



Leveraging seasonality and timing to optimize pediatric weight management interventions: Novel directions for future research

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Abstract

National estimates suggest that more than 35% of American children, ages 2–19 years, are overweight or obese, which increases their risk for weight-related comorbidities including diabetes, cancer, cardiovascular disease risk factors, depression, and anxiety. While obesity prevention is most cost-effective, for youth with existing obesity, the United States Preventive Services Task Force recommends ≥ 26 h of comprehensive lifestyle intervention over 6–12 months. This include standard behavioral therapy, dietary counseling, and an emphasis on physical activity. Although such programs are effective in reducing weight status, there are many barriers to completing these programs. A novel consideration for both the prevention and treatment of childhood obesity is the recognition that the timing of intervention, both duration and time of the year, can impact family engagement and intervention effectiveness. This paper discusses the potential of targeting high-risk periods for weight gain and offering brief behavioral intervention, in hopes of inspiring research on novel approaches to the prevention and treatment of childhood obesity.

KEYWORDS

pediatric weight management, prevention, timing, treatment

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1 | INTRODUCTION

Nearly 20% of American children and adolescents, ages 2–19 years, have obesity, and another 16% are overweight.¹ Increased weight status in childhood is associated with adverse physical sequelae including asthma, type 2 diabetes mellitus, cardiovascular disease risk factors, and certain types of cancer.^{2–5} Recent data show that the incidence of type 2 diabetes in American children has nearly doubled since 2001, which is attributed, in large part, to the rising incidence and severity of childhood obesity.⁶ Childhood obesity is also bidirectionally associated with depression, lower perceived quality of life, and emotional and behavioral disorders, which may be due to the fact that children with excess adiposity face increased stigma, teasing and bullying.⁷ As with many diet-related diseases, children from lower-income households⁸ and those with a history of adverse childhood experience are more likely to have obesity,⁹ and they also experience a significantly greater burden of comorbidities.^{10,11} Given the transmission of obesity from childhood through adolescence and into adulthood,^{12,13} the medical costs associated with childhood obesity amount to nearly \$1.3 billion dollars annually.¹⁴ Moreover, these costs disproportionately impact lower-income and minoritized communities with higher rates of disease.

As with many chronic diseases, obesity prevention and treatment are critical to reduce healthcare costs and improve the quality of life. In 2017 the U.S. Preventive Services Task Force (USPSTF) reissued a 2010 Grade B recommendation for clinicians to screen children aged 6–18 years for obesity and refers identified youth to comprehensive, multicomponent treatment programs. They identified successful programs as those with ≥ 26 contact hours comprised of nutrition and physical activity targets supported by behavioral strategies.¹⁵ This is consistent with the recently released American Academy of Pediatrics clinical practice guidelines for the management of overweight and obesity in youth.¹⁶ These guidelines highlight the importance of comprehensive, multicomponent programs, although the majority of American children with obesity lack access to effective treatment programs or do not have the resources to access treatment for 26 contact hours.¹⁷ Block and Oken highlight that insufficient and disparate access to treatment programs is due to financial barriers related to the cost of multicomponent programs as well as basic lack of availability across the United States.¹⁸ Additionally, there are clear disparities in access to treatment among racial and ethnic minority youth, who are disproportionately impacted by obesity but are underrepresented in studies evaluating the efficacy of obesity treatment programs.¹⁹ Families who engage in USPSTF-compliant obesity treatment programs often have low engagement and retention rates. In addition to barriers of cost and access,¹⁸ parents cite lack of time, scheduling conflicts and lack of adequate insurance coverage for long-term treatment.²⁰ The use of mHealth and telehealth visits may mitigate some barriers (e.g., transportation) associated with traditional in-person treatment.²¹ However, new barriers arise, such as cost and digital access, that may limit the impact of mHealth and telehealth for racial and ethnic minority youth, and those from

lower-income backgrounds.^{21,22} Further, 26 contact hours of intervention likely remains challenging for families to coordinate and access, whether in person or virtual. Thus, in parallel to efforts to increase access, innovative approaches are needed to improve engagement and/or the impact of interventions, particularly for youth living in lower-income communities.

