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Challenges and Opportunities in Diagnosis and Management of Cardiometabolic Risk in Adolescents

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Abstract

Purpose of Review This review aims to elucidate the limitations of diagnosing metabolic syndrome in adolescents as well as challenges and opportunities in the identification and reduction of cardiometabolic risk in this population.

Recent Findings There are multiple criticisms of how we define and approach obesity in clinical practice and scientific research, and weight stigma further complicates the process of making and communicating weight-related diagnoses. While the goal of diagnosing and managing metabolic syndrome in adolescents would be to identify individuals at elevated future cardiometabolic risk and intervene to reduce the modifiable component of this risk, there is evidence that identifying cardiometabolic risk factor clustering may be more useful in adolescents than establishing a cutoff-based diagnosis of metabolic syndrome. It has also become clear that many heritable factors and social and structural determinants of health contribute more to weight and body mass index than do individual behavioral choices about nutrition and physical activity. Promoting cardiometabolic health equity requires that we intervene on the obesogenic environment and mitigate the compounding effects of weight stigma and systemic racism.

Summary The existing options to diagnose and manage future cardiometabolic risk in children and adolescents are flawed and limited. While striving to improve population health through policy and societal interventions, there are opportunities to intervene at all levels of the socioecological model in order to decrease future morbidity and mortality from the chronic cardiometabolic diseases associated with central adiposity in both children and adults. More research is needed to identify the most effective interventions.

Keywords Cardiometabolic risk · Adolescents · Obesogenic environment · Weight stigma · Metabolic syndrome · Obesity

Introduction

While the current use of body mass index (BMI) alone to define obesity is flawed, it is important to acknowledge the rising global prevalence of central adiposity associated with insulin resistance, dyslipidemia, and hypertension which has contributed to significant cardiovascular morbidity and mortality [1–4]. This cluster of chronic diseases, now known commonly as metabolic syndrome, was noted in adults as early as the 1940s and has been given different names with varying definitions since then [5]. In 1988, Reaven noted that insulin resistance was associated with hypertriglyceridemia, decreased high-density lipoprotein (HDL), hypertension, and an increased risk for coronary artery disease and named this cluster syndrome X [6]. In 1989, Kaplan highlighted the importance of central adiposity in addition to hypertension, diabetes, and hypertriglyceridemia in what he called the deadly quartet for cardiovascular risk [7]. In the decades since then, multiple researchers and organizations have proposed varying names and definitions for the cardiometabolic risk associated with central adiposity—with the American Association of Clinical Endocrinologists (AACE) and American College of Endocrinology (ACE) most recently proposing adiposity-based chronic disease (ABCD) in 2017 and cardiometabolic-based chronic disease (CMBCD) in 2020 [8, 9•].

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This constellation of chronic diseases which was previously found mainly in adults has become increasingly common in children and adolescents, and much has been described about the pathophysiology, risk factors, clinical features and assessment, and common comorbidities of metabolic syndrome in adolescents [10–14]. While the goal of diagnosing and managing metabolic syndrome in adolescents would be to identify individuals at elevated future cardiometabolic risk and intervene to reduce the modifiable component of this risk, there is evidence that this diagnosis may have limited utility in this population [4]. This review aims to elucidate the limitations of diagnosing metabolic syndrome in adolescents as well as challenges and opportunities in the identification and reduction of cardiometabolic risk in this population.

Challenges in Cardiometabolic Risk Stratification

Fear of Reinforcing Weight Stigma

Weight stigma complicates the process of making and communicating weight-related diagnoses including overweight, obesity, and metabolic syndrome. Weight stigma is a well-established concept defined by Tomiyama et al. as "social rejection and devaluation that accrues to those who do not comply with prevailing social norms of adequate body weight and shape" [15]. Due to the societal prevalence of weight stigma, many individuals experience negative healthcare interactions related to weight—despite the evidence that weight stigma does not promote positive health behavior change and instead contributes to worse outcomes [15]. Given this context, even when a provider approaches a conversation about weight with appropriate empathy and sensitivity, a diagnosis of overweight or obesity can feel morally charged and reflective of judgement [15–18]. As adolescence is a vulnerable and critical period in development, the fear of reinforcing weight stigma and triggering or exacerbating poor self-image or unhealthy weight control behaviors may add to other logistical barriers in contributing to the underdiagnosis and subsequent undertreatment of pediatric and adolescent obesity [19–23]. A decrease in societal weight stigma would facilitate the nonjudgmental diagnosis and prevention of cardiometabolic risk associated with central adiposity, and clinicians should be leaders in mitigating weight stigma in their own practices and advocating for broader societal changes in part by accessing training and education which address this issue [24].

