The Importance of Addressing Multilevel Transactional Influences of Childhood Obesity to Inform Future Health Behavior Interventions

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KEYWORDS

• Obesity prevention • Child health • Risk factors • Multi-level interventions

KEY POINTS

- Although past research has identified numerous factors related to obesity, such factors are typically evaluated in isolation, which provides a limited understanding of how these factors work together across systems.
- This article synthesizes past research on childhood obesity into a coherent model of the etiology of obesity to support a broader conceptual basis for understanding the etiology of obesity and to inform future health behavior interventions.
- We provide an overview of the multi-level, transactional influences on childhood obesity by reviewing recent research on genetic, biological, cognitive, sociocultural, social determinants, and intrapersonal regulatory processes.
- We highlight the usefulness of using a theoretic framework that includes the ecological model to identify the mechanisms that may reinforce social nurturance and the promotion of positive social environments across contexts.
- Finally, we provide a series of examples of multi-level transactional interventions for improving childhood weight-related behaviors and outcomes, including interventions that intervene within community, school, and health care settings.

Across the past 2 decades, the emergence and persistence of worldwide obesity have led to numerous empirical studies on understanding the origins of childhood obesity and other related health outcomes. The prevalence of obesity increases from

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Pediatr Clin N Am 69 (2022) 657–669
https://doi.org/10.1016/j.pcl.2022.04.003
pediatric.theclinics.com

childhood through adolescence, ranging from 13.9% of children ages 2 to 5, to 18.4% of children ages 6 to 11, and 20.6% of adolescents ages 12 to 19.[1] Approximately 80% of adolescents with obesity continue to have obesity in adulthood,[2] which increases the risk for health complications across the lifespan, including cardiovascular disease, type 2 diabetes, cancer, and premature death.[3–5] Such findings highlight the critical need to understand the causes and correlates of obesity to better identify and develop effective interventions to prevent obesity.

A growing evidence-base demonstrates the independent contributions of several obesity-related person- and context-level factors. These factors range from genetic, biological, cognitive, and sociocultural factors. More specifically, these factors include stress-related life events, family processes, peer processes, and characteristics and climate of community/neighborhood, school, and home-related risk and protective factors. However, research has largely focused on these factors in isolation, without taking into consideration the other key influences within this developmental system, resulting in a loose array of diverse predictors of obesity without an understanding of how these factors operate together. This article aims to synthesize findings into a coherent model of the etiology of obesity to support a broader conceptual basis for understanding the etiology of obesity and to inform future health behavior interventions.

The emergence of obesity-related health behaviors and outcomes may be conceptualized using a transactional biopsychosocial ecological developmental model.[6,7] Drawing from Relational and Dynamic Systems life course perspectives of human development[8,9] and Bioecological/Ecological Models of health behavior specifically[9,10] this model highlights the dynamic interactions between individuals (ie, biological, intrapersonal characteristics) and their environments over time to promote and optimize health, but also postulates directional and temporal sequence and key transactions between key components of the developmental system. This model posits that biological factors and sociocultural contexts (eg, poverty) place certain children at greater risk in early life than others, but life experiences (eg, social determinants including parenting, peers, neighborhood, school) function to moderate and/or mediate this level of risk. That is, reciprocal coactions between biological/genetic characteristics, contexts, and life experiences lead to recursive iterations across time that exacerbates or diminish an individual's level of risk for developing obesity and comorbidities (**Fig. 1**).

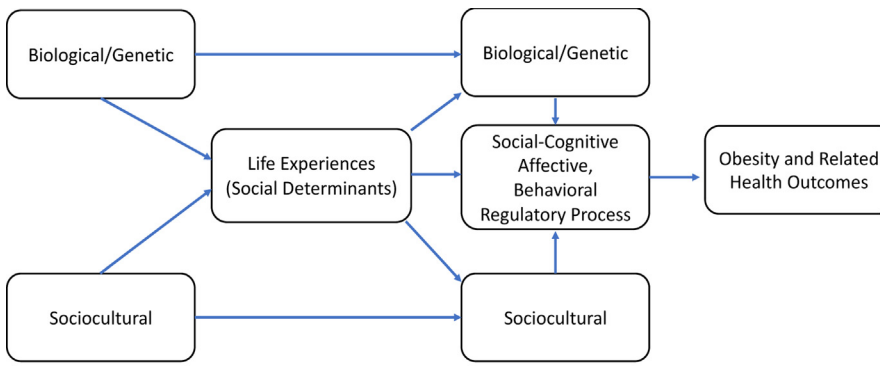

Fig. 1. Transactional biopsychosocial echological developmental model of the etiology of obesity.

