Author's version of paper accepted 3.6.19, Circulation.

Cite as
Wood, A.C., Blissett, J., Brunstrom, J.M., Carnell, S., Faith, M.S., Fisher, J.O., Hayman, L.L., Khalsa, A.S., Hughes, S.O., Miller, A., Momin, S., Welsh, J.A., Woo, J.G., Haycraft, E. Caregiver influences on eating behaviors in young children: A scientific statement from the American Heart Association. *Circulation*. 2019; [in press]

AHA Scientific Statement

Caregiver Influences on Eating Behaviors in Young Children

A Scientific Statement from the American Heart Association

Alexis C. Wood, PhD, Chair, Jacqueline Blissett, PhD, Jeffrey M. Brunstrom, PhD, Susan Carnell, PhD, Myles S. Faith, PhD, Jennifer O. Fisher, PhD, Laura L. Hayman, PhD, Amrik Singh Khalsa, MD, MSc, Sheryl O. Hughes, PhD, Alison Miller, PhD, Shabnam Momin, PhD, Jean A. Welsh, PhD, Jessica G. Woo, PhD, Emma Haycraft, PhD, Co-Chair, on behalf of the American Heart Association Council on Lifestyle and Cardiometabolic Health; Epidemiology and Prevention; and Cardiovascular Disease in the Young; Council on Cardiovascular Stroke Nursing and the Stroke Council

Corresponding Author:

Alexis Wood, PhD

Baylor College of Medicine

Children's Nutrition Research Center – Pediatrics

Houston, Texas 77071

Phone: 205-975-9198

Fax: 205-934-8665

Email**:** lekkiwood@gmail.com

ABSTRACT

A substantial body of research suggests that efforts to prevent pediatric obesity may benefit from targeting not just *what* a child eats, but *how* they eat. Specifically, child obesity prevention should include a component which addresses reasons why children have differing abilities to start and stop eating in response to internal cues of hunger and satiety, a construct known as "eating self-regulation". This review summarizes current knowledge regarding how caregivers can be an important influence on children's eating self-regulation during early childhood. First, we discuss the evidence supporting an association between caregiver feeding and child eating self-regulation. Second, we provide recommendations for caregivers on how to lower children's obesity risk by supporting their eating self-regulation. Finally, we consider these recommendations in the light of a broader social, economic and cultural context and the implications of this context for implementation. As far as we are aware, this is the first American Heart Association Scientific Statement to focus on a psychobehavioral approach to reducing obesity risk in young children. It is anticipated that the timely information provided in this review can be utilized not only by immediate caregivers within the immediate and extended family but also by a broad range of community-based care providers.

INTRODUCTION

Need for statement. A healthy body mass index (BMI) is one of seven core factors which the American Heart Association (AHA) emphasizes as important to ideal cardiovascular health.[1] Eight percent of infants (0-2 y) and 23 percent of children (2-5 y) in the United States suffer from excess adiposity.[2] There is wide recognition that cardiovascular disease (CVD) prevention should begin in early childhood,[3] with a component aimed at reducing obesity.[3, 4] Behavioral dimensions of eating ("eating behaviors"), collectively describing *what*, *when* and *how much* children eat, are robust correlates of childhood weight status (**Table 1**),[5-26] and child obesity prevention efforts should benefit from a component focused on these. Yet, most interventions[27] and / or recommendations[3, 28] to reduce child obesity risk only try to manipulate *what* a child eats. This review has been compiled to discuss the role of caregiver feeding behaviors in shaping child eating behaviors associated with healthy body weight outcomes.

Focus of statement. First, we describe available evidence on how caregiver feeding behaviors influence obesogenic child eating behaviors, adopting a developmental perspective prenatally to childhood, and consider the limitations to this evidence. In the next section, we present evidence-based recommendations designed to help caregivers provide a feeding environment which supports healthy eating behaviors in children. In the final section, we discuss challenges to implementing these recommendations.

Limitations to statement Although a wide variety of caregiver factors may influence child eating behaviors, such as attachment quality,[29] this review focusses only on caregiver factors which influence child eating behaviors within the immediate feeding environment. Although such factors also often associate with children's dietary intake, this review does not discuss how caregivers may influence children's dietary composition, quality or variety. It is beyond the

scope of this document to review any mechanisms underlying caregiver feeding and child eating behavior associations.

THE FEEDING ENVIRONMENT

Conceptual framework Feeding children is a reciprocal process that depends on the abilities of the caregiver and the child.[29] Early observational data[30-34] indicated that many children inherently vary their food intake in response to the caloric density of foods and energy expenditure to maintain healthy growth. This ability is thought to arise from the "satiety cascade" which cues children to eat in response to hunger, and stop eating in response to satiation, and a biobehavioral mechanism termed "eating self-regulation". [35] Some studies refer to 'regulation' over relatively short periods (e.g., 24 hours, or immediately following a fixed preload meal),[36] while other studies consider eating self-regulation as children's general behavioral responses to hunger, satiation and satiety, which can be measured over a longer term.[37]

Under the assumption that eating self-regulation is present from birth (even in preterm infants[34]), caregivers are thought to either (1) support children's innate eating self-regulation tendency; or (2) promote a deviation from this tendency. Thus, early feeding research has focused on a didactic relationship between children and caregivers, examining the interrelationship between children's appetite cues, caregiver responsivity to these, and the effect this has on child eating self-regulation.

At the same time, observational data[30-34, 38] reveal that children vary widely in the extent to which they demonstrate eating self-regulation, even in controlled settings. The strong heritability underlying child eating behaviors, ranging from 49-74% during the first year of life to 62-75% in early childhood (see [9, 39] for reviews), calls into question whether all children are born with good eating self-regulation, and highlights the need for research into a more tailored approach to the feeding environment that reflects children's predispositions around eating. Yet,

it is not possible to infer the importance of environmental influences from heritability estimates. For example the heritability for child BMI is inversely associated with parental education level[40] suggesting the environmental moderation of genetic effects. Changes in the heritability of standardized BMI across childhood (~40% at 4 y and 75% at 19 y),[41] thought to result from factors such as growing child autonomy over their personal food intake within the home, and increasing exposure to the wider obesogenic environment, demonstrate that heritable traits can still be influenced by the environment. When considered alongside decades of developmental science demonstrating that sociocultural context can have a powerful role in shaping a wide range of outcomes for children, including general self-regulatory skills,[42-44] these findings highlight a core concept underlying this Scientific Statement, which is that while strong heritability estimates suggest inherent individual differences in child eating self-regulation, they do not negate the potential for caregivers to shape, or moderate the expression of, children's eating tendencies.

CAREGIVER INFLUENCES UNDERLYING CHILD APPETITIVE TRAITS

Prenatal influences. Pre-pregnancy obesity,[45] maternal diet,[46] and excess weight gain[45] during pregnancy are all associated with increased risk of obesity among offspring. Long-standing research suggests that what a woman eats during pregnancy not only influences children's taste preferences[47-49] (with effects that can occur across their lifetime[50-52]), but may also influence children's growth via effects on appetite. Little human research on this topic exists, although higher correlations have been shown between children's protein and fat consumption at 10 years of age with their mother's intake of these macronutrients during pregnancy, than with her postnatal intake.[53] However, undernutrition may also be problematic; survivors of the Dutch famine (1944-45) who experienced caloric restriction during pregnancy saw increased obesity rates in their children up to thirty years after birth.[54] Given the challenges of implementing long-

term experimental studies in humans, animal studies, which allow for much greater experimental control of exposure, have been widely used to examine the association between diet and various health and health-related outcomes.[55, 56] Offspring of obese (but not lean) dams who are subsequently fed high-fat diet for two-to-seven years, including during gestation and lactation, may be more likely to overconsume fat and sucrose,[57] be heavier at birth,[58] gain more weight,[57] and be more susceptible to diet-induced obesity[58] and poor glycemic control.[58] Dams who are fed a low-protein diet for discrete periods of gestation have female offspring who consume lower amounts of fat, and show less compensation for changes in the caloric content of foods[59], an effect not seen in males. Animal studies suggest that a prenatal diet impacts offspring neurocircuits involved in satiety,[60] and alters offspring dopamine signaling.[57]

The feeding environment. After birth, psychobehavioral aspects of the feeding environment become a more important influence on child eating self-regulation. To maintain good eating self-regulation in children, current research suggests that a caregiver's overarching goal should be: *to allow children autonomy over their eating, such that they start and stop eating in response to their hunger and satiation*. Yet, recognizing the potential role of good dietary quality and variety in healthy growth trajectories for children,[61, 62] and the availability of calorically dense, nutrient poor foods for many children, caregivers also need to *provide structure within the eating environment* such that children can be autonomous without compromising a healthy diet.[48,75,91,92] It is important to acknowledge that factors such as cultural practices and beliefs (e.g., preference for breastfeeding[63] about ideal body size[64]) and resources (e.g., food insecurity that may limit food options[65]) can shape caregivers' methods to achieve these goals. Thus, the challenge for caregivers is to provide structure and boundaries without decreasing children's eating autonomy to the extent that they no longer self-regulate their eating, but instead look to external factors to cue eating.