To prevent adverse health outcomes and reduce the prevalence of obesity, it is crucial to identify strategies that are accessible to families, affordable, and effective.²³ One approach for both the prevention and management of childhood obesity is to consider the delivery of brief, targeted interventions during high-risk periods of weight gain and development of persistent health behaviors. Childhood and adolescence are punctuated by several naturally occurring social/behavioral and biological time periods in which the risk for rapid or excess weight gain is documented. These include puberty and seasonal risk periods, such as summer and school vacations.^{24–30} By focusing on a time-limited period, smaller behavioral changes may have a relatively greater effect on weight trajectories, thereby requiring less behavioral effort from the family. Moreover, adult literature suggests that offering treatment in smaller “clusters” (e.g., shorter periods separated by breaks) does not affect efficacy and may be another option for families grappling with time limitations. For all families, but particularly lower-income families who have increased barriers to traditional pediatric weight management programs, focus on high-risk periods and alternative treatment delivery schedules has the potential to minimize family burn-out, maximize weight change, and reduce or remove barriers to treatment.

The purpose of this perspective paper is to highlight innovative approaches to the *prevention* and *treatment* of childhood obesity that have potential to reduce the impact of obesity prevalence. Recognizing that the duration and timing of an intervention can impact family engagement and outcomes, this paper explores brief critical periods for intervention and schedules of intervention delivery that may help to maximize family efforts. By intervening during these critical periods, interventions may be shorter in duration, allowing for greater engagement, lower attrition, and subsequent improved health outcomes. Given that these approaches are less well explored than interventions that meet USPSTF guidelines, this study aims to inspire future research directed at high-risk periods.

2 | BIOLOGICAL PERIODS OF INTERVENTION

Considerable evidence suggests that, once established, there is a strong likelihood for childhood overweight and obesity to persist through adolescence and into adulthood.^{23,31} However, longitudinal studies document that approximately 22% of children “exit” out of obesity between kindergarten and eighth grade, and up to one third of adolescents do so during the transition to young adulthood.^{32,33} Obesity remission during childhood has been *inconsistently* related to increases in height but, instead, associated with gaining less weight in the time interval preceding linear growth.³⁴ This aligns with findings

from our previous work, documenting that relatively small weight changes could help children with overweight/obesity achieve non-overweight status in 1 year, potentially because some of these children grew linearly during that time.³⁵

While increased height in and of itself has not consistently been related to reductions in weight status, there may be ways to leverage vertical growth to support the normalization of weight status. Increase in height is characterized by mini growth spurts at irregular intervals as well as a larger growth spurt during puberty.^{36,37} Timing a brief behavioral weight stabilization intervention during the pre-adolescent or adolescent phase, in advance of the pubertal growth spurt, may lead to greater success with weight control. Pubertal growth spurts can last years, longer in males than females, with pubertal growth spurts in females occurring after the initiation of breast development, whereas in males this occurs after an increase in testicular size.³⁸ Given the variability in the timing of pubertal development and differences in growth patterns, intervention timing would have to be individualized.³⁹ Family history related to pubertal onset (e.g., early/average/late) may provide a general sense of timing. Further, pubertal assessment is part of standard well child visits throughout childhood, in conjunction with review of growth, which can be used to identify puberty as it begins (thelarche in females, increase in testicular volume in males). Clinicians could consider a combination of a child's growth pattern and pubertal stage to predict the onset of the pubertal growth spurt, and thus recommend a time-limited intervention to promote weight stabilization around the timing of puberty.