As depicted in Fig. 1, early biological/genetic characteristics and sociocultural factors directly influence health-related life experiences, and in a transactional way, these life experiences, in turn, influence the development and later expression of biological and genetic characteristics (ie, reinforce or alter epigenetic processes) and sociocultural factors (eg, access to health care). Together, transactions that occur over time between biological/genetic and sociocultural factors with life experiences shape children's health-related social-cognitive, affective, and behavioral regulatory processes and consequent health outcomes. The role of the health care providers in promoting positive social environments across contexts to reduce childhood obesity has become of increasing interest in health promotion. Although in isolation, only a small proportion of reductions in long-term morbidity is explained by access to health care.[11] Thus, models are needed to integrate the health care sector into broader community-based trials, which we highlight through our focus on ecological systems as a framework.

Health is not predetermined but is actively construed through the choices and actions that individuals' take within the range of resources and constraints of their biological and contextual situations across time. Thus, social, cognitive, affective, and behavioral regulatory/motivational processes within the child are proposed to mediate the relation between life experiences and health outcomes. Key characteristics of the individual including health-based self-concepts and identities, self-efficacy, and expectancies for the future achievement of one's health-based goals, as well as one's interest/value of health promotive or compromising behaviors have been identified as primary predictors of individuals' engagement in health behaviors.[12–14] These intrapersonal processes are highly influenced by biological/genetic factors, contexts, and life experiences and thus, typically support continuity of risk pathways. However, they can also function as protective factors and are common mechanisms targeted in behavioral interventions to mitigate risk.[15–18] Example studies cover a vast range of health-promoting behaviors including dietary modifications through fostering youth self-efficacy for healthy eating,[17,19,20] building efficacy for engaging in physical activity[21] and fostering efficacy through key change agents to impact physical activity and wellbeing within youth settings.[16,18,22]

In this model, there is no single causal agent for obesity, but rather obesity results from multiple diverse risk and promotive factors. The various potential relations between these diverse factors indicate that there are numerous pathways that may link to obesity, and thus, that there are likely multiple different obesity etiology subtypes, each with its own unique developmental pathway. Across the past decade, research adopting a biopsychosocial[23] or relational systems perspective[8,9] that considers multiple systems of influence across development has uncovered some important transactions between biological and sociocultural factors, social determinants, and intrapersonal processes to inform critical points of intervention during the developmental years.

BIOLOGICAL, SOCIOCULTURAL, SOCIAL DETERMINANTS, AND INTRAPERSONAL REGULATORY PROCESSES

Health is a process that develops over the lifespan with the prenatal through adolescent years viewed as a critical time in the lifespan for the acquisition and optimization of health capacities that set the course for health through adulthood. These are particularly formidable years in which individuals are highly dependent on the degree of access they have to external environmental resources to establish and maintain optimal health functioning.[9,24] Therefore, under optimal developmental conditions, this early part of the lifespan through adolescence can be used to invest in future health

potentials and build health "reserves" to help offset the impact of declines experienced in later life.[24]

Within this framework, obesity pathways are conceived as driven by cumulative risk or protective processes with the development of earlier health promotion/compromising behaviors influencing one's capacity for later health and wellbeing. Risk for obesity begins before conception with a woman's access to resources/health habits and reproductive health (eg, nutrition, neural-hormonal environment) and continues postconception with transactions between maternal prenatal health and resources and fetal and postnatal development.[25] Specifically, past research has shown that biological and sociocultural factors including mother's weight status before pregnancy, gestational weight gain, nutritional constraint/undereating during pregnancy, and an infant's birth weight, as well as early postnatal life experiences of overnutrition/overfeeding are strongly associated with risk of developing obesity later in childhood.[26] Increasing evidence suggests that father's health and wellbeing are also important for fetal, infant, and childhood health with paternal depression, anxiety, and stress shown to influence prenatal development indirectly through the impact it has on maternal stress and experiences during pregnancy,[27,28] and may make significant and unique direct contributions to infant's postpartum physiologic regulatory functioning independent to the impact of maternal stress and wellbeing.[29,30] Thus, biological and life experiences alter epigenetic processes within the fetus/infant that lead to long-term changes in metabolism (eg, through genes that impact lipid, carbohydrate metabolism, appetite-energy balance, insulin resistance, inflammatory response),[26] shape affective, social-cognitive, and behavioral processes around eating (eg, food preferences, eating schedules) and physical activity, all of which can further reinforce parental health promotion and feeding practices and perpetuate risk for obesity in a transactional way.

