

Model of the home food environment pertaining to childhood obesity

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The home food environment can be conceptualized as overlapping interactive domains composed of built and natural, sociocultural, political and economic, micro-level and macro-level environments. Each type and level of environment uniquely contributes influence through a mosaic of determinants depicting the home food environment as a major setting for shaping child dietary behavior and the development of obesity. Obesity is a multifactorial problem, and the home food environmental aspects described here represent a substantial part of the full environmental context in which a child grows, develops, eats, and behaves. The present review includes selected literature relevant to the home food environment's influence on obesity with the aim of presenting an ecologically informed model for future research and intervention in the home food environment.

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INTRODUCTION

In the United States, children and adolescents (under age 18) as a whole are faring poorly in meeting recommended nutritional goals.¹⁻³ Many children are consuming excess calories and exceeding recommended intakes of total fat, saturated fat, added sugar, and sodium.⁴ Recent data from the Centers for Disease Control and Prevention show that only about 20% of adolescents reported eating five or more fruits and vegetables a day in the past week.³ Such nutritional shortcomings can result in both short- and long-term health problems, such as obesity, which has seen an extraordinary increase in prevalence over the past 30 years (Figure 1).^{5,6} Poor eating habits and obesity contribute to the development of health burdens such as hypertension, dyslipidemia, chronic inflammation, asthma, endothelial dysfunction, hyperinsulinemia, diabetes, cardiovascular disease, certain cancers, and premature death.⁷

Children's eating patterns are strongly influenced by environmental characteristics.⁸ Despite the growth of fast food, convenience foods, and trends toward increased eating away from home, about two-thirds of the foods

children consume is from home.⁹ Home and family environments are essential in the development of food preferences and consumption habits, and families represent a promising avenue toward improvement of children's eating habits and prevention of obesity.^{10,11} Although parental and familial contributions to obesity are well documented, research has insufficiently addressed the bigger picture or full environmental context of nutrition-related behaviors and adiposity status of children.¹⁰ Specifically, the home food environment has not been consistently defined or measured in this body of literature.

Childhood obesity is a multifactorial problem, and a variety of approaches have been used to study the problem and to create and test interventions.¹⁰ Egger and Swinburn argued for an ecological approach, conceptualizing obesity as a normal response to an abnormal "obesogenic" environment.¹² As the interplay of environmental factors and health behaviors continues to emerge as a science, a need exists for attention to the home, one of the most influential environments for the development of eating behaviors and obesity in children. This review aims to present an ecologically informed model for future

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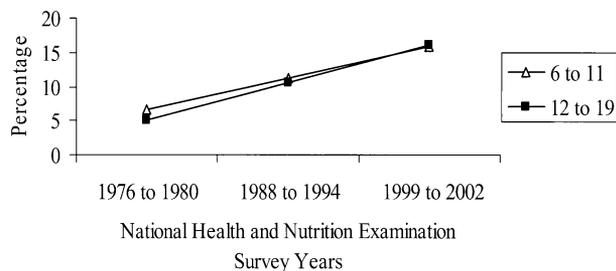


Figure 1 U.S. prevalence of obesity by age group.
Data from Hedley et al. (2004).⁶

research and intervention in the home food environment, the source of a majority of children's dietary intake.

This model of the home food environment pertaining to childhood obesity (Figure 2) is composed of three domains, each with macro- and micro-level contributions. Micro-level components are defined here as those most proximal to a child's home life, whereas macro-level components are defined as existing at the larger community level, with potential carry-over into the child's home life. Built and natural environments are those composed of physical structures. Political and economic environments are those composed of financial resources, policies, and laws. Sociocultural environments are those composed of social interactions, demographic characteristics, and secular trends. Components may interact across domains, represented here via bidirectional arrows connecting the three domains. For example, a parent's education level can influence the family's socioeconomic status, which can influence parenting practices, each impacting the degree to which fresh fruit is available and accessible at home. Although micro-level components are contained within the macro-level, the collection of micro-level components across a population also shapes the macro-level environment. The extent and quality of these micro- and macro-level components in the home combine to bring the full home food environment picture into focus. From there, the influence of the home environment on the dietary intake of children can be moderated or mediated by factors within the individual child.^{12,13} The following literature review illustrates this model.

POLITICAL AND ECONOMIC ENVIRONMENTS

As the global economy continues to develop, international political and trade practices influence the types and costs of foods grown and brought to market, as well as trends in employment, wages, and other factors shaping our way of life. Within nations, states, and communities, laws and policies determine our financial resources, available foods, and food costs. From the international level to

the neighborhood level, political and economic environments play a role in shaping the home food environment.

Macro-level

Food pricing. The prices of foods are strongly related to the likelihood of those foods being present in the home. In a nationally representative sample of almost 3,000 adults, Glanz et al.¹⁴ found that cost was second only to taste as a criterion for food selection, and nutritional concerns and weight impact were much less important in food choice. In small-scale experiments, researchers have found that pricing strategies directly influence food purchases.¹⁵⁻¹⁷ French et al.¹⁸ reported that household income is associated with the types of foods consumed, with higher income families being more likely to purchase healthful foods. In related articles applying national dataset findings from France, Drewnowski and Darmon^{19,20} found that lean meats, fish, fresh vegetables, and fruit generally cost more than less healthful alternatives such as energy-dense foods made from refined grains, sugars, and fats. Another article used the dataset from France to demonstrate how those spending the least money on food had diets higher in energy density and lower in micronutrients.²¹ Between 1980 and 2000, childhood obesity more than doubled in the USA as relative prices of all food fell 14%, with even greater drops in the cost of energy-dense foods.²² These findings support contentions that food costs partly explain consumption patterns and obesity rates as the obesigenic foods are less expensive.

Government and business policies. The pricing of food is a result of government and business policies that determine the costs and profits associated with production, distribution, and marketing (see Nestle²³ for a full review). Drewnowski and Darmon²⁰ posited that a broader problem lies with the economics of food production, importation, and trade, along with poverty, employment, and minimum-wage policy. Agricultural subsidies and trade practices affect the quantity and types of crops grown, resulting in imbalances and price differences for certain commodities. Businesses make use of inexpensive commodities by processing and adding value to create and market profitable, palatable, energy-dense foods.²³ Families are targeted through marketing and often ignore long-term health implications when purchasing food. Several European governments have banned advertising directed at children, but the American food industry has resisted similar efforts.²⁴ While some research has shown connections between advertising and obesity,²⁵ there is no good evidence that advertising bans, by themselves, can prevent or reduce obesity.²⁶ Drewnowski and Darmon^{19,20} called for cooperation between governments,

