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ORIGINAL ARTICLE

A Review of Environmental Influences on Food Choices

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Abstract
Background Diet-related environmental and policy interventions are being advocated at a population level because individual change is more likely to be facilitated and sustained if the environment within which choices are made supports healthful food options.
Purpose This study aims to review research that examines factors having an influence on food choices in social environments, physical environments, and macroenvironments.
Methods A snowball strategy was used to identify relevant peer-reviewed studies and reviews, with a focus on research completed in the US and published within the past 10 years.
Results Research has identified a number of environmental factors associated with dietary intake; however, the majority of completed studies have methodological limitations which limit their credibility to guide interventions and policy changes.
Conclusions Future research will need to emphasize multilevel investigations, examine how associations vary across population subgroups, develop a standard set of measures for assessing food environments and policies, and improve dietary assessment methodology.

Keywords Dietary intake · Eating behavior · Social norms · Environment · Policy

Introduction

What and how much people eat defines to a large extent their health [1]. As obesity and other diet-related chronic diseases are recognized as major public health issues associated with risk for several of the leading causes of death and disability, there is strong interest in the determinants of food selection and the most effective ways to provide food guidance to individuals and populations to improve their health and well-being. It is known that eating behavior is highly complex, resulting from the interplay of multiple influences across different contexts and conditions. There is growing interest in the role of the environment in promoting or hindering healthy eating. It has been suggested that individual change is more likely to be facilitated and sustained if the environment within which choices are made supports healthful food options [1]. Swinburn et al. emphasize that as with other major public health issues, such as smoking reduction, injury prevention, and infectious disease prevention, success at the population level for reducing obesity and diet-related chronic diseases is not likely to occur until environmental influences are identified and modified [2]. Diet-related environmental and policy interventions are also being advocated at a population level because individual behavior change strategies are expensive and cannot reach large numbers of people on a cost-effective basis. Environmental changes may also have a more lasting effect on behavior change because they can become incorporated into structures, systems, policies, and sociocultural norms [2].

A goal of public health is to give people the best chance to enjoy many years of healthy and active life [1]. Public health encompasses a population-focused, organized effort to help individuals, groups, and communities reduce health risks and maintain or improve health. Improving dietary and lifestyle patterns and reducing obesity will require addressing not only individual behaviors but the environmental context and conditions in which people live, make choices, and eat and addressing the disparities that exist in

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access to healthy foods in low-income and disadvantaged communities. Different types of environmental influences operate across multiple domains: (1) individual-level factors related to food choices and eating behaviors include attitudes, preferences, and biological and demographic factors; (2) the social environment includes interactions with family, friends, peers, and others in the community and can impact food choices through mechanisms such as role modeling, social support, and social norms; and (3) the physical environment includes the multiple settings where people eat or procure food. The physical settings within the community influence what foods are available and accessible and (4) macro-level environmental factors play a more distal and indirect role but have a substantial and powerful effect on what people eat.

According to ecological models, these four broad levels of influence—individual, social environments, physical environments, and macro-level environments—interact, both directly and indirectly to impact eating behaviors [3]. For example, consider the case of a child's consumption of vegetables. Individual factors such as whether the child likes or dislikes vegetables, social factors like whether the parent eats vegetables, physical environmental factors such as whether vegetables are available in the multiple contexts where children spend their time (home, school, after school) and whether families have easy access to high-quality and affordable produce in their neighborhood, and macro-level factors such as US agricultural policy and economic price structures for the costs of vegetables all can influence individual eating behavior.

The research on determinants of eating behaviors in adults, adolescents, and children has predominantly focused on individual-level determinants of these behaviors, for example, attitudes, preferences, behavioral intentions, and self-efficacy [4]. Although there has been a recent shift in attention to environmental determinants of eating behavior, the empirical evidence on environmental factors is scant, and little research has been done on what aspects of the food environment are more influential than others, how environmental factors interact with individual factors, or about the most feasible and effective interventions and policies for improving food environments in various populations [4–7]. Other manuscripts extensively review individual-level factors that influence food choices [8–10]. This article reviews research that examines factors having an influence on food choices in (1) social environments, such as family, peers, and social networks; (2) physical environments (settings), including schools and child care, worksites, retail food stores, and restaurants; and (3) macro-environments, such as socioeconomic status, cultural norms, food marketing, and food and agriculture policy. Future research directions are also discussed.

