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Table of content

Synthesis 4

Feeding skill, Appetite and Feeding Behaviours of Infants and Young Children and Their Impact on Growth and Psychosocial Development 7
MARIA RAMSAY, PHD, SEPTEMBER 2025

Feeding Behaviour of Infants and Young Children and Its Impact on Child Psychosocial and Emotional Development 21
YI HUI LIU, MD MPH, MARTIN T. STEIN, MD, SEPTEMBER 2013

Helping Children Develop Healthy Eating Habits 28
MAUREEN M. BLACK, PHD, KRISTEN M. HURLEY, PHD, SEPTEMBER 2013

Assessment and Treatment of Pediatric Feeding Disorders 38
[1]SUZANNE M. MILNES, PHD, [1]CATHLEEN C. PIAZZA, PHD, [2]TAMMY CARROLL, PHD, SEPTEMBER 2013

Genetic Influences on Child Eating Behaviour 43
CLARE LLEWELLYN, PHD, JANE WARDLE, PHD, SEPTEMBER 2013

Screen time Use and Food Marketing Influences on Children's Eating Behaviors 50
[1]CHRISA ARCAN, PHD, MPH, RD, [2]ANINDA SEN, MBBS, MPH, [3]MEG BRUENING, PHD, MPH, RD, [4]MARY STORY, PHD, RD, OCTOBER 2025

Eating Behaviour in Studies of Child Growth, Development and Health – Measure Precisely, Early and in Context: Commentary on Ramsay, Liu & Stein, Black & Hurley, Milnes, Piazza & Carrol, Llewellyn & Wardle, and Arcan, Bruening and Story 67
MYLES S. FAITH, PHD, SEPTEMBER 2013

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Synthesis

How important is it?

Oral motor skills such as sucking and chewing develop rapidly during the first year, allowing young children to discover an increasing number of foods and textures. Refinements in fine motor skills also allow infants to develop more autonomy in regards to feeding, and by the end of the second year, most children have acquired good feeding skills. At this age, children become increasingly influenced by external signals such as family, friends, and society, to dictate their hunger.

Feeding problems are common, and touch approximately 25% to 50% of young children. These problems are usually minor and temporary. They tend to be seen when children are exposed to new foods or events during mealtime, or when they are trying to master a new feeding skill. However, 1% to 2%of children experience chronic feeding problems, including overeating, malnutrition, problematic behaviours during meals and atypical eating choices. These problems are especially common in children born prematurely, and those with developmental disabilities. Eating problems can be highly stressful for parents and can result in a strained parent-child relationship.

What do we know?

Early feeding experiences can have long-lasting consequences on eating habits and food preferences later on in life. A healthy diet consisting of ample fruits and vegetables in the first two years may increase future preferences for healthy food. In contrast, unhealthy habits, such as favoring food that is high in fat and sugar tend to persist over time.

Feeding problems are associated with a number of poor developmental, psychological and health outcomes. For instance, children who overeat are more likely to develop medical conditions and potential psychological issues, whereas insufficient calorie intake can result in stunted growth.

Several factors play a role in the development of feeding problems. Feeding difficulties are likely to emerge when feeding has been paired with a painful or unpleasant experience that the child comes to associate with mealtime. Temperament traits such as the inability to self-regulate and

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to communicate one's hunger level can make feeding routine challenging. Similarly, a genetic predisposition for big or small appetite can increase the likelihood of feeding problems.

Parents play a central role during feeding throughout the early years. Breastfeeding, for instance, not only protects against contagious diseases, but also allows infants to develop the ability to control their own calorie intake, an important healthy eating habit. Parents also contribute positively to their child's feeding by modeling healthy eating habits and making mealtimes enjoyable.

When feeding problems emerge, mealtimes can become loaded with anxiety and frustration for both children and parents. Misreading the child's signals can further aggravate problematic behaviours. Strategies to encourage eating such as punishment, distractions, and toys can work temporarily, but they tend to worsen problems over time. The most effective approach is responsive feeding, where reciprocal interactions during meals are based on the child's signals, and are age-appropriate.

At a larger scale, culture also contributes to feeding experiences by its influence on feeding choices, behaviours and exposure to different types of food. For instance, children's exposure to advertisements of unhealthy food is related to their preference for this type of food, and this is especially problematic in the African American and Hispanic American communities.

What can be done?

Given that feeding problems most often originate from multiple causes, multidisciplinary approaches that consider cultural and temperamental differences are strongly recommended. Although not all children respond equally well to interventions, several strategies have been successful at promoting a healthy diet, starting with those involving parents. Parents can help reduce overeating by cooking smaller quantity of food per meal, thereby limiting access to oversized portion, and by encouraging their children to slow down their eating speed by putting their utensils down after each bite. Parents can also encourage healthy habits by discussing feelings of satiety, modelling healthy eating habits, and limiting the amount of television watching to 1 to 2 hours a day of quality programming, and only in children over 2 years. Parents who discuss the content of advertisement messages and who regulate the type of food their young child eats are likely to be successful at discouraging unhealthy habits.

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In cases of insufficient calorie intake, medications that increase appetite have been shown to positively affect weight gain, and can make psychosocial intervention more efficient. The acceptance of new foods can also be encouraged by pairing the new food with a preferred food until the new food becomes familiar. To make mealtimes pleasant, children should be given enough time to eat (between 10 to 30 minutes) and proper equipment (ex., highchairs, and small utensils). Feeding is an intricate skill that takes time to develop. Parents and professionals can be about the specific impact of problematic feeding behaviour and motivation. Information about healthy habits can be transmitted to parents during regular health check-ups.

At the policy level, several steps can be undertaken to reduce accessibility to unhealthy foods. These include the elimination of vending machines in schools, stricter advertising and menu regulations, quotas assigned to the number of fast food restaurants and changes in supermarket layouts.

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Feeding skill, Appetite and Feeding Behaviours of Infants and Young Children and Their Impact on Growth and Psychosocial Development

Maria Ramsay, PhD

McGill University, Canada

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Introduction

Feeding, like other sensorimotor skills, is a developmental skill that matures during the first two years of life. It is a highly complex sensorimotor process with developmental stages based on neurological maturation and experiential learning.[1] However, feeding, unlike other sensori-motor skills, is heavily reliant on internal incentive or motivation to initiate ingestion, and is essential for survival of the newborn. Thus, the act of feeding is highly charged emotionally for the mother, whose primary responsibility, as viewed by the family, society and culture around her, is to ensure the early growth and well being of her child. Therefore, from the very beginning the mother-infant feeding relationship is influenced by physiologic as well as interactional forces at multiple levels.[2]

Subject

When feeding skills are intact and appetite is robust, feeding times, and later on, mealtimes are a source of pleasant socialisation resulting in adequate nutrient intake and good growth. Demanding food at regular intervals, sucking, eating and drinking with good rhythm, trying new food tastes or textures, and expressing satisfaction at the end of feeding are all considered good feeding behaviours by family and society. These pro-feeding behaviours invite praise and positive feeding interactions and thus reinforce the feeling of self-mastery in the young child and promote continued food acceptance and independent feeding behaviours.

However, when feeding skills are impaired (e.g.: poor oral-motor skills, taste and texture sensitivities) and or poor appetite (inadequate hunger), they manifest themselves in problematic feeding behaviours such as not signalling hunger, sucking or eating excessively slowly, gagging, and not bringing food to the mouth.[3-7] In addition, associative conditioning to painful

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gastrointestinal cues is particularly powerful in young infants and this conditioning often manifests itself in problematic feeding behaviours.[8,9] Temperamental characteristics and regulatory capacities of the infant may further modulate feeding behaviours.[10,11] Maternal attempts at increasing her infant's nutrient intake by feeding more frequently or longer duration tend to result in stressful feeding experiences for both.[12] While these efforts may work well initially for maintaining good weight gain, they tend to become ineffective and maladjusted mealtime interactions and behavioural mismanagement prevail.[2,13-15] Maternal and family characteristics and societal expectations about the size of the young child and the type of food eaten further influence an already stressful feeding relationship.[16,17]

Problems

Feeding difficulties are one of the most common developmental disturbances in otherwise healthy infants and young children, often resulting in poor growth. Although an estimated 25%-50% of children experience transient feeding problems under two years of age,[18,19] most feeding issues resolve by the end of early childhood. However, an estimated 3-10% of children present with more severe forms of feeding problems which put children at risk for impaired growth, chronic illnesses and behavioural developmental problems.[20] As well, a large percentage of children with special needs, children with developmental disabilities and children born prematurely have severe and chronic feeding problems where families need support in resolving the feeding issues.[21-23] At the clinical level, the mother (and her paediatrician) is often not aware of the underlying reasons for problematic feeding behaviours. Thus, the mother's reactions to a poor feeder may be exposed to covert or overt family criticism, which often lead to internal doubt about her own ability to nurture.[4] At the policy level, there is a lack of education of professionals and young parents about feeding as a highly complex developmental skill, motivated by hunger and conditioned by parental reactions. Furthermore, professionals are still not trained to recognize that when either feeding skills or motivation or both are impaired, problematic feeding behaviours, stressed mealtime interactions and family conflicts are likely to result.

Research Context

Earlier cross-sectional clinical studies examined the relationship between feeding difficulties and attachment, maternal characteristics, family dynamics[24] and feeding practices.[24-30] These studies were conducted prospectively, that is, after the children were diagnosed with poor growth. Several observational studies focused on feeding interactions and problematic feeding

behaviours.[31,32] The development of feeding and patterns of food acceptance have been studied by numerous psychologists.[33-36] More recently, few researchers started to focus on possible pathophysiology (heart rate variability, hormonal balance) of poor growth and problematic feeding behaviours.[37-39] Other studies were conducted in the context of primarily behavioural interventions for problematic feeding behaviours in medically ill and very premature infants.[40-43]

Key Research Questions

The extensive research in the area of feeding problems and poor growth can be divided along the following three research questions:

1. How do maternal (family) characteristics (cognitive abilities, personality disorders, psychological status and early attachment history) influence feeding behaviours and growth?
2. How do infant characteristics (feeding skills, appetite, temperament and other physiological characteristics) influence feeding behaviours, mealtime interactions and growth?
3. How effective are behavioural and other forms of intervention for severe problematic feeding behaviours in medically ill infants?