In describing the behaviors which reflect caregiver goals around child feeding/eating, the literature has made the distinction between caregiver feeding *styles* and caregiver feeding *practices*. Feeding *styles* (**Figure 1**) capture the overall emotional climate of meals, and are measured along two dimensions: responsiveness (represented by warmth, acceptance, and involvement during feeding) and demandingness (represented by parental control and supervision of feeding). Feeding behaviors are often categorized using these dimensions into four feeding styles: authoritarian, authoritative, indulgent, and uninvolved,[66] which characterize the extent to which a caregiver's overall feeding behaviors reflect responsiveness to the child within the context of boundary setting around food.[66] Alternatively, feeding *practices* describe specific goal-oriented behaviors and can be organized along higher-order dimensions of coercive control (e.g. pressuring children to eat), structure (e.g. limit setting), and autonomy support (e.g. praise, active guidance).[67]

Authoritative and indulgent feeders are both considered high in responsiveness, however they differ in that the indulgent feeding style is low in demandingness (indicating a lack of structure; **Figure 1**).[67, 68] It is the indulgent feeding style out of the two which is associated with higher child adiposity and lower child eating-self-regulation, emphasizing the importance of setting boundaries around food.[48,75,91,92.] Both authoritative and authoritarian feeders set boundaries around food (**Figure 1**);[69] but authoritarian parents are considered less responsive and show behaviors aiming to change the child's behavior overtly. Such overt behaviors can include using rewards and/or punishments to control food intake, or physically struggling with the child, and are often labelled as "directive".[69] Authoritative feeders also set boundaries, but implement these via more covert "non-directive" strategies that support the child's autonomy[69, 70] These strategies include reasoning, complimenting, and exerting control over the food environment rather than the child, for example making the most readily available foods nutrient dense options from which the child can make selections, and setting mealtime routines within which the child can decide how much to eat.[69] When compared to the authoritarian feeding

style, the authoritative style is associated with better child dietary quality.[70, 71] As the key difference between these two styles lies in the higher responsivity of authoritative feeders to child cues, these findings highlight the need to implement boundaries within a responsive feeding environment.

A strong evidence base suggests that children's eating self-regulation is best supported when caregivers provide a feeding environment which *covertly* sets boundaries around food, such as meal timing and the types of foods eaten by children.[70-72] Using overt, directive attempts to control what children eat seems to have "spill over" effects on *how* and / or *how much* they eat.[73] It seems that when children choose foods based on parental directives, they also start and stop eating in response to these, and no longer self-regulate their eating to their appetite cues. The first five years of life is a time of rapid development – below we discuss how each developmental stage during this time (infancy, toddlerhood and preschool) poses unique challenges to maintaining a structured, yet responsive, feeding environment.

Infancy. Responsive feeding is a reciprocal relationship – children need to communicate their needs in order for caregivers to respond to these. From infancy, children display a number of external appetite cues. The earliest hunger cues include sucking, opening/closing mouth repeatedly, smacking and licking lips, and increased alertness.[74] Corresponding fullness cues include turning the head away, increased interest in the environment, decreased activity level, frowning and grimacing, gaze aversion and putting hand(s) to face.[74] Such cues are non-verbal and covert and an early challenge to responsive feeding is the ability of caregivers to perceive and accurately interpret these cues, which varies considerably.[75] By contrast, crying is a late-stage feeding cue, which is widely recognized by caregivers,[76, 77] but which may be confused with non-hunger infant distress. Caregivers endorsing crying as a reliable hunger cue are nearly 3 times as likely to have a pressuring feeding style, perhaps due to feeding when the infant is not hungry.[77] Infants who are fed to soothe non-hunger related distress, which may sometimes

be driven by caregivers mistaking distress signals for hunger, are also perceived to have a high responsiveness to food,[78] and have a higher BMI in childhood.[79] Interventions which have taught caregivers how to discriminate infant cues of hunger from cues of other distress, and how to soothe non hunger related fussiness without food, have had success in supporting healthy growth.[80-82] Parents of children in neonatal intensive care are more involved in feeding, and show better awareness of infant distress cues post discharge when they had social support via an intervention.[83]

The ability of caregivers to recognize and respond to children's cues of internal hunger/satiation may be influenced by early feeding modality (bottle vs. breast). Many studies refute an association between breastfeeding and child obesity risk,[84-88, 89] which it is beyond the scope of this review to discuss. However, some studies have shown that breastfeeding is associated with better child eating self-regulation,[90] including better satiety responsiveness,[91] and a lower likelihood of emptying a bottle or cup,[92] than bottle feeding. Contrary findings have also been shown.[32] A small randomized study using weighted, opaque bottles that removed external cues to bottle fullness, resulted in less formula intake and greater maternal responsiveness to infant feeding cues compared with a standard bottle.[93] This effect was seen particularly in mothers who were less responsive to infant satiation cues (defined as highly pressuring). It is theorized that less responsive mothers may be more susceptible to feeding in response to cues other than hunger/satiation from infants and so benefit the most from early interventions.[93] In addition, in-home recorded sessions found that breastfed infants displayed more engagement and disengagement clues than formula-fed infants,[94] perhaps making the hunger/satiation cues from infants fed at the breast easier to "read".

Toddlerhood. The rapid development of toddlerhood enables children to communicate their appetite more overtly, such as with rudimentary language and reaching for food. While this may

make toddlers' appetites easier to read, toddlerhood brings new challenges as children strive for autonomy and independence. Striving for autonomy is thought to bring about two food-related behaviors which present a particular challenge to responsive, non-directive feeding: food neophobia (wariness of trying new foods) and food fussiness / "picky" eating (a more general selectivity regarding which foods are consumed).[29, 95] Both of these behaviors can be associated with children eating a more limited, often less unhealthy diet, and with weight status (**Table 1**).[96] Food fussiness and neophobia can involve disgust-response to disliked foods, the rejection of foods on sight, and for some children a contamination-response where disliked foods touching or hidden under liked foods may lead to rejection of the whole meal..[97] While this phase is developmentally normative and typically short-lived, both behaviors also have trait-like dimensions that result in the persistence of these behaviors throughout childhood and adolescence for some children. Little is understood about why food neophobia or fussiness persist in a some children, but not in others.[73] This uncertainty, which is often reported as a significant source of caregiver stress,[98] may push caregivers to employ feeding strategies designed to reduce fussiness around food. Parents who perceive their children as more "picky" with food report using more directive attempts to control child intake, than do parents who do not perceive their children as picky.[73] Picky eating in toddlerhood is associated with controlling feeding practices in caregivers, with mothers who perceive their children as "picky" more likely to report restriction and pressure to eat.[99-102] Not only may directive feeding behaviors pose challenges to child eating self-regulation, which can disrupt children's ability to respond to internal hunger/fullness cues thereby contributing to overweight, but they are also associated with increased parental stress at mealtimes.[73] Observational data show that stressful feeding encounters are not likely to stimulate a positive response from the child to novel and/or aversive tasting foods,[103-105] and overall do not appear to alter children's food acceptance.[106, 107] Non-directive strategies such repeatedly offering foods,[108-110] offering a familiar and accepted food alongside novel, or refused foods (such as ketchup[111] or other palatable dip[112]), and having

caregivers[113] and/or peers[114] model eating the food with enjoyment have been demonstrated to increase the consumption of a given food, to support children's liking for a wider variety of healthy foods, and may help maintain responsivity in the feeding environment.