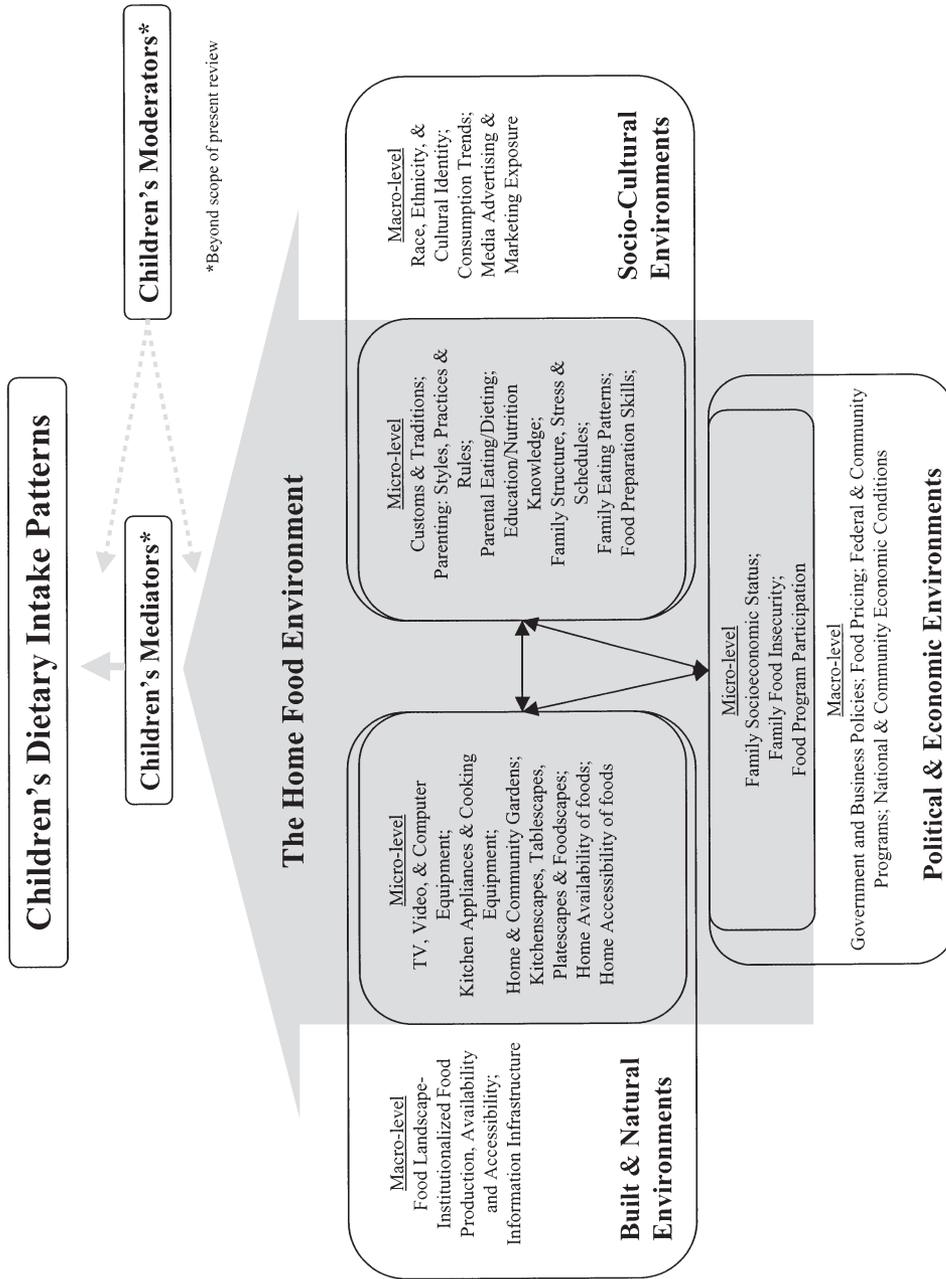


Figure 2 Model of the home food environment pertaining to childhood obesity.

Table 1 Socioeconomic status influence on nutritional outcomes and the home food environment.

Compared to their higher-SES counterparts, children from lower-SES families . . .

▶ Eat fewer family meals. ¹¹¹	▶ Are more likely to be food-insecure. ^{33,37}
▶ Have parents with less authoritative feeding practices. ³²	▶ Are more likely to skip breakfast. ¹²⁰
▶ Have parents less concerned with child weight. ³¹	▶ Are less likely to have healthful foods at home. ¹⁸
▶ Have parents more likely to use food as a reward. ⁹⁹	▶ Have less healthy food habits. ^{37,162}
▶ Get less parental discouragement from sweets. ³²	▶ Are more likely to eat fast food. ²⁰
▶ Have parents who eat less fruits and vegetables. ³²	▶ Drink more sugar-sweetened beverages. ¹⁶²⁻¹⁶⁴
▶ May live in neighborhoods without grocery stores or restaurants that provide fruits and vegetables. ¹³¹	▶ Have lower calcium intakes. ¹³⁸
▶ Have less availability of fruits and vegetables. ²⁰	▶ Watch more television. ^{48,153,162}
▶ Eat less fruits and vegetables. ^{32,162}	▶ Are more likely to watch television while eating. ¹⁵³
	▶ Are more likely to be overweight. ^{163,165}
	▶ Are more likely to become overweight as adults. ¹⁶⁶

businesses, and academia, to address increasingly unequal distributions of wealth and an economic slant toward consumption of obesigenic foods.^{19,20}

Federal and community food programs. In the United States, federal special assistance food programs are available to bolster the dietary adequacy of low-income families, including the WIC (women, infants, and children) program, food stamps, school meals, child and adult care, and other programs. Many communities also have food banks or support programs available to the needy. Such programs can impact nutritional outcomes of participants, even more than equivalent increases in earned income.²⁷ The U.S. Food Stamp Program and WIC are structured to improve participants' home food environments by directly providing foods to be stored, prepared, and consumed at home. Other programs may not directly influence the home food environment (e.g., the National School Lunch Program), but they can have an impact through food exposure, shaping preferences, and offsetting total food costs. Beyond affecting participants, federal programs have ripple effects by shaping institutional policy in schools and after-school programs. Federal programs also help shape the national food supply through financial support and outlet mechanisms for excess commodities, though sometimes to the detriment of other food sources.²³ Federal agencies have responded to some criticisms by making efforts to provide more fresh fruits and vegetables, and by using local farmers markets (<http://www.fns.usda.gov>, accessed 1 January 2007).

National and community economic conditions. Worldwide, the link between diet and economics is clearly visible. As wealth rises and populations become less rural, societies undergo a nutrition transition, wherein diets high in unrefined carbohydrates and fiber are replaced by varied diets higher in fats, saturated fats, and sugars.²⁸ Within developed countries and at the community level, economic conditions are related to

employment, wages, health, and nutrition.²⁹ Economic recessions, depressions, layoffs, and unemployment are likely to affect families' home food environments by altering the socioeconomic status, relative food costs, and food insecurity at the micro-level.