Recent Research Results

Only questions 2 and 3 will be summarised here. With a focus on infant characteristics, studies have shown that feeding problems often co-occur with sleeping and behavioural disturbances (irritability, poor self-calming and intolerance to change), suggesting that these are symptoms of a common underlying constitutional “regulatory disorder” in infants and young children.[44,45] In a large whole-population survey of children’s growth and development, a significant portion (36%) of the 47 children identified with failure to thrive at one year of age were found to have oral motor difficulties, suggesting that these children were biologically more vulnerable to poor eating from birth.[46] Another study showed that young infants with gastroesophageal reflux were significantly more likely to have delay in their feeding skills and readiness behaviour for solids than controls.[47] In a prospective study of a group of healthy term infants (n=330), infants with inefficient sucking, as measured by tracings on a polygraph, at one week and two months were significantly more likely to have mothers with greater effort at feeding than infants with efficient sucking.[14]

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A number of studies have shown that children under 3 to 4 years of age eat primarily in response to appetite or hunger cues, whereas older children's eating are influenced by a variety of environmental (extra food available) and social factors.[48,49] As well, children with poor growth were observed to refuse offered food more often and fed themselves significantly less often than controls.[50] In terms of the third question, the literature reflects the reality that presently we are better at identifying factors contributing to feeding problems at any level of severity than treating them.[28,51,52] Treating feeding problems at the primary or secondary level, while desirable, is not always available for parents.[53] Treating feeding disorders associated with severe medical illnesses, developmental disabilities and gavage feedings requires the collaboration of multidisciplinary teams for successful outcome.[54-59] Lastly, studies have shown that appetite stimulating medications result in good weight gain, and thus making intervention more efficacious.[60-62]

Conclusions

Understanding feeding behaviours requires the knowledge of feeding as a developmental skill that matures over time and is reliant on hunger (appetite) cues and experiential learning. Whereas feeding skills are well established by two years of age, hunger cues shift from primarily internal to external (family, school and societal) control only by 4-5 years. Thus, although initially problematic feeding behaviours tend to be reactions to internal cues, these behaviours can become conditioned to external (coaxing parents) and societal cues. Medical illnesses, prematurity and developmental disorders further interfere with the development of normal feeding behaviours.

In order to help identify feeding problem, a number of feeding scales have been devised,[63-65] but rarely used for assessment or treatment outcome. Yet, early behavioural intervention can play an important role in normalizing feeding behaviours and mealtime interactions, which in turn help promote independence and other self-help skills in the child. Most recently, an easy and short screening tool was developed for detecting problematic feeding behaviours in primary care offices, allowing early referral to appropriate feeding clinics.[66]

An example of a Feeding Scale, which takes only 5 minutes to fill and may be filled by a pediatrician or nurse or other professionals, given that they possess the necessary information about infant/child feeding, or know where to refer the child with feeding problems.

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Implications for Policy and Services

The major findings from this updated summary continue to be that the physiological make up of the infant, medical illnesses, developmental disabilities and parental responses all play an important role in the dynamic relationship in which problematic feeding behaviours develop. This finding has several implications for policy and services in hospitals where premature infants and infants with medical needs grow poorly, requiring enteral feedings. Thus, intervention with staff specialized in feeding disorders, usually occupational or speech therapists, help initiate oral feedings. As well, doctors or pediatricians following infants and young children need continued education in possible causes of poor growth in otherwise healthy infants.

1. At the primary care level, the use of easy to administer feeding scales for earlier detection and thus, treatment of feeding problems should continue to be advocated. (See an example of the Feeding Scale below).
2. The continuation of mandated multidisciplinary feeding clinics addressing feeding disorders in hospital settings. These feeding programs need to be easily accessible to parents, where effective behavioural intervention and preventive strategies may be implemented in the early stages of reported difficult feeding behaviours.
3. The training of experts in the field of feeding disorders, which should include training in the behavioural, developmental and interactional components of feeding, as well as understanding the physiological, as well as the medical components should be advocated.

The Pediatric Feeding Program' research at The Montreal Children's Hospital:

Feeding infants and young children can be challenging. Initially, the feeding scale was developed to have a common language with the mothers about feeding difficulties they experience with their children, and to assess the intervention. This scale (MCH-FS) has become known word-wide, and as of now, it has been translated and standardized on a healthy children population in Montreal and in several other countries. The author of this article has approved all translations by using back-translations before the translated version could be used in 8 languages. Depicted in the graphic below is only 7 as Canada used the results of the English and French languages combined.[66-77] The scale was later translated and standardized in another four languages: Italian[71], Mexican[70,75] Turkish[76] and Chinese[77].

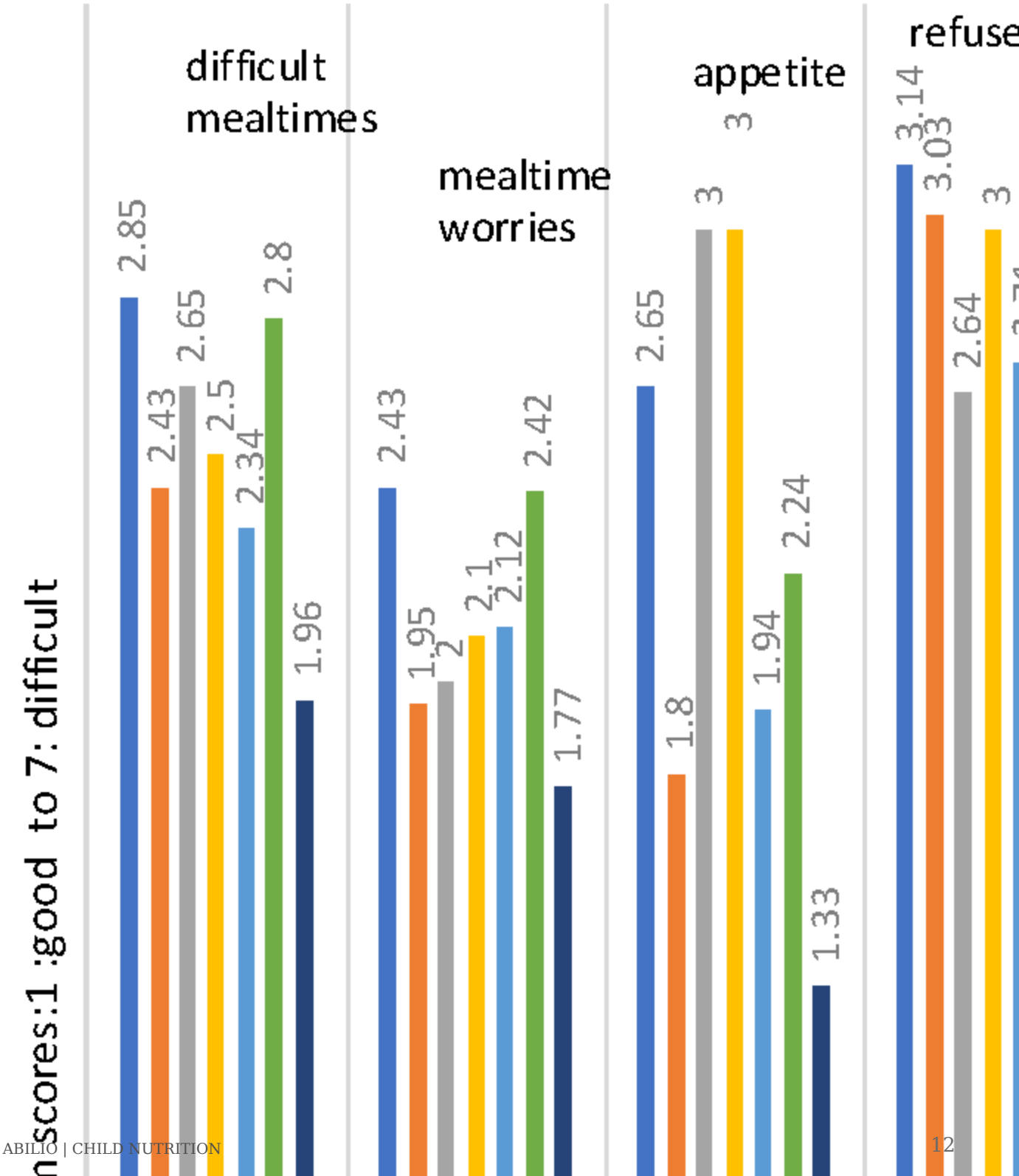
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See the MCH-FS above: Of note is that other infant/child feeding scales do not take into consideration the variability of infant/child level of appetite, which influences maternal approach to feeding and the child's acceptance of food.[66-77]

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Feeding Behaviour of Infants and Young Children and Its Impact on Child Psychosocial and Emotional Development

Yi Hui Liu, MD MPH, Martin T. Stein, MD

University of California San Diego, USA

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Introduction

Feeding is a primary event in the life of an infant and young child. It is the focus of attention for parents and other caregivers, and a source of social interaction through verbal and non-verbal communication. The eating experience provides not only sustenance but also an opportunity for learning. It affects not only children's physical growth and health but also their psychosocial and emotional development. The feeding relationship is affected by culture, health status and temperament.

Subject

The essential component of feeding behaviour in young children is the relationship between the child and the primary caregiver. The first three years of life are a particular challenge because a child's feeding abilities and needs change with motor, cognitive and social development. In the first stage (birth to three months) of self-regulation and organization, the child integrates experiences of hunger and satiety to develop regular feeding patterns. In the second stage (three to seven months), the infant and parent form an attachment that allows them to communicate with each other and the infant develops basic trust and self-soothing behaviours. In the third stage (six to 36 months), the child gradually "separates" emotionally from the parent and discovers a sense of independence or autonomy, making use of developing motor and language skills to control the environment and establish independent feeding.

With participation in family meals, the social component of feeding expands. The child begins to mimic eating choices, patterns and behaviours modelled by family members. The structure of family meals sets limits for the child as he or she achieves independent feeding skills. The accessibility of particular foods, modelling, media exposure and feeding interactions shape a

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child’s eating behaviour and food preferences.

The caregiver’s behaviours and the child’s temperament influence the feeding relationship. The parent who allows her infant to determine timing, amount and pacing of a meal helps her infant develop self-regulation and secure attachment. The parent who allows her toddler to explore the environment while providing structure and appropriate limits helps her child develop motor and social skills. The effective parent adjusts and responds appropriately to her child’s temperament — the child’s emotional reactivity, adaptability and response to change. Temperament can affect how a child approaches and responds to new foods and to a parent’s feeding patterns.

Culture may significantly influence the feeding experience. It may determine not only the choice of infant feeding (breast milk or formula) but also associated behaviours (co-sleeping is linked to prolonged breastfeeding), the length of feeding method (later weaning in developing countries versus earlier weaning for working mothers in developed countries), and exposure to feeding environments outside the home (child care among families with mother who work outside the home).

Problems

Mild and transient feeding problems occur in 25% to 35% of young children while severe and chronic feeding problems occur in 1% to 2%.[1] Common conditions include overeating, poor eating, feeding behaviour problems and unusual or unhealthy food choices. Although medical disorders and inappropriate food selection can result in feeding problems, these conditions are often associated with early problems in parent-child feeding experiences. Problems with self-regulation, attachment, temperament and the development of autonomy can contribute. A poor attachment may result from substance abuse or mental illness in the caregiver, developmental delay or a medical condition in the child, and parent-child personality/temperament conflict.