Limitations of Using Obesity Alone

Although BMI is easily measured and ubiquitous, there are multiple criticisms of the definition of and approach to obesity in clinical practice and scientific research [16, 25, 26]. The definition of obesity based only on BMI, which was first described by Quetelet in 1832 as the ratio of the weight in kilograms divided by the square of the height in meters and later named by Keys in 1972, has clear limitations [27, 28]. Body composition and the distribution of adiposity can vary greatly among individuals with the same BMI, and not accounting for variations by race/ethnicity and sex can make BMI thresholds particularly inaccurate in predicting future disease [29, 30]. Although diagnoses of overweight and obesity based on BMI have many limitations, a subset of such individuals, particularly those with central adiposity, are at elevated risk of developing chronic cardiometabolic diseases including diabetes, hypertension, hyperlipidemia, and atherosclerotic cardiovascular disease. Not identifying these individuals limits our ability to intervene and decrease any of this modifiable risk.

Issues with Diagnosing Metabolic Syndrome

Diagnosing metabolic syndrome is one option for identifying elevated cardiometabolic risk. While many definitions have been proposed for metabolic syndrome in children and adolescents, there is no established consensus definition [31]. In 2007, the International Diabetes Federation (IDF) published a consensus report with global diagnostic criteria which recommended against making the diagnosis before age 10 and required central obesity based on waist circumference (WC ≥ 90th percentile or adult cutoff if lower in adolescents age 10–15 and using ethnic-specific adult WC cutoffs in adolescents age 16 +) plus two of the following: hypertriglyceridemia, low HDL-C, hypertension, or evidence of impaired glucose metabolism with elevated fasting glucose or known type 2 diabetes [32].

Although the IDF urged the development of ethnic-specific normal ranges for waist circumference as part of this report, ranges which account for ethnic and national differences across adolescent populations have not been developed or broadly available, though this need has been recently re-emphasized [33–35]. Before metabolic syndrome could be systematically diagnosed in adolescents, multiple ranges of waist circumference would need to be published and validated, if not fully integrated into the electronic health record, in order to assess whether adolescents meet percentile-based or cutoff-based criteria. Furthermore, despite some practice guidelines recommending the measurement of waist circumference in particular patient populations, waist circumference is not routinely measured in the clinical setting, and members of the clinical team would need to be trained to measure it in a validated and reproducible way [36, 37].

Added Utility of Metabolic Syndrome Diagnosis

While the logistical barriers to diagnosing metabolic syndrome in adolescents could be surmountable, there is uncertainty around whether metabolic syndrome is a useful

construct in adolescents. There is evidence that the cut-off-based diagnosis of metabolic syndrome can be highly unstable in adolescents and result in many individuals who met criteria at one point not meeting criteria at a later point despite not having lost weight; this instability can manifest over weeks or years and may be partially explained by normal changes in insulin resistance as a result of puberty [38–41]. Based on these and other factors, the American Academy of Pediatrics (AAP) in 2017 suggested shifting the focus from establishing a cutoff-based diagnosis of metabolic syndrome to using cardiometabolic risk factor clustering and associated risk factor screening to identify adolescents with overweight or obesity who are at elevated risk for developing cardiometabolic disease [4]. The lasting benefit of adult diabetes prevention programs suggests that intervening effectively to identify and address clustered risk factors in adolescence is likely to provide durable benefits over time [42].

Challenges and Opportunities in Intervening for Prevention and Management

Once recognized, the treatment of metabolic syndrome consists of treating obesity as well as the components of abnormal glucose metabolism, dyslipidemia, and hypertension if present. While the additional utility of diagnosing metabolic syndrome in adolescents is unclear, the American Heart Association (AHA) and National Heart, Lung, and Blood Institute (NHLBI) recommend prioritizing early treatment of obesity as a foundational component of reducing associated cardiometabolic risk [43, 44]. Given this, the remainder of this section will be focused on challenges and opportunities in intervening to prevent and manage obesity in adolescents.

Barriers to Intervening in Clinic

It is commonly accepted that pediatricians and other primary care clinicians are in a unique position to diagnose and treat individual adolescents in the context of their families and communities through measuring and trending BMI, counseling about lifestyle modifications through motivational interviewing, prescribing pharmacotherapy when appropriate, and referring to comprehensive multidisciplinary intervention programs when these are available [45–47]. However, there are many barriers to effectively diagnosing and treating overweight and obesity in pediatric primary care; these encompass staff factors including knowledge and competence, professional-parent/patient interaction factors including risk to therapeutic relationship when raising a sensitive topic in the setting of insufficient trust, organizational factors including limited time and contact opportunities, and lack of available treatment programs and resources [19, 20]. The AAP recommends referral to intensive health behavior and lifestyle treatment, ideally with 26 or more hours of contact over a 3- to 12-month period [47]. Qualitative work has shown that providers sometimes feel a sense of futility about their ability to make a difference in trying to address such a complex issue as well as frustration about limited availability of resources for referrals [48–51].