Likewise, sociocultural influences such as poverty, food insecurity, racial discrimination, lack of neighborhood resources, have been shown to impact parental stress which prompts similar effects on fetal and postfetal epigenetic processes and development (ie, low birth weight) and cascading transactional processes on intrapersonal factors and risk for obesity.[31,32] Such findings highlight the importance of addressing access and quality of women's health care (pregestational, prenatal, postnatal care) and for developing interventions to support positive parenting and to reduce parental stress including consideration for the broader environmental and social factors that drive chronic stress (eg, discrimination, poverty). There is a growing interest in addressing the stress and coping of underserved communities to reduce obesity-related risk in early childhood.[33]

These early prenatal/postnatal developmental experiences that either support or hinder the development of personal capacity (ie, physical, social, cognitive assets) continue to cumulate through the childhood and adolescent years and determine the degree to which individuals are capable of effectively interacting with their biological, physical, and social environments to optimize their health trajectories and to adapt to any unanticipated or expected challenges. Similarly, early disruptions in capacity development can set in motion a cascade of developmental processes that result in an individual's reduced capacity to optimize their health potential. However, life experiences and the exposure and degree of influence of key social determinants change as youth develop, offering opportunities for youth to "change course" in terms of their personal capacity to optimize health and offset risk for obesity. For example, during infancy through childhood, individuals have the greatest dependency on parents and other caregivers and thus risks and promotive factors embedded within the family system are likely to have the greatest influence on health.[34]

Furthermore, previous research has demonstrated that an authoritative (autonomy-supportive) parenting style that supports attachment, warmth, and the development of self-regulation skills, as well as positive parental feeding practices (eg, parental monitoring of diet) and physical activity practices (eg, role modeling, values) are highly influential on children's physical activity and dietary intake.[17,35,36] At the other extreme, exposure to adverse experiences, such as violence or maltreatment, or day-to-day impoverished interactions between parent and child due to parent depression, economic hardship, and/or stress during is associated with lifelong health risk behaviors and outcomes including obesity, heart disease, and type 2 diabetes.[34,37,38] However, the influence of other social systems (ie, school policies, teachers, peers, and daycare/aftercare) can play a role in supporting youth health behaviors, values, and regulatory processes. These processes operate to reinforce positive transactions within the home context that support health capacity and mitigate risk for obesity by forming new types of transactions between youth and biological, sociocultural, and life experiences.

As youth develop through adolescence, their increased orientation toward and interactions with peers also function to exacerbate the impact of social and cultural systems on youths' health behaviors.[39,40] Previous research has demonstrated the powerful influence that adolescents' peers and friends have on their health promotive[41] and risky behaviors[42] through a variety of mechanisms including direct modeling effects and normative influences. However, transactions between peer experiences and other key social systems, like family are whereby there is the greatest influence. For example, in a diverse middle school sample of youth[43] investigators found significant interactions between peer social functioning and familism (support/connections from family) whereby the positive effect of peer social functioning on healthy eating was greater for those youth who reported higher (vs lower) familism. Peer influences have also been shown to interact with other key social systems and life experiences to either reinforce existing transactional processes or set in motion new transactional processes. For instance, neighborhood socioeconomic deprivation has been shown to be significantly associated with higher fat mass and increased likelihood of overweight/obesity among adolescents. These relations hold even after accounting for youth key health behaviors (ie, physical activity, sedentary behavior, diet quality, demographics),[44] indicating that health behaviors do not fully explain the relations between neighborhood deprivation and weight status.

In summary, theoretic, and empirical research support the importance of taking a future-orientated approach to health promotion that addresses biological, sociocultural, contextual, and intrapersonal risk and protective factors and their cumulative, and transactional, impact on youths' health trajectories.

THEORETIC FRAMEWORKS FOR MULTI-LEVEL TRANSACTIONAL INTERVENTIONS

The transactional biopsychosocial ecological approach emphasizes the importance of addressing the transactional relationship between individuals and their environments over time.[23] This framework advocates for multi-level interventions that address individual-level characteristics (eg, behavioral skills, coping strategies), social-environmental factors (eg, social groups, cultural influences), *and* broader community and environmental factors (eg, policy, neighborhood access), as the most effective approach for promoting health behavior change,.[10,45]