While most feeding problems in infants and young child are temporary, emotional and social development may be impacted during late childhood, adolescence and adulthood. Obesity, cardiovascular disease, diabetes mellitus and behavioural problems are more frequent in those with early childhood feeding problems.

1. *Overeating.* The prevalence of overweight and obesity in the United States has increased to 10.4% in two- to five-year olds, 15.3% in six- to 11-year olds, and 15.5% in 12- to 19-year olds.[2] These children are not only at risk for medical problems (e.g. diabetes mellitus,

hypertension, orthopedic problems, obstructive sleep apnea), but also poor self-esteem, disturbed body image, social isolation, maladjustment, depression and eating disorders. Social stigmatization begins as early as preschool and continues into school-age as their peers may reject overweight children. Parental concerns about overeating and obesity may result in inappropriate restriction of their young child's diet.

2. *Poor eating or not gaining sufficient weight*. A parent may misperceive her child as having insufficient nutritional intake when the child is active and more interested in play and the environment than in meals. Some parents have inappropriate expectations about sufficient food portions and weight gain. Failure to thrive (FTT) occurs when a child's rate of weight gain has decreased to below the third to fifth percentile for gestation-corrected age and sex, or the child's weight has fallen and crossed two major percentiles in a standardized growth chart. Children with FTT may have impaired growth (e.g. height, head circumference) and developmental skills and are at risk for long-term developmental and behavioural problems.
3. *Feeding behaviour problems.* Parents may have difficulty making the transition from an infant who is cooperative during feeding to a toddler who seeks independence at mealtime. Limited food preferences may be normal and temporary during this period or may develop into a behavioural disorder. Food phobias or a post-traumatic feeding disorder may result from a painful episode (e.g. choking with a particular food) or a difficult experience associated with a food-induced allergic reaction.
4. *Unusual choices.* Pica, or the ingestion of non-food substances, is normal in children under two years of age who explore their environment through hand-to-mouth experiences. After two years of age, pica is a behavioural condition more frequent in children with insufficient stimulation, psychological disorders and mental retardation.
5. *Unhealthy food choices.* Food preferences are established through exposure and accessibility to foods, modelling and advertisements. Most "alternative" diets are not harmful, although specific nutrient deficiencies should be addressed with some (for example, iron and vitamin B12 in vegan diets).

Research Context

Early childhood feeding experiences affect both health and psychological well-being. Because many feeding problems have their roots in infancy and childhood, current research focuses on

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determining the antecedents to these problems and the effectiveness of modifying various factors.

Key Research Questions

What are the most significant behavioural antecedents to childhood obesity that affect feeding? How can they be modified? How can behavioural changes be sustained? What are the most effective community-based interventions that have an impact on optimal nutritional choices and early feeding behaviours? What cultural determinants influence optimal feeding behaviours in early childhood? How can a better understanding of unique cultural values and habits influence medical and public-health programs to improve childhood nutrition?

Recent Research Results

Behavioural research in childhood feeding has focused on breastfeeding (choice, initiation and sustainability), teaching parents developmentally-appropriate feeding methods, and behavioural programs directed to specific feeding disorders, including obesity, failure to thrive and anorexia nervosa. In each case, principles of behaviour modification, health promotion and education have been applied effectively.

Many studies have examined the proposal that breastfeeding protects against the development of obesity later in life. While some have found an insignificant effect,[3,4,5,6,7] others have found a significant[8] and even a dose-response relationship[9,10,11] between breastfeeding duration and lower risk of child obesity. Without a consensus, the benefits of breastfeeding (e.g. establishment of attachment, optimal nutrition and protection against certain infectious diseases), still support encouraging breastfeeding whenever possible. With breastfeeding, lower maternal control of food intake and greater maternal responsiveness to infant cues has a beneficial effect on infant-feeding style and food intake, acknowledges the infant's ability to self-regulate appropriate food intake, and may contribute to healthier eating patterns.[12]

Child-feeding practices and behavioural interventions may modify patterns of intake. An overview of pediatric obesity treatment concluded that dietary changes accompanied by behaviour change methods, exercise and parental involvement are important in long-term success.[13] Parental participation and modelling is instrumental in establishing and changing eating patterns in children. Modelling consumption of healthy foods, such as fruit and vegetables, has a positive effect on the consumption of those foods by children[14] whereas

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modelling dieting behaviours results in problems in regulating a child's intake.[15] Television has a powerful influence on the foods children request; limiting television viewing can lessen obesity.[16] Birch and Fisher have written an excellent review detailing the determinants of children's dietary intake and responses to their modification.[17]

Conclusions

Feeding infants and young children is a behavioural event influencing their growth and development. Early experiences with feeding set the stage for healthy feeding-associated behaviours in later childhood and adulthood. Understanding the development of normal feeding behaviour in infants and young children makes it easier to distinguish between self-limited concerns and those requiring further intervention. Parents and other caregivers need knowledge about both nutritional content and developmentally appropriate feeding behaviours. Since earlier onset of problems results in more significant consequences, prevention of feeding disorders and related behaviour problems should be targeted towards guiding the feeding behaviours of infants and young children and their feeding relationships with parents and caregivers. Obesity (especially in developed countries) and undernutrition (especially in developing countries) can be addressed only through a combination of making healthy food available, ensuring an understanding of age-appropriate feeding practices, and supporting the emotional health of families. Cultural differences and temperament variations should be incorporated into any recommendations.

Implications for Policy and Service

1. Establish national dietary guidelines that are specific for children and easily understood and applied by parents.
2. Promote and support breastfeeding. The goals of *Healthy People 2010* are to increase the proportion of mothers who breastfeed to 75% in the early postpartum period, 50% at six months and 25% at one year.[18] Educate pregnant and new mothers on the advantages and maintenance of breastfeeding.
3. Advocate for nutrition in schools. Endorse and fund healthy school lunches and free school breakfasts (e.g. the United States federal government's *School Breakfast Program*[19]). Remove soda, sweetened beverages and unhealthy snacks from school campuses.[20] Support nutrition education in classrooms.

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4. Require regular physical education in schools to promote a healthy lifestyle and to help decrease obesity.[21]
5. Restrict television advertisements endorsing unhealthy food choices. Use media to promote healthy eating and regular physical activity.
6. Increase the availability of affordable fresh foods, especially fruit and vegetables, in low socioeconomic communities.
7. Promote education about healthy eating habits through public-health messages and increase funding for public-health campaigns promoting breastfeeding, healthy foods and obesity prevention.
8. Fund research investigating the etiology, prevention and treatment of obesity; factors influencing choice of breastfeeding, food intake and physical activity; and child-feeding practices in differing socioeconomic and ethnic groups.
9. Form public and private partnerships to promote healthy eating. Coordinate efforts of policy-makers, health professionals, community leaders and parents.

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Helping Children Develop Healthy Eating Habits

Maureen M. Black, PhD, Kristen M. Hurley, PhD

University of Maryland School of Medicine, USA

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Introduction

The first year of life is characterized by rapid developmental changes related to eating. As infants gain truncal control, they progress from sucking liquids in a supine or semi- reclined position to eating solid foods in a seated position. Oral motor skills progress from a basic suck-swallow mechanism with breast milk or formula to a chew-swallow mechanism with semi-solids, progressing to complex textures.[1,2] As infants gain fine motor control, they progress from being fed exclusively by others to at least partial self-feeding. Their diet extends from breast milk or formula, through purees and specially prepared foods, to the family diet. By the end of the first year of life, children can sit independently, can chew and swallow a range of textures, are learning to feed themselves and are making the transition to the family diet and meal patterns.

As children transition to the family diet, recommendations address not only food, but also the eating context. A variety of healthy foods promote diet quality, along with early and sustained food acceptance. Data gathered on infants and young children 6 to 23 months of age across 11 countries have demonstrated a positive association between dietary variety and nutritional status.[3] Exposure to fruits and vegetables in infancy and toddlerhood have been associated with acceptance of these foods at later ages.[4-6]

Children's eating patterns and food preferences are established early in life. When children refuse nutritious foods such as fruits or vegetables, mealtimes can become stressful or confrontational, and children may be denied both the nutrients they require and healthy, responsive interactions with caregivers. Caregivers who are inexperienced or stressed, and those who have poor eating habits themselves, may be most in need of assistance to facilitate healthy, nutritious mealtime behaviour with their children.

Subject

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Problems associated with eating occur in 25% to 45% of all children, particularly when children are acquiring new skills and are challenged with new foods or mealtime expectations.[7] For example, infancy and toddlerhood are characterized by bids for autonomy and independence as children strive to do things themselves. When these characteristics are applied to eating behaviours, children may be neophobic (hesitant to try new foods) and insist on a limited repertoire of foods,[8] leading them to be described as picky eaters.

Most eating problems are temporary and easily resolved with little or no intervention. However, eating problems that persist can undermine children's growth, development, and relationships with their caregivers, leading to long-term health and developmental problems.[9] Children with persistent eating problems whose caregivers do not seek professional advice until the problems become severe, may be at risk for growth or behaviour problems.

Problems

Eating patterns have developmental, family and environmental influences. As children become developmentally able to make the transition to family foods, their internal regulatory cues for hunger and satiety may be overridden by familial and cultural patterns. At the family level, children of caregivers who model healthy food intakes are likely to consume more fruits and vegetables than children of caregiver who do not, whereas children of caregivers who model less healthy, snack food intakes are likely to establish patterns of eating behaviours and food preferences that include excess amounts of fat and sugar.[10] At the environmental level, children's frequent exposure to fast-food and other restaurants has led to increased consumption of high-fat foods, such as french fries, rather than more nutritious options, such as fruit and vegetables.[11] In addition, caregivers may not realize that many commercial products marketed for children, such as sweetened drinks, may satisfy hunger or thirst, but provide minimal nutritional benefits.[12]

National surveys have reported excessive caloric intakes during toddlerhood,[13,14] and many children continue to consume alarmingly low quantities of fruit and vegetables and essential micronutrients.[15] By elementary school, many children receive over half their beverage intake from sweetened drinks,[16] a pattern that undoubtedly begins during the toddler and preschool years. These poor nutritional patterns (high fat, sugar and refined carbohydrates; sweetened drinks; and limited fruit and vegetables) increase the likelihood of micronutrient deficiencies (e.g., Iron Deficiency Anemia) and excess weight gain in young children.[17]

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Research Context

Eating is often studied through observational studies or caregiver reports of mealtime behaviour. Some investigators rely on clinical samples of children with growth or eating problems, while others recruit normative children.

Key Research Questions

Key questions include the progression of eating behaviours from infancy through toddlerhood, methods children use to signal hunger and satiety, and why some children (the so-called “picky” eaters) have selective food preferences. Key questions for caregivers and families are how to promote healthy eating behaviours in young children, how to encourage children to eat healthy food, and how to avoid problems in feeding and growth.