Micro-level

Family socioeconomic status. Socioeconomic status (often measured by income, education, occupation, food-program eligibility, or the like) has a well-established influence on dietary habits, nutritional outcomes, and obesity.¹⁹⁻²² The potential influence of socioeconomic status on the home food environment (Table 1) is pervasive enough that nutrition-related studies usually measure and account for its contribution or confounding potential in relationships between other observed variables.³⁰⁻³² Strauss and Knight³⁰ conducted a prospective study of children to determine risks for obesity in the home environment.³⁰ These authors found that family income and home cognitive stimulation were significantly related to obesity in children at follow-up, controlling for other socioeconomic factors, marital status, race, ethnicity and baseline body mass index (BMI) of mother and child.

Family food insecurity. Food insecurity is the limited or uncertain availability of nutritionally adequate foods, and is strongly related to financial insecurity and poverty.³³ Food insufficiency, a term used by some authors, is an inadequate amount of food intake due to a lack of money or resources. In the United States, more than 14 million children under age 18 live in a home where they sometimes do not get enough to eat.³⁴ These children have significantly greater likelihood of poor health, lower quality of life, poorer physical function, and school difficulties.^{34,35} Food insecurity can often be characterized by alternating patterns of "feast and famine" wherein family members over-eat when food is available, and under-eat when little food is available. Food insecurity may be asso-

ciated with lower intakes of fruits and vegetables and higher intakes of energy-dense foods (when available).^{33,36} Such dietary patterns may lead to a net positive energy balance and result in obesity. A large nationally representative sample using NHANES III data revealed that poverty and food insecurity were unrelated to nutritional outcomes and obesity among schoolchildren, and that poverty was a suitable predictor for nutritional outcomes in preschoolers.³⁷ The authors offered the possibility that food stamps and national school lunch programs could explain the null result. This finding suggests caution is required when considering connections between food insecurity and nutritional outcomes. However, a more recent study, based on NHANES III data, found that household and child food insecurity were related to risk for obesity among certain demographic categories of children.³⁸ Food-insecure adolescents, young children, Mexican-American children, and youth living below the poverty level were more likely to be above the 85th percentile in BMI. Another study demonstrated a potential moderating effect of the food stamp program on health-related outcomes of food-insecure households.³⁹ Thus, child food insecurity may be independently related to childhood obesity.

Food program participation. Less than 75% of those eligible actually use federal assistance programs, and three related explanations for lack of participation have been offered: stigma, transactions costs, and lack of information.⁴⁰ Despite eligibility, family decision-makers may not participate due to barriers of required documentation, perceived enrollment difficulties, guilt and shame from taking handouts, or ignorance of the program, process, or benefits.⁴⁰ Among the eligible, immigrants (especially Hispanics) are less likely to participate in assistance programs.⁴⁰ Those who do participate in food programs are likely to have better food security and nutritional intakes,²⁷ possibly improving home food environments and decreasing risk for obesity, though little evidence is available. Cook et al.³⁹ found that children in food stamp program-participating, food-insecure households had lower adjusted odds of fair/poor health than children in similar non-program households. In a study of participating families with preschool children, Rose et al.²⁷ found that the WIC program positively influenced the intakes of ten nutrients, while the food stamp program positively influenced intake of five nutrients.

SOCIOCULTURAL ENVIRONMENTS

Children are socialized from birth by the social forces and cultures that surround them. Early on, parents and caretakers provide the bulk of influence. As children age,

other individuals, institutions, and media increasingly add to their sociocultural environmental influences.

Macro-level

Race, ethnicity, and cultural identity. Callery⁴¹ noted the importance of recognizing how diets differ across and within societies and how food patterns are part of cultural expression. Dettwyler⁴² posited that cultural ideas of child feeding may influence nutritional intake to an extent similar to availability and household income. Two major determinants of culture are race and ethnicity, both with important impacts on home food environments. Though certain groups of people purchase and prepare specific foods in certain ways, cultural impact can be confounded by education and economics. Race and ethnicity appear to work through assorted mechanisms to influence the home food environment, and this influence can vary by time, place, and food.⁴³

Racial and ethnic influences may stem from cultural and genetic differences, affecting food selection and nutritional outcomes of children and adults.^{44,45} Children from ethnically diverse groups are at increased risk for obesity and are more likely to have diets failing to meet nutritional recommendations.⁴⁴ In a study of adolescent meal patterns, blacks were about four times as likely as whites to eat less than two meals per day, indicative of food insufficiency, meal skipping, or a predominance of snacking, all of which raise concerns for health, weight status, and nutritional adequacy.⁴⁶ Children of Mexican Americans may be held to culturally specific standards, as their parents are more inclined to push food, expect hearty appetites, and have differing ideals of child body weight.⁴⁷ One cross-cultural study showed that ethnic differences for child feeding responsibility, child weight concern, and perceived child weight were moderated by parent education and child BMI.³¹

Media advertising and marketing exposure. Innovative strategies continue to emerge via schools, endorsements, internet, and movies, but television remains the pinnacle of food marketing targeting children and families.⁴⁸ A review of television and consumption patterns revealed that in Western industrialized countries food is the most frequently advertised product category on children's television programs, with sugary products and fast food predominating.⁴⁹ Market segments are also apparent as analyses of television ads appearing during African-American program content showed a greater likelihood of featuring fast food, candy, soda, and meat, with a reduced likelihood of promoting cereals, grains, pasta, fruits, vegetables, desserts, or alcohol compared to general program content.⁵⁰ Children exposed to television advertisements are more likely to prefer the advertised product,

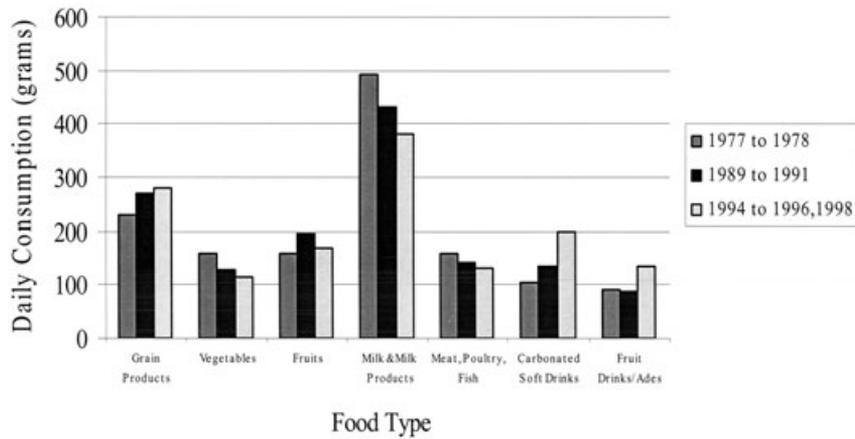


Figure 3 Dietary consumption trends for girls aged 6–11 years in the United States. Data from Nielsen et al. (2002).⁵⁴

to request such products from parents, and to consume these products.⁵¹ Because advertising is effective⁵¹ and currently directs children and families disproportionately toward less nutritious foods, legislated regulations or bans have been used in some countries and proposed in many more⁴⁸ though the impact of such legislation has not been determined.