Aligned with biopsychosocial ecological theories,[8,10] we also propose that to effectively increase health-promoting behaviors it is important to understand the mechanisms that may reinforce social nurturance and the promotion of positive social

environments across contexts.[46] Growing evidence suggests that interventions that integrate family systems, motivational, and behavioral theories are likely to have greater success in producing positive health behavior changes.[20,46,47] Family Systems Theory (FST) emphasizes the importance of parental nurturance and monitoring to promote shared-decision making as youth transition into young adulthood.[20,48] Consistent with FST, Self-Determination Theory (SDT) also emphasizes the importance of the social environment for promoting an individual's long-term motivation for health behavior change, including the need for autonomy, competency, and relatedness across a variety of social contexts. These include interactions with health care providers, family, and friends.[13,49] Social Cognitive Theory (SCT) proposes that the self-regulation of health behaviors is shaped, in part, by broader social and structural impediments to change, including impediments rooted in the inequitable delivery of health services.[12,15] Thus, we argue for a transactional biopsychosocial ecological model[6,7] that integrates elements from FST,[48] SDT,[13] and SCT[12,15] to better understand how individual-level behavioral skills and autonomous motivation, family-level support, and communication, as well as other key socializing agents and contexts (eg, health care, school, peers), are shaped by and help shape later biological characteristics and influence how youth interact with the broader social environment and life experiences, to facilitate health.

Many past studies have not been successful, and we argue, through the examples provided later in discussion, for more multilevel (systems) approaches to address the broad range of influences on the development and prevention of early childhood obesity.

EXAMPLES OF HEALTH BEHAVIOR INTERVENTIONS THAT INTEGRATE COMMUNITY COMPONENTS

An example of a community-based multi-level intervention is the 'B'More Healthy Communities for Kids' study, a cluster-randomized controlled trial that aimed to prevent obesity among youth ages 9 to 15 years by improving household purchasing of healthy food and dietary intake.[50] The intervention targeted multiple systems, including individual, interpersonal, environmental, and policy-related changes. Community "zones" consisting of a recreation center in a low-income predominantly African American neighborhood in the Baltimore area were randomized to the multi-component environmental intervention or served as a comparison. The intervention involved partnerships between recreation centers and local corner stores and/or carryout restaurants within walking distance. The recreation centers implemented a peer-led nutrition educational program targeting healthier beverages, snacks, and cooking methods. Complementing this approach, the corner stores were incentivized to stock and promote healthier food items, and social media was used to engage caregivers (eg, sharing recipes, advertising upcoming events). Caregivers also received text messages with information about goal-setting strategies and tips for implementing healthy eating strategies. City stakeholders were encouraged to support policies to sustain a healthy community food environment.[51]

At the end of the 5-year trial, youth in the intervention significantly increased their purchasing of healthier foods and beverages, with this effect being more pronounced among younger adolescents.[52] Among older adolescents, there was a significant reduction in the percentage of calories from sweet snacks and desserts. This trial highlights the value of intervening within community settings, addressing the community food environment, and engaging both adolescents, caregivers, and stakeholders through a range of individual, interpersonal and environmental strategies.

Another example of a multi-level intervention is "Shape Up Summerville," a community-based participatory study that tested whether an environmental intervention could prevent obesity among early elementary school children.[53,54] In a 2-year trial, 3 socio-demographically matched communities participated, with 2 acting as controls and one receiving the environmental intervention. The environmental intervention was designed to promote enhanced opportunities for physical activity and healthy eating by intervening across multiple systems and contexts, including targeting changes at school, at home, and through broader community initiatives/policies. Intervention activities included a walk to school program, increased access to healthy foods in school cafeterias, delivery of an after-school curriculum targeting greater physical activity and healthy snacks, parent outreach and education, partnering with local restaurants to promote healthy menus, and the development of community-based policies to promote long-term sustainability (eg, wellness programs, pedestrian safety). Multiple groups and organizations within the community were involved in the delivery of the intervention, including children, parents, teachers, before and after-school staff, school food-service providers, policy makers, health care providers, restaurants, and local media.

After 1 year of intervention delivery, children in the intervention community demonstrated a greater decrease in their body mass index (BMI) z-score than those in the control communities,[53] which was sustained through 2-year follow-up.[54] Additionally, the intervention resulted in a significant reduction in sugar-sweetened beverage consumption, increased participation in sports and physical activity, and reduced screen time.[55] The positive impact of the intervention also extended to parents, as demonstrated by a significant decrease in parent BMI.[56] Taken together, the results from the Shape Up Summerville support the efficacy of intervening across multiple systems to promote the behavioral and environmental changes to prevent childhood obesity.

EXAMPLES OF HEALTH BEHAVIOR INTERVENTIONS THAT INTEGRATE HEALTHCARE COMPONENTS

One example of a multi-level intervention with a health care component is the Stanford GOALS study, a randomized controlled trial that tested the efficacy of a multi-component intervention relative to a health education program for reducing BMI among overweight/obese children (ages 7–11) from low socioeconomic status neighborhoods.[52] The multi-component intervention included a community-based after school sports program, a home-based behavioral counseling family component to promote healthy eating, reduce screen time, and behavioral counseling from a primary care provider. The study sample was primarily Latinx and thus the intervention was also culturally tailored to address cultural values, such as collectivism, familism, and religiosity. The multi-component intervention targeted a variety of processes, including individual factors (eg, behavioral skills training), interpersonal factors (eg, social belongingness, team sports), and environmental factors (eg, changes to the home environment).