Recent Research Results

Attachment and eating

Healthy eating behaviour begins in infancy, as infants and their caregivers establish a partnership in which they recognize and interpret both verbal and non-verbal communication signals from one another. This reciprocal process forms a basis for the emotional bonding or attachment between infants and caregivers that is essential to healthy social functioning.[18] If there is a disruption in the communication between children and caregivers, characterized by inconsistent, non-responsive interactions, the attachment bond may not be secure, and eating may become an occasion for unproductive, upsetting battles over food.

Infants who do not provide clear signals to their caregivers or do not respond to their caregivers’ efforts to help them establish predictable routines of eating, sleeping and playing are at risk for regulatory problems that may include eating.[9] Infants who are premature or ill may be less responsive than healthy full-term infants and less able to communicate hunger or satiety. Caregivers who do not recognize their infants’ satiety cues may overfeed them, causing infants to associate feelings of satiety with frustration and conflict.

The caregiver-child context of feeding

Variability in the caregiver-child feeding context is related to children’s eating behaviour and growth.[19] The dimensions of parental structure and nurturance, which incorporate parents’

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perceptions of their child's behaviour, have been applied to the feeding context (Figure 1).[20,21,22] Responsive feeding reflects a reciprocal pattern in which caregivers provide guidance and developmentally appropriate responses to their child's signals of hunger and satiety. Unresponsive feeding is marked by a lack of reciprocity between the caregiver and child, often characterized by the caregiver taking excessive control of the feeding context (forcing/pressuring or restricting food intake), the child controlling the feeding context (e.g., demanding a limited repertoire of food, indulgent feeding), or the caregiver ignoring the child's signals or failing to establish mealtime routines (uninvolved feeding).[23,24]

Figure 1. The Caregiver-Child Feeding Context: Patterns of Parenting and Feeding

		NURTURANCE	
		HIGH	**LOW**
		AUTHORITATIVE	AUTHORITARIAN
		• Involved • Nurturing • Structured	• Forceful • Restrictive • Structured
HIGH		**Responsive**	**Controlling**
		INDULGENT	UNINVOLVED
		• Involved • Nurturing • Unstructured	• Unengaged • Insensitive • Unstructured
LOW		**Indulgent**	**Uninvolved**

A responsive feeding style, high in nurturance and structure, a derivative of authoritative parenting, represents caregivers who form a relationship with their child that involves clear demands and mutual interpretation of signals and bids for mealtime interaction. Responsive feeding is characterized by interactions that are prompt, contingent on the child's behaviour and developmentally appropriate with an easy give-and-take.[22,25,26]

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A controlling feeding style, high in structure and low in nurturance, represents caregivers who use forceful or restrictive strategies to control mealtimes. Controlling feeding is embedded in an overall authoritarian pattern of parenting and may include over-stimulating behaviours, such as speaking loudly, forcing foods or otherwise overpowering the child.[27] Controlling caregivers may override their child's internal regulatory cues for hunger and satiety.[28] The innate capacity that infants have to self-regulate their energy intake declines during early childhood in response to family and cultural patterns.[29]

An indulgent feeding style, high in nurturance and low in structure, is embedded in an overall indulgent style of parenting, and occurs when caregivers allow children to make decisions around meals, such as when and what they will eat.[23] Without parental guidelines, children are likely to be attracted to high salt/high sugar foods, rather than to a more balanced variety including vegetables.[23] Thus, an indulgent feeding style may be problematic, given infants' genetic predispositions to prefer sweet and salty tastes.[30] Children of caregivers who display an indulgent feeding style are often heavier than children of caregivers who use non-indulgent feeding styles.[24]

An uninvolved feeding style, low in both nurturance and structure, often represents caregivers who have limited knowledge and involvement in their child's mealtime behaviour.[23] Uninvolved child feeding styles may be characterized by little or no active physical help or verbalization during feeding, lack of reciprocity between the caregiver and child, a negative feeding environment and a lack of feeding structure or routine. Uninvolved feeders often ignore both child feeding recommendations and their toddler's cues of hunger and satiety and may be unaware of what or when their toddler is eating. Egeland and Sroufe[31] found that children of uninvolved or psychologically unavailable caregivers were more likely to be anxiously attached when compared with children of available caregivers. An uninvolved feeding style is embedded in an overall uninvolved style of parenting.[23]

Several recent systematic reviews report associations between parental feeding control and infant and early child weight gain and/or weight status.[24,32,33] Controlling feeding has been associated with increased weight gain (e.g., children of caregivers who use restrictive feeding practices tend to overeat)[34] and to decreased weight gain (e.g., children who are pressured to eat more, do not).[35] However, the cross-sectional design of most studies, along with a tendency to rely exclusively on caregiver behaviour, rather than consider the reciprocal nature of feeding interactions, has hindered the understanding of caregiver-child feeding interactions. A recent

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randomized controlled trial among infants in Australia found that providing anticipatory guidance regarding infant feeding behaviour led to healthier weight gain and higher rates of self-reported responsive feeding behaviour.[36] Additional trials are needed to better understand strategies to promote healthy feeding interactions and healthy growth.

Food preferences

Children who are raised with caregivers who model healthy eating behaviours, such as a diet rich in fruit and vegetables, establish food preferences that include fruit and vegetables.[4]

Food preferences are also influenced by associated conditions. Children are likely to avoid food that has been associated with unpleasant physical symptoms, such as nausea or pain. They may also avoid food that has been associated with the anxiety or distress that often occurs during meals characterized by arguments and confrontations.

Children also accept or reject food based on qualities of the food, such as taste, texture, smell, temperature or appearance, as well as environmental factors, such as the setting, the presence of others and the anticipated consequences of eating or not eating. For example, consequences of eating may include relief from hunger, participation in a social function or attention from caregivers. Consequences of not eating may include additional time to play, becoming the focus of attention or getting snack food instead of the regular meal.

Increasing familiarity with the taste of a food increases the likelihood of acceptance.[37,38] Caregivers can facilitate the introduction of new foods by pairing the new food with preferred food and presenting the new food repeatedly until it is no longer “new.”

Conclusions

Eating patterns are established early in life in response to internal regulatory cues, caregiver-child interactions, mealtimes routines, foods offered and modeling from family members. Exposing children to fruits and vegetables early in life establishes a pattern of fruit and vegetable preference and consumption throughout life. Research is needed to investigate the individual, interactive and environmental determinants of the caregiver-child feeding context, relationships between responsive/unresponsive feeding and children’s eating behaviour and weight gain and population-specific validated tools to measure responsive/unresponsive feeding.[24]

Early childhood eating behaviours are heavily influenced by caregivers and are learned through early experiences with food and eating. Education and support provided by health professionals (i.e., public health nurses, family physicians and pediatricians) and nutrition programs need to be strengthened to ensure that caregivers have the facilities needed to address issues of eating behaviours during childhood.

Caregivers should eat with children so modelling can occur and mealtimes are viewed as pleasant social occasions. Eating together lets children watch caregivers try new foods and helps children and caregivers communicate hunger and satiety, as well as enjoyment of specific foods.[39]

Caregivers control both the food that is offered and the mealtime atmosphere. Their "job" is to ensure that children are offered healthy food on a predictable schedule in a pleasant setting.[39] By developing mealtime routines, caregivers help children learn to anticipate when they will eat. Children learn that feelings of hunger are soon relieved and there is no need to feel anxious or irritable. Children should not graze or eat throughout the day, so they develop an expectation and an appetite around mealtime.[39]

Mealtimes should be pleasant and family-oriented, with family members eating together and sharing the events of the day. When mealtimes are too brief (less than 10 minutes), children may not have enough time to eat, particularly when they are acquiring self-feeding skills and may eat slowly. Alternatively, sitting for more than 20 or 30 minutes is often difficult for a child and mealtimes may become aversive.

When meals are characterized by distractions from television, family arguments or competing activities, children may have difficulty focusing on eating. Caregivers should separate mealtime from playtime and avoid using toys, games, or television to distract the child during mealtime. Child-oriented equipment, such as highchairs, bibs and small utensils, may facilitate eating and enable children to acquire the skills of self-feeding.

Implications

Implications can be directed to environmental, family and individual levels. At the environmental level, encouraging fast-food and other restaurants to also provide healthy, palatable food options that are appealing to young children may reduce some of the feeding problems that occur when children are repeatedly exposed to high-fat foods, such as french fries, rather than to nutritious

options, such as fruit and vegetables. At the family level, guidelines for children's nutrition should include information on their nutritional needs and on strategies to promote healthy eating behaviour, including recognizing children's signals of hunger and satiety and use of appropriate feeding interactions, allocating time for meals, scheduling meals at relatively consistent times, promoting new foods through modelling and avoiding stress and conflict during meals. At the individual level, programs that help children develop healthy eating patterns by eating nutritious foods and eating to satisfy hunger, rather than to satisfy emotional needs, may prevent subsequent health and developmental problems.[40]

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Assessment and Treatment of Pediatric Feeding Disorders

[1]Suzanne M. Milnes, PhD, [1]Cathleen C. Piazza, PhD, [2]Tammy Carroll, PhD

[1]Munroe-Meyer Institute, University of Nebraska Medical Center, USA,

[2]University of Alabama, USA

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Introduction

A feeding disorder is identified when a child is unable or refuses to consume a sufficient quantity or variety of solids and liquids to maintain proper nutrition.[1] The complications from feeding problems range from mild (e.g., missed meals) to severe (e.g., severe malnourishment).[2] Mealtime difficulties occur in approximately 25% to 35% of typically developing children and up to 80% of individuals with developmental disabilities.[3-6] Feeding disorders may be manifested by total refusal to eat, dependence on supplemental feedings (e.g., gastrostomy tube), inappropriate mealtime behaviour, and selectivity by type and texture.

Subject

The causes of feeding disorders are equally varied. Feeding problems are often caused by a number of biological and environmental factors, which interact.[7,8] For example, Rommel et al. evaluated 700 children referred to an interdisciplinary feeding team and found combined causes (e.g., medical, behavioural, oral-motor) of the feeding problem occurred in over 60% of patients.[8]

Biological factors may include early experiences with medical procedures, chronic hospitalization, or medical problems, which cause eating to be painful. Even after the painful medical condition is treated, the child may continue to refuse food because if the child never or rarely eats, he or she never learns that eating is no longer painful. If the child refuses to eat, he or she does not have the opportunity to practice eating and does not develop the skills to become a capable eater. Refusal to eat may lead to growth failure, which contributes to poor feeding skills as undernourished children lack the energy to become capable eaters.[9] Thus, a cycle develops in which the child refuses food, fails to learn that eating is no longer painful, misses opportunities to develop oral motor skills, and fails to gain weight.