Given that pubertal growth and development are characterized by increased energy, macro- and micronutrient needs,⁴⁰ one potential avenue for intervention may be focusing on improving diet quality. Evidence supports that both higher diet quality and improvements in diet quality are associated with the prevention of excess weight gain in the transition from adolescence to young adulthood.⁴¹ However, as this approach has not been well researched in the context of a growth spurt, evidence on the type and intensity of behavioral recommendations needed to stabilize weight during periods of growth is needed. It is important to consider clinical limitations to this approach, in that if children are not seen annually, the onset of puberty may not be captured. Further, there may be logistical barriers to integration into clinical care (e.g., clinician burden). That said, the time limited nature of a pubertal growth spurt has the potential to reduce some barriers associated with traditional behavioral weight management interventions, including burnout and retention.

3 | SEASONAL RISK

In addition to intervening during a critical period of development and growth, there are critical seasons, or times, that may lend themselves to time-limited obesity prevention interventions. It is well established that structure and routine positively impact emotional and behavioral outcomes in youth.⁴²⁻⁴⁴ Maintaining household routines, such as

having regular family mealtimes, has been associated with lower rates of pediatric obesity through establishment of healthy weight-related habits and routines.⁴⁵⁻⁴⁷ Further limiting screen time and maintaining sleep routines are associated with a 40% decreased likelihood of obesity, compared to children from families that are not exposed to these routines.⁴⁵

In their "Structured Days Hypothesis", Brazendale and colleagues posit that structure or routine, as provided by the school day and other supervised programming, occupies a child's time with "favorable activities" thereby limiting time for engagement in less favorable activities.⁴⁸ Thus, in the absence of routine and structure (i.e., during the weekends or school vacations), children are at greater risk for engaging in obesogenic behaviors. Specifically, without the structured school day, children lose access to gym class, recess, and calorie-controlled school meals; and they have more free time for sedentary behavior and snacking. This is supported by evidence that children eat more often and consume larger portions of energy-dense foods and beverages, resulting in greater energy intake and lower diet quality on weekend versus weekdays.^{49,50} Early work regarding weekend changes has identified that a larger difference in weekend and weekday sleep is associated with increased eating in the absence of hunger for children.⁵¹ Although it is not well understood how weekend changes in dietary intake and sleep patterns affect weight gain and obesity risk in children. Similarly, data suggest that children engage in less moderate to vigorous physical activity (MVPA) and more sedentary behavior, have decreased physical fitness, consume a lower quality diet, and have more dysregulated sleep in the summer versus the school year.²⁴⁻²⁹ Given that there are fewer opportunities for children from lower-income households to access healthy, structured programs during the summer, it is likely that summer vacation contributes to income-related disparities in childhood obesity prevalence and severity.⁵²

Data strongly support that the annual school vacation during the summer contributes to excess weight gain, particularly among children from lower-income communities, racial and ethnic minority groups, and those with overweight or obesity. On average, observational data suggest that children gain more weight during the three summer months than during the 9-month school year.⁵³⁻⁵⁷ After following 3754 children from kindergarten to fifth grade, Moreno and colleagues found that they predominately gain weight during the summer and only lose a portion of it during the subsequent school year.^{53,54} Data from the COVID-19 pandemic also support the Structured Days Hypothesis, as children lost school structure, sleep routines, and access to school meals during nationwide lockdowns. Findings from a longitudinal cohort of 432,302 children, ages 2-19 years, suggest that the rate of BMI increase nearly doubled during the pandemic as compared to a pre-pandemic period.⁵⁸ In another cohort of nearly 200,000 children, BMI increased 1.57 kg/m² during the pandemic, and similar to summer, was most pronounced in children and adolescents with existing overweight or obesity.⁵⁹ In addition to BMI changes, obesity-related comorbidities increased during the pandemic as well, with new Type 2 diabetes diagnoses

significantly increasing across multiple cohorts.^{60–62} While there are a multitude of factors (including increased stress and depression, isolation, and food insecurity) that may have contributed to these findings, they highlight the potential effect of unstructured time on weight and related obesogenic behaviors. Taken together, there is reasonable evidence suggesting that unstructured seasons or periods of time represent a unique time for time-limited obesity prevention interventions.