Preschool period. As the child progresses into the preschool period, food neophobia and food fussiness typically decline, and a wider variety of foods are consumed. While the increased dietary variety is considered a positive development for health, the preschool period brings more possibilities for autonomy as children can access a greater variety of foods and self-feed more capably. Research suggests that for good child eating self-regulation, the preschool period is critical for boundaries around food, but without overt control of child eating. Directive approaches which focus on what (or the amount) a child is eating directly, such as pressure to eat certain foods or restricting the types and amount of food consumed are often well-intentioned (the goal is usually to improve dietary quality, for example vegetable intake, or overall variety[115]). However, pressure to eat has been associated with an impaired ability to self-regulate eating behaviors in preschool,[116] and poorer energy compensation in childhood.[105] By contrast, restrictive feeding practices such as limiting intakes of certain (typically snack) foods, have been associated with higher consumption of food when not hungry,[117] energy intake,[103] adiposity,[118] and likelihood of failing to stop eating when full,[119] as well as poorer compensation for the energy density of food[120] in early childhood. In preschool, more supportive approaches, such as questions, suggestions, and offering choices within a structured environment which limits the types of food available and the timing of meals rather than places limits on the child's eating behaviors is associated with better eating self-regulation and growth trajectories.[66, 71, 121]

Limitations of research. Much, but not all, of the caregiver feeding research to date is cross-sectional, particularly in the preschool age group, which makes it hard to rule out confounding influences such as socioeconomic status (SES). Yet SES is positively correlated with rates and

duration of breastfeeding in most countries,[122, 123] and may be inversely correlated with child obesity,[124, 125] suggesting it may confound the relationships between breastfeeding and child adiposity outcomes. Similarly, mothers with obesity are less likely to initiate breastfeeding,[126-128] and, those that do breastfeed, do so for shorter periods than their healthy weight counterparts.[126, 127, 129-131] There may also be a confounding role for caregiver characteristics; parents with a high BMI are more likely to use controlling[132, 133] and restrictive[104] feeding practices. One study in 7-12 year old siblings discordant for parent feeding did not support a causal role in caregiver feeding control with child obesity risk, [133] which highlights the importance of considering factors in addition to caregiver feeding when developing strategies for child obesity prevention.

Even the extant longitudinal studies to date make it difficult to identify the direction of many associations**.** Evidence has supported directionality from child eating behaviors [134-136] and child BMI[137-140] to controlling feeding practices from caregivers, as well as the reverse.[141-143] Taken together, this and similar evidence suggests a bi-directionality between child eating behaviors and / or adiposity and caregiver feeding behaviors which some studies have found supported.[144, 145] Finally, despite a strong theoretical foundation, there is relatively little empirical evidence demonstrating the benefits of approaches that reflect warmth and responsiveness to children's eating cues while providing developmentally appropriate expectations, structure, and involvement, with more focusing on the sequelae of less responsive, more directive behaviors. Relatedly, much of the extant evidence is observational and only a small number of intervention programs have demonstrated evidence of effectiveness at changing caregivers' food-related interactions and behaviors.[81, 146]

RECOMMENDATIONS FOR CAREGIVERS

Tremendous progress has been made linking specific aspects of the caregiver provided feeding environment with children's ability to self-regulate their eating behaviors. The associated

literature is now substantial, and suggests that good eating self-regulation, and lowered obesity risk, is supported when:

1. Prenatal influences on child eating self-regulation are largely inferred from animal studies which support the recommendation that pregnancies are initiated at a healthy weight, current dietary guidelines for the intake of total calories, fats and sugars are adhered to throughout their pregnancy, and weight gain during pregnancy is kept within guideline levels.
2. Caregivers have knowledge of infant hunger (such as opening mouth wide or settling into the feed[74]) and satiety (such as taking interest in surroundings, decreases in activity level, pulling away abruptly or detaching from the nipple, and falling asleep[74]) cues, and can distinguish these from non-appetite related cues.
3. Caregivers are responsive to children's hunger and fullness cues, paying attention to children's verbal and non-verbal signals and not pressuring children to eat more than they wish. For a child who is not underweight (zBMI less than two standard deviations from the WHO Median; [147]), caregivers should allow children the choice of when to stop eating during a meal, and perhaps the choice not to eat at all.
4. Caregivers do not focus on what, or how much, a child eats. Rather, a varied diet is encouraged via environmental structure such as the consistent and repeated offering of healthy foods to children, the use of "preferred" foods (such as a dip), and caregivers enthusiastically consuming the food themselves.
5. An appropriate structure around food is set which focuses not on child behavior specifically, but instead provides rules and limits around children's meals, via consistent snack routines, timing of meals, and selective availability of foods in the home.

POTENTIAL CHALLENGES IN IMPLEMENTATION OF RECOMMENDATIONS Caregivers should feel empowered to contribute to the development of a healthy eating behavior trajectory in children. However, we recognize that translating these findings into recommendations for caregivers faces significant challenges.

The role of child development. Most children have developed the motor skills necessary to self-feed by around 14 months of age[148]. During this time, caregivers typically try socialize children, and their eating behaviors, to their personal, familial and cultural values. Such socialization is enabled by children's rapid cognitive development during early childhood children, when children learn language comprehension (~11-12m[149]), and that others have beliefs, requests and intentions (~14m;[150]). However, such cognitive development also enables non-compliance with caregiver requests (the emergency of autonomy; ~1.5 y; [151]). Physically, height increases linearly until four years of age, at which time growth slows.[152] However, this pattern may be different for children with a lower birth weight who experience "catch up" growth in early life, which then slows to mirror the expected trajectory.[152] BMI typically has a strongly non-linear growth trajectory, with significant changes in BMI growth rate at approximately 7-9 months of age (peak)[153] and close to 6 years of age (trough).[152] Growth changes are often accompanied by changes in food consumption,[154] and emerging research shows that parent feeding practices are influenced by child BMI[139, 140] and child eating behaviors[135, 136] as well as the reverse. And we recognize that there are individual differences with how children transition through developmental periods and growth changes, and there is no one single healthy way. Taken together this highlights that children's individual differences influence the feeding-eating relationship, and can pose challenges to caregiver attempts to shape healthy eating behaviors in children.

The role of child characteristics. We have already shown that eating behaviors have strong heritabilities. While a strong heritability does limit the potential for the environment to mediate the expression of child eating behaviors, we acknowledge that the downstream heritable phenotypes, such as temperament, may represent additional challenges to caregivers. There is now emerging evidence for associations between infant temperament, defined as "individual differences in reactivity and self-regulation that are assumed to have a constitutional basis",[155] and elevated adiposity indices. Adiposity at 6-, 9-, and 12-months of age associates with early distress to limitations .[156, 157] At 6 years of age, BMI associates with early infant low negative affectivity.[157, 158] Poorer general self-regulation and self-soothing ability at 9 months has predicted BMI at ~4 years of age.[157, 159] Temperament may pose a challenge to responsive caregiver feeding practices if food is used to assuage distress,[160, 161] and may influence the associations of caregiver feeding with child eating behaviors, highlighting the reciprocal nature of the relationship between caregiver feeding and child eating.

The wider socio-economic context. At a broader level, caregivers who are living in poverty or in under-resourced circumstances may face unique challenges to implementing recommended feeding practices. Income and SES can influence feeding practices through many interrelated and complex pathways, including the relatively limited access to relatively more expensive healthy foods for many poor families,[162] especially when such foods require time, expertise, and facilities to prepare and store.[163] In addition, unpredictable job schedules can constrain meal planning and mitigate against regular routines such as family mealtimes.[164-166] Food insecurity may also impact a parent's food options[167] and drive caregivers to restrict the range of foods given to children, in order to ensure consumption and avoid waste.[168, 169] Living in poverty can increasing caregiver stress; caregivers who are under stress have been found to engage in more restrictive feeding practices with their preschool-aged children.[170] An additional stressor that may influence caregiver feeding practices is the pressure to be a "perfect parent". Although

this has not been examined explicitly in regard to feeding, online social comparisons can negatively affect parenting and relationship outcomes, such as parental competence, co-parenting relationship quality, and perceived social support.[171]

These social-contextual factors shape feeding practices at multiple levels. Mental health issues, such as depression, presents challenges in child feeding.[171] Differences of opinion on feeding practices between caregiver and partner have been associated with conflict around feeding strategies during early childhood.[172, 173] Culture may also shape which individuals are responsible for child feeding (e.g., mothers vs. fathers; [174, 175] the role of grandparents[176, 177]) and beliefs about the role of restrictive vs. indulgent feeding[178, 179] in achieving feeding or obesity prevention goals. This statement acknowledges that a single caregiver often does not control the child's entire feeding environment, which may pose a challenge to an individual caregiver's capacity to follow recommendations for their children. Caregivers may feel particularly frustrated when their feeding goals for their children are disrupted by others who care for the child, for example grandparents or daycare providers.[168] It may therefore be helpful to develop recommendations for caregivers that include advice on how to navigate such conflicts, for example by encouraging them to explain responsive feeding practices to others involved in their child's care and/or identifying ways to respect cultural and/or family-of-origin influences on feeding while incorporating other options (e.g., healthier preparations of traditional foods).[168]

Considerations: Recommendations to caregivers regarding their feeding behaviors need to be offered within the context of implementation challenges. It is important to recognize that:

1. Infants and caregivers can learn from each other regarding healthy, responsive feeding practices, and recognition of hunger and satiety cues, regardless of decisions about what the infant is fed.