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Problems

Even when the cause of food refusal is a painful medical condition, caregiver responses to the child during meals may worsen the problem. Piazza and colleagues observed caregivers and children with feeding problems during meals, which showed that caregivers used a variety of strategies to encourage eating such as distracting, coaxing, and reprimanding; allowing the child to periodically take a break from or avoid eating; and providing preferred food or toys.[10] All children displayed refusal behaviour and infrequently ate bites of food. When Piazza et al. analyzed the effects of caregiver behaviour during meals on child feeding behaviours, results indicated that the above listed strategies used by the caregivers to encourage eating actually worsened behaviour for 67% of the children.[10]

These results are not surprising given the relation between the causes of feeding problems and caregiver behaviour. Parental strategies such as stopping the meal or coaxing may produce the immediate effect of temporarily stopping undesirable child behaviour. From the child's perspective, the study by Piazza et al. suggested that if refusal behaviour produces a "good outcome" for the child (e.g., the meal ends), refusal will continue.[10]

Research Context

The treatment strategies with the most scientific support are based on behaviour analysis.[11-16] Kerwin and Volkert and Piazza examined the research literature on treatment of pediatric feeding disorders to identify which treatments had enough scientific support to be labeled "effective." Kerwin and Volkert and Piazza found that behavioural interventions were the only treatments with enough scientific evidence to be labeled "effective." Similar analyses by Sharp and colleagues, Ledford and Gast, and Williams and colleagues supported those of Kerwin and Volkert and Piazza.[11,13-16]

Research Results and Conclusions

Because children have feeding problems for a variety of reasons, treatment should focus on all of the components (i.e., biological, oral motor and psychological) that contribute to feeding problems and should be interdisciplinary.[17,18] One preliminary analysis of the outcomes for 50 children admitted to an interdisciplinary day-treatment feeding program indicated that over 87% of the goals for treatment were met by discharge from the program. When increases in calories consumed by mouth were the goal of treatment, 70% of patients reached their goal. Even when

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children did not reach 100% of their oral intake goal, their levels of oral intake were increased substantially and within 20% of the goal One hundred percent of patients met their goals for increasing texture, decreasing bottle dependence, increasing self-feeding skills, and increasing variety of foods consumed.

All patients receiving their nutrition via tube experienced decreases in tube feedings and 70% of patients met their goals for decreases in tube feedings. Patients who entered the program with a *nasogastric tube* either left the program without the tube (75%), or the tube was removed shortly after discharge (100%). Ninety-seven percent of patients met their goals for decreasing inappropriate mealtime behaviour. Eighty-eight percent of caregivers were trained to implement the treatments with greater than 90% accuracy, and the treatment was transferred successfully to the home and community in 100% of cases.

Follow-up data indicated that the majority of patients continued to make progress toward age-typical feeding (e.g., volume increases *gastrostomy-tube* feeding decreases and initiation of self-feeding).[17] Williams and colleagues, Greer and colleagues, and Laud and colleagues provided similar data in that interdisciplinary treatment with a behaviour analysis focus produces positive outcomes for children with severe feeding problems.[19-21]

Implications

Interdisciplinary, intensive treatment of pediatric feeding disorders is successful in improving a wide variety of feeding problems, including dependence on supplemental feedings, selectivity by type and texture of food, inappropriate mealtime behaviour, failure to transition to age appropriate textures of food, and failure to self-feed to name a few. Successful treatment of these feeding problems has a number of important implications for children with feeding problems, their families, and society. Long-term, chronic feeding problems are associated with (a) health risks for the child,[22] (b) increased perceived stress for the child and family,[23] (c) mental health problems in families,[24] (d) increased risk of eating disorders such as anorexia,[25] and (e) increased health care costs for the child and family.[19] Therefore, treatment of pediatric feeding problems can result in (a) improved health of the child, (b) improved quality of life for the child and family, (c) decreased mental health problems in families, (d) reduced risk of long-term eating problems, and (e) reduced health care costs. Obviously, children who are dependent on technology such as gastrostomy-tubes (G-tube) for their nutritional needs have high health care costs. For example, the health care cost for a child with a G-tube is approximately $41,811 for the first year. Over

two years, the health care cost for that child is estimated to be $78,811 and after five years, the cost is $189,811. These estimates are for uncomplicated care (e.g., no other significant medical problems related to the gastrostomy-tube) and do not include costs associated with family or individual therapy that may be necessary as a result of increased stress or psychopathology that has been documented in families of children with feeding problems. Moreover, the health care costs for these children may extend over many years if the child continues to need the gastrostomy-tube for nutrition or if the child develops eating problems such as anorexia later on. Williams and colleagues found that intensive, behavioural treatment was a cost-effective alternative to long-term supplemental feedings.[19] Intensive, interdisciplinary treatment for feeding problems can eliminate the need for a gastrostomy-tube and result in age typical feeding, which can end the need for ongoing medical treatment in about 2 years. The estimated cost of intensive treatment for the feeding problem is approximately $55,620 over 2 years. Thus, treatment of the feeding problems results in a savings of $23,191 over a 2-year period and a cost savings of a minimum of $134,191 over 5 years when compared to using a gastrostomy-tube for the problem.

Thus, not only are there obvious quality of life improvements for children with feeding problems and their families, but also there are significant cost savings when feeding problems are treated using interdisciplinary approaches with a behaviour-analytic focus.

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Genetic Influences on Child Eating Behaviour

Clare Llewellyn, PhD, Jane Wardle, PhD

Health Behaviour Research Centre, University College London, United Kingdom

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Introduction

Obesity is a global epidemic; its prevalence is increasing[1] and it is developing earlier in childhood.[2] It is therefore crucial to identify causal factors underlying early weight gain. Recent changes to the environment – such as increased opportunity to eat high calorie food and decreased opportunity to be physically active – have undoubtedly played a role. Nonetheless, not everyone is overweight. Body weight has a strong genetic basis,[3,4] leading to the hypothesis that genes may influence how vulnerable an individual is to gaining weight in the modern environment.[5] Genetically-determined susceptibility to the environment would help to explain how obesity can be both genetic and environmental.

Subject

Eating behaviour, or appetite, has been proposed as one mechanism through which genes influence obesity susceptibility.[5,6] In particular, individuals who inherit a more avid appetite – high responsiveness to external food cues and low sensitivity to internal satiety (fullness) processes – may be more likely to take advantage of the multiple eating opportunities presented by the modern environment, and consequently gain more weight. That is, genes may influence how big or small an individual's appetite is, and ultimately these genes therefore impact on their weight, so-called "inherited behavioural susceptibility to obesity."

Problems and Research Context

Eating behaviours of interest are those with evidence for a causal role in early life weight gain.[7-11] Broadly these can be thought of as "food approach" behaviours which indicate a bigger appetite and a greater interest in food (e.g., enjoyment of food[11] and responsiveness to external food cues [8,11]) and predispose to weight gain, and 'food avoidance' behaviours which suggest better appetite regulation and a lower interest in food (e.g., sensitivity to satiety[9,11] and slower eating speed[7,10,11]) and protect against weight gain. Observational measurement of eating behaviour

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provides detailed information, but is time-consuming and expensive so the number of observations is limited, which is problematic for genetic research which requires large samples (see below). It is also possible that participants alter their eating behaviour in response to being observed, especially self-conscious overweight adults. Using children instead of adults helps get around this issue, and the development of a parent-report measure of child eating behaviour (the Child Eating Behavior Questionnaire [CEBQ][12,13] or the Baby Eating Behavior Questionnaire [BEBQ][14]) has enabled information to be collected reliably on very large samples, for a range of eating behaviours.

Two different approaches allow researchers to explore genetic influences on eating behaviour. So-called "quantitative genetic" studies estimate broadly the extent to which behaviour is influenced by genes or environment.[15] Studies compare family members who differ in their genetic relatedness – if relatives who are more genetically similar are also more similar for eating behaviour, genetic influence is inferred. Twins are commonly used because identical twins (monozygotic pairs, MZs) are 100% genetically identical, while non-identical or "fraternal" twins (dizygotic pairs, DZs) share on average only about 50% of their genes, like regular siblings. At the same time, MZs and DZs can be assumed to share environmental factors to a very similar extent (e.g., they are born at the same time into the same family), so they can be compared. Greater similarity between MZs compared to DZs suggests that genes influence eating behaviour.[15] Heritability is the statistic that is derived from twin studies, and it indicates the extent to which individual differences in the sample are explained by genetic variation. The statistic ranges from 0% (genetic variation does not contribute to individual differences) to 100% (individual differences can be explained entirely by genetic variation).[1] Twin studies are limited in that they cannot tell us anything about the actual genes involved, they simply indicate the relative importance of genes versus environment.

Molecular genetic studies try to identify the specific genes. Early research studied individuals and families with extreme manifestations of the trait – e.g., severe early onset obesity – to find genes.[16] These studies identified genes responsible for rare and serious genetic disorders, but not common genes influencing variation across the general population (e.g., body weight). Recent technological advances combined with the completion of the Human Genome Project in 2000 have made it possible to explore the impact of millions of genetic variants on traits across the wider population, using a method called genome-wide association (GWAS).[17] Large samples are needed for quantitative genetic studies and even larger samples for molecular genetic studies.[15]

Key Research Questions

1. Is eating behaviour heritable?
2. Which genes influence eating behaviour?
3. Do weight-related genes influence weight via eating behaviour?

Recent Research Results

The high heritability of body weight in children and adults (~70%) is a long-standing finding established from a wealth of twin and family studies.[3,4] Similar heritability estimates have been found for infant and child eating behaviour. The CEBQ was used in 5,435 pairs of 10 year old British twins to demonstrate that the majority of individual differences in responsiveness to food cues and satiety responsiveness are determined by genes (75% and 63% respectively).[5] A similar estimate was obtained for an observational measure of eating speed (63%) in a subsample of 254 of these twins at age 11.[18] An infant-version of the CEBQ (the BEBQ[19]) showed comparably high heritability estimates for enjoyment of food (53%), food responsiveness (59%), satiety responsiveness (72%) and slowness in eating (84%), in 2,402 infant twin pairs.[20] The same sample of infant twins was also used to show that about a third of the genes that influence eating behaviours influence weight as well, supporting the idea that genes influence weight via their effects on eating behaviour.[21]

Early studies of obese individuals and families identified major mutations in one of a few genes resulting in severe early-onset obesity, as well as extreme appetite voraciousness and no apparent satiety.[22] These genes are fundamental regulators of the *leptin-melanocortin pathway* that controls hunger and satiety centrally, and is located in an ancient part of the brain called the hypothalamus. While the discovery of these genetic mutations provided important insights into the biology of body weight and eating behaviour, they are extremely rare and therefore do not explain weight variation at the population level.

Genome-wide association studies (GWAS) have identified more than 30 common genetic variants associated with body weight in adults and children.[23] The first to be discovered was the “fat mass and obesity-associated gene,” FTO.[24] Nearly half of us carry at least one of the weight-related FTO variants; and those of us carrying two are on average 3 kilograms heavier than those carrying none. Not only is FTO expressed primarily in the hypothalamus, but it is associated with observational measures of food responsiveness measured at test meals,[25] and with satiety

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responsiveness as measured by the CEBQ.[26] Many of the other variants discovered through GWAS are also expressed in the hypothalamus, suggesting that common genetic variants, like the rare mutations, influence body weight through eating behaviour. However, as yet relationships between these other common variants with eating behaviour have not been explored.

