense foods (fast foods, added sugar in food and drinks, saturated fat) (42-44). A typical diet of an adolescent may contain added sugar, salt, saturated fats, and inadequate micronutrients. Eating fast food and skipping breakfast were found to be more common during adolescence resulting in weight gain into adulthood (45,46). According to the Youth Risk Behavior Surveillance (YRBS), the dietary behaviors of students in the United States reported during the 7 days preceding the survey were the following: 41.8% had not eaten fruit or drunk 100% fruit juices; 40.7% had not eaten vegetables; and 16.7% had not eaten breakfast on all 7 days. There is decline in students who consumed soda, sports drinks and those who limited water intake (47). The general observation is still the poor dietary behaviors in adolescents (47).

Adolescents may consume inadequate protein-energy in their diet. When evaluating caloric intake, it is essential to understand the required nutrition and level of physical activity for optimal growth and development (34). Low energy dense diets may not be appropriate for adolescents who are yet to achieve their full physiological maturity (16). Maternal diet before pregnancy should be discussed, with emphasis on breastfeeding, delaying introduction of solid foods, and encouraging adequate fruit and vegetable intake at a young age (48-50). Since adolescents spend most of the day at school, availability of healthy school lunches is important (51).

Dieting is common in adolescents at a time when everyone is conscious about their physical appearance in comparison to peers. The intended result is weight loss; however, when done long term, there is the potential unwanted weight gain due to eventual development of disordered eating behavioral patterns (52). Fad diets, which have increased in popularity among adolescents and young adults, should be discouraged due to their detrimental effects

leading to eating disorders, such as binge-eating disorders, which commonly cause uncontrolled weight gain (52-56).

One study on obese adolescents who significantly reduced their intake of saturated fatty acids showed improved inflammatory markers and carotid intima-media thickness, lowering their cardiovascular risks (15,57). Intake of fruits and vegetables known to have low energy density, rich in fiber and phytochemicals, lowers the risk for type 2 diabetes mellitus and improves metabolic parameters (58). Increasing family meals have demonstrated better eating habits of adolescents as parents' model positive behavior (11,49).

Some studies suggest a relationship between sleep habits and diet. Many adolescents currently get a markedly insufficient amount of sleep (16). A recent study examining 256 adolescents ages 10–16 years old measured both sleep quality and quantity against food cravings, dietary intake, and dietary quality. The study revealed an inverse relationship between sleep efficiency and food cravings. Sleep duration and quality were positively correlated with quality of diet. Thus, sleep duration and quality may be a contributing factor to adolescent obesity (15). The recommended 8 to 10 hours of sleep for adolescents age 13 to 18 years promote better health, both mentally and physically (59-61).

The sedentary behavior

The recent YRBS survey also found worsening physical activity behaviors despite at least half of surveyed students had played on at least one sports team the past year. Less than half had been physically active for at least 60 minutes a day on all days (47). Diminished physical activity has added to the burden of the obesity epidemic. The effect of widespread use of electronics ensuing lack of social interactions has contributed to the worsening state of being sedentary (62). Increased media use with excessive screen time, resulting in reduced exercise and poor dietary choices, has been linked to obesity (63). There is enough evidence to support that an adolescent engaged in at least 20 to 60 minutes of moderate to vigorous physical activity, at least five days a week, has improved metabolic health (43,63). There is growing interest in research looking at technology use as an opportunity to target weight-related behaviors (64-68).

Adolescents are quick to adapt to the fast-paced updates in the technology; however, the resulting media use (television, computer, and video games) showed the strong evidence of sedentary behavior and reduced physical activity (34). One study described lower adiposity in adolescents who took breaks that are more frequent during their sedentary time. This indicates the importance of breaking up sedentary time as a preventative measure for adolescent obesity.

Role of relationships

Adolescence is complicated by varying relationships with family, peers, school, and the community. In the early stages of psychosocial development, attainment of autonomy begins followed by the peak of parental conflict (27). It is a common practice for the physician to primarily engage parents or other adults during a medical visit; however, adolescents seek that attention to be involved in their own medical care (69). As the adolescent gradually reaches independence, role readjustments take place. One study reported that parents were considered by adolescents to be significant in "future-oriented" decisions, while friends, especially of the same sex, were more valuable for "current" decisions (69,70).