Methods

A snowball strategy was used to identify relevant peer-reviewed studies and reviews, with a focus on research completed in the US and published within the past 10 years. Searches were completed using PubMed and MEDLINE in 2008 with keywords specific to each level of environmental influences and the following general terms: dietary intake, food choice, eating patterns, nutrition, environment, policy, adults, adolescents, and children. The references cited in articles that were indexed in these search engines were also checked, and additional relevant articles were retrieved to ensure representation of the current state of the field. To be included in the review, articles had to describe research addressing at least one level of environmental influence and nutrition among healthy populations aged two or more years.

Social Environments

Family and Home Environment

Family members and the home food environment are important influences on dietary intake, especially for children and adolescents. Several studies have found family resemblances in intakes of energy, foods, and key nutrients [11–13]. Parents and other family food preparers play central roles in shaping the dietary habits of household members [14, 15]. Food preparers act as nutritional gatekeepers by determining what foods are available in the home, the quantities in which they are stored, and how they are prepared. Parents additionally serve as models for eating behavior, use feeding practices that develop their children's ability to self-regulate intake, transmit nutrition attitudes, and determine the structure of shared meals.

Research suggests that the types, amounts, and convenient storage of food available at home may positively or adversely impact on the eating behaviors of adults and youth. Several observational and intervention studies have reported evidence of a direct relationship between the home availability or accessibility of fruits and vegetables and consumption [16]. For example, one study in 1,196 families of fourth-grade students examined fruit and vegetable intakes of parents and students according to tertiles of parent-reported home fruit and vegetable availability [17]. Results showed that parents and students having the highest compared to the lowest availability at home, respectively, consumed 1.2 and 0.7 additional daily fruit and vegetable servings. Other studies have focused on the practice of stockpiling groceries and indicate that bulk purchases lead to increases in the quantity and frequency of convenience product consumption (e.g., cookies, chips, granola bars) [18]. The findings suggest that families should avoid

purchasing energy-dense, nutrient-poor products in bulk and storing these products in highly visible locations at home. Fruits, vegetables, and other healthful foods should be purchased regularly and kept accessible at home (e.g., keeping cut-up vegetables in the refrigerator, having a bowl of fruit on the counter). While the family food preparer often assumes primary responsibility for managing the food available at home, their food-purchasing decisions may be influenced by interactions among all members of a family [19].

In addition to providing healthy food at home, parents can promote the development of healthful eating behaviors by modeling the consumption of nutritious foods and consistently using authoritative feeding practices. Research in both children [20, 21] and adolescents [22, 23] has demonstrated parent–offspring relationships in dietary intake. Further, at least one longitudinal study has found evidence to suggest that parental modeling continues to influence dietary intake when adolescents transition to young adulthood [24]. Attempts to control children's eating (e.g., restricting access to sweets, rewarding intake of healthful foods with sweets) are generally associated with overeating, poor self-regulation of energy intake, and dislike of foods they are pressured to consume [15]. Coercive feeding practices may have an immediate positive impact on diet but negatively impact the development of preferences for healthy foods [25, 26]. In contrast, research has found that authoritative feeding practices, characterized by clear expectations for children's eating behavior and responsiveness to eating cues, are associated with healthful dietary patterns and lower risk for becoming overweight [27, 28]. For example, among a sample of 231 parents and preschool-aged children enrolled in Head Start, parental use of an authoritative feeding style was found to be associated with greater child consumption of dairy and vegetables while use of an authoritarian feeding style was associated with lower vegetable consumption [27].

Having regular family meals is another strategy that parents can use to help ensure their children consume a nutritious diet and develop healthy eating patterns. Research in children [29] and adolescents [30, 31] has found that having more frequent family meals is related to higher intakes of fruit, vegetables, calcium-rich foods, protein, fiber, and several essential micronutrients. In addition, having more frequent family meals has been related to lower intakes of soft drinks, fried foods, and saturated fat. Most studies to date have used a cross-sectional design; however, at least two longitudinal studies have found that the benefits of family meals may be carried through adolescence and into young adulthood [32, 33]. For example, a 5-year follow-up study of high school students found that family meal frequency during adolescence predicted higher intakes of fruit, vegetables, and key nutrients and lower intakes of soft drinks in the sample when they were ages 18 to 24 years. Compared to young adults who never ate family meals, those who reported having seven or more family meals per week in adolescence consumed approximately 0.7 additional servings of fruit and vegetables per day during young adulthood [32].