Research Gaps

Although research has made headway in establishing that eating behaviour, like weight, has a strong genetic basis, we still know very little about the specific genes involved. A good starting point would be to explore whether the weight-related common genes identified so far are also associated with eating behaviour. The biology linking genes to behaviour also needs to be characterized. In addition, it is crucial to test the feasibility of modifying eating behaviour in individuals who are genetically susceptible to obesity. There has been little research into modifying eating behaviour so far, but some studies are promising. Epstein and colleagues succeeded in slowing the eating speed of 7 year old children over a 6-month period by encouraging them to put their knife and fork down after each bite.[27] Another study demonstrated that it is possible to train 4-5 year old children to become better at recognizing and attending to their internal satiety sensations.[28]

Conclusions

Twins studies have established that differences between individuals in eating behaviour is explained partly by genetic variation, in typical western societies at this time; although the actual genes involved remain to be identified. Twin studies have also shown that the same genes which influence eating behaviour also influence weight, suggesting that the size of an individual's appetite ultimately influences their vulnerability to obesity in the modern permissive environment. In support of this, the most important common weight-related gene (FTO) appears to influence body weight through its effects on satiety sensitivity in children. This so-called inherited behavioural susceptibility to obesity helps to overcome the seeming paradox of both genetic and environmental determination of weight.

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Figure 1. Interactions between individual genetics susceptibility to obesity and the food environment

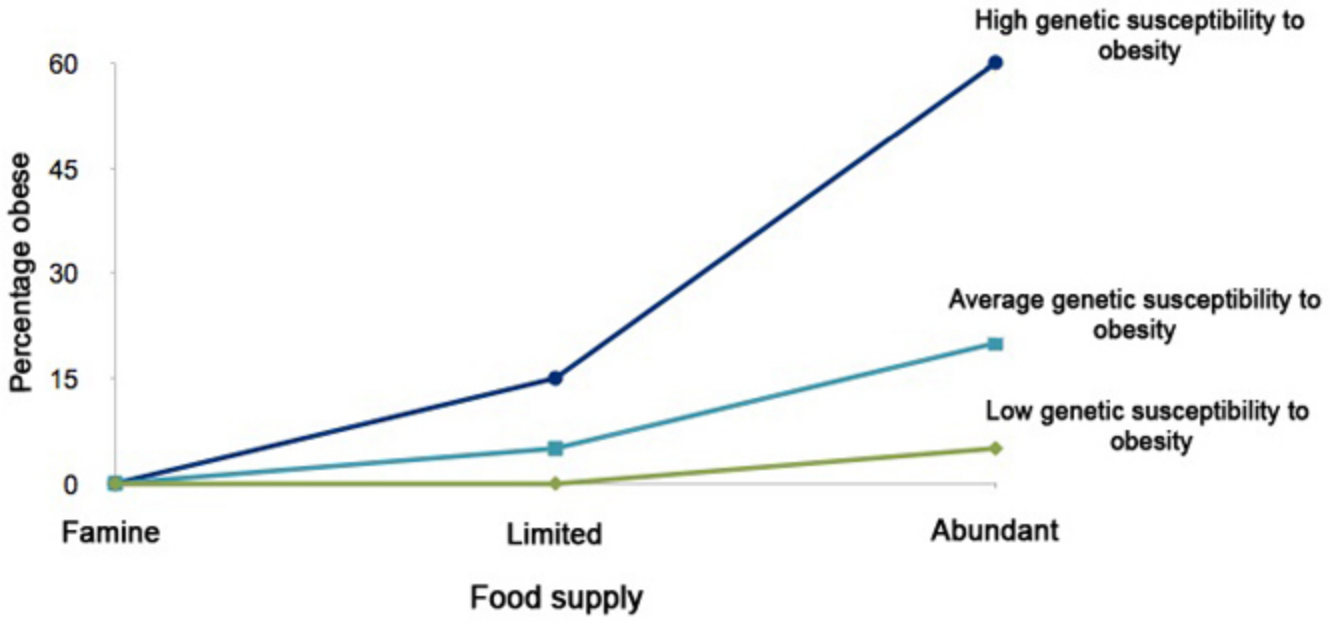


Figure 1 is a hypothetical demonstration of the percentage of children who are obese under three different environmental conditions, according to whether they have a low, average or high genetic susceptibility to obesity.[29-30] Under conditions of famine there would be no obese children, regardless of genetic susceptibility to obesity; when the food supply is limited slightly more of the children at high genetic susceptibility would be obese than those at average susceptibility, but none of the children at low genetic susceptibility would be obese; under conditions of abundance (like the modern food environment in the U.S.) the majority of children at high genetic susceptibility would be obese, a considerable number at average genetic susceptibility, but very few children at low genetic susceptibility would be obese.

Implications for Parents, Services and Policy

This research suggests that some individuals are more vulnerable to overeating in response to the multiple opportunities presented by the modern food environment, by virtue of their genes, and more likely to gain weight. This calls into question the notion of personal responsibility for obesity. It is a commonly held belief that a child's weight reflects the rearing strategies of the parent. However, this research suggests that some children (more often those who have overweight parents and are therefore likely to have inherited higher risk genes.[31] may find it harder than others to regulate their food intake appropriately because they have a more avid

appetite, which is partly due to genes inherited from their parents. This can make it more difficult to resist over-consuming in response to the many eating opportunities presented by the modern environment.

[An effective strategy might be tighter state regulation of the wider food environment to reduce opportunities and incentives for overconsumption, such as removal of vending machines from schools, tighter control of food marketing to children, limitation of the number of fast food venues, and regulation of supermarket layouts.[32] Parents can also modify the home environment – e.g., by cooking smaller amounts of dinner to remove the temptation for "seconds," keeping problem foods out of sight (or better, out of the home), and teaching their children how to recognize feelings of fullness.

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Screen time Use and Food Marketing Influences on Children's Eating Behaviors

[1]Chrisa Arcan, PhD, MPH, RD, [2]Aninda Sen, MBBS, MPH, [3]Meg Bruening, PhD, MPH, RD, [4]Mary Story, PhD, RD

[1]Renaissance School of Medicine, Stony Brook University, USA, [2]University of North Carolina at Chapel Hill, USA, [3]PennState College of Health and Human Development, USA, [4]Duke University, USA

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Introduction

Among children and adolescents, a key determinant of food preferences is taste which is shaped by early environmental exposure to food during infancy and childhood. Taste preferences are acquired through learning processes,[1] including repeated exposure and positive messaging about various foods. Additionally, two of the strongest dietary predictors appear to be familiarity and sweetness of food.[2–4] Repeated exposure and high frequency to food marketing, often of unhealthy foods, influences food preference, purchase requests, consumption, and importantly long term brand preferences, with negative health outcomes for youth.[5–7]

Screentime, including time spent in front of a television (TV) and other digital platforms results in increased exposure to food advertising increasing the risk of overweight or obesity among children and adolescents.[8] In recent years, the expansion of digital media platforms has caused a shift from TV viewership to digital media providing food companies with additional platforms to expand their food marketing strategies to children. This shift is more prevalent among adolescents whereby TV viewership has decreased while digital media use has increased leading the food and beverage companies to increase their investment in food advertising in digital media spaces.[9,10] Trends also suggest that adolescents are more likely to have unhealthy diets compared to younger children, partly due to aggressive marketing practices.[11] Despite the decrease in TV viewing among children in recent years, it still remains an important source of exposure to food advertising among these age groups.[12] Additionally, TV advertisements for certain food products viewed by children exert a persuasive and motivating effect through visual, emotional, and sensorineural stimulation, exerting a large influence on purchase requests, purchases, and ultimate consumption of energy dense and unhealthy foods, compared to adults

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viewing such advertisements, thus highlighting the importance of children's screentime towards shaping their dietary practices.[13,14]

There are associations between increased screen time among children and adolescents and lower intakes of fruits and vegetables higher intakes of energy-dense snacks, beverages, and fast foods, and a higher percentage of energy intake from dietary fats and added sugars leading to subsequent obesity.[5,15–17] From 1999 to 2023, the prevalence of obesity among 2-19 year olds in the US has increased from 13.9% to 21.1%, while the prevalence of severe obesity has nearly doubled from 3.6% to 7%.[18] Studies have shown that due to psychological and neurological mechanisms affecting children's judgement, they tend to make more immediate food-related decisions than older adults following exposure to food advertisements. This leads to decisions favoring taste over health[19] leading to over-consumption of foods high in calories, refined sugars and salt, all of which are associated with outcomes such as obesity and other negative health outcomes.[20]

Prevalence and types of screentime use among children and adolescents

In the US, there has been a decline in traditional TV viewership by 57% and 60% among 2-11 years old children and 12-17 year old adolescents, respectively.[21] During this same period, the amount of entertainment-related screen time has increased among all age groups, with 8–12-year-old children and 13–18-year-old adolescents reporting 5.5 hours per day and 8 hours per day of screen time, respectively. This is largely attributed to digital media platforms, especially those accessed via mobile devices.[21]

With the growth of digital media and the use of mobile devises, the pervasiveness of advertising to children has increased as well. In the US, the most popular social media sites among children aged 5 years and older and adolescents aged 11-17 years are TikTok, Snapchat, and Instagram, while younger viewers aged 3-5 years primarily watch YouTube and YouTube kids.[21,22] This highlights that social media, video streaming, branded websites, and gaming sites take up the majority of younger viewers' screen time and have replaced traditional cable TV as the preferred alternative platform for entertainment access. In turn, the increase in screen time choices has presented food companies with a plethora of digital venues to engage in food marketing to children. Due to its diverse nature and unique characteristics, digital food marketing compared to traditional advertisement (TV, print media) presents a challenge in assessing children's exposures and impact on their health outcomes and in developing policies and solution to

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address potential harms. The diversity and constantly evolving media platforms (e.g. mobile phones, gaming, social media, websites, etc.) and message sources allow for targeted and personalized messaging (e.g., sociodemographic) using creative approaches (e.g., influencers, branding, artificial intelligence, etc.) are a few of the characteristics of food digital marketing.[21]

Food and beverage marketing strategies and budget

Advertisements on TV, and more recently, on digital media platforms, have been identified as the two most popular venues where unhealthy, energy-dense, nutrient poor foods[23] are advertised to children and adolescents by employing sponsored content, influencers, data collection technology, and personalized behavioral marketing using machine learning.[7,24] To appeal to younger audiences, companies use strategies, such as celebrity endorsements, promotions, gifts / incentives (e.g., toys), games, branding, and other salient claims such as sporting prowess to promote products.[7] Studies indicate that in the US, food, beverage, and restaurant companies spend around $14 billion each year for advertisements, with over 80% of that budget dedicated towards food which are generally considered unhealthy for children and adolescents, such as fast food, sugary drinks, candy, and snacks.[25] The food and beverage advertising budget dedicated to TV reaches $11 billion annually.[26] In Canada, in 2019, advertisers spent an estimated $628.6 million dollars on food advertising and 79.5% of this went to ads on television (67.7%) and digital media (11.8%). According to a study in Canada,[27] there were over 54 million food display ads (e.g., pop-up ads and banner ads) in one year on the most popular Canadian children's websites.