The Obesogenic Environment: a Complex Systemic Issue

It has become clear that many heritable factors and social and structural determinants of health as part of an obesogenic environment contribute more to weight and BMI than do individual choices about nutrition and physical activity [15, 52–56]. Some of these factors are depicted in Fig. 1, adapted from the socioecological model [57–59]. As shown, the weight of an individual is influenced by variables at an individual, interpersonal (most often family), organizational (frequently school and in some cases clinic), community, and societal/policy level—most of these variables are outside of a particular adolescent or family's control. Structural and social determinants of health (SDOH) including food insecurity, education, access and affordability of less processed food, and housing instability can influence both the risk of developing obesity as well as the ability of adolescents and their families to implement recommended lifestyle modifications related to nutrition and physical activity [60, 61, 62••]. Adolescents with excess weight are more likely to have been born to a person with overweight or obesity who may not have had access to paid parental leave or other support for breastfeeding, more likely to have been exposed to adverse childhood experiences (ACES) and chronic stress, more likely to have experienced food insecurity and/or housing instability, more likely to have grown up in a segregated neighborhood affected by a food swamp or food desert, and less likely to have access to reliable transportation and caregivers whose work environments facilitate cooperation with intensive behavioral interventions [62••, 63–66, 67••].

It is well documented that structural racism has enormously detrimental effects on the health of minoritized children and adults in the USA [68–73]. The harms of racism influence weight across the lifespan and at every level of the socioecological model [55, 56, 67••, 74–77]. While significant racial disparities in obesity and cardiometabolic disease—particularly notable for increased prevalence in Black, Latiné, and indigenous youth—long preceded the ongoing COVID-19 pandemic, these disparities have been further highlighted and exacerbated in the last few years [78–83].

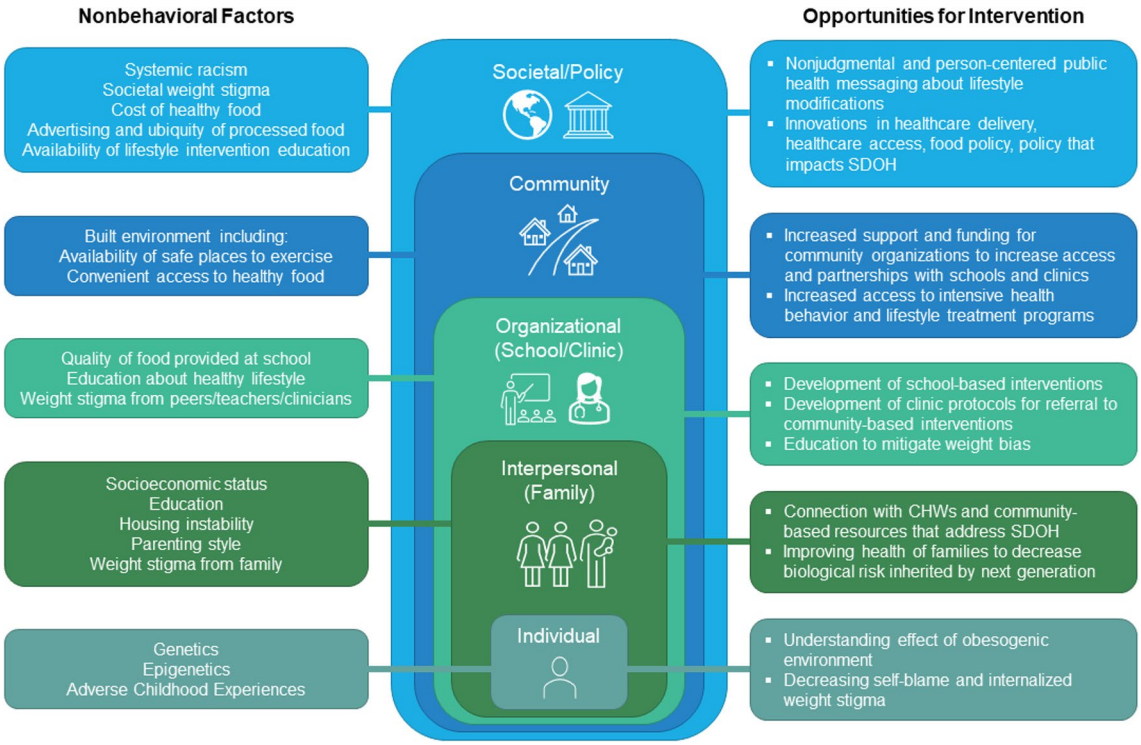

Fig. 1 Adapted socioecological model of the obesogenic environment for adolescents with nonbehavioral factors (to the left) and opportunities for intervention (to the right) at the individual, interpersonal, organizational, community, and societal/policy levels. CHWs, community health workers; SDOH, social determinants of health