Consumption trends. Recent data show that the availability of food calories has increased dramatically since 1980,^{52,53} and consumption patterns have also changed (Figures 3 and 4).⁵⁴⁻⁵⁶ Over the past few decades, soda consumption, snacking, and food portion sizes both in and out of the home have shifted in an obesogenic direction.⁵⁷ Portion sizes, which predict food consumption, have increased over recent decades, and are implicated in overeating and obesity.⁵⁸⁻⁶¹ Children in the United States get approximately 20% of their daily calories through

snacks, while Chinese children receive only 1% of daily calories from snacks.⁹ In the United States there has been an increased prevalence across all age groups of youth for frequent snacking and for deriving a large proportion of one's total daily calories from energy-dense snacks, and some evidence exists linking opportunities for snacking with youth obesity.⁶²⁻⁶⁴

Overall caloric consumption may have increased slightly in recent years (Figure 5), though perhaps not among children.⁵⁴⁻⁵⁷ A nationally representative sample revealed no increased consumption for children aged 6–11 years, but significant increases for adolescent boys and girls.^{55,56} Whether caloric intake has changed among children requires further study, but solid data show that the source of calories has shifted remarkably over the past few decades.^{58,62,65} Sweetened beverage consumption increased from the 1970s through the beginning of the 21st century.⁵⁷ Prevalence of soft drink consumption

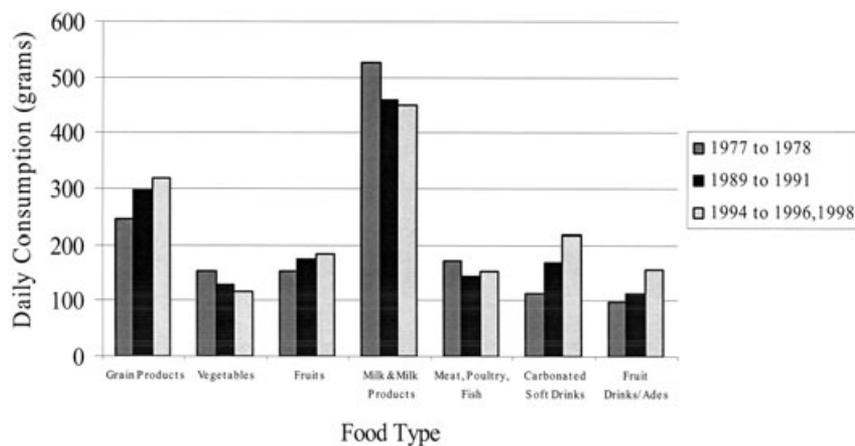


Figure 4 Dietary consumption trends for boys aged 6–11 years in the United States. Data from Nielsen et al. (2002).⁵⁴

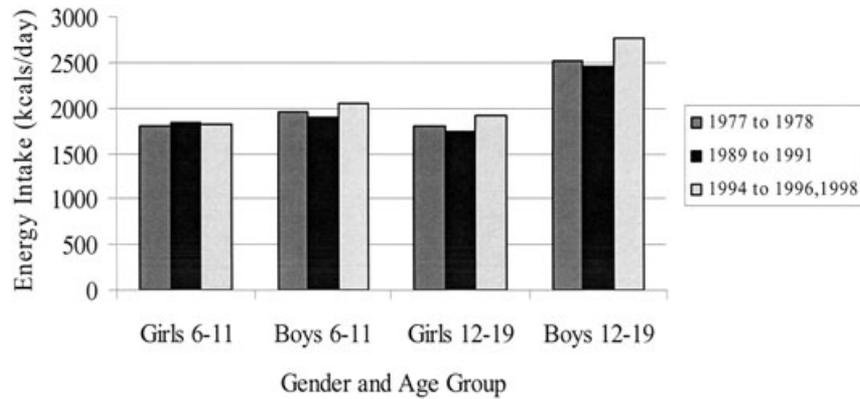


Figure 5 Caloric intake trends for children and adolescents in the United States.
Data from Enns et al. (2002)⁵⁵ and Enns et al. (2003).⁵⁶

among children aged 6–17 years has increased 48% during roughly the same time period.⁶⁶ Nielson et al.^{54,62} reported increases in the proportions of calories being obtained from salty snacks, soda, cheeseburgers and pizza, with decreases in those from milk, desserts, beef, and pork consumption. While consumption of milk has dropped, that of cheese has more than doubled.¹⁸

A nationally representative sample of children in the United States consumed about 33% of their calories in food prepared away from home, with about 20% in the form of fast food.⁹ Foods prepared away from home find their way to the home food environment via takeout, carry out, and delivery. In a study of Australian parents, over 70% reported purchasing carry-out foods for the evening meal at least twice per month.⁶⁷ Food preferences and exposures outside the home help shape the home food environment. Among foods consumed at home, modern times have brought an increasing variety of pre-packaged convenience foods²³ (added value to food through preparation, processing, and packaging) requiring minimal preparation time or effort.^{18,68} Between 1977 and 1996, portion sizes increased for most foods consumed in or out of the home.^{18,58} Unfortunately, many convenience foods sacrifice nutritional quality (loss of fiber, vitamins, minerals, and phytonutrients; addition of sugars, fillers, preservatives, hydrogenated or saturated fats, sodium, artificial colors and flavors), come in large portion sizes, have high energy density, and may promote obesity.^{19,23,69} With these consumption trends, poor nutritional outcomes are predictable.

Micro-level

Customs and traditions. In the home food environment the impact of traditions, culture, religious practices, ethnicity, race, and related social influences is important to consider since many customs and traditions involve food

as a central focus. In a study of familial aggregation of dietary intake, cultural inheritance accounted for 30–40% of the dietary intake variance for children.⁷⁰ Correlations in energy intake and macronutrients were higher between spouses and between siblings than between parents and children, suggesting a stronger contribution from culture and shared environment than from genetics. The study also found that families who shared meals together more often had more similar dietary intakes.