2. Modifying one's feeding behaviors can be harder for some caregivers than others. Caregiver feeding behaviors are not "set", but differ based on the child's temperament,[180] and the caregiver's psychological wellbeing.[107, 181, 182] The guilt and judgement some caregivers feel when their child does not conform to their idea of "good" eating behaviors"[98] can be relinquished, which may ultimately encourage a more responsive partnership between the caregiver and child with feeding.
3. Optimal feeding strategies may differ depending on a child's genetically-influenced behavioral profile, and research has not yet delineated the form this tailoring should take. A caveat to an individually-tailored approach to food parenting is that being critiqued for their weight and directly encouraged to lose weight may promote poorer body self-esteem and disordered eating in children.[183] Thus, strategies should likely be adopted for the whole family.[184, 185]

CONCLUSIONS AND FUTURE DIRECTIONS

A substantial body of literature links specific caregiver feeding behaviors to child eating self-regulation. Our recommendations are that caregivers focus not on child characteristics (how much he child eats, or their adiposity), but on creating a structured environment which inherently limits undesirable behaviors (e.g. eating certain foods) without requiring overt control over children. However, such recommendations are made in light of several pressing research needs, perhaps the most pertinent of which is integrating how children's individual differences in temperament, appetite, and adiposity shape parent feeding behaviors and influence their effects on feeding self-regulation. Caregiver feeding recommendations will need to be updated as such understanding increases. Further, recognizing the difficulties inherent with implementing our recommendations, we encourage policies which address barriers within the wider socioeconomic context, including the social determinants of health, alongside individual caregiver efforts in child obesity prevention. While efforts that encourage caregivers to provide a

responsive, structured feeding environment could be an important component of reducing obesity and cardiometabolic risk across the lifespan, it is likely they will be most effective as part of a multi-level, multi-component prevention strategy.

ACKNOWLEDGMENTS

Dr Wood is supported in part by USDA/ARS (Cooperative Agreement 58-3092-5-001). The contents of this publication do not necessarily reflect the views or policies of the USDA, nor does mention of trade names, commercial products, or organizations imply endorsement from the US government. Dr Wood also receives funding from the American Academy of Pediatrics, and has previously received funding from Sabra Dipping Company and Unilever. Dr. Khalsa is supported by the Center for Innovation in Pediatric Practice at Nationwide Children's Hospital. Dr. Khalsa has previously received funding from an institutional awarded National Research Service Award (NRSA) granted to Cincinnati Children's Hospital Medical Center (T32 HP10027).

REFERENCES

1. Benjamin EJ, Blaha MJ, Chiuve SE, Cushman M, Das SR, Deo R, Floyd J, Fornage M, Gillespie C, Isasi C. Heart disease and stroke statistics-2017 update: A report from the american heart association. *Circulation*. 2017;135:e146-e603
2. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the united states, 2011-2012. *JAMA*. 2014;311:806-814
3. Kumanyika SK, Obarzanek E, Stettler N, Bell R, Field AE, Fortmann SP, Franklin BA, Gillman MW, Lewis CE, Poston WC. Population-based prevention of obesity: The need for comprehensive promotion of healthful eating, physical activity, and energy balance: A scientific statement from american heart association council on epidemiology and prevention, interdisciplinary committee for prevention (formerly the expert panel on population and prevention science). *Circulation*. 2008;118:428-464
4. Kavey R-EW, Daniels SR, Lauer RM, Atkins DL, Hayman LL, Taubert K. American heart association guidelines for primary prevention of atherosclerotic cardiovascular disease beginning in childhood. *Circulation*. 2003;107:1562-1566
5. Carnell S, Wardle J. Appetite and adiposity in children: Evidence for a behavioral susceptibility theory of obesity. *Am. J. Clin. Nutr.* 2008;88:22-29
6. Hill C, Llewellyn CH, Saxton J, Webber L, Semmler C, Carnell S, van Jaarsveld CH, Boniface D, Wardle J. Adiposity and 'eating in the absence of hunger' in children. *Int J Obes (Lond)*. 2008;32:1499-1505
7. Croker H, Cooke L, Wardle J. Appetitive behaviours of children attending obesity treatment. *Appetite*. 2011;57:525-529
8. Fisher JO, Birch LL. Eating in the absence of hunger and overweight in girls from 5 to 7 y of age. *Am. J. Clin. Nutr.* 2002;76:226-231

9. Wood AC. Appetitive traits: Genetic contributions to pediatric eating behaviors. *Pediatric food preferences and eating behaviors*. Elsevier; 2018:127-146.
10. Webber L, Hill C, Saxton J, Van Jaarsveld CH, Wardle J. Eating behaviour and weight in children. *Int J Obes (Lond)*. 2009;33:21-28
11. Butte NF, Cai G, Cole SA, Wilson TA, Fisher JO, Zakeri IF, Ellis KJ, Comuzzie AG. Metabolic and behavioral predictors of weight gain in hispanic children: The viva la familia study. *Am. J. Clin. Nutr.* 2007;85:1478-1485
12. Faith MS, Berkowitz RI, Stallings VA, Kerns J, Storey M, Stunkard AJ. Eating in the absence of hunger: A genetic marker for childhood obesity in prepubertal boys? *Obesity (Silver Spring)*. 2006;14:131-138
13. Kral TV, Allison DB, Birch LL, Stallings VA, Moore RH, Faith MS. Caloric compensation and eating in the absence of hunger in 5-to 12-y-old weight-discordant siblings. *The American journal of clinical nutrition*. 2012;96:574-583
14. Remy E, Issanchou S, Chabanet C, Boggio V, Nicklaus S. Impact of adiposity, age, sex and maternal feeding practices on eating in the absence of hunger and caloric compensation in preschool children. *Int. J. Obes.* 2015;39:925
15. Reyes M, Hoyos V, Martinez SM, Lozoff B, Castillo M, Burrows R, Blanco E, Gahagan S. Satiety responsiveness and eating behavior among chilean adolescents and the role of breastfeeding. *Int J Obes (Lond)*. 2014;38:552-557
16. Faith MS, Hittner JB. Infant temperament and eating style predict change in standardized weight status and obesity risk at 6 years of age. *Int J Obes (Lond)*. 2010;34:1515-1523
17. van Jaarsveld CH, Boniface D, Llewellyn CH, Wardle J. Appetite and growth: A longitudinal sibling analysis. *JAMA Pediatr*. 2014;168:345-350

18. Santos JL, Ho-Urriola JA, Gonzalez A, Smalley SV, Dominguez-Vasquez P, Cataldo R, Obregon AM, Amador P, Weisstaub G, Hodgson MI. Association between eating behavior scores and obesity in chilean children. *Nutr J*. 2011;10:108
19. Fisher JO, Cai G, Jaramillo SJ, Cole SA, Comuzzie AG, Butte NF. Heritability of hyperphagic eating behavior and appetite-related hormones among hispanic children. *Obesity (Silver Spring)*. 2007;15:1484-1495
20. Sleddens EF, Kremers SP, Thijs C. The children's eating behaviour questionnaire: Factorial validity and association with body mass index in dutch children aged 6–7. *International Journal of Behavioral Nutrition and Physical Activity*. 2008;5:49
21. Viana V, Sinde S, Saxton JC. Children's eating behaviour questionnaire: Associations with bmi in portuguese children. *Br. J. Nutr.* 2008;100:445-450
22. Braet C, Van Strien T. Assessment of emotional, externally induced and restrained eating behaviour in nine to twelve-year-old obese and non-obese children. *Behav. Res. Ther.* 1997;35:863-873
23. Baños R, Cebolla A, Etchemendy E, Felipe S, Rasal P, Botella C. Validation of the dutch eating behavior questionnaire for children (debq-c) for use with spanish children. *Nutr. Hosp.* 2011;26
24. van Strien T, Oosterveld P. The children's debq for assessment of restrained, emotional, and external eating in 7-to 12-year-old children. *Int. J. Eat. Disord.* 2008;41:72-81
25. Dubois L, Farmer A, Girard M, Peterson K, Tatone-Tokuda F. Problem eating behaviors related to social factors and body weight in preschool children: A longitudinal study. *International Journal of Behavioral Nutrition and Physical Activity*. 2007;4:9
26. Sleddens EF, Kremers SP, Thijs C. The children's eating behaviour questionnaire: Factorial validity and association with body mass index in dutch children aged 6-7. *Int J Behav Nutr Phys Act*. 2008;5:49