Several research studies have demonstrated the promise of time-limited summertime interventions designed to prevent excess weight gain in children across the weight continuum.^{63–66} In *Camp NERF*, an 8-week multi-component summer program offered to school-age children along with the Summer Food Service Program, Hopkins and colleagues found a modest intervention effect of -0.03 BMIz units, on average, from baseline to post-intervention between youth in the intervention versus control groups.⁶⁷ In a quasi-experimental study, *Promoting Health and Activity in the Summer Trial (PHAST)*, with children aged 6–12 from lower-income households, there was a significant -0.10 unit difference in change in BMIz between kids who engaged in a half-day physical activity-based program that included lunch provided through the Summer Food Service Program (SFSP) versus those who experienced an unstructured summer.⁶⁸ Further, children in the intervention group engaged in 41 more minutes of MVPA and spent 8.5% less time sedentary on days they attended PHAST as compared to days they stayed home.⁶⁸ To test a more scalable model, a subsequent pilot trial was conducted. In this trial, 94 youth, ages 6–12 years and from low-income households, were randomized to attend an 8-week Boys and Girls Club summer day camp or to experience an unstructured summer as usual (SAU). There was a significant difference such that children randomized to camp lost -0.03 BMIz units, while those in SAU gained 0.07 BMIz units.⁶⁹ While effect sizes of these magnitudes will not reverse existing overweight or obesity, they do suggest that engaging children in summer interventions is feasible and that the prevention of excess summer weight gain is achievable, particularly among children from lower-income households.

Delivering annual interventions during a high-risk period like the summer would likely prevent excess weight gain among children at high risk for obesity. The evidence from summer-time interventions suggest that it is feasible to engage children outside of the school setting, and that lighter touch interventions, like summer camp, may be adequate to prevent excess summer weight gain.^{64,68,69} Summer day camps, particularly those run by community-based non-profits like the YMCA, the Boys & Girls Club, Boy Scouts of America and Girl Scouts, are widely available to children in the US and are well positioned to prevent excess summer weight gain. There are over 5000 summer day camps across the US, 91% of which offer financial assistance and scholarships.⁷⁰ Accordingly, this approach holds great promise as relates to obesity prevention. Partnering with existing summer camps to focus on the promotion of positive health behaviors, in addition to increasing program access (e.g., sliding scale fees, programs in accessible locations) to children at highest risk for

obesity is critical to effective summer intervention to decrease obesity-related health disparities.

4 | PULSED INTERVENTIONS

Given the potential for these brief intervention periods (e.g., puberty, summertime) to overcome time as a barrier to prior pediatric weight management interventions, one strategy that has shown promise in adults is the use of “pulsed” or “clustered” interventions. Pulsed interventions are periods of intensive intervention offered in discrete periods interspersed with periods without intervention delivery. This design, which allows for brief periods of instruction and skills training, followed by time for independent practice that can support the transition to habitual and sustained behaviors, may offer certain advantages over more traditional intervention delivery.⁷¹ Given that time is a common barrier to pediatric obesity treatment, a benefit of pulsed interventions is that they are a shorter commitment and may be a better fit with participant schedules.⁷² Relatedly, a shorter period of intervention may protect against other life demands taking precedence over treatment activities and waning motivation, which can lead to attrition.⁷³ Behavioral weight loss intervention (BWL) studies in adults have generally shown that pulsed interventions produce comparable outcomes to traditional interventions when matched for time. As adult caregivers are often active participants in pediatric weight management interventions, findings from adult research on pulsed interventions likely have direct applications in considering methods for delivering child-focused BWLs. Wing and colleagues found that a 14-session BWL offered weekly, with a 6 weeks break in the middle, or with 3 two-week breaks throughout, showed no differences in overall weight loss among participants in the three conditions.⁷⁴ Similarly, Jeffery and colleagues (2009) found that participants who completed six 8-week intervention session clusters interspersed with 4-week breaks had slower weight loss than a traditional tapered BWL, but better weight maintenance.^{75,76}