Research Context

Influence of TV viewing and digital use and advertising on eating behaviours of children

As one in five of U.S. children and adolescents have obesity and diets high in added sugars, sodium, and saturated fats are associated with a host of diet-related chronic diseases in adulthood, it is critical to examine the extent to which TV viewing and digital media use and food marketing negatively influence current and future eating behaviours among children and adolescents. Thus, it is important to discuss potential regulations that can protect children from TV and digital deceptive marketing practices. Finally, given the ubiquitous nature of food marketing using traditional and digital platforms, implications for policy makers and parents will be discussed.

Key Research Questions

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- Is there an association between food marketing through traditional and digital platforms and eating behaviors in children and adolescents?
- Does advertising in TV and digital media platforms impact the quality of diet among children and adolescents? What are the effects of digital food marketing on children?
- Are there racial and socioeconomic differences in children's exposure to food marketing?
- Are TV viewing and digital media use and food advertising associated with diet-related health issues, such as obesity in children?
- What are the policy implications of existing marketing practices employed by food companies?

The role of TV and digital platforms in shaping the diet quality of children and adolescents

The overall diet quality of children and especially adolescents remains low with over half of all youth ages 5-18 years in the US having poor dietary patterns with an average Healthy-Eating Index score of about 50 out of a possible 100.[28] It has been documented that among young children, TV viewing is significantly associated with increased consumption of unhealthy foods, including fast food,[29] increased requests of foods seen on TV, and more positive attitudes toward unhealthy foods.[12,13,30–32] With the addition of digital food marketing, the increase in the overall screentime exposure has exposed children to more sources of high salt, sugar, and high energy-dense foods, including snacks, sugar-sweetened beverages, and fast food.[4,33,34]

While children younger than 7 years old display limited ability to recognize the persuasive nature of food advertisements, children from 7-14 tend to show greater awareness of the intent behind such advertisements. Despite this, adolescents are still undergoing cognitive development, and companies target this inability to comprehend disguised, persuasive marketing strategies, by influencing attitudes, food preferences, and poor impulse control.[10] Adolescents are particularly vulnerable to celebrity endorsements, music sponsorships, social media and influencer-based marketing of potentially unhealthy food products leading to high levels of engagement and trust towards many brands across both traditional and digital marketing platforms.[32,35] While adolescents might be more aware against such marketing tactics, their social desire to fit in and peer influence can overcome their skepticism towards media advertisements, thus creating a positive emotional associations to advertised products and making them feel more open to trying

out new foods and beverages.[32,36]

Overall, both traditional TV advertising and digital food marketing have the same negative impact on children's food-related behaviors and more broadly on social norms and family relations; additionally, efforts to advertise healthy foods through digital media do not increase consumption of these foods neither do they decrease consumption of unhealthy foods.[21] Based on World Health Organization (WHO) reviews, unhealthy food marketing exposure increases immediate food intake and request for purchases. The frequent and amplified effects of food exposure through all multiple media platforms also has an effect on intermediate outcomes including brand awareness and loyalty, favorable ads, taste preferences, and purchasing intent for unhealthy foods.[37]

Racial and socioeconomic differences in children's exposure to food marketing

Targeted advertisements associated with TV and digital media usage can lead to disparities in diet-related health outcomes. Food and beverage advertising companies employ marketing practices targeting younger Hispanic and Black consumers in a disproportionate manner, which can have detrimental effects on the health of children and teenagers of ethnically diverse backgrounds.[38–40] Reports indicate that fast food companies increased their budget for advertisements on Spanish speaking TV channels by 33% from 2012 to 2019, compared to a 9% increase across all channels combined. As a result of such discriminatory practices, viewing of fast-food advertisement among Hispanic children and adolescents increased in 2019. During the same time, Black children and adolescents also reported viewing 75% more fast food advertisements compared to their white counterparts, due to increased advertisements during TV programming popular among Black youth.[41] Overall, despite the decrease in overall screen time associated with TV programming among all children and adolescents, the number of TV advertisements viewed by Black youth was higher compared to the number of advertisements viewed by youth in other racial groups.

Recognizing the rising presence of Black and Hispanic users in digital medial platforms, companies have also employed food marketing geared towards younger audiences from these population groups in recent years.[42] Recent studies found that social media accounts of food and beverage companies on platforms such as Facebook, Instagram, and TikTok have amassed significantly higher numbers of Hispanic and Black youth followers compared to social media accounts of other commercial products. Hispanic and Black youth have even reported feeling

more valued by food and beverage companies who employ racially targeted advertisements, which can lead to higher levels of online brand engagement compared to consumers from other racial backgrounds, affecting purchasing intent and actual purchases of unhealthy food and beverages.[42] These findings parallel the demographic differences in the prevalence of obesity among youth across different racial and ethnic groups, with Hispanic and Black children and adolescents being more likely to have obesity compared to their white counterparts.[43,44]

Children and adolescents in socioeconomically disadvantaged families are at a relatively higher risk of exposure to food and beverage advertisements from TV viewing compared to other groups. While the types of foods included both healthy and unhealthy items, the differences in exposure to unhealthy food advertisements is higher among younger viewers from lower socioeconomic backgrounds compared to the more affluent families.[38] This may be due to children from lower socioeconomic backgrounds spending more time in front of screens compared to children from higher socioeconomic backgrounds resulting in a subsequent dose-response relationship, with higher screen-time and advertisement exposure leading to increased purchases and higher consumption of unhealthy food and beverages.[38,40]

Parental educational attainment has been shown to play a role on a child's exposure to food and beverage advertisements, especially on mobile devices, with children of lesser educated parents reporting higher advertisement exposure.[38] The reason for this discrepancy seems to be more related to the type of content viewed rather than duration of screen time, as families reporting lower socioeconomic status are found to be more likely to avoid higher subscription fees associated with subscription only streaming services. This results in more frequent commercial breaks in-between online entertainment, thus, greater exposure to food marketing practices.[45]

Policies to limit TV and digital media food advertising

The World Health Organization at the 63rd World Health Assembly in 2010, called for Member States to introduce policies that reduce the impact of advertising to children of foods high in sodium, sugars and saturated fat.[46] In 2023 WHO updated their statement calling for global action to reduce the impact of marketing of these foods to children. Specifically, they called for comprehensive and mandatory polices that reduce exposure of unhealthy food and beverage advertising among both children and adolescents based on nutrition criteria developed by governments.[47] Currently, 20 countries have mandatory policies, that vary in scope and enforcement.48 For example, in 2023, Norway's parliament agreed to new regulations to restrict

all advertisements of unhealthy foods to children under the age of 18 and will ban the marketing of unhealthy foods and beverages that are high in fats, sugars and salt in all media that children are likely to see, such as television, radio, the internet, and social media.[47] Chile and Portugal have the most comprehensive policies restricting all marketing and persuasive techniques in broadcast and non-broadcast platforms in children and adolescents.[49] Chile requires manufacturers to include front-of-package warning labels on prepackaged foods high in saturated fats, added sugars, and sodium or beverages, and bans their marketing to children under the age of 14 in media intended for children. These marketing restrictions apply to schools, product packaging, point-of-sale, print media, radio, television, and websites.[47,48]

In the US, in 2006, in partnership with the Council of Better Business Bureau's Children's Food and Beverage Advertising Initiative (CFBAI), a coalition of 21 of the largest food companies pledged to improve the nutritional quality of foods advertised to children under the age of 12 years.[50] Companies that participate in the CFBAI pledge that will only advertise foods and beverages that meet only "strict" nutrition criteria in "advertising primarily directed to children under age 13 in the U.S." Together, these stakeholders pledged to advertising only products which meet CFBAI criteria on children-directed media.[51] Prior evaluation of these policies has found that they excluded certain marketing venues, such as product packaging, in-store marketing, company own digital marketing, brand marketing etc. It is important to note that adolescents are not offered the same protections under the CFBAI increases their vulnerability for exposure to unhealthy food and the potential for altered food preferences, over-consumption, and subsequent health issues.[51]

In response to the rise in digital media usage among children, in 2018 the CFBAI updated their core principles to expand the digital media section of the agreement that was implemented in 2020.[52] Additionally, Children's Advertising Review Unit (CARU) is the primary self-regulatory mechanism for the advertising industry.[53] Disney and Google have established additional policies addressing food marketing to children on their own digital platforms.

Even after the updated CFBAI principles, analysis shows that the total number of products which are regulated by the CFBAI through self-regulatory practices across traditional TV and digital media platforms represent a very small portion of the overall calories consumed by children, which negates the possibility of such principles having any significant public health impact in curtailing childhood obesity rates.[52] Food and beverage companies continue to advertise products with low nutritional value to young audiences, encouraging unhealthy dietary habits that lead to

obesity and related negative health outcomes.[51,54] Recent studies also indicate that while many companies avoid marketing their brands on made-for-kids channels on platforms like YouTube and YouTube Kids, they can by-pass existing CFBAI guidelines through strategic product placements and endorsements of candy, sugar-sweetened beverages, salty snack and junk food on child-influencer videos.[55–57] In addition, the lack of protection for adolescents through the CFBAI policies, and the various vulnerabilities of this age group to targeted advertisement campaigns have so far not been addressed by any regulatory authorities as public health priority.[58] Given the failure of the food industry's self-regulation initiatives, stronger policies are needed to protect children and adolescents from the harmful impact of food marketing. There is a need for government agencies in the US to implement and enforce mandatory regulatory policies on unhealthy marketing to children and youth.

In Quebec, the Consumer Protection Act prohibits commercial advertising, including all foods directed at children under the age of 13. In Canada, in 2016 the Minister of Health launched the Healthy Eating Strategy to help improve the food environment. Restricting food advertising to children is an important component of this Strategy. Health Canada considers the monitoring of food advertising to children as a priority and the Department of Health is monitoring the strategies that are most frequently used in advertising directed at children.[59]

Research Findings and Gaps

Some progress has been made in assessing the degree of exposure and content of TV and digital advertisement to children and adolescents, including expansion on newer popular media forms such as social media (e.g., Instagram), video streaming (e.g., Netflix, YouTube, TikTok), and livestream gaming (Twitch). Based on a panel report published by Healthy Eating Research (HER),[21] recent studies have expanded on the growing trend of influencer videos and other creative strategies in these platforms indicating the increased prevalence of branded posts and their impact on children. As adolescents engage more frequently with social media, recent studies have focused on adolescents compared to older studies that mostly included younger children. They have also observed that exposure to food advertising through influencers have immediate impact on young adolescents' consumption of unhealthy foods, despite providing ad disclosures.