27. Wang Y, Wu Y, Wilson RF, Bleich S, Cheskin L, Weston C, Showell N, Fawole O, Lau B, Segal J. Childhood obesity prevention programs: Comparative effectiveness review and meta-analysis. *Database of abstracts of reviews of effects (dare): Quality-assessed reviews [internet]*. Centre for Reviews and Dissemination (UK); 2013.
28. Williams CL, Hayman LL, Daniels SR, Robinson TN, Steinberger J, Paridon S, Bazzarre T. Cardiovascular health in childhood: A statement for health professionals from the committee on atherosclerosis, hypertension, and obesity in the young (ahoy) of the council on cardiovascular disease in the young, american heart association. *Circulation*. 2002;106:143-160
29. Satter E. Feeding dynamics: Helping children to eat well. *J. Pediatr. Health Care*. 1995;9:178-184
30. Birch LL, Fisher JO. Development of eating behaviors among children and adolescents. *Pediatrics*. 1998;101:539-549
31. Birch LL, Fisher JO. Food intake regulation in children. Fat and sugar substitutes and intake. *Ann. N. Y. Acad. Sci.* 1997;819:194-220
32. Timby N, Hernell O, Lonnerdal B, Domellof M. Parental feeding control in relation to feeding mode and growth pattern during early infancy. *Acta Paediatr.* 2014;103:1072-1077
33. Fomon SJ, Filer LJ, Thomas LN, Anderson TA, Nelson SE. Influence of formula concentration on caloric intake and growth of normal infants. *Acta Paediatr.* 1975;64:172-181
34. Saunders RB, Friedman CB, Stramoski PR. Feeding preterm infants: Schedule or demand? *J. Obstet. Gynecol. Neonatal Nurs.* 1991;20:212-220
35. Tan CC, Holub SC. Children's self-regulation in eating: Associations with inhibitory control and parents' feeding behavior. *Journal of Pediatric Psychology*. 2011;36:340-345

36. Johnson SL. Improving preschoolers' self-regulation of energy intake. *Pediatrics*. 2000;106:1429-1435
37. Connell LE, Francis LA. Positive parenting mitigates the effects of poor self-regulation on bmi trajectories from age 4 to 15 years. *Health psychology : official journal of the Division of Health Psychology, American Psychological Association*. 2014;33:757-764
38. Satter E. *Child of mine: Feeding with love and good sense*. Bull Publishing Company; 2012.
39. Wood AC. Gene-environment interplay in child eating behaviors: What the role of "nature" means for the effects of "nurture". *Current nutrition reports*. 2018:1-9
40. Silventoinen K, Huppertz C, van Beijsterveldt CE, Bartels M, Willemsen G, Boomsma DI. The genetic architecture of body mass index from infancy to adulthood modified by parental education. *Obesity*. 2016;24:2004-2011
41. Silventoinen K, Jelenkovic A, Sund R, Hur Y-M, Yokoyama Y, Honda C, vB Hjelmborg J, Möller S, Ooki S, Aaltonen S. Genetic and environmental effects on body mass index from infancy to the onset of adulthood: An individual-based pooled analysis of 45 twin cohorts participating in the collaborative project of development of anthropometrical measures in twins (codatwins) study. *The American journal of clinical nutrition*. 2016;104:371-379
42. Raver CC. Placing emotional self-regulation in sociocultural and socioeconomic contexts. *Child Dev.* 2004;75:346-353
43. Calkins SD, Hill A. Caregiver influences on emerging emotion regulation. *Handbook of emotion regulation*. 2007;229248
44. Bernier A, Carlson SM, Whipple N. From external regulation to self-regulation: Early parenting precursors of young children's executive functioning. *Child Dev.* 2010;81:326-339

45. Reynolds RM, Osmond C, Phillips DIW, Godfrey KM. Maternal bmi, parity, and pregnancy weight gain: Influences on offspring adiposity in young adulthood. *The Journal of Clinical Endocrinology & Metabolism*. 2010;95:5365-5369
46. Shapiro AL, Kaar JL, Crume TL, Starling AP, Siega-Riz AM, Ringham BM, Glueck DH, Norris JM, Barbour LA, Friedman J. Maternal diet quality in pregnancy and neonatal adiposity: The healthy start study. *Int. J. Obes.* 2016;40:1056
47. Mennella JA, Beauchamp GK. Understanding the origin of flavor preferences. *Chem. Senses*. 2005;30:i242-i243
48. Mennella JA, Johnson AJ, Beauchamp GK. Garlic ingestion by pregnant women alters the odor of amniotic fluid. *Chem. Senses*. 1995;20:207-209
49. Mennella JA, Jagnow CP, Beauchamp GK. Prenatal and postnatal flavor learning by human infants. *Pediatrics*. 2001;107:E88
50. Loper Hb Fau - Loper HB, La Sala M Fau - La Sala M, Dotson C Fau - Dotson C, Steinle N Fau - Steinle N. Taste perception, associated hormonal modulation, and nutrient intake.
51. Zhang G-H, Chen M-L, Liu S-S, Zhan Y-H, Quan Y, Qin Y-M, Deng S-P. Effects of mother's dietary exposure to acesulfame-k in pregnancy or lactation on the adult offspring's sweet preference. *Chem. Senses*. 2011;36:763-770
52. Teegarden SL, Scott AN, Bale TL. Early life exposure to a high fat diet promotes long-term changes in dietary preferences and central reward signaling. *Neuroscience*. 2009;162:924-932
53. Brion M-JA, Ness AR, Rogers I, Emmett P, Cribb V, Davey Smith G, Lawlor DA. Maternal macronutrient and energy intakes in pregnancy and offspring intake at 10 y: Exploring parental comparisons and prenatal effects. *The American journal of clinical nutrition*. 2010;91:748-756

54. Roseboom T, de Rooij S, Painter R. The dutch famine and its long-term consequences for adult health. *Early Hum. Dev.* 2006;82:485-491
55. Lai M, Chandrasekera PC, Barnard ND. You are what you eat, or are you? The challenges of translating high-fat-fed rodents to human obesity and diabetes. *Nutrition & diabetes*. 2014;4:e135
56. Even PC, Virtue S, Morton NM, Fromentin G, Semple RK. Are rodent models fit for investigation of human obesity and related diseases? *Frontiers in nutrition*. 2017;4:58
57. Rivera HM, Kievit P, Kirigiti MA, Bauman LA, Baquero K, Blundell P, Dean TA, Valleau JC, Takahashi DL, Frazee T, Douville L, Majer J, Smith MS, Grove KL, Sullivan EL. Maternal high-fat diet and obesity impact palatable food intake and dopamine signaling in nonhuman primate offspring. *Obesity (Silver Spring, Md.)*. 2015;23:2157-2164
58. Tamashiro KL, Terrillion CE, Hyun J, Koenig JI, Moran TH. Prenatal stress or high-fat diet increases susceptibility to diet-induced obesity in rat offspring. *Diabetes*. 2009;58:1116-1125
59. Bellinger L, Lilley C, Langley-Evans SC. Prenatal exposure to a maternal low-protein diet programmes a preference for high-fat foods in the young adult rat. *Br. J. Nutr.* 2004;92:513-520
60. Bhagat R, Fortna SR, Browning KN. Exposure to a high fat diet during the perinatal period alters vagal motoneurone excitability, even in the absence of obesity. *The Journal of Physiology*. 2015;593:285-303
61. Golley RK, Smithers LG, Mittinty MN, Emmett P, Northstone K, Lynch JW. Diet quality of uk infants is associated with dietary, adiposity, cardiovascular, and cognitive outcomes measured at 7–8 years of age–. *The Journal of nutrition*. 2013;143:1611-1617
62. Okubo H, Crozier SR, Harvey NC, Godfrey KM, Inskip HM, Cooper C, Robinson SM. Diet quality across early childhood and adiposity at 6 years: The southampton women's survey. *Int. J. Obes.* 2015;39:1456

63. Reeves EA, Woods-Giscombé CL. Infant-feeding practices among african american women: Social-ecological analysis and implications for practice. *J. Transcult. Nurs.* 2015;26:219-226
64. Rosas LG, Harley KG, Guendelman S, Fernald LC, Mejia F, Eskenazi B. Maternal perception of child weight among mexicans in california and mexico. *Maternal and child health journal*. 2010;14:886-894
65. Chen W-t. From “junk food” to “treats” how poverty shapes family food practices. *Food, Culture & Society*. 2016;19:151-170
66. Hughes SO, Power TG, Papaioannou MA, Cross MB, Nicklas TA, Hall SK, Shewchuk RM. Emotional climate, feeding practices, and feeding styles: An observational analysis of the dinner meal in head start families. *Int J Behav Nutr Phys Act*. 2011;8:60
67. Vaughn AE, Ward DS, Fisher JO, Faith MS, Hughes SO, Kremers SP, Musher-Eizenman DR, O’connor TM, Patrick H, Power TG. Fundamental constructs in food parenting practices: A content map to guide future research. *Nutr. Rev.* 2015;74:98-117
68. Hughes SO, Power TG, Orlet Fisher J, Mueller S, Nicklas TA. Revisiting a neglected construct: Parenting styles in a child-feeding context. *Appetite*. 2005;44:83-92
69. Hughes SO, Shewchuk RM, Baskin ML, Nicklas TA, Qu H. Indulgent feeding style and children’s weight status in preschool. *Journal of developmental and behavioral pediatrics: JDBP*. 2008;29:403
70. Patrick H, Nicklas TA, Hughes SO, Morales M. The benefits of authoritative feeding style: Caregiver feeding styles and children's food consumption patterns. *Appetite*. 2005;44:243-249
71. Arlinghaus KR, Vollrath K, Hernandez DC, Momin SR, O'Connor TM, Power TG, Hughes SO. Authoritative parent feeding style is associated with better child dietary quality at dinner among low-income minority families. *The American journal of clinical nutrition*. 2018;108:730-736