Research further suggests that several characteristics of the mealtime environment may influence dietary intake. The foods served at meals, the accessibility of food at the table, the size of dinnerware and utensils, and media use have all been related to the types or amount of food individuals consume. Having vegetables and milk served at dinner during adolescence predicts higher intakes of vegetables and calcium, respectively, in young adulthood [24]. Similar findings have also been reported for school-age children. For example, one study found that 9-year-old girls who were served milk "almost always or always" at meals and snacks drank 56% more milk than girls who were "sometimes" served milk and almost double the amount consumed by girls who were "never or rarely" served milk [34]. Experiments involving the manipulation of serving ware, dinnerware, and utensils have found that individuals eat greater quantities of food when larger containers or implements are provided [35, 36]. One such experiment found that even young children (3–5 years) presented with large portions respond by taking bigger bites of food [37]. Child participants consumed 15% more energy at lunch when they were served double the age-appropriate portion of macaroni and cheese compared to an age-appropriate portion. Turning off the television during dinner has been related to higher diet quality among children, adolescents, and parents [38–40].

Social and Peer Networks

The food choices of individuals are additionally influenced by interactions with others beyond the family unit, including coworkers, peers, and close friends. Research indicates the context of shared meals is an important influence on eating. However, social norms and attitudes among members of a group may also impact the types or amounts of foods that individuals consume regardless of whether they eat together. Several research studies regarding the influence of peers have focused on dieting, weight-control behaviors, and overweight status. These studies have shown that weight stigma and negative friendship qualities are associated with problematic, unhealthy eating behaviors among adolescents. Having social ties to peers with a high or increasing body mass index (BMI) has been related to increased risk for obesity in a small number of observational studies among adolescents and adults.

Friends, peers, and the context in which social eating occurs may influence the selection of different foods over others. Children, adolescents, and adults report that the attitudes, encouragement, and behaviors of friends and

peers influence their food choices [41–44]. This perception has been supported by a number of cross-sectional and prospective studies, especially in relation to fruit and vegetable intake [11, 45–48]. For example, a health promotion program found that the multiethnic, working-class adults enrolled in the study had greater improvements in fruit and vegetable intake if they reported having more social ties and more supportive social norms (e.g., number of coworkers/friends who ate at least five servings of fruits and vegetables a day) [48]. Another study among adolescents and adults assessed correlations between specific food items consumed by 348 pairs of friends [11]. The results showed significant correlations for 8–11% of foods consumed by adult friends and 19% of the foods consumed by adolescent friends. At least one experimental study has further examined the influence of context when eating occurs in the presence of unfamiliar peers. This study, conducted among 21 normal-weight and 18 overweight school-age children (10 to 12 years), provided participants' with unlimited access to healthy snack foods (i.e., grapes and baby carrots), unhealthy snack foods (i.e., chips and cookies), and several games to play instead of eating [49]. The social context was found to be influential; the consumption of healthy snack foods by children was significantly related to the consumption of these foods by the unfamiliar partner sharing the play and eating space.

Research also suggests that youth and adults tend to consume larger quantities of food when they eat in groups compared to when they eat alone [50]. This phenomenon, known as the social facilitation of eating, is especially strong when the group is composed of close friends or relatives. Social facilitation may occur because individuals use the behavior of others to judge "appropriate" portions and avoid incurring the stigma of excessive eating. The presence of multiple conflicting norms for portions within a group likely liberates individuals to consume as much food as they would like [51]. However, the presence of others has been shown to impact the eating of overweight and normal-weight individuals differently, possibly due to concerns about weight stigmatization. In contrast to normal-weight individuals, overweight individuals have been found to eat less in the presence of others at a normal weight and more in the presence of other overweight individuals [49, 52, 53]. One illustrative experiment provided overweight and nonoverweight school-age children (6 to 10 years) an unlimited amount of pizza and access to several board games for 45 min in group and individual conditions [52]. The results showed that, when they were alone, overweight children consumed an average of 144 additional kilocalories than when they were with peers. Normal-weight children eating alone consumed an average of 163 fewer kilocalories compared to when they were eating with peers.

Weight stigma, social norms idealizing thinness, and negative friendship qualities have been related to disordered or restrained eating patterns among adolescents [54–58]. For example, one study in a racially and socioeconomically diverse sample of 2,337 adolescent girls examined relationships between normative dieting behaviors in schools, perceptions of friends' dieting behavior, and use of unhealthy weight-control behaviors (UWCBs; e.g., taking diet pills, skipping meals) [55]. The school-wide prevalence of trying to lose weight and the dieting behaviors of friends were significantly related to use of UWCBs in normal-weight as well as moderately overweight girls. The results showed that, compared to normal-weight girls whose friends were "not at all" involved with dieting, twice the proportion of normal-weight girls whose friends were "very much" involved with dieting used UWCBs. Friendship qualities that have been related to greater use of UWCBs and restrained eating include feeling alienated from one's friends and experiences of conflict such as arguing and hostile feelings [54, 58].