Additional research gaps need to be addressed in future research.[21] In addition to traditional TV advertisements, the plethora of digital platforms and the constantly evolving creative marketing

strategies, require continuous research to understand the long-term impact of the cumulative and synergistic exposure on children's eating behaviors, health risks, and socio-cultural outcomes. While some research has been conducted to record unhealthy food marketing to racially and socioeconomically diverse children, more extensive research is needed to understand and address the impact of digital food marketing on the health inequities among these groups. It's important to develop programs addressing the impact of the expanding food marketing practices on children's eating behaviors as well as to evaluate the effectiveness of policies.

Conclusions

The types and amount of screen time that children and adolescents are exposed to has dramatically increased mainly due to the increase in the availability of digital entertainment platforms. While TV viewership has decreased, the increase in digital media has provided a plethora of food and beverage advertisements that amplified the persuasive massaging seen in traditional forms of media. Unfortunately, the vast majority of foods and beverages that are advertised to younger audiences across all digital platforms are unhealthy in nature[7] supporting the link between increased screentime, food marketing, and childhood and early life obesity.[60] The ubiquitous digital entertainment offerings in digital platforms and social media, (TikTok, Snapchat, Instagram) gaming platforms and video streaming services and the creative marketing strategies blur the lines between food promotion and entertainment with immediate and long term effect on food tastes and preferences of older children and adolescents.[22,36]

Youth from certain racial minority and socioeconomic backgrounds have been disproportionately affected as companies that cater to these audiences use targeted food marketing strategies in specific platforms and time-slots. Parental educational attainment has also been shown to contribute towards disproportionate exposure to unhealthy food advertisements among children and adolescents.[38] The exposure and impact of these diverse and targeted food marketing practices across different age, racial, and socioeconomic groups need to be further evaluated in order to develop policies aimed at protecting youth especially from vulnerable backgrounds.

There are no uniform policies and restrictions on food advertising to children internationally.[61] In North America, only Quebec and Mexico have mandatory restrictions on food advertising to children.[59]

Implications for Parents, Providers, and Policy

Parents' and caregivers' efforts to promote healthy eating at home are undermined by the high volume and influence of food advertisements that children see and hear where they learn, live, and play. Parents play an important role in the lives of young children, however the evolving landscape of food advertising to children undermines the parents' and caregivers' efforts to promote healthy eating to their children. When possible, parents can opt for child friendly plans when it comes to TV and digital media viewing, which will use high-quality media content that are considered less harmful in influencing unhealthy eating behavior. Clear and open communication between parents and children on how to assess marketing tactics on TV, social media, gaming websites and other screen-based platforms can equip young audiences with better skills for navigating unhealthy foods such as fatty foods, sugary-drinks, salted snacks, candy and others which can lead to both short and long-term negative health outcomes. Steps for building awareness within families of children who are disproportionately targeted by aggressive marketing will be key in shaping future dietary outcomes among minority and socioeconomically disadvantaged communities. School meetings, community events, and even places of worship can be used for disseminating information regarding digital media literacy, so that parents, guardians, and children of all ages can become better equipped in building their awareness of marketing strategies. Parents should also understand the importance of refraining from watching TV or using mobile devices during meals, removing TV from children's bedrooms, and generally limiting their children's exposure to TV and other devices. According to American Academy of Pediatrics, children below the age of 2 years should not watch TV and anyone older than 2 years should only watch 1 to 2 hours of quality programming per day.[62] Health care providers should be abreast of the latest research and policies regarding TV viewing and digital media use and children's dietary behaviours and obesity. At well-child visits, health care practitioner should discuss with families their media habits and inform them about the negative impact of food advertising on children's dietary behaviours.

Policy makers should monitor the media and strategies employed by food advertisers and collaborate with the food industry to develop evidence-based strategies and enforce regulatory guidelines to limit the TV and digital marketing of unhealthy products to children in all age groups. The regulatory principles can be extended in order to incorporate children 14 years old and older in order to offer added protection to adolescents during this crucial developmental stage in their lives, when lifelong dietary habits are being shaped and consolidated. Finally,

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digital media platforms can be pressured in order to restrict their usage of personal data from mobile phones, tablets and other streaming and gaming devices which make it easier for advertisers to target certain groups for advertising food and beverages under the guise of social desirability and increased celebrity / influencer engagement.

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Eating Behaviour in Studies of Child Growth, Development and Health – Measure Precisely, Early and in Context: Commentary on Ramsay, Liu & Stein, Black & Hurley, Milnes, Piazza & Carrol, Llewellyn & Wardle, and Arcan, Bruening and Story

Myles S. Faith, PhD

Gillings School of Global Public Health, University of North Carolina at Chapel Hill, USA

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Introduction

Eating is essential for healthy growth and development. Along with physical activity, eating is the major behavioural conduit through which energy balance is regulated, through which food choices are made, and around which numerous interactions with family members and peers occur. Children's food choices and diet composition influence health status during development and, potentially, later life. Perhaps there is no better example of this than that of pediatric obesity, which tracks through adolescence and into adulthood and predicts a number of health disorders. For all these reasons, it is imperative that clinical guidelines and policy recommendations intended to foster healthy eating by children be guided by rigorous scientific studies and methodology. Quality measurement is fundamental to this endeavour and, as noted below, is a focal point of the papers[1-6] in this chapter.

The papers[1-6] reviewed in this section address a variety of topics related to the development of feeding and eating patterns throughout development, starting in infancy. The papers address biological and environmental drivers of refined eating phenotypes within "normal" populations as well as more specialized patient samples (e.g., feeding disorders).[1-6] They present some of the strongest scientific innovations in the pediatric ingestive behaviour fields, while highlighting real-world clinical and policy implications where real lives are touched. This is where the "rubber meets the road" of real-world eating behaviour.

A cross-cutting, if not unifying theme, across these papers[1-6] is the critical role of measurement in driving scientific advances. Armed with quality measurement, new insights have emerged which ultimately may better inform policy. Three conclusions can be drawn upon review of these

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papers,[1-6] with respect to measurement: (1) Measure eating behaviour precisely; (2) Measure eating behaviour early; and (3) Measure eating behaviour in context. These are discussed next.

Research and Conclusions

Measure eating behaviour precisely

The contributions in this chapter[1-6] reveal insights that can be gleaned by using quality assessment tools that capture precise, refined dimensions of child eating behaviour. For example, as reviewed by Llewellyn and Wardle,[5] development of the Child Eating Behavior Questionnaire[7] over the past decade has yielded critical insights into the development of children's "food responsiveness" and "satiety awareness" – both of which are linked to childhood obesity.[8,9] The tool has been used internationally and allowed for replication of findings across diverse populations. This suggests novel targets for intervention (e.g., training children to recognize hunger/fullness cues) that, with rare exception,[10] have not been explored to date. Milnes et al.'s[4] contribution illustrates how researchers can quantify specific parenting strategies in the context of pediatric feeding disorders (e.g., coaxing, reprimanding) and how these may impact on specific child eating patterns (e.g., bites of food, food refusal). Ramsay's[1] contribution illustrates how inefficient sucking, assessed by polygraph among young infants with gastroesophageal reflux, predicted poorer feeding skills and readiness for solid foods. Interestingly, there is other evidence that voracious sucking by infants is a risk factor for childhood obesity.[11,12] These examples underscore a point that is implicit throughout these contributions – but which needs explicit highlighting – that precise measurement has been essential for these scientific advances and will be critical to the next generation of discovery.

Measure eating behaviour early

As illustrated in this chapter,[1-6] eating behaviours can be measured reliably at earlier ages including infancy. This is illustrated by the Baby Eating Behaviour Questionnaire,[13-15] discussed by Llewellyn and Wardle,[5] the subscales of which may reflect early markers for obesity risk. As Black et al.[3] discuss, excess caloric intake during toddlerhood has been documented in population-based research, along with insufficient intake of fruits and vegetables and essential micronutrients. Ramsay's[1] contribution raises the topic of temperament and to what extent it might impact on feeding behaviour. Interestingly, there is emerging evidence that a "difficult" infant temperament in the first years of life may be risk factor for childhood obesity.[16] With the

development of new tools to assess eating behaviour in early life, researchers will be able to explore new causal models for (un)healthy growth and development.

Measure eating behaviour in context

The contributions to this chapter[1-6] reveal that eating behaviour occurs in a multi-level context. This context includes individual-level factors (e.g., genetics; temperament), as well as family-level factors (e.g., parental feeding practices; family relations) and societal/cultural factors (e.g., television commercials; laws regulating advertisements). This framework is consistent with the "socio-ecological model"[17,18] and has been endorsed by an American Heart Association task force on the promotion of healthy eating.[19] Understanding multi-level systems is scientifically challenging yet a pressing research and policy need.[20] This includes research linking genetics to individual child eating behaviour (as illustrated by Llewellyn and Wardle[5]) as well as individual child food preferences and intake to advertising policy (as illustrated by Arcan et al.[6]).

What's missing?

The contributions to this chapter[1-6] reveal the importance of measurement and its potential to provide refined characterizations of infant/toddler/child eating dimensions. This is profoundly important. Armed with these assessment tools, one of the greatest research needs can be better addressed: Better understanding the children for whom, and conditions under which, specific eating behaviours will promote or protect against disease onset. Answering these questions will require birth cohorts that are tracked across the development and – ideally – into adulthood. For example, are refined traits such as sucking intensity,[12] food neophobia,[21] food responsiveness,[8] and negative affect when eating[22] causally related to childhood obesity onset? If so, for whom and under what environmental conditions are these associations intensified or attenuated?

Development and Policy Implications

The authors provide thoughtful discussions regarding the policy implications for their respective topics. The findings, collectively, suggest an important implication for policy-level changes striving to modify child eating behaviour: It is unclear that all children necessarily will respond the same way to a given intervention. Whatever the policy may be (e.g., providing fruits and vegetables to schools; limiting the portion sizes of sugary beverages), one potentially should anticipate individual differences that drive non-uniform responses to the same policy. These individual differences might, conceivably, be related to factors such food responsiveness or

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satiety awareness (which may have a sizable genetic loading), temperament, family interactions, neighborhood characteristics, or other unknown factors that influence how children eat. Being positioned to assess individual differences may help to reveal the conditions under which, and children for whom, certain policy changes will be more/less effective in fostering a healthier diet.

Finally, given the many factors that potentially impact on child eating behaviour, experimental studies that allow for strong causal inference are needed to guide policy development for healthy eating and obesity prevention. Indeed, laboratory studies and quasi-experimental designs can be enormously informative in this regard. This is illustrated by a recent review by Epstein et al.[23] which examined the impact of taxes and subsidies on food purchases. The review focused on studies using experimental designs, including laboratory-based investigations.

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