Obesity-related behaviors are linked to the adolescent's personal connections (71-75). Such that family-based interventions continue to be an effective tool in both prevention and treatment of obesity (13,14,76,77). More recent studies have looked at the adolescent's choices of food in relation to social connections and one identified that peer influence is critical (78). Physical activity involvement, screen time, and high caloric intake were associated with school-based friendship networks (73). An overweight girl trying to lose weight tended to engage in weight control behaviors when other overweight girls in school were also trying to lose weight (79).

Effect of obesity on mental health

During the psychological transition period of adolescence, it is not unusual for adolescents with chronic illnesses to have poor adherence to self and medical care; however, this observation cannot be generalized. Their wellbeing and quality of life are affected by disease severity and the intensity of treatment needed (28). Being overweight or obese is a significant risk factor for being bullied and increases the likelihood of experiencing depression and depressive symptoms (80-84). Obesity is associated with low self-esteem and promotes social isolation (85-89).

During adolescent medical visits, it is important for physicians to pay attention to clues relating to comorbid

Table 4 Interventions

Intervention	Comments
Pharmacologic	Limited approved drugs for use in adolescent age group
	Adherence is a concern because of side-effects
	Drugs approved by US FDA include: orlistat, liraglutide, metformin
Bariatric surgery	Effective in carefully selected cases – morbid obesity, failure of non-surgical interventions, presence of co-morbid conditions
	Adolescent's developmental maturity to comprehend risks and benefits should be considered
	Support system is essential for long term follow up and outcome
Behavioral	Cognitive-behavioral therapy
	Family-based interventions
	Mindfulness
	Acceptance-based interventions
	Behavioral sleep intervention
Lifestyle	Prevention and health promotion
	Diet
	Exercise
	Stress management

depression—flat affect, body dissatisfaction, excessive eating, sleeping problems, and school underachievement (42,59). An eating disorder should not be missed in adolescents presenting with binge eating and/or unhealthy compensatory mechanisms (11,42,56). Encouraging the adolescent to engage in physical activity is beneficial for weight management and improve mood (63). Assessment for self-harm behaviors and suicidal risk is crucial.

It is commonly reported that obesity is a risk factor for the development of depression and anxiety (13). Additionally, adolescent dieting as a result of obesity is commonly recognized risk factor for depressive symptoms (14). Overweight and obesity is a physical trait that is significantly associated with victimization and detrimental effects on the adolescent's mental health. Victimization prevention should therefore be added to healthy weight development programs to promote mental health and adherence (18).

Treatment interventions

A number of interventions have been found to be variably effective in the management of obesity in adolescents. These include limited use of drugs, bariatric surgery in selected cases, various behavioral interventions, lifestyle modifications and stress management (*Table 4*).

Pharmacologic therapy in the treatment of obesity in adolescents

Despite lack of long-term benefits, weight loss from pharmacologic treatment of obesity is derived from appetite suppression and increased satiety (26). Several drugs have been approved by the US Food and Drug Administration (FDA) for use in adults with obesity; however, drugs approved for use in adolescents are limited. Use of pharmacotherapy in adolescents is also limited and complicated by considerations for the developmental stage of adolescents, their understanding of risks and benefits and their likelihood of adherence to recommended treatment. Adherence is further affected by side effects of drugs that may not be acceptable to adolescents within their psychosocial developmental context.

Orlistat is approved for use in adolescents aged 12 year and older. Its gastrointestinal side effect (abdominal pain, gastric upset, dyspepsia, fecal incontinence and urgency, flatulence) is a concern for adherence by adolescents (90-92).

Liraglutide, a glucagon-like peptide-1 receptor agonist, is very recently approved by the FDA for adolescents aged 12–17 years, who have a body weight over 60 kg and a baseline

body mass index of greater than or equal to 30 kg/m^2. The approval came following results of a randomized, double-blind trial that showed significant BMI reduction with the use of liraglutide plus lifestyle therapy, compared to placebo and lifestyle therapy (93).