These findings suggesting a relationship between characteristics of social networks and dietary intake are in correspondence with studies in adults and adolescents which have linked an individual's risk for obesity to the weight status of one's social ties. Among 12,067 adults participating in the Framingham Heart Study from 1971 to 2003, a person's chances of becoming obese increased by 57% if he or she had a friend who became obese [59]. If both participants reported a mutual friendship, the relationship was stronger; an individual's risk of obesity increased by 171% if their friend became obese. Similarly, among a cross-sectional sample of 2,800 adolescent participants in the National Longitudinal Study of Adolescent Health, when the mean BMI of an individual's friends was one unit higher, the individual's weight was found to be higher by 0.3 BMI units [60]. Several factors may contribute to these findings; it is possible that shared environmental factors could explain a large part of the observed correlations [61]. However, the findings suggest that peers likely have at least some influence on consumption of higher-calorie food patterns. Weight loss treatment trials have also shown that youth and adults are more likely to maintain weight loss when the intervention addresses social support for healthy behaviors or the development of social skills [62, 63].

Physical Environments (Settings)

Child Care

Child care is now the norm in the US. Approximately 80% of children ages 5 years and younger with employed mothers are in a child care arrangement for an average of almost 40 h/week, and almost two thirds (63%) of children

6–14 years spend an average of 21 h/week in nonparental care [64]. Nationwide, nearly half of children under 5 years with a working mother are cared for in child care centers (32%) and family child care homes (16%), 23% by a relative or friend, 23% by a parent, and 6% by a nanny or baby sitter [64]. Since children spend so much time in child care settings, they have the potential to influence the diets of children; however, there is little research on the food choices available or dietary intakes of children in these settings. The few published studies suggest that nutritional quality could be improved [65]. One recent study in North Carolina child care centers suggested that children are not consuming recommended amounts of whole grains, fruit (excluding juice), or vegetables while attending full-time child care and consume excess amounts of saturated fats and added sugar [66]. There is also relatively little intervention research that has been conducted in child care settings to address changing the food environment or preventing obesity.

Family child care homes and center-based care programs that are licensed or approved to provide services may be eligible to receive federal support for meals and snacks served to children. The Child and Adult Care Food Program (CACFP), administered by the US Department of Agriculture (USDA) through grants to designated state agencies, provides meals and snacks for more than two million children in 47,000 center-based care programs and over 850,000 low-income children in 145,000 family child care homes [67]. While CACFP guidelines require that meals and snacks include a minimum number of age-appropriate servings from four food categories, they do not require meals and snacks to meet any nutrient-based standards or be consistent with the Dietary Guidelines for Americans. CACFP guidelines also do not prohibit offering additional nonreimbursable foods or beverages that might be high-calorie, low-nutrition foods. Further, there are no funding provisions or legislative requirements for nutrition education. CACFP regulations for meals and snacks for children aged two and older should be consistent with the Dietary Guidelines for Americans. With the exception of the federal Head Start program, child care facilities are regulated by states, and state rules vary widely. Only two states require that meals and snacks follow the Dietary Guidelines for Americans, and only 15 states specify the percentage of children's daily nutritional requirements to be provided per meal or per a given number of hours in care [65]. Stronger state licensing requirements in regard to the nutritional quality of foods served and training for child care providers could help ensure healthier food environments.

Schools

The school food environment can have a large impact on the dietary intake of children and adolescents because up to two meals and snacks can be eaten at school, comprising 19–50% of students' total daily energy intake [68]. Food at school is typically available through federally reimbursed school meals and "competitive foods," so called because they compete with the school meals program. Competitive foods are all foods and beverages sold outside of the federal meal programs and include vending machines, a la carte offerings in the cafeteria, snack bars, school stores, and fundraisers. Meals served as part of the National School Lunch Program and School Breakfast Program must meet federally defined nutrition standards and the Dietary Guidelines for Americans. However, federal requirements currently do very little to limit the sale of competitive foods or to set school-wide nutrition standards.