Family structure, stress, and schedules. Secular trends have revealed an increase in dual-earner and single-parent families and more women in the workforce.^{18,71} Working mothers are more likely to have reduced participation in meal planning, shopping, and food preparation.⁷² Mothers who work may opt for greater convenience in food choices, as time pressures influence the foods prepared in their home environment.¹⁸ Demographic shifts have resulted in less time available for food preparation, with significant effects on the home food environment.⁷³ Children living with a single mother were shown to have higher saturated fat intake.⁷⁴ In another study, children of single mothers were more likely to become obese in a six-year prospective study, though this effect appeared to be mediated by other socioeconomic factors.³⁰ Teens from a single-parent household were more than twice as likely as those from a dual-parent household to have inconsistent meal patterns (placing them at risk for poor nutritional outcomes and obesity).⁴⁶ The makeup and size of families may influence the impact of the home food environment on children's risk for overweight, but few data supporting this are available in the literature. Households having more than one adult may have more family income and opportunities for monitoring or socialization. Family size may be associated with financial security, time constraints, and opportunities for the modeling of desirable or undesirable eating habits.

Family stress may be partially determined by socio-economics, race, ethnicity, employment, and health. Data have shown that food-insufficient households are much more likely than food-sufficient households to have experienced recent events that stress household budgets, such as job loss, gaining a household member, or losing food stamps.⁷⁵ Stress may have a reciprocally determined relationship with the environment.¹⁰ Relationship stress could mediate the effect of other influences of the home food environment. For instance, stress could decrease the quality and frequency of family meals, or alter the degree to which parents monitor and regulate the types of foods purchased and consumed. Children living in a stressful home environment may eat and behave in ways that exacerbate their exposure to stress and further shape their home food environments.

Parenting: practices, styles, and rules. Golan et al.⁷⁶⁻⁷⁹ have consistently argued that parents can and should play the primary role in controlling the obesigenic environment at home. Other researchers have acknowledged the importance of parents while focusing interventions on prevention and treatment of weight problems in children.⁸⁰⁻⁸³ However, children and parents may not perceive the home food environment in the same way.^{84,85}

The home food environment typically has one nutritional gatekeeper, often the mother, who controls a majority of the food eaten.⁸⁶ According to parental surveys, parents believe that they control an average of 83% of the food that children eat at home, with the proportion remaining high regardless of parental body mass, sex, age, cooking ability, and food type.⁸⁶ Mothers are often presumed to be nutritional gatekeepers, but studies have attested to the fact that fathers are also influential.^{80,87-89}

Parenting style provides the emotional context of the parent-child relationship, reflecting attitudes and creating an emotional climate wherein parenting practices and behavior are enacted.⁹⁰ Too often, studies have enmeshed general parenting styles within more specific domains, such as child feeding practices.^{91,92} Specific parenting practices always take place within a greater parenting style context, and outcomes of individual practices may vary as a function of parenting style. In the parenting literature, three parenting styles are typically discussed: permissive, authoritarian, and authoritative.

Permissive parents are warm but not firm, allowing their children great freedoms in behavior and decision-making.⁹⁰ Typically, permissive parents are less likely to set limits or control the food choices of their children.⁹³ Authoritarian parents are firm but not warm.⁹⁰ They are likely to set rigid limits for children, and to employ punitive and forceful actions of enforcement.⁹⁴ In contrast, authoritative parents are warm, firm, and accepting of the

child's needs for autonomy.⁹⁵ Authoritative parents are likely to set limits for children based on reasoning, and to enforce limits through persuasion, rather than intimidation.⁹⁴ In research on parenting style and obesity-related behavior, parental permissiveness has been significantly related to soda consumption, while fruit consumption and fruit-specific cognitions were best among adolescents who reported that their parents were authoritative, followed by those with permissive and authoritarian parents.^{32,96}

Parenting practices are specific actions, but they may be categorized similarly to style. Parents with authoritative-type feeding practices tend to provide better availability of fruits and vegetables, make more attempts to get children to eat dairy, fruit, and vegetables, and raise children with better consumption of dairy and vegetables.⁹¹ Authoritarian-type feeding practices have been negatively related to vegetable consumption and fruit/vegetable availability. Maternal child feeding practices and perceptions of daughters' risk for obesity have been shown to predict girls' eating and weight status.⁸⁷ A review of the literature, discussed the development of food preferences as a function of exposure to foods and parenting practices.⁹⁷ This review highlighted how genetic predispositions to like foods with high-energy density, sweet and salty flavors, and to dislike sour and bitter tastes are modified with experience and exposure. Repeated exposure to foods can increase a child's liking for that food.

Using food as a reward is associated with nutritional problems for children, and parents practicing this had children with higher regular sweet consumption.^{32,98} Less-educated and lower-income mothers are more likely to reward good behavior with food, but obese mothers were no more likely than non-obese mothers to do so.^{99,100} In contrast, parental support and verbal praise have been positively associated with children's fruit and vegetable consumption.^{32,101}

Research on control in the context of the home food environment has frequently failed to distinguish different types of control. Authoritative and authoritarian parents both employ behavioral control, but psychological control reflects restrictive practices and is associated only with the authoritarian parenting style.¹⁰² Ogden et al.¹⁰³ further differentiated control as either covert (undetectable), or overt (detectable). Lighter parents and those with heavier children were more likely to use covert control, while parents of higher social status were more likely to use overt control. Some studies have shown a positive relationship between controlling practices and child overweight, while others have not.^{89,104} Restricting access to palatable foods has backfired in laboratory studies, such that children showed increased interest for restricted foods.¹⁰⁵ Overweight parents, those concerned with their child's weight, and those having difficulty with

self-control are more likely to use control, which may interact with genetics to foster child eating and weight problems.^{10,92}

Overfeeding and pressure to eat have been shown to be associated with undesirable nutritional outcomes in most studies.^{47,91} Some studies have also focused on family rules such as eating with the television on or snacking between meals.⁷⁸ In an Australian sample, about one-third of families reported watching television more than four times per week while eating the evening meal, and only 11% had a rule against using the phone during dinner.⁶⁷ More research is needed to illustrate the influences of family rules on children's dietary behavior.