Metformin is commonly used to treat type 2 diabetes mellitus in children at least 10 years of age. Its efficacy in improving fasting glucose at 3 months and reducing BMI at 6 months superior to placebo was demonstrated in the Metformin in Obese Children and Adolescents (MOCA) trial (94). The most common side effects of metformin are gastrointestinal (abdominal discomfort, diarrhea, flatulence, nausea, indigestion). Sympathomimetic drugs used in the treatment of obesity include phentermine, benzphetamine, diethylpropion, and phendimetrazine.

The presence of other chronic conditions independent of obesity in adolescents should be taken into consideration when prescribing medications. Long-term corticosteroid use in teens with autoimmune diseases and asthma may result in weight gain and hyperglycemia, among other adverse effects on bone and gastrointestinal health (95). Choice of an antiepileptic drug in initiating treatment should take into consideration its effect on weight, insulin sensitivity and lipid profile (96). When prescribing antipsychotic drugs for the indicated diagnosis, it should be weight neutral (26). In children with autism spectrum disorders, commonly prescribed pharmacologic treatment have been associated with obesity (97).

Bariatric surgery

Surgery has been proven more effective than lifestyle changes, pharmacologic treatment, and established weight loss programs (98-100). To be considered for bariatric surgery, the adolescent should be readily involved with good understanding of the indications, procedures, repercussions, and realistic expectations. The psychological and cognitive state of development of the adolescent would guide the conversation and consideration of bariatric surgery. The ability of the adolescent to fully comprehend the risks and benefits as well long-term post-operative management would be critical in decision-making. The reasons to consider bariatric surgery in adolescents include its effectiveness in long-term weight loss, failure of non-surgical lifestyle and behavioral treatment, and significant co-morbidities (101-104). A comprehensive approach to surgical intervention should include a psychological and psychosocial assessment of the adolescent and the family environment. The adolescent's ability to adhere to post-operative dietary, exercise and other lifestyle change recommendations should be considered carefully.

Behavioral intervention approaches

Cognitive-behavioral therapy

It has long been suggested that to achieve long-term successful childhood obesity interventions, unhealthy behaviors must be replaced fully with healthier, positive lifestyle changes that persist throughout the individual's life (105,106). Thus, it has been the goal of many strategies to adjust behavior to promote and maintain a healthier weight. One of the most widely recognized and useful theories to prevent and treat obesity is cognitive-behavioral therapy (CBT). In this theory, human behavior is defined by a complex interplay of an individual's thoughts, feelings, behaviors, and external factors such as physical and social environment (107). Therefore, CBT seeks to treat the dysfunctional cognitions and beliefs that may have resulted in the observed adolescent obesity. As put forward by Bandura, a cornerstone of CBT theory is the idea of self-efficacy, the belief and confidence of an individual in their own innate ability to overcome the difficulty presented them (108). Additionally, in order to properly motivate an individual, proper outcome expectations ought to be determined. Thus, in conjunction with a sense of self-efficacy, an individual may set tangible goals and begin to construct a framework for achieving behavioral change (107). The preserved self-control and power over one's behaviors and their surroundings gained as a result of successfully attaining endpoints encourages a true initiation and preservation of behavioral change (107,108).

In practice, however, CBT has shown mixed results. A 2008 study of adolescents assigned to a 20-week CBT treatment program demonstrated obvious improvements (109). CBT improved BMI, weight, body and abdominal fat, and displayed a significant reduction in sugary drink consumption than the control group. On the other hand, physical activity was not improved as a result of CBT. Another more recent study again presented data showing a significantly decreased BMI in CBT treatment groups when compared to a control. These data were suggested to be a result of decreased food-seeking behaviors and consumption of fast foods, in addition to CBT treatment groups displaying an increased knowledge base on food (110). Contrary to these studies, however, a 2018 systematic literature review presented numerous studies arguing the lack of efficacy of CBT (107). In 2012, a high-quality randomized control trial of adolescent females

treated with CBT exhibited no significant changes in BMI following one year of treatment. No significant improvements were observed across any biometric standards or behavioral goals, save for a reduction in screen time in the treatment group (111). There continues to be a mixture of both encouraging and discouraging studies on CBT efficacy, and further research is certainly warranted. It may be helpful to more closely analyze the components of CBT treatment programs that display significant improvements in adolescent obesity such that they may be parsed out and merged into one more efficacious form of cognitive-behavioral therapy.