The rise in obesity over the past few decades has been accompanied by an increase in the number of alternative food options available throughout the school day [69]. The national 2006 School Health Policies and Programs Study (SHPPS) [70] conducted by the Centers for Disease Control and Prevention found that 33% of elementary schools, 71% of middle schools, and 89% of high schools had either a vending machine or a school store, canteen, or snack bar where students could purchase food or beverages. The most common beverages sold were sports drinks, soda pop, and fruit drinks (not 100% juice), and the most common foods sold were higher-fat salty snacks. SHPPS 2006 data indicate that, while some progress has been made since the 2000 SHPPS, much more is needed.

The Third School Nutrition and Dietary Assessment study (SNDA-III) [71, 72] also confirms that current offerings in schools do not fully support a healthy diet for children and adolescents. Vending machines and a la carte sales were available in the vast majority of middle and high schools, and these sources often contained low-nutrient, energy-dense foods. Unhealthy foods were much more pervasive in high schools than elementary schools and in rural schools compared to urban and suburban schools, but there were no significant differences between low-income and higher-income schools [72].

SNDA-III found that students who obtained competitive foods at school consumed more than 150 cal from foods that were low in nutrients and energy dense. Several studies have related the availability of snacks and drinks sold in schools to higher intakes of total calories, soft drinks, total fat, and saturated fat and lower intakes of fruits and vegetables, milk, and key nutrients [71, 73]. In response to growing concerns over obesity, attention has focused on the need to establish stronger school nutrition standards and limit access to competitive foods. The Institute of Medicine (IOM) Report *Nutrition Standards for Healthy Schools: Leading the Way to Healthier Youth* recommended that, if competitive foods are available, they should consist solely of fruits, vegetables, whole grains, and nonfat or low-fat

dairy products, consistent with the Dietary Guidelines for Americans, in order to help children and adolescents develop healthful lifelong eating patterns [69]. Currently, only 16 states require nutrition standards for competitive foods and beverages at school and none have standards as strong as the IOM recommendations [69].

Schools have made substantial improvements the past 15 years in improving the nutrition profile of the school lunch and breakfast programs, most notably reducing the percentage of calories from fat and saturated fat [71]. For example, the recent SNDA-III study [71] showed that, although the majority of US schools offer breakfasts and lunches that meet the standards for key nutrients, such as protein, vitamins A and C, calcium, and iron, less than one third of public schools meet the USDA standards for total fat and saturated fat. These data indicate that stronger efforts are needed to improve school meals.

Worksites

Two thirds of the US population aged 16 years and older participates in the labor force [74]. Consequently, workplace environments may have a great influence on the diets of adolescents and adults. Full-time employees spend at least half their waking hours at work and consume a substantial proportion of daily calories in and around work settings. Food choices and eating behaviors are influenced by the physical availability of food in the workplace and surrounding neighborhood, workplace policies, organizational support for health programs, and social norms among coworkers [75]. Research suggests that health programs addressing these characteristics of worksite environments effectively promote improvements in dietary intake [76]. Nationally representative survey data further indicate that the majority of adults would like to have access to healthy food in their workplace and nearly half are interested in healthy eating classes or counseling [77]. However, many workers have few opportunities for healthful eating at work and face a number of barriers that limit their participation in health programs [78–80].

Sources of food in the workplace environment include company cafeterias, vending machines, company-sponsored meetings and events, office fundraisers, and shared refrigerated or cupboard space. In addition, the neighborhood surrounding a workplace may have grocery stores, convenience stores, snack carts, and restaurants. A number of strategies addressing these varied food sources have been suggested, and evaluation studies have demonstrated that making changes in the workplace food environment can lead to significant dietary improvements among employees [76]. For example, sales of fruit and salads rose threefold in a cafeteria setting when a 3-week intervention increased the number of daily fruit and salad options and discounted the prices of these foods by 50% [81]. Other recommendations for intervening on access to healthy food in and around the workplace have been to coordinate a Farmers' Market on site, provide refrigeration and cupboard space for employees to store healthy snacks, provide preferential pricing for healthful vended food, place a water filtration system near vending machines, and promote area restaurants that offer healthful food choices [82].

Workplace policies relevant to eating behavior include the amount of time allotted for meals, catering policies for company-sponsored events, and provided incentives and time for participating in health programs. The University of Minnesota's School of Public Health has developed model guidelines for offering food at meetings, seminars, and catered events [83]. The guidelines encourage the provision of healthy food choices, as defined by the 2005 Dietary Guidelines for Americans, at mealtimes and discourage the provision of food mid-morning or mid-afternoon. Comprehensive health programs that address multiple levels of influence on eating behaviors have been shown to produce promising improvements in dietary intake [84–86]. However, national survey data indicate that lack of time is often a barrier to participation in workplace health programs, especially among certain groups. Management and higher-educated employees tend to have more flexibility in their work schedule and are more likely to participate in health promotion programs than employees in manual trades and those with lower levels of education [79]. Research suggests that it is important for employers to provide flexible programs or paid time off during the workday to promote program participation and reduce disparities in program access [77].