Parental eating/dieting. Similarity exists in the dietary habits of people living together, irrespective of genetic relationships.⁷⁰ In children, food preferences are strong predictors of consumption, and those for fruits and vegetables are influenced by availability, variety, and exposure, likely stemming from foods mom and dad eat.¹⁰⁶ Siblings, peers, and parents can act as role models to encourage tasting of novel foods.⁹⁷ In a sample of middle-school students, parental modeling predicted adolescent fruit and vegetable consumption.¹⁰¹ Separating out potential genetic effects, parental overweight is frequently cited as a predictor of child overweight but parents can also model positive food attitudes and intake, and practice appropriate socialization techniques.^{10,87} Home social influences may impact eating behaviors consciously or unconsciously via attitudes, subjective norms, mimicry, awareness, and involvement.¹³ Parental reluctance to meet nutritional recommendations in their own dietary practices may serve to undermine attempts to ensure healthful dietary practices of their children.¹⁰⁷ If this is true, modeled eating and availability of obesigenic foods in the home food environment will prove a stronger influence on child consumption patterns than parental encouragement or instructions. Several studies have focused on parental dietary practices, including disinhibition and dietary restraint, with a majority finding dietary restrictive practices a risk factor for children.^{10,108,109}

Family eating patterns. The family mealtime aspect of the home food environment has great potential to affect the eating behaviors of youth in the family.^{85,110} Among adolescents, those eating six or more family dinners per week had significantly better dietary outcomes, being less likely to do the following: skip breakfast; eat fewer than two servings of fruit; eat fewer than two servings of vegetables; consume fewer than two servings of dairy products.¹¹¹ Eating family dinner has been associated with healthful dietary patterns, better fruit and vegetable intake, lower intake of fried food and soda.¹¹² Children without regular family dinners ate sweets and fast foods more often, and

had more behavioral problems than those having regular family dinners.¹¹³ In a longitudinal study of television and food intake, the frequency of family dinners was inversely related to overweight prevalence at baseline, but not with likelihood of becoming overweight at follow-up.¹¹⁴ The frequency of meals eaten at home was shown to influence the success of 10-year family treatment outcomes of obesity.¹¹⁵ Overall, there is ample cross-sectional evidence showing positive associations from family meals, though further work is necessary to determine whether family meals have the potential to prevent obesity.

Eating a breakfast meal has been associated with positive outcomes for both school performance and protection from obesity.¹¹⁶⁻¹¹⁹ Among preschoolers, lack of daily breakfast consumption nearly doubled the odds of being overweight.¹²⁰ Unfortunately, research has demonstrated a documented decline over past decades in breakfast consumption among both boys and girls.¹²¹ Eating breakfast also tends to decline as children age.¹¹⁸ Studies show female adolescents are more likely to skip breakfast than are males.^{111,119,121} Meal skipping is more prevalent among children of working mothers, and urban versus rural or suburban children^{72,122}

Education and nutrition knowledge. In parents, general education level contributes to socioeconomic status, and is thought to have far-reaching effects on many health outcomes. Parent education may impact the home food environment via financial income, money management, priority for nutrition, nutritional knowledge, parenting skills, general resources, or in other ways. Education level of mothers has been associated with consumption of fruits, vegetables, and soft drinks by the child and mother, use of restrictions, verbal praise, negotiation, discouragement from sweets, and restraint from negative modeling behavior.³² In a population study, better maternal nutritional knowledge was associated with better diets in children, although the influence decreased with child age.¹²³ Conversely, a study of adolescents found a significant association between nutrition knowledge and food choices for seventh and eighth grade boys and girls, but not for sixth graders.¹²⁴ These findings depict shifts in knowledge-related influence from parent to child as the child ages and develops more autonomy. However, environmental availability may moderate the impact of knowledge, and self-efficacy or parental support may mediate the knowledge-behavior relationship.^{101,125}

Food preparation skills. Using interviews, focus groups, and surveys, Wansink¹²⁶ showed how nutritional gatekeepers vary in cooking skill, food usage, motivations, and personality, suggesting that interventions should consider such factors when targeting dietary change in the home.¹²⁶ A recent study of young adults showed that

although they had positive attitudes toward food preparation, they overestimated their food preparation ability and held negative views of from-scratch preparation.¹²⁷ This highlights how limited skill may prevent adults from making improvements to the home food environment. According to another study in England, most people learn food preparation skills from their mothers, though cooking classes in schools also serve an important role.¹²⁸ This study's data suggests that socioeconomic status and education are associated with the sources of people's knowledge about cooking, and that knowledge may be an important factor in dietary choices and health.

BUILT AND NATURAL ENVIRONMENTS

According to Sobal and Wansink,¹²⁹ certain aspects of the built environment are able to influence perceptions and cognitions regarding food consumption, to provide distractions or disruptions to self-regulation processes, or to increase awareness and promote convenience toward facilitation of eating. Built environments exert influence on what and how much is eaten, when and where it is eaten, and who is eating. In describing the physical environment in relation to obesity, Wells¹³⁰ suggested that a full spectrum, from small-scale design elements to large-scale community infrastructure, should be considered. Food acquisition is a function of numerous influences both inside and outside the home as outlined above. Once food is available within the home, it becomes part of the physical makeup of the home food environment.

Postulating that behavior is simultaneously influenced consciously and unconsciously by the environment, the Environmental Research Framework for Weight Gain Prevention (EnRG), has been put forth as an attempt to describe the obesigenic environment.¹³ This framework bears resemblance to the ecological model published by Egger and Swinburn in describing types and levels of the environment, but expands the areas related to moderators and cognitive mediators of the environment-behavior relationship.¹² In the EnRG framework, moderators include demographic, personality, awareness, involvement, habit strength, and clustering, while mediators include attitudes, subjective norms, intention, and perceived behavioral control. The home food environment model presented here (Figure 2) builds on the ideas put forth by the authors above in depicting the influence of moderators and mediators of the environment-behavior connection.

Macro-level

Food landscape—institutionalized food production, availability, and accessibility. Food becomes available and

accessible through a wide variety of channels, including grocery stores, convenience stores, restaurants, shops, markets, schools, and churches. Overall availability per capita (including children) in the USA increased from 3300 kilocalories in 1970 to 3800 kilocalories in 1994.⁵³ Caloric availability is a large overestimate of food consumption due to spoilage and waste, but micro-level studies show that availability is associated with consumption.^{18,106}

Recently, studies have examined relationships among food landscape, availability, and intake. Low-income neighborhoods are less likely to have grocery stores or restaurants offering fruits and vegetables.¹³¹ Wealthier neighborhoods have significantly more supermarkets than poor and ethnically diverse neighborhoods.¹³² Edmonds¹³¹ used a sample of African-American Boy Scouts to assess the influence of food landscape, finding that census tract methods were useful for determining fruit and vegetable availability from restaurants, but not from grocery stores. Among African Americans, a nearby grocery store predicted an increased likelihood of meeting dietary standards for fruit, vegetable, and saturated fat consumption. Massive increases in fruit and vegetable consumption were seen in local residents following construction of a supermarket in a “retail-poor” area.¹³³ The measurement of food deserts and other uses of geographic information systems are still in their infancy as tools of science. As these measurement tools continue to develop, so too will methods of analysis that may bolster our understanding of how the macro-level environment carries over to the home food environment.