Over the course of the 3-year study, children in the intervention gained less weight in the first 2 years of the intervention than those in the health education comparison group, but this effect was not sustained in 3 years.[52] Similar positive intervention effects were observed in the first 2 years of the program for physical activity, diet changes, and cardiometabolic risk factors. Although the overall retention rate was high, there was steady drop off in participation over time, which may explain why the treatment effect was not maintained. While the Stanford GOALS study was successful at promoting behavioral change across a 2-year period, these findings

highlight some of the challenges of engaging families long-term and the need to better understand how to best capitalize on partnerships across community and health care settings to promote maintaining healthy body weight.

Another example of a multi-level intervention with a primary care component is the "Now Everybody Together for Amazing and Healthful Kids" (NET-WORKS), a randomized trial that integrated home, community, primary care, and neighborhood intervention strategies to prevent obesity among preschool-age children.[57] Participants were recruited through primary care clinics, with the intervention being implemented across multiple settings, including brief counseling component delivered in pediatric primary care settings, a home-based program, community-based parenting classes and linking families to neighborhood and community resources for physical activity and healthy eating. The home-based program targeted positive parenting strategies, goal-setting, and home-based environmental changes to promote positive changes in healthy eating, physical activity, and screen time. The parenting classes were designed to build on the curriculum from the home-based program, while also providing an opportunity for enhanced social support. Additionally, primary care providers received updates from the home-based program on families' progress and delivered key messages to parents during their child's annual checkup visit.

Compared with usual care, children in the NET-WORKS intervention demonstrated significantly lower energy intake and television watching at 24 and 36 months. However, these behavioral changes do not seem to have facilitated significant changes in BMI as a change in BMI was not significantly different between the intervention and usual care at 24 or 26 months. Secondary analyses revealed that children who had overweight or obesity at baseline showed a greater decrease in BMI in the intervention than usual care at 36 months. Additionally, the intervention seems to have been more effective for Hispanic children (58.4% of the total sample) who demonstrated a lower BMI in the intervention at 36 months. The NET-WORKS study provides an example of how partnerships with health care providers can be used to facilitate recruitment and the reinforcement of key intervention elements. These results suggest that future multi-level interventions may benefit from tailoring toward baseline weight status and differences across racial and ethnic groups.

Another example of a multi-component intervention in a primary care setting is a trial by Resnicow and colleagues,[53] which targeted parents of overweight/obese children ages 2 to 8 years. This trial targeted health care providers and parents as 2 key ecological systems critical to obesity prevention. Pediatric offices were randomized to deliver 1 of 3 interventions: usual care; motivational interviewing sessions delivered by a primary care provider; or motivational interviewing sessions delivered by a primary care provider plus additional sessions delivered by a registered dietician (RD). Integrating elements from SDT,[13] motivational interviewing is a counseling style that promotes autonomous motivation and self-initiated behavioral change through techniques such as shared decision-making and reflective listening.[54] Additionally, integrating elements from SCT,[15] the motivational interviewing sessions included behavioral skills training to facilitate positive changes in diet and physical activity among families, included goal setting, self-monitoring, and problem solving. At the 2-year follow-up, youth whose parent received motivational interviewing and behavioral skills training from both a primary care provider and an RD had a significantly lower BMI than the usual care group. These results suggest that families may benefit most from nurturing environments that integrate autonomy support and behavioral skills training from multiple sources.

In another primary care setting obesity treatment trial, the "High Five for Kids" study,[55] children (ages of 2–6 years) were randomized to an integrated health care provider plus

family systems approach versus a usual care comparison. Primary caregivers were randomized to an SDT and SCT weight loss program or a usual care program. Ten pediatric facilities participated to test whether a family-based intervention delivered in a primary care setting would be successful in reducing BMI and obesity-related behaviors, such as television watching, and fast-food consumption among overweight/obese children. Health care providers at the pediatric offices were trained to integrate multiple medical care providers (nurse practitioners, physicians, medical assistants). The intervention specifically integrated motivational interviewing and targeted behavioral skills for promoting weight loss, including decreasing television viewing, and intake of fast food and sugar-sweetened beverages over 1 year.