Opportunities for Intervention

Clinic-Based Interventions

It is important for clinicians to approach conversations related to weight without judgement and acknowledge the complex effects of the obesogenic environment [19, 20, 24]. While more research is needed on the most effective ways to decrease implicit and explicit weight stigma among clinicians, providers can avoid stigmatizing language and imagery, learn and implement adolescents' preferences for weight-related conversations, and provide appropriately sized medical equipment and furniture [17, 84–86]. Consistent nonjudgmental and person-centered anticipatory guidance and motivational interviewing about health behaviors including nutrition and physical activity are foundational to pediatric primary care and a necessary, although insufficient, part of obesity prevention [87–89]. The development and implementation of clear protocols for evaluation, treatment, and referrals to intensive lifestyle intervention programs, specialty clinics, and school-based and community-based interventions could promote clinician confidence and likelihood of identifying and addressing diagnoses of overweight, obesity, and elevated cardiometabolic risk [47, 90]. Since obesity in children and adolescents is strongly linked with obesity in parents, family weight management programs provide opportunity to intervene at both individual and interpersonal levels [91–93]. Further research is needed to determine the most effective changes to our current model of healthcare delivery.

School-Based Interventions

Given their ability to provide consistent access to children and adolescents which is less dependent on healthcare access or family transportation, schools have been a natural setting for pediatric weight management interventions [94–97]. School-based interventions which address nutrition and physical activity with some home involvement as well have proven most effective [98]. The HEALTHY study identified the complex challenges involved in conducting weight and diabetes risk interventions in schools and showed promise in decreasing adiposity [99].

Community-Partnered Interventions

Community-based interventions are another important resource. Community organizations and partnerships can help address many social determinants of health as well as provide a setting for weight-specific education and interventions [100–102]. It is important for social needs interventions

to acknowledge and address the impact of racism to more effectively promote equity in cardiometabolic health [103]. Community health workers represent another opportunity to provide motivational interviewing about health behaviors, identify barriers related to SDOH, and make connections to both community resources and clinical care—multiple such interventions have been attempted and studied with a meta-analysis in 2018 showing a small but significant impact on BMI percentile although significant heterogeneity limited the ability to definitively identify best practices [104].

Policy Interventions

Policy interventions encompass policy that impacts healthcare delivery; impacts food availability, quality, and affordability; and impacts SDOH. Some of the barriers to clinic interventions which were previously described could be addressed by policies supporting increased access to healthcare and multidisciplinary care teams including dieticians, social workers, psychologists, and community health workers as well as subsidized referral options for intensive health behavior and lifestyle treatment programs [105–108]. Food policy opportunities include decreasing food insecurity by increasing access to food; making healthy food choices available through the Supplemental Nutrition Assistance Program (SNAP) and Special Supplemental Nutrition Program for Women, Infants and Children (WIC); promoting healthy school lunch options through the National School Lunch Program (NSLP) and School Breakfast Program (SBP), as well as regulating the advertising, affordability, and availability of ultra-processed versus nutritionally dense food [109, 110]. Finally, policy that impacts weight also includes policy addressing the myriad of factors that affect the obesogenic environment such as poverty, housing discrimination, neighborhood safety, education, and transportation among many others [55, 56, 111]. Aligned multisector approaches are needed to address obesity and related risk factors in adolescents; such approaches show promise when successfully implemented [112].

Conclusions/Future Directions

Although the existing options to diagnose and manage future cardiometabolic risk in children and adolescents are flawed and limited, we must intervene to decrease future morbidity and mortality from the chronic cardiometabolic diseases associated with central adiposity in both children and adults. While the ultimate goal is to improve population health through policy and societal interventions, there is an urgent need to stratify risk given limited resources and to identify and implement effective interventions at all levels of the socioecological model (see Fig. 1). Two priorities are mitigating the compounding effects of weight stigma and systemic racism to promote cardiometabolic health equity.

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Declarations

Conflict of Interest The authors declare no competing interests.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- • Of importance
- •• Of major importance

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