Information infrastructure. Considering the resources devoted to television, radio, cable, satellite, internet, newspapers, magazines, books, podcasts, billboards, and related vehicles, a truly vast information transfer system exists in modern society. Among its many uses, this vast system is used to direct consumers to food purchase and consumption opportunities.

Micro-level

Home availability and accessibility of foods. Children are unable to eat foods not available to them.¹³⁴ This simple point, however, has practical and theoretical implications for the home food environment. Less availability of obesity-protective foods such as fruits and vegetables predict lower consumption levels, while more availability of obesity risk-factor foods predict higher consumption, with each pathway leading toward obesity. Hearn et al.¹³⁵ reported in two studies that children's fruit and vegetable consumption was significantly related to availability of these foods. In a review of the literature, Blanchette and

Brug¹³⁶ found that along with taste preferences, the availability and accessibility of fruits and vegetables were most consistently and most positively related to consumption. Le Bigot Macaux⁸⁴ found that children's taste preferences for fruit are similar to those of candy, suggesting that the taste of fruit is more of a benefit than a barrier to consumption, and that greater availability should promote consumption. Availability moderates children's consumption such that homes with greater availability of fruits and vegetables have higher levels of motivating factors for children's consumption of fruits and vegetables.¹³⁷ Larson et al.¹³⁸ studied the eating habits of more than 4,000 teens in Minnesota, and found that the calcium intakes of males and females were positively related to the availability of milk at meals. A pilot intervention that used nutrition information and media literacy to increase availability and parental social support, found that children were able to increase their consumption of fruits and vegetables.¹³⁹ The better the availability and accessibility of nutrient-dense foods in the home environment, the more likely it is that children will choose to eat these obesity-protective foods. Intervention programs should target the availability and accessibility of healthful foods, such as the preparation of fruits and vegetables so that they are flavorful and ready to eat.¹⁴⁰

For obesigenic foods, the home food environment is the largest source of sugar-sweetened beverages; consumption increased from 5 oz/day to 12 oz/day from the mid-1970s to the late-1990s.⁶⁶ A review of the literature showed strong evidence for the role of such beverages in the development of obesity in children, accounting for 8–9% of children's daily calories.¹⁴¹ Among high-fat foods, cheese consumption has increased in convenience foods such as pizza, tacos, nachos, and fast-food sandwiches.¹⁸ Stockpiling of foods in the home may increase consumption for preferred and convenient products when food is visible and accessible, and when the family is frequently reminded of the food via marketing.¹⁴² As nutritional gatekeepers, parents are capable of manipulating the availability of foods in the home food environment through their purchases, which can influence children's eating patterns without undue control or restriction.

Audiovisual media equipment. In the late 1990s and early 2000s, the average child in the United States lived in a home with three televisions, two VCR or DVD players, and a computer, and these numbers may have climbed even higher recently.^{143,144} In American homes a television is on about 25% of each day, and television watching begins at an early age, with many children exceeding the recommended levels of viewing.¹⁴⁵ Research has tied television viewing to a host of nutrition-related outcomes including fast-food consumption, lower fruit and

vegetable intake, higher intakes of fat and salty snacks, and obesity.^{49,114,146–149}

Figure 6 illustrates how television may promote an obesigenic home food environment through the following three main avenues of influence: promotion of sedentary behavior, food advertising, and eating while watching television.¹¹ Sedentary behavior results in lower energy expenditure, which leads to weight gain unless caloric intake is proportionally reduced. Sedentary behavior inside the home allows opportunities for eating as food is nearby, and because being sedentary (as opposed to being vigorously active) is compatible with eating. Mindless eating can occur while watching TV, wherein a person is unlikely to be aware of how much is eaten, leading to higher energy intake and obesity.¹⁵⁰ Food is the most frequently advertised product type, often sugary snacks or fast-food products.⁴⁹ Children purchase personally and influence their parents to buy advertised foods, and parents respond directly to advertising from their own TV viewing.¹⁵¹ Thus, advertising can lead to energy-dense foods being available at home, foster more eating opportunities, higher energy intake, and promotion of obesity, unless offset by physical activity.

Computer use can also promote sedentary behavior and lower energy expenditure, although its influence on energy intake is not likely as powerful, due to the more interactive nature, occupation of one's hands, and currently lower levels of exposure to food advertising. Supplemental to the advertising influence, the internet has become one avenue for the direct purchase of food that may be delivered to the home. Presumably, advertising via internet or related media technologies could function in similar ways to television. In the 1990s, numerous ethically questionable corporate data-collection practices were revealed wherein food companies' child-friendly websites used animated characters to gather personal information via interactive surveys.⁴⁸ Such information was then used to create targeted marketing for children. While this specific practice has subsided, the use of internet advertising overall is growing.⁴⁸

Irrespective of the advertising source, controlled studies have demonstrated the effectiveness of children's advertising in product recognition, selection, purchase requests, and parental acquiescence, resulting in the presence of advertised products at home.⁴⁹ Older children with access to money may purchase advertised food products themselves. Time-strapped parents are likely to let children watch television, and to seek time-sparing methods of food provision through conveniently prepared foods.⁶⁹ Whatever the mechanism, television has shown a larger effect on obesity than either physical activity or nutritional intake alone.¹⁵²

Saelens et al.¹⁵³ longitudinally followed 169 families, finding that television viewing, number of televisions,

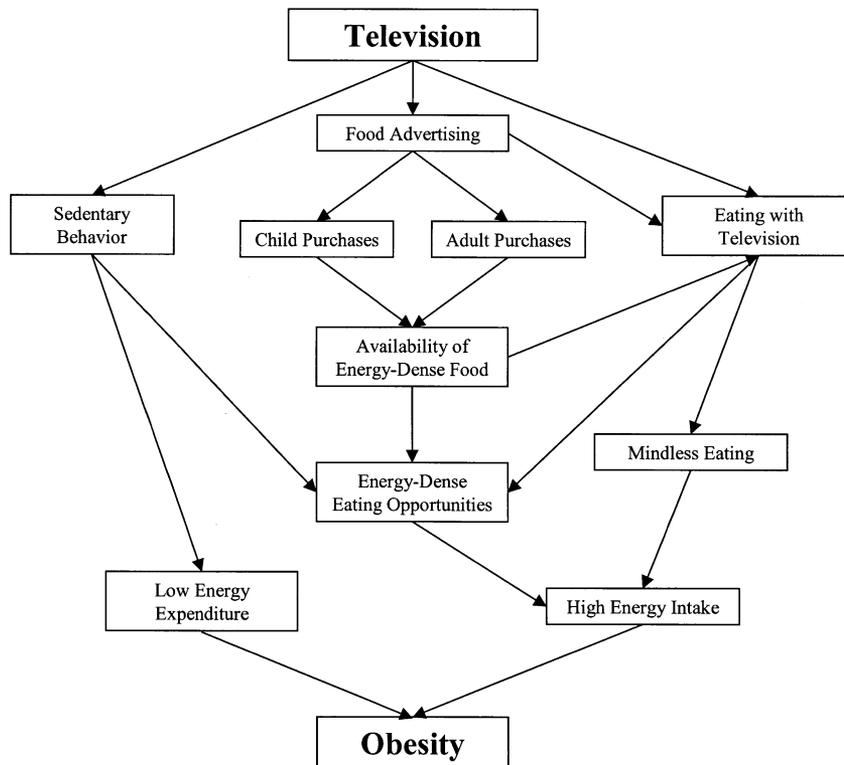


Figure 6 Conceptual model of television's impact in a permissive home food environment.