Family based interventions

Given the obvious presence of the family as a whole and its impact on an adolescent's life, it is reasonable to target inter-family relations and interactions as a means to treat adolescent obesity. Additionally, there is a growing body of evidence that illustrates a positive correlation between a parent's BMI and a child's BMI, suggesting that behavioral weight loss targeting of the whole family may be effective at reducing obesity in adolescence (112). In family-based behavioral intervention (FBBT), the dynamics of the entire family are addressed in an effort to form and solidify new healthy routines and habits that benefit each individual (113). For example, the entire family may be incorporated into forming specific goals and supporting each other in efforts to reduce caloric intake, dietary improvements, increased physical activity, and heightened self-monitoring (114). FBBT can manifest in several forms, from reworking parent-child interactions to simple alterations in daily inter-family interactions and event scheduling. Simple alterations to daily life such as more frequent scheduled family meals (as opposed to infrequent, individual meals), scheduled family-wide physical activities, limited screen time, stricter rules regarding sleep, and a clear focus on healthy living are all key facets of an FBBT intervention (113).

Other theories of FBBT incorporate strategies involving social cognitive theory, parenting styles, or ecological frameworks, among other ideas (115). One FBBT intervention currently being implemented involves a 10-week family-based program followed by four long-term maintenance meetings. Features of the intervention include group meetings led by program providers, online materials, and scheduled self-directed activities all directed towards a healthier diet and lifestyle (116). There have been numerous studies exhibiting significant results using a FBBT-type intervention. One study, for example, displayed significant reductions in body weight, BMI, and blood pressure in addition to increased consumption of vegetables (117). In another long-term study, obese children displayed a significant reduction in body weight and obesity over a 10-year period attributed to successful family-based therapy interventions (118). Despite the successes seen with FBBT, significant gaps exist in classically underrepresented individuals. In particular, family-based therapy needs further investigation in lower-income countries where obesity tends to have a higher prevalence (115). A similar problem exists for non-traditional families and minority families where obesity-risks are higher than the general population (115).

Mindfulness and acceptance-based interventions

In an effort to resolve the high remission rates of popular weight loss interventions, mindfulness- and acceptance-based therapies have recently been explored in greater detail. As many as 30–40% of adolescents with a diagnosed eating disorder treated with current cognitive-based therapy enter remission, underscoring the need for novel treatment (119). Mindfulness as an obesity treatment therapy involves conscious focus and self-awareness, in particular to thoughts, feelings, and actions surrounding food and eating behaviors (120). Most often some form of meditation is practiced as a subset of cognitive therapy to treat obesity-related disorders, namely by promoting healthy eating and discouraging unhealthy eating (120). One mindfulness-based study demonstrated an increase in aerobic exercise and increased consumption of low calorie foods in their obese adolescent cohort. The authors then pointed to the potential to implement a "school-based mindful eating program" in high school in an attempt to address the increasingly early onset of obesity in these individuals (121,122). In another pilot study, no improvements were made in BMI and body weight despite a demonstrated decrease in stress-eating following the mindfulness-based program. Another study sought to address parent-stress in low-income families via mindfulness-based intervention as a means to address childhood obesity, in which childhood BMI decreased in families where parent-stress also decreased (122,123).

In a similar fashion, acceptance-based therapy (ABT) intervention seeks to modify the psychological experience of weight loss treatment. ABT allows the individual to recognize their desires to avoid the unpleasant requirements of weight loss treatment and to then separate those thoughts from beneficial behaviors (124). In short, ABT is acceptance of the negative aspects of weight loss treatment in order to focus on the positive aspects. ABT intervention has been proven to successfully augment weight loss in adults but has yet to be fully studied in adolescents (124). A recent

study provides promising results, demonstrating a reduced BMI and modest improvements in food and eating related behaviors (124). A recent long-term study performed one year of acceptance-based therapy compared to standard behavioral treatment for obesity, reporting that ABT produced increased weight loss in the individuals studied. ABT treated participants also demonstrated a higher quality of life score when compared to the standard treatment group three years after treatment concluded and were more likely to have maintained their weight loss (125). Further research still needs to be performed to elicit which facets of ABT may be adopted into other therapy interventions for a more holistic and successful approach.