After 1 year, there was no significant difference in BMI; however, the researchers found there was a significant reduction in the amount of time children viewed television in the intervention group relative to the usual care group.[56] Importantly, only half of the families completed 2 of the 6 sessions. In a post hoc analysis, the researchers found a significant change in BMI among girls, but not boys. This study highlights that although the intervention that integrated SDT and SCT had a positive impact on obesity-related health behaviors, future studies may need to consider further strategies for maximizing participant engagement and intervention dose through addressing broader social contextual factors beyond the health care setting. Specifically, while the above studies suggest that a multi-systems approach that integrates multiple practitioners and families into the interventions are critical for obesity prevention in young children, future studies should consider engaging broader community systems to reinforce long-term changes.

SUMMARY AND RECOMMENDATIONS

In this article, we advocate for a biopsychosocial ecological approach to health for understanding the early risk of obesity in youth that integrates a multi-level systems approach. We argue that positive health is actively construed through the choices and actions that youth take within the range of resources and constraints of their biological and contextual situations across time. Obesity pathways are conceived as driven by cumulative risk or protective processes with the development of earlier health promotion/compromising behaviors influencing one's capacity for later health and wellbeing. Risk for obesity begins before conception with access to resources/health habits and reproductive health (eg, nutrition, neural-hormonal environment) and continues postconception with transactions between paternal prenatal health and resources and fetal and postnatal development.[25] A critical focus is on the role of protective factors in early childhood through early adulthood that we argue comes from a broad range of social contextual factors including family, peers, teachers, and health care providers.

We provided examples of theoretic approaches to weight management and weight loss that integrate multi-level systems which demonstrated the efficacy and effectiveness of multi-level intervention approaches that engage youth, family, communities, and health care providers. While these studies begin to provide evidence of impact of addressing multiple systems including health care providers, families, and communities, the causal determinants of change are not well understood. Future research is needed to further address the mediators and mechanisms through which this transactional model can be used for the early prevention of childhood obesity. Further research will provide the evidence base to develop a comprehensive approach for developing policies to address early childhood social and environmental risk factors for obesity at a national level.

CLINICS CARE POINTS

- Health behavior interventions for treating childhood obesity show that it is important to include multiple systems including health care providers, families, peers, and community engagement to effectively improve health behaviors and weight loss in youth.
- While community-based trials have begun to integrate primary care sectors into their obesity prevention and treatment approaches for effective childhood weight loss, further efforts are needed to better understand long-term compliance.
- Family systems factors such as parental nurturance, monitoring, and role modeling are critical to address given these early childhood factors place children are greater risk or protection of developing obesity.
- Increasing evidence suggests that creating a positive social and supportive environment and integrating behavioral skills such as goal setting are critical intervention components across all systems for early childhood obesity prevention.

DISCLOSURE

All authors have nothing to disclose.

REFERENCES

1. Hales CM, Carroll MD, Fryar CD, et al. Prevalence of Obesity Among Adults and Youth: United States, 2015-2016. NCHS Data Brief 2017;(288):1–8.
2. Simmonds M, Llewellyn A, Owen CG, et al. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. Obes Rev 2016;17(2):95–107.
3. Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. Int J Obes 2011;35(7):891–8.
4. Franks PW, Hanson RL, Knowler WC, et al. Childhood Obesity, Other Cardiovascular Risk Factors, and Premature Death. N Engl J Med 2010;362:485–93.
5. Kelsey MM, Zaepfel A, Bjornstad P, et al. Age-related consequences of childhood obesity. Gerontology 2014;60:222–8.
6. Cicchetti D, Toth SL, Maughan A. An Ecological-Transactional Model of Child Maltreatment. In: Sameroff A, Lewis M, editors. Handbook of developmental Psychopathology. 2nd edition. Kluwer Academic/Plenum Press; 2000. p. 689–722.
7. Sameroff A, Chandler M. Reproductive risk and the continuum of care-taking casualty. In: Horowitz F, editor. Review of child development research. Chicago: University of Chicago Press; 1975. p. 187–244.
8. Bronfenbrenner U. Making human beings human: Bioecological perspectives on human development. Thousand Oaks, CA: Sage Publications; 2005.
9. Halfon N, Larson K, Lu M, et al. Russ S. Lifecourse health development: Past, present and future. Matern Child Health J 2014;18(2):344–65.
10. Sallis J, Owen N, Fisher E. Ecological models of health behavior. In: Glanz K, Rimer BK, Viswanath K, editors. Health behavior: theory, research, and practice. 5th edition. San Fransisco, CA: John Wiley & Sons; 2015. p. 43–64.
11. Kaplan R. More than medicine: the Broken Promise of American health. Cambridge, MA: Harvard University Press; 2019.
12. Bandura A. Social Foundations of Thought and action: a social cognitive theory. New Jersey: Prentice-Hall, Inc; 1986.

13. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol 2000;55:68–78.
14. Eccles JS, Wigfield A. Motivational Beliefs, Values, and Goals. Annu Rev Psychol 2002;53(1):109–32.
15. Bandura A. Health Promotion by Social Cognitive Means. Health Educ Behav 2004;31(2):143–64.
16. Zarrett N, Law LH, Wilson DK. Connect through PLAY: A randomized controlled feasibility trial in after school programs to increase youth physical activity. J Behav Med 2021;44:379–91.
17. Wilson DK, Sweeney AM, Van Horn ML, et al. The Results of the Families Improving Together (FIT) for Weight Loss Randomized Trial in Overweight African American Adolescents. Ann Behav Med 2022. https://doi.org/10.1093/abm/kaab110.
18. Zarrett N, Wilson DK, Sweeney A, et al. An overview of the Connect through PLAY trial to increase physical activity in underserved adolescents. Contemp Clin Trials 2022;114:106677.
19. Bestle SMS, Christensen BJ, Trolle E, et al. Reducing Young Schoolchildren's Intake of Sugar-Rich Food and Drinks: Study Protocol and Intervention Design for "Are You Too Sweet?" A Multicomponent 3.5-Month Cluster Randomised Family-Based Intervention Study. Int J Environ Res Public Health 2020;17(24):9580.
20. Wilson DK, Kitzman-ulrich H, Resnicow K, et al. An Overview of the Families Improving Together (FIT) for Weight Loss Randomized Controlled Trial in African American Families. Contemp Clin Trials 2016;42:145–57.
21. Olander EK, Fletcher H, Williams S, et al. What are the most effective techniques in changing obese individuals' physical activity self-efficacy and behaviour: a systematic review and meta-analysis. Int J Behav Nutr Phys Act 2013;10(1):29.
22. Toledano-González A, Labajos-Manzanares T, Romero-Ayuso D. Well-Being, Self-Efficacy and Independence in older adults: A Randomized Trial of Occupational Therapy. Arch Gerontol Geriatr 2019;83:277–84.
23. Adler RH. Engel's biopsychosocial model is still relevant today. J Psychosom Res 2009;67(6):607–11.
24. Li S-C, Freund AM. Advances in Lifespan Psychology: A Focus on Biocultural and Personal Influences. Res Hum Dev 2005;2(1–2):1–23.
25. Larqué E, Labayen I, Flodmark CE, et al. From conception to infancy — early risk factors for childhood obesity. Nat Rev Endocrinol 2019;15(8):456–78.
26. Lillycrop KA, Burdge GC. Epigenetic changes in early life and future risk of obesity. Int J Obes 2011;35(1):72–83.
27. Tanner Stapleton LR, Schetter CD, Westling E, et al. Perceived partner support in pregnancy predicts lower maternal and infant distress. J Fam Psychol 2012;26(3):453–63.
28. Vismara L, Rollè L, Agostini F, et al. Perinatal parenting stress, anxiety, and depression outcomes in first-time mothers and fathers: A 3-to 6-months postpartum follow-up study. Front Psychol 2016;7:938.
29. Gao M, Brown MA, Neff D, et al. Prenatal paternal stress predicts infant parasympathetic functioning above and beyond maternal prenatal stress. J Reprod Infant Psychol 2021. https://doi.org/10.1080/02646838.2021.1941822.
30. Van Den Berg MP, Van Der Ende J, Crijnen AAM, et al. Paternal depressive symptoms during pregnancy are related to excessive infant crying. Pediatrics 2009;124(1):e96–103.