72. DiSantis K, Hodges E, Johnson S, Fisher J. The role of responsive feeding in overweight during infancy and toddlerhood: A systematic review. *Int. J. Obes.* 2011;35:480
73. Mascola AJ, Bryson SW, Agras WS. Picky eating during childhood: A longitudinal study to age 11 years. *Eating behaviors*. 2010;11:253-257
74. Hodges EA, Wasser HM, Colgan BK, Bentley ME. Development of feeding cues during infancy and toddlerhood. *MCN. The American journal of maternal child nursing*. 2016;41:244
75. Hodges EA, Hughes SO, Hopkinson J, Fisher JO. Maternal decisions about the initiation and termination of infant feeding. *Appetite*. 2008;50:333-339
76. Pridham KF, Berger Knight C, Stephenson GR. Mothers' working models of infant feeding: Description and influencing factors. *J. Adv. Nurs.* 1989;14:1051-1061
77. Gross RS, Fierman AH, Mendelsohn AL, Chiasson MA, Rosenberg TJ, Scheinmann R, Messito MJ. Maternal perceptions of infant hunger, satiety, and pressuring feeding styles in an urban latina wic population. *Academic pediatrics*. 2010;10:29-35
78. Mallan KM, Sullivan SE, Susan J, Daniels LA. The relationship between maternal feeding beliefs and practices and perceptions of infant eating behaviours at 4 months. *Appetite*. 2016;105:1-7
79. Stifter CA, Anzman-Frasca S, Birch LL, Voegtline K. Parent use of food to soothe infant/toddler distress and child weight status. An exploratory study. *Appetite*. 2011;57:693-699
80. Paul IM, Savage JS, Anzman SL, Beiler JS, Marini ME, Stokes JL, Birch LL. Preventing obesity during infancy: A pilot study. *Obesity*. 2011;19:353-361
81. Savage JS, Birch LL, Marini M, Anzman-Frasca S, Paul IM. Effect of the insight responsive parenting intervention on rapid infant weight gain and overweight status at age 1 year: A randomized clinical trial. *JAMA pediatrics*. 2016;170:742-749

82. Hohman EE, Paul IM, Birch LL, Savage JS. Insight responsive parenting intervention is associated with healthier patterns of dietary exposures in infants. *Obesity*. 2017;25:185-191

83. Olmsted RW, Minde K, Shosenberg N, Marton P, Thompson J, Ripley J, Burns S. Self-help groups in a premature nursery—a controlled evaluation. *The Journal of pediatrics*. 1980;96:933-940

84. Brion M-JA, Lawlor DA, Matijasevich A, Horta B, Anselmi L, Araújo CL, Menezes AMB, Victora CG, Smith GD. What are the causal effects of breastfeeding on iq, obesity and blood pressure? Evidence from comparing high-income with middle-income cohorts. *Int. J. Epidemiol.* 2011;40:670-680

85. Colen CG, Ramey DM. Is breast truly best? Estimating the effects of breastfeeding on long-term child health and wellbeing in the united states using sibling comparisons. *Soc. Sci. Med.* 2014;109:55-65

86. Kramer MS, Guo T, Platt RW, Sevkovskaya Z, Dzikovich I, Collet J-P, Shapiro S, Chalmers B, Hodnett E, Vanilovich I. Infant growth and health outcomes associated with 3 compared with 6 mo of exclusive breastfeeding. *The American journal of clinical nutrition*. 2003;78:291-295

87. Kramer MS, Matush L, Vanilovich I, Platt RW, Bogdanovich N, Sevkovskaya Z, Dzikovich I, Shishko G, Collet J-P, Martin RM. Effects of prolonged and exclusive breastfeeding on child height, weight, adiposity, and blood pressure at age 6.5 y: Evidence from a large randomized trial–. *The American Journal of Clinical Nutrition*. 2007;86:1717-1721

88. Oken E, Patel R, Guthrie LB, Vilchuck K, Bogdanovich N, Sergeichick N, Palmer TM, Kramer MS, Martin RM. Effects of an intervention to promote breastfeeding on maternal adiposity and blood pressure at 11.5 y postpartum: Results from the promotion of

breastfeeding intervention trial, a cluster-randomized controlled trial–. *The American journal of clinical nutrition*. 2013;98:1048-1056

89. Martin RM, Kramer MS, Patel R, Rifas-Shiman SL, Thompson J, Yang S, Vilchuck K, Bogdanovich N, Hameza M, Tilling K. Effects of promoting long-term, exclusive breastfeeding on adolescent adiposity, blood pressure, and growth trajectories: A secondary analysis of a randomized clinical trial. *JAMA pediatrics*. 2017;171:e170698-e170698

90. Disantis KI, Collins BN, Fisher JO, Davey A. Do infants fed directly from the breast have improved appetite regulation and slower growth during early childhood compared with infants fed from a bottle? *Int J Behav Nutr Phys Act*. 2011;8:89

91. Brown A, Lee M. Breastfeeding during the first year promotes satiety responsiveness in children aged 18–24 months. *Pediatric obesity*. 2012;7:382-390

92. Li R, Fein SB, Grummer-Strawn LM. Do infants fed from bottles lack self-regulation of milk intake compared with directly breastfed infants? *Pediatrics*. 2010;125:e1386-1393

93. Ventura AK, Pollack Golen R. A pilot study comparing opaque, weighted bottles with conventional, clear bottles for infant feeding. *Appetite*. 2015;85:178-184

94. Shloim N, Vereijken C, Blundell P, Hetherington MM. Looking for cues - infant communication of hunger and satiation during milk feeding. *Appetite*. 2017;108:74-82

95. Dovey TM, Staples PA, Gibson EL, Halford JC. Food neophobia and 'picky/fussy'eating in children: A review. *Appetite*. 2008;50:181-193

96. Carruth BR, Skinner J, Houck K, Moran III J, Coletta F, Ott D. The phenomenon of "picky eater": A behavioral marker in eating patterns of toddlers. *J. Am. Coll. Nutr.* 1998;17:180-186

97. Brown S, Harris G. Disliked food acting as a contaminant during infancy. A disgust based motivation for rejection. *Appetite*. 2012;58:535-538

98. Harris HA, Ria-Searle B, Jansen E, Thorpe K. What's the fuss about? Parent presentations of fussy eating to a parenting support helpline. *Public health nutrition*. 2018;21:1520-1528
99. Webber L, Cooke L, Hill C, Wardle J. Associations between children's appetitive traits and maternal feeding practices. *J. Am. Diet. Assoc.* 2010;110:1718-1722
100. Birch LL, McPhee L, Shoba B, Pirok E, Steinberg L. What kind of exposure reduces children's food neophobia?: Looking vs. Tasting. *Appetite*. 1987;9:171-178
101. Faith MS, Kerns J. Infant and child feeding practices and childhood overweight: The role of restriction. *Maternal & child nutrition*. 2005;1:164-168
102. Galloway AT, Fiorito L, Lee Y, Birch LL. Parental pressure, dietary patterns, and weight status among girls who are "picky eaters". *J. Am. Diet. Assoc.* 2005;105:541-548
103. Fisher JO, Birch LL. Restricting access to palatable foods affects children's behavioral response, food selection, and intake. *The American journal of clinical nutrition*. 1999;69:1264-1272
104. Francis LA, Hofer SM, Birch LL. Predictors of maternal child-feeding style: Maternal and child characteristics. *Appetite*. 2001;37:231-243
105. Johnson SL, Birch LL. Parents' and children's adiposity and eating style. *Pediatrics*. 1994;94:653-661
106. Murashima M, Hoerr SL, Hughes SO, Kaplowitz SA. Feeding behaviors of low-income mothers: Directive control relates to a lower bmi in children, and a nondirective control relates to a healthier diet in preschoolers–. *The American journal of clinical nutrition*. 2012;95:1031-1037
107. Blissett J. Relationships between parenting style, feeding style and feeding practices and fruit and vegetable consumption in early childhood. *Appetite*. 2011;57:826-831
108. Birch LL, Marlin DW. I don't like it; i never tried it: Effects of exposure on two-year-old children's food preferences. *Appetite*. 1982;3:353-360