To our knowledge, studies of pulsed interventions related to weight management have not been completed in children; however, future research in this area could be valuable and may provide avenues to more feasible interventions for childhood obesity prevention and treatment. In the development of pulsed interventions for children, it is critical to consider the approach and goals of such an intervention. This is not proposed to be a brief period of extreme calorie reduction; rather, treatment activities and recommendations would mirror existing evidence-based programming in which there is strong focus on improving diet quality, decreasing high-calorie foods, and increasing enjoyable physical activity for the child over the long-term. The treatment breaks would offer opportunities for individual skill practice that could promote the sustainability of these newly learned behaviors and promote the sustainment of changes over the long term. Time-limited interventions may be particularly relevant for children from lower-income households, given that they reduce the time demands of traditional obesity treatment programs. Pulsed

interventions are consistent with the treatment of other pediatric health conditions, such as asthma, where a brief period of intervention (e.g., corticosteroid) is prescribed during high-risk periods for exacerbation.⁷⁷ However, given that pulsed or time-limited interventions have not yet been tested in pediatric populations, it is unclear the extent to which intervention effectiveness may translate to brief intervention periods.

5 | CONCLUSIONS

The USPSTF guidelines clearly define the gold-standard approach to childhood obesity treatment as multicomponent programs that provide 26-contact hours comprised of nutrition and physical activity targets supported by behavioral strategies. While evidence supports the efficacy of these programs, barriers of cost, access, time, and retention persist and contribute to disparities in obesity prevalence and severity.⁷⁸ For adolescents with severe obesity, further intervention (e.g., surgical or pharmacological) may be indicated^{16,79}; however, the alternatives presented herein may have potential to help overcome some obesity prevention and treatment barriers, particularly for children with overweight or for those whose BMI has recently crossed the 95th percentile. With respect to obesity treatment, interpreting growth patterns and the timing of the pubertal growth spurt to inform when to intervene has the potential to improve the likelihood of weight stabilization by capitalizing on the increased energy demands created by growth. Future research is needed to utilize this approach, first, to identify how best to predict periods of growth and, second, to determine what type of brief behavioral intervention is most effective and acceptable. Given the risk for disordered eating pathology in adolescence, particular care must be taken in addressing weight and weight-related behaviors in this age group.⁸⁰ Further, future research should consider the need to promote healthy weight without perpetuating weight stigma.⁸¹ Pulsed interventions have the potential to minimize the risk of other life demands taking precedence over treatment activities and waning motivation, which can lead to attrition. This may be especially relevant for families from lower-income households, for whom time has been listed as a consistent barrier to treatment.⁸² Additional research is needed to determine whether optimizing the delivery of time-limited interventions is an effective alternative to longer-term interventions that align with the USPSTF guidelines.

AUTHOR CONTRIBUTIONS

E. Whitney Evans: Conceptualization; writing – original draft; writing – reviewing and editing. **Katherine E. Darling:** Conceptualization; writing – original draft; writing – reviewing and editing. **Amy Egbert:** Conceptualization; writing – original draft; writing – reviewing and editing. **Jacqueline F. Hayes:** Conceptualization; writing – original draft; writing – reviewing and editing. **Elissa Jelalian:** Conceptualization; writing – original draft; writing – reviewing and editing. **Jennifer Warnick:** Conceptualization; writing – original draft; writing – reviewing and editing. **Lisa Swartz Topor:** Writing – original draft;

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CONFLICT OF INTEREST STATEMENT

Andrea Goldschmidt consults for Thrive Behavioral Health.

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