31. Cao-Lei L, Dancause KN, Elgbeili G, et al. DNA methylation mediates the impact of exposure to prenatal maternal stress on BMI and central adiposity in children at age 13 1/2 years: Project Ice Storm. Epigenetics 2015;10(8):749–61.
32. Dunkel Schetter C, Lobel M. Pregnancy and birth outcomes: a multilevel analysis of prenatal maternal stress and birth weight. In: Baum T, Revenson T, Singer J, editors. Handbook of health psychology, vol. 431-463. London: Psychology Press; 2012. p. 431–63.
33. Quattlebaum M, Kipp C, K WD, et al. A Qualitative Study of Stress and Coping to Inform the LEADS Health Promotion Trial for Overweight African American Adolescents. Nutrients 2021;13:1–18.
34. Repetti RL, Taylor SE, Seeman TE. Risky families: Family social environments and the mental and physical health of offspring. Psychol Bull 2002;128(2):330–66.
35. Loncar H, Wilson DK, Sweeney AM, et al. Associations of parenting factors and weight related outcomes in African American adolescents with overweight and obesity. J Behav Med 2021;44:541–50.
36. Wilson DK, Sweeney AM, Quattlebaum M, et al. The Moderating Effects of the Families Improving Together (FIT) for Weight Loss Intervention and Parenting Factors on Family Mealtime in Overweight and Obese African American Adolescents. Nutrients 2021;13:1745.
37. Amemiya A, Fujiwara T, Shirai K, et al. Association between adverse childhood experiences and adult diseases in older adults: A comparative cross-sectional study in Japan and Finland. BMJ Open 2019;9(8):e024609.
38. Hughes K, Bellis MA, Hardcastle KA, et al. The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. Lancet Public Heal 2017;2(8):e356–66.
39. Brown BB, Larson J. Peer relationships in adolescence. In: Lerner RM, Steinberg L, editors. Handbook of adolescent psychology. Hoboken, NJ: John Wiley & Sons, Inc; 2009. p. 74–103.
40. Steinberg L. Cognitive and affective development in adolescence. Trends Cogn Sci 2005;9(2):69–74.
41. Springer AE, Kelder SH, Hoelscher DM. Social support, physical activity and sedentary behavior among 6th-grade girls: A cross-sectional study. Int J Behav Nutr Phys Act 2006;3(1):8.
42. Defoe IN, Semon Dubas J, Romer D. Heightened Adolescent Risk-Taking? Insights From Lab Studies on Age Differences in Decision-Making. Policy Insights Behav Brain Sci 2019;6(1):56–63.
43. Salvy SJ, Miles JNV, Shih RA, et al. Neighborhood, Family and Peer-Level Predictors of Obesity-Related Health Behaviors Among Young Adolescents. J Pediatr Psychol 2017;42(2):153–61.
44. Clennin M, Brown A, Lian M, et al. Neighborhood Socioeconomic Deprivation Associated with Fat Mass and Weight Status in Youth. Int J Environ Res Public Health 2020;17(17):6421.
45. Bronfenbrenner U. Ecological systems theory. In: Vasta R, editor. Six theories of child development: revised formulations and current issues. London: Jessica Kingsley Publishers.; 1992. p. 187–249.
46. Wilson DK, Sweeney AM, Kitzman-Ulrich H, et al. Promoting Social Nurturance and Positive Social Environments to Reduce Obesity in High-Risk Youth. Clin Child Fam Psychol Rev 2017;20:64–77.
47. Kitzman-Ulrich H, Wilson DK, St George SM, et al. The integration of a family systems approach for understanding youth obesity, physical activity, and dietary programs. Clin Child Fam Psychol Rev 2010;13(3):231–53.

48. Broderick CB. Understanding family process: basics of family systems theory. Thousand Oaks, CA: Sage Publications, Inc; 1993.
49. Ng JYY, Ntoumanis N, Thøgersen-Ntoumani C, et al. Self-Determination Theory Applied to Health Contexts. Perspect Psychol Sci 2012;7(4):325–40.
50. Schwendler T, Shipley C, Budd N, et al. Development and Implementation: B'More Healthy Communities for Kid's Store and Wholesaler Intervention. Health Promot Pract 2017;18(6):822–32.
51. Nam CS, Ross A, Ruggiero C, et al. Process Evaluation and Lessons Learned From Engaging Local Policymakers in the B'More Healthy Communities for Kids Trial. Health Educ Behav 2019;46(1):15–23.
52. Trude ACB, Surkan PJ, Cheskin LJ, et al. A multilevel, multicomponent childhood obesity prevention group-randomized controlled trial improves healthier food purchasing and reduces sweet-snack consumption among low-income African-American youth. Nutr J 2018;17(1):1–15.
53. Economos CD, Hyatt RR, Goldberg JP, et al. A community intervention reduces BMI z-score in children: Shape up somerville first year results. Obesity 2007; 15(5):1325–36.
54. Economos CD, Hyatt RR, Must A, et al. Shape Up Somerville two-year results: A community-based environmental change intervention sustains weight reduction in children. Prev Med (Baltim) 2013;57(4):322–7.
55. Folta SC, Kuder JF, Goldberg JP, et al. Changes in diet and physical activity resulting from the shape up Somerville community intervention. BMC Pediatr 2013; 13(1):1–9.
56. Coffield E, Nihiser AJ, Sherry B, et al. Shape up somerville: Change in parent body mass indexes during a child-targeted, community-based environmental change intervention. Am J Public Health 2015;105(2):e83–9.
57. Sherwood NE, French SA, Veblen-Mortenson S, et al. NET-Works: Linking families, communities and primary care to prevent obesity in preschool-age children. Contemp Clin Trials 2013;36(2):544–54.