109. Sullivan SA, Birch LL. Pass the sugar, pass the salt: Experience dictates preference. *Dev. Psychol.* 1990;26:546
110. Carruth BR, Ziegler PJ, Gordon A, Barr SI. Prevalence of picky eaters among infants and toddlers and their caregivers' decisions about offering a new food. *J. Am. Diet. Assoc.* 2004;104:57-64
111. Pliner P, Stallberg-White C. "Pass the ketchup, please": Familiar flavors increase children's willingness to taste novel foods. *Appetite*. 2000;34:95-103
112. Fisher JO, Mennella JA, Hughes SO, Liu Y, Mendoza PM, Patrick H. Offering "dip" promotes intake of a moderately-liked raw vegetable among preschoolers with genetic sensitivity to bitterness. *Journal of the Academy of Nutrition and Dietetics*. 2012;112:235-245
113. Pelchat ML, Pliner P. "Try it. You'll like it". Effects of information on willingness to try novel foods. *Appetite*. 1995;24:153-165
114. Momin SR, Hughes SO, Elias C, Papaioannou MA, Phan M, Vides D, Wood AC. Observations of toddlers' sensory-based exploratory behaviors with a novel food. *Appetite*. 2018;131:108-116
115. Orrell-Valente JK, Hill LG, Brechwald WA, Dodge KA, Pettit GS, Bates JE. "Just three more bites": An observational analysis of parents' socialization of children's eating at mealtime. *Appetite*. 2007;48:37-45
116. Carper J, Fisher JO, Birch LL. Young girls' emerging dietary restraint and disinhibition are related to parental control in child feeding. *Appetite*. 2000;35:121-129
117. Fisher JO, Birch LL. Restricting access to foods and children's eating. *Appetite*. 1999;32:405-419
118. Fisher JO, Birch LL. Restricting access to foods and children's eating. *Appetite*. 1999;32:405-419

119. Johnson SL, Birch LL. Parents' and children's adiposity and eating style. *Pediatrics*. 1994;94:653-661
120. Tripicchio GL, Keller KL, Johnson C, Pietrobelli A, Heo M, Faith MS. Differential maternal feeding practices, eating self-regulation, and adiposity in young twins. *Pediatrics*. 2014:peds. 2013-3828
121. Hughes C, Ensor R. Individual differences in growth in executive function across the transition to school predict externalizing and internalizing behaviors and self-perceived academic success at 6 years of age. *J. Exp. Child Psychol.* 2011;108:663-676
122. Flacking R, Nyqvist KH, Ewald U. Effects of socioeconomic status on breastfeeding duration in mothers of preterm and term infants. *European journal of public health*. 2007;17:579-584
123. Amir LH, Donath SM. Socioeconomic status and rates of breastfeeding in australia: Evidence from three recent national health surveys. *Med. J. Aust.* 2008;189:254-256
124. Shrewsbury V, Wardle J. Socioeconomic status and adiposity in childhood: A systematic review of cross-sectional studies 1990–2005. *Obesity*. 2008;16:275-284
125. Sobal J, Stunkard AJ. Socioeconomic status and obesity: A review of the literature. *Psychol. Bull.* 1989;105:260
126. Wojcicki JM. Maternal prepregnancy body mass index and initiation and duration of breastfeeding: A review of the literature. *Journal of Women's Health*. 2011;20:341-347
127. Donath S, Amir L. Does maternal obesity adversely affect breastfeeding initiation and duration? *J. Paediatr. Child Health*. 2000;36:482-486
128. Thompson LA, Zhang S, Black E, Das R, Ryngaert M, Sullivan S, Roth J. The association of maternal pre-pregnancy body mass index with breastfeeding initiation. *Maternal and child health journal*. 2013;17:1842-1851

129. Oddy WH, Li J, Landsborough L, Kendall GE, Henderson S, Downie J. The association of maternal overweight and obesity with breastfeeding duration. *The Journal of pediatrics*. 2006;149:185-191
130. Donath SM, Amir LH. Maternal obesity and initiation and duration of breastfeeding: Data from the longitudinal study of australian children. *Maternal & Child Nutrition*. 2008;4:163-170
131. Li R, Jewell S, Grummer-Strawn L. Maternal obesity and breast-feeding practices. *The American journal of clinical nutrition*. 2003;77:931-936
132. Haycraft EL, Blissett JM. Maternal and paternal controlling feeding practices: Reliability and relationships with bmi. *Obesity*. 2008;16:1552-1558
133. Saelens BE, Ernst MM, Epstein LH. Maternal child feeding practices and obesity: A discordant sibling analysis. *Int. J. Eat. Disord.* 2000;27:459-463
134. Haycraft E, Blissett J. Predictors of paternal and maternal controlling feeding practices with 2-to 5-year-old children. *Journal of nutrition education and behavior*. 2012;44:390-397
135. Bauer KW, Haines J, Miller AL, Rosenblum K, Appugliese DP, Lumeng JC, Kaciroti NA. Maternal restrictive feeding and eating in the absence of hunger among toddlers: A cohort study. *international journal of behavioral nutrition and physical activity*. 2017;14:172
136. Jansen E, Williams KE, Mallan KM, Nicholson JM, Daniels LA. Bidirectional associations between mothers' feeding practices and child eating behaviours. *international journal of behavioral nutrition and physical activity*. 2018;15:3
137. Gregory JE, Paxton SJ, Brozovic AM. Maternal feeding practices, child eating behaviour and body mass index in preschool-aged children: A prospective analysis. *International Journal of Behavioral Nutrition and Physical Activity*. 2010;7:55

138. Webber L, Cooke L, Hill C, Wardle J. Child adiposity and maternal feeding practices: A longitudinal analysis–. *The American journal of clinical nutrition*. 2010;92:1423-1428
139. Jansen PW, Tharner A, Van Der Ende J, Wake M, Raat H, Hofman A, Verhulst FC, Van Ijzendoorn MH, Jaddoe VW, Tiemeier H. Feeding practices and child weight: Is the association bidirectional in preschool children? *The American journal of clinical nutrition*. 2014;100:1329-1336
140. Afonso L, Lopes C, Severo M, Santos S, Real H, Durão C, Moreira P, Oliveira A. Bidirectional association between parental child-feeding practices and body mass index at 4 and 7 y of age. *The American journal of clinical nutrition*. 2016;103:861-867
141. Farrow CV, Blissett J. Controlling feeding practices: Cause or consequence of early child weight? *Pediatrics*. 2008;121:e164-169
142. Rodgers RF, Paxton SJ, Massey R, Campbell KJ, Wertheim EH, Skouteris H, Gibbons K. Maternal feeding practices predict weight gain and obesogenic eating behaviors in young children: A prospective study. *International Journal of Behavioral Nutrition and Physical Activity*. 2013;10:24
143. Campbell K, Andrianopoulos N, Hesketh K, Ball K, Crawford D, Brennan L, Corsini N, Timperio A. Parental use of restrictive feeding practices and child bmi z-score. A 3-year prospective cohort study. *Appetite*. 2010;55:84-88
144. Tschann JM, Martinez SM, Penilla C, Gregorich SE, Pasch LA, de Groat CL, Flores E, Deardorff J, Greenspan LC, Butte NF. Parental feeding practices and child weight status in mexican american families: A longitudinal analysis. *International Journal of Behavioral Nutrition and Physical Activity*. 2015;12:66
145. Thompson AL, Adair LS, Bentley ME. Pressuring and restrictive feeding styles influence infant feeding and size among a low-income african-american sample. *Obesity*. 2013;21:562-571

146. Daniels L, Mallan K, Battistutta D, Nicholson J, Perry R, Magarey A. Evaluation of an intervention to promote protective infant feeding practices to prevent childhood obesity: Outcomes of the nourish rct at 14 months of age and 6 months post the first of two intervention modules. *Int. J. Obes.* 2012;36:1292

147. Organization WH. *Who child growth standards: Length/height for age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age, methods and development*. World Health Organization; 2006.