Behavioral sleep intervention

The prevalence rates of obesity in individuals 2 to 19 years old continues to be significantly high, with one study citing a rate of 16.9% (126). At the same time, inadequate amounts of sleep in adolescents is a continued problem that may have links to obesity-risk (126,127). This increased risk of obesity occurs simultaneously with a reported century-long decrease in adolescent sleep duration (127,128). In addition to sleep duration, the patterns of sleep time may be contributory to obesity prevalence. Both biological and behavioral mechanisms have been proposed as avenues of increased obesity, including alterations in eating timing, type of food consumption, and variations of hormonal levels (129). Behavioral sleep intervention employs a simple theory, yet one that may be difficult to implement properly. Common facets of sleep interventions to treat obesity include goal setting of increasing sleep time by 1–1.5 hours, specific and tangible plans to achieve set goals, constant interactions with program staff along with positive reinforcement (130). One study reported being able to successfully increase minutes of sleep per night in adolescent participants while also slightly decreasing motivation for food consumption (130). Another follow-up study associated increased sleep length with decreases in food consumption and body weight, participants measuring in on average 0.22 kg lower than the decreased-sleep cohort over a short study period (131). Although studies on behavioral sleep intervention need additional work to elicit the mechanisms of sleep on adolescent obesity, the potential for sleep intervention to augment other therapies is promising (130).

Health promotion and stress management intervention

Similar in practice to mindfulness interventions, health promotion and stress management interventions seeks to address adolescent obesity from a psychological perspective. One research group described the stress response as a "chronic hypersecretion of cortisol, epinephrine, norepinephrine, immune CRH, and interleukin-6 [that] contribute substantially to the increased secretion of insulin and decreased release of growth hormone, androgens and estrogens, leading to accumulation of visceral fat, loss of bone mass (osteoporosis) and muscle mass (sarcopenia)" (132,133). Thus a dedicated attempt at reducing the stress response in adolescents may provide a therapeutic approach to treating obesity. Many programs incorporate techniques such as muscle relaxation, meditation, focused breathing and relaxation, and therapeutic introspection. One study employed an 8-week stress management intervention to reducing stress and negative emotions surrounding overeating, resulting in healthier eating behaviors in addition to a significant 4.44 kg average weight loss in the treatment group (133,134). Another study utilized portable mp3 players and virtual reality as means to deliver relaxation training to obese females. The stress management intervention successfully reduced stress-eating responses and decreased anxiety and depressive symptoms associated with eating (135). On the other hand, some studies have reported unsuccessful results at treating obesity. For example, at 12-month follow-up of a 10-week relaxation training program researchers found no significant changes in mean body weight despite significant improvements in stress and depression symptoms (136). It is possible that stress management interventions take a more indirect approach to obesity treatment, and thus should be utilized as part of combination therapy. Further study in larger groups is necessary to properly evaluate the effects of stress management in the treatment of adolescent obesity (132).

Limitations of research

This paper offered to provide a narrative review and limited to current research reviewed.

Our objective is to provide a narrative review of specific developmental and behavioral considerations in the management of obesity in adolescents, which is multifactorial and requires intervention of several factors. Biological, cultural and environmental influences all affect eating behaviors that can lead to obesity. Data on effects of modification of individual factors are available but still lacking, particularly when looking at the combination of all in specific populations.

Future research

Future research in this topic should focus on identifying specific strategies that can be translated to clinical application with long-term outcomes favorable to the obese adolescent. Exploring other pharmacologic therapies approved for adults in the treatment of adolescent obesity, as well as focusing on other therapeutic interventions such as hydrogel technology (137) and use of probiotics, should continue, but with careful attention to challenges unique to this age group (137,138). Similarly, despite universal acceptance of the importance of behavioral health interventions, additional research on specific approaches and their effects in the prevention and management of obesity are needed.

Conclusions

Obesity continues to be prevalent in the youth, which significantly affects both the physical and psychosocial aspects of health. There are established guidelines when caring for the affected adolescent; however, the clinician should be aware of the unique challenges during this period of transition and development. Involving the adolescent in decision-making should be in place and could be beneficial in tackling the ever-growing epidemic of this chronic illness. Management is complex, thus focusing on preventive interventions is likewise imperative. Continued promotion of healthy diet, activity and environment should be the goal, as well as providing education and support early on to children and adolescents.

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Footnote

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