presence of VCRs, frequency of eating meals while watching television, and percentage of children with a television in the bedroom all increased from ages 6 to 12 years. Television watching was related to weight status when children were younger and older, and watching more than 2 hours per day was a risk factor for higher weight. Some research suggests an increase in television viewing at mealtimes.⁸⁴ In one study of an ethnically diverse sample of children, about 20% of calories were consumed while watching television, and food fat content consumed with television was related to BMI in the 3rd grade sample.¹⁵⁴ Other work has found that television viewing predicted fat intake in both black and white adolescents.¹⁴⁰ Reducing the frequency of meals eaten while watching television may be useful for reducing television exposure and obesity risk.¹⁵³

Beyond television, modern food marketing impacts the home food environment via internet websites, movie product placement, movie or TV character toy tie-ins, sponsorship of sports teams and icons, postal mail advertisements, newspaper and magazine advertisements and inserts, and even with coupons or vouchers from school programs.^{48,155,156} With such ubiquitous product pushing aimed at children, reducing television exposure or advertising may only partially stem the tide of influence on the home food environment. Various public health policies have been proposed to protect children by regulating

food marketing to children, but the issue is politically charged. Many have called for food companies to self-regulate and to develop more healthful product lines, yet the feasibility of this approach remains unknown.¹⁵⁶

Kitchenscapes, tablesapes, platescapes, and foodsapes. Food intake is influenced by the physical setting and the objects therein.¹⁸ The “micro-scale” built environment has become a substantial focus of research relating to obesity. A recent literature review described how small-scale elements of the built environment have an influence on food intake and obesity.^{129,150} Rooms, furniture, containers, and the structure of food itself have been shown to modify consumption patterns. For instance, characteristics such as the visibility and accessibility of food, kitchen ambience and size, furniture characteristics, organization pattern of serving, size, and shape of serving utensil, plate, and food all have been shown to influence eating habits. Preferred foods that are prominently visible and accessible, along with larger plates, bowls, cups, and serving utensils are all likely to promote greater food consumption.¹⁵⁰ Small kitchens with inefficient designs may discourage the preparation and consumption of less convenient and more healthful meals.¹²⁹ Kitchenscapes, tablesapes, platescapes, and foodsapes provide subtle, yet pervasive influence in the home food environment, partially determining food choices, consumption, and

obesity. Structural changes to the micro-scale built environment may offer an effective means to change food intake.^{129,150} Some examples of structural changes to alter obesigenic micro-scale built environments may include the use of smaller tableware, increasing the accessibility of stored fresh fruits and vegetables, storing otherwise convenient energy-dense foods in hard-to-reach and out-of-sight areas, limiting the size of food storage areas, or keeping dining areas clear of clutter and set up for family meals at home.

Kitchen appliances and cooking equipment. If the micro-scale built environment is intended to account for influences on eating behaviors in the home, it should also include food preparation and storage equipment such as refrigerators, freezers, microwave ovens, ranges, and conventional ovens, cooking utensils, pots and pans, and other such items. While literature is lacking, these aspects of the built environment could influence consumption patterns in the home food environment. One study in the United Kingdom, showed that those with unskilled occupations were significantly more likely to own a deep fat fryer and least likely to own a food processor, suggesting potential negative impacts on their diet.¹⁵⁷

Home and community gardens. Before most Americans lived in cities, much of the food in the home was grown in gardens and farms nearby. More recently, gardening became more hobby than necessity, but garden-grown foods can positively impact the diet and budget of families.¹⁵⁸ Foods grown in the garden may be consumed in season, or canned, dried, and frozen for later use. An overabundance of certain foods ripening simultaneously may also result in sharing these foods with friends, neighbors, and relatives.¹⁵⁹ As many as one-quarter of households in the United States have gardens, saving families hundreds of dollars in food costs each year.¹⁵⁹ Because the types of foods grown in home or community gardens are likely to be fruits, vegetables, herbs, spices, and grains, the more frequently a family uses products from gardens, the less obesigenic their home food environment should be. Recently, interventions have focused on ways to involve youth in horticultural activities to promote physical activity, decrease sedentary activity, and increase fruit and vegetable preferences and consumption.^{160,161}

DISCUSSION AND CONCLUSIONS

The home food environment can be conceptualized as overlapping interactive domains composed of built and natural, sociocultural, political and economic, micro-level and macro-level environments. Each type and level of environment uniquely contributes influence in a mosaic

of determinants depicting the home food environment as a major behavior setting for child dietary behavior and the development of weight status. Obesity is a multifactorial problem, and the home food environmental aspects described in the present paper represent a substantial part of the full environmental context in which a child grows, develops, eats, and behaves.

The epidemic levels of obesity now seen among children and the nearly pandemic level in adults warrant grave concern due to decreased quality of life, potential tracking of weight and health behaviors from childhood to adulthood, and comorbid cardiovascular diseases, certain cancers, diabetes, and other health conditions. If preventive measures are not taken, the negative outcomes of obesity are likely to result in great costs to society, not only in terms of health and quality of life, but also in fiscal impact on the healthcare system and the national economy. Preventive changes are needed, spanning individual to national levels, and researchers have called for the development of family-based prevention programs for childhood obesity as a primary public health goal.¹⁰

Dufour⁹³ cogently noted that the phenotypic development of obesity is only possible in an environment that permits overeating relative to energy expenditure. Although the present review does not address energy expenditure or physical activity, consideration of both sides of the energy balance equation is essential for the study of obesigenic environments and the development of obesity. These environments consist not only of physical structures, but also interlaced social, cultural, economic, and political components that create behavior settings for individuals and groups of people. An attempt was made in this review to draw upon ecological frameworks and extant literature to describe a comprehensive conceptual model of the home food environment that likely plays a strong role in the escalating problem of childhood obesity. It is hoped that this model will help to inform intervention efforts designed to alter the obesigenic qualities of the home food environment.

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