148. Carruth BR, Skinner JD. Feeding behaviors and other motor development in healthy children (2–24 months). *J. Am. Coll. Nutr.* 2002;21:88-96

149. Hallé PA, de Boysson-Bardies B. Emergence of an early receptive lexicon: Infants' recognition of words. *Infant behavior and development*. 1994;17:119-129

150. Mitchell P, Lacohée H. Children's early understanding of false belief. *Cognition*. 1991;39:107-127

151. Kuczynski L, Kochanska G, Radke-Yarrow M, Girnius-Brown O. A developmental interpretation of young children's noncompliance. *Dev. Psychol.* 1987;23:799

152. Silva IdS, De Stavola BL, Mann V, Kuh D, Hardy R, Wadsworth ME. Prenatal factors, childhood growth trajectories and age at menarche. *Int. J. Epidemiol.* 2002;31:405-412

153. Sun J, Nwaru BI, Hua J, Li X, Wu Z. Infant bmi peak as a predictor of overweight and obesity at age 2 years in a chinese community-based cohort. *BMJ open*. 2017;7:e015122

154. Monteiro POA, Victora CG. Rapid growth in infancy and childhood and obesity in later life–a systematic review. *Obesity reviews*. 2005;6:143-154

155. Rothbart MK, Ahadi SA, Evans DE. Temperament and personality: Origins and outcomes. *J Personal Soc Psych*. 2000;78:122-135

156. Slining MM, Adair L, Goldman BD, Borja J, Bentley M. Infant temperament contributes to early infant growth: A prospective cohort of african american infants. *Int J Behav Nutr Phys Act*. 2009;6:51
157. Bergmeier H, Skouteris H, Horwood S, Hooley M, Richardson B. Associations between child temperament, maternal feeding practices and child body mass index during the preschool years: A systematic review of the literature. *Obesity Reviews*. 2014;15:9-18
158. Hittner JB, Johnson C, Tripicchio G, Faith MS. Infant emotional distress, maternal restriction at a home meal, and child bmi gain through age 6years in the colorado adoption project. *Eat Behav*. 2016;21:135-141
159. Peacock-Chambers E, Radesky JS, Parker SE, Zuckerman B, Lumeng JC, Silverstein M. Infant regulatory problems and obesity in early childhood. *Acad Pediatr*. 2017;17:523-528
160. Wasser H, Bentley M, Borja J, Davis Goldman B, Thompson A, Slining M, Adair L. Infants perceived as "fussy" are more likely to receive complementary foods before 4 months. *Pediatrics*. 2011;127:229-237
161. Stifter CA, Anzman-Frasca S, Birch LL, Voegtline K. Parent use of food to soothe infant/toddler distress and child weight status. An exploratory study. *Appetite*. 2011;57:693-699
162. Horning ML, Fulkerson JA. A systematic review on the affordability of a healthful diet for families in the united states. *Public Health Nurs.* 2015;32:68-80
163. Carty SA, Mainvil LA, Coveney JD. Exploring family home food environments: Household resources needed to utilise weekly deliveries of free fruits and vegetables. *Nutrition & dietetics*. 2017;74:138-146
164. Devine CM, Jastran M, Jabs J, Wethington E, Farell TJ, Bisogni CA. “A lot of sacrifices:” work–family spillover and the food choice coping strategies of low-wage employed parents. *Soc. Sci. Med.* 2006;63:2591-2603

165. Roy KM, Tubbs CY, Burton LM. Don't have no time: Daily rhythms and the organization of time for low-income families. *Family Relations*. 2004;53:168-178
166. Jarrett RL, Bahar OS, Kersh RT. "When we do sit down together" family meal times in low-income african american families with preschoolers. *Journal of Family Issues*. 2016;37:1483-1513
167. Vedovato GM, Surkan PJ, Jones-Smith J, Steeves EA, Han E, Trude AC, Kharmats AY, Gittelsohn J. Food insecurity, overweight and obesity among low-income african-american families in baltimore city: Associations with food-related perceptions. *Public health nutrition*. 2016;19:1405-1416
168. Mena NZ, Gorman K, Dickin K, Greene G, Tovar A. Contextual and cultural influences on parental feeding practices and involvement in child care centers among hispanic parents. *Childhood obesity*. 2015;11:347-354
169. Daniel C. Economic constraints on taste formation and the true cost of healthy eating. *Soc. Sci. Med.* 2016;148:34-41
170. Swyden K, Sisson SB, Morris AS, Lora K, Weedn AE, Copeland KA, DeGrace B. Association between maternal stress, work status, concern about child weight, and restrictive feeding practices in preschool children. *Maternal and child health journal*. 2017;21:1349-1357
171. Coyne SM, McDaniel BT, Stockdale LA. "Do you dare to compare?" associations between maternal social comparisons on social networking sites and parenting, mental health, and romantic relationship outcomes. *Computers in Human Behavior*. 2017;70:335-340
172. Thullen M, Majee W, Davis AN. Co-parenting and feeding in early childhood: Reflections of parent dyads on how they manage the developmental stages of feeding over the first three years. *Appetite*. 2016;105:334-343

173. Khandpur N, Charles J, Blaine RE, Blake C, Davison K. Diversity in fathers' food parenting practices: A qualitative exploration within a heterogeneous sample. *Appetite*. 2016;101:134-145

174. Galanti G-A. The hispanic family and male-female relationships: An overview. *J. Transcult. Nurs.* 2003;14:180-185

175. O'Connor T, Perez O, Garcia IC, Gallagher M. Engaging latino fathers in children's eating and other obesity-related behaviors: A review. *Current nutrition reports*. 2018;7:29-38

176. Kumanyika SK. Environmental influences on childhood obesity: Ethnic and cultural influences in context. *Physiol. Behav.* 2008;94:61-70

177. Pulgaron ER, Marchante AN, Agosto Y, Lebron CN, Delamater AM. Grandparent involvement and children's health outcomes: The current state of the literature. *Families, Systems, & Health*. 2016;34:260

178. Cardel M, Willig AL, Dulin-Keita A, Casazza K, Beasley TM, Fernández JR. Parental feeding practices and socioeconomic status are associated with child adiposity in a multi-ethnic sample of children. *Appetite*. 2012;58:347-353

179. Tovar A, Must A, Metayer N, Gute DM, Pirie A, Hyatt RR, Economos CD. Immigrating to the us: What brazilian, latin american and haitian women have to say about changes to their lifestyle that may be associated with obesity. *Journal of immigrant and minority health*. 2013;15:357-364

180. McMeekin, S., Jansen, E., Mallan, K., Nicholson, J., Magarey, A., and Daniels, L. Associations between infant temperament and early feeding practices. A cross-sectional study of Australian mother-infant dyads from the NOURISH randomised controlled trial. *Appetite* 60, 2013; 239-245.

181. Hurley KM, Black MM, Papas MA, Caufield LE. Maternal symptoms of stress, depression, and anxiety are related to nonresponsive feeding styles in a statewide sample of wic participants. *The Journal of nutrition*. 2008;138:799-805

182. Haycraft E, Farrow C, Blissett J. Maternal symptoms of depression are related to observations of controlling feeding practices in mothers of young children. *Journal of Family Psychology*. 2013;27:159

183. Gillison FB, Lorenc AB, Sleddens EF, Williams SL, Atkinson L. Can it be harmful for parents to talk to their child about their weight? A meta-analysis. *Prev. Med.* 2016;93:135-146

184. Epstein L. Family-based behavioural intervention for obese children. *International journal of obesity and related metabolic disorders: journal of the International Association for the Study of Obesity*. 1996;20:S14-21

185. Boutelle KN, Cafri G, Crow SJ. Parent predictors of child weight change in family based behavioral obesity treatment. *Obesity*. 2012;20:1539-1543

186. Johnson SL, Taylor-Holloway LA. Non-hispanic white and hispanic elementary school children's self-regulation of energy intake. *The American journal of clinical nutrition*. 2006;83:1276-1282

187. Powers SW, Chamberlin LA, Schaick KB, Sherman SN, Whitaker RC. Maternal feeding strategies, child eating behaviors, and child bmi in low-income african-american preschoolers. *Obesity*. 2006;14:2026-2033

188. Rydell A-M, Dahl M, Sundelin C. Characteristics of school children who are choosy eaters. *The Journal of genetic psychology*. 1995;156:217-229

Table 1: The Association of Appetitive Traits with Child Adiposity

Appetitive Trait	Definition	Direction of Association	Evidence of null associations?[1]
Traits with consistent evidence across studies			
Eating in the absence of hunger (EAH)	Eating when having recently consumed a meal to satiation	Positive[6, 8, 11, 12, 19]	-
Enjoyment of food	The extent to which palatable foods provoke eating	Positive [10, 21, 26]	-
Restrained eating	How strong attempts to restrain eating are	Inverse[22-24]	
Satiety responsiveness	The extent to which children avoid eating, and for how long after, satiation	Positive[5, 10, 21, 26]	-
Slowness in eating	Fewer bites per minute, usually as a meal progresses	Inverse [10, 21, 26]	-
Traits with null studies and studies suggesting a consistent direction of association with child adiposity			
Compensation of energy intake	The extent to which energy intake is reduced, following a caloric 'preload'	Positive[13, 105]	One exception[186]
Desire to drink	The tendency to carry drinks, (often sweetened).	Positive [10, 21]	One exception[187]
Emotional Overeating	The extent of a tendency to eat in response to negative emotions	Positive [10, 21]	One exception[26]

Emotional undereating	The extent of a tendency reduce food intake in response to negative emotions	Inverse[21]	Yes[10, 26]
External eating / Food responsiveness	Eating in response to external (usually food-related stimuli).	Positive[5, 10, 21-23, 26]	One exception[187]
Food fussiness / pickiness	Selectivity regarding which foods are consumed	Positive[10, 21, 25, 26]	Yes[26, 188]

[1]To date, to the authors' knowledge

Figure 1: Feeding Styles Typology