Social norms around eating may also provide support for healthful food choices when coworkers exchange ideas or encouragement, make choices about where to dine out for lunch, and bring snacks or potluck meals to share. Creating advisory boards to guide health promotion activities is an effective strategy for ensuring the involvement of employees and developing healthy norms [86, 87]. The Seattle 5-a-Day Program created an employee advisory board at all 14 intervention worksites including the cafeteria manager and a representative from all employee groups [86]. These advisory boards were given responsibility for tailoring and implementing program activities, which led to significant increases in employees' consumption of fruit and vegetables. Additionally, social norms around eating may be positively influenced by training employees to educate their peers about good nutrition [88]. Peer educators can provide daily support for colleagues making a behavioral change and are best qualified to tailor healthy eating messages to the unique needs and culture of their coworkers [89].

Retail Food Stores

Research in adults and children suggests that access to various types of retail food stores and the physical availability of food products in local stores impacts food choices. Further, research has produced some evidence that access to retail food stores may influence risk for obesity. Studies have focused on three categories of food stores: supermarkets, grocery stores, and convenience stores [90]. Supermarkets include large stores offering a full-line of products and typically the services of a deli and bakery. Relative to other food stores, supermarkets tend to have the lowest prices and offer the greatest variety of high-quality products [91]. Grocery stores stock dry goods, canned goods, and nonfood items but generally offer fewer perishable products than supermarkets. Convenience stores have limited shelf space and selections of staple groceries, ready-to-eat foods, and nonfood items. Typically, convenience stores have higher prices and stock little fresh produce [92].

With few exceptions, studies in adults have found that persons with better access to supermarkets tend to have healthier diets [93–96]. The Multiethnic Atherosclerosis Neighborhood Study examined the number of supermarkets within 1 mile of participants' homes and diet quality using the Alternate Healthy Eating Index. In the study sample of 2,384 adults ages 45 to 84 years, participants with no supermarkets near their homes were 25% less likely to have a healthy diet (more fruit, vegetables, nuts, soy protein, cereal fiber, and polyunsaturated versus saturated fat) than those with the most stores [96]. Other studies have highlighted the potential impact of supermarket access on dietary intake in lower-income and nutritionally vulnerable populations such as pregnant women and US Food Stamp households [93, 94]. The results of these studies have similarly shown that easy access to supermarket shopping is associated with better intakes of fruit, vegetables, grains, folate, iron, and calcium.

Studies in children have not found evidence indicating that dietary intake is related to supermarket access but instead have shown that the distance from home to a convenience store may impact food choices [97, 98]. One study among 204 young adolescent Boy Scouts (10–14 years) in Texas showed that living a greater distance from a convenience store was associated with higher intakes of fruit, 100% juices, and low-fat vegetables [98]. Research in 800 Australian children (ages 5–6 years and 10–12 years) likewise found that each additional convenience store within a 10-min walk from home (800 m) was associated with 16% lower odds of consuming fruit two or more times per day and vegetables three or more times per day [97]. These two studies suggest that easy access to foods available in convenience stores may reduce fruit and vegetable intake. However, no studies were found to have examined the impact of living near a convenience on intakes of other types of food or beverages. Studies in older youth with driving privileges were also not found.

These findings are supported further by studies in adults [99], adolescents [100], and children [101] which have found that having better access to supermarkets and lower access to convenience stores reduces risk for obesity. For example, the Monitoring the Future Study used nationally representative data on 73,079 students in grades 8 and 10 to examine relationships between weight status and the density of supermarkets, convenience stores, and grocery stores within school ZIP codes [100]. Each additional chain supermarket outlet per 10,000 capita was shown to reduce the prevalence of overweight by 0.6 percentage points while, in contrast, each additional convenience store was shown to increase the prevalence of overweight by 0.15 percentage points. Convenience store density was additionally found to mediate the relationship between neighborhood income and weight status, indicating that the greater availability of convenience stores in low-income neighborhoods may partly explain higher rates of overweight among low-income adolescents.

At least five studies have more directly examined the physical availability of food products in local stores [91, 102–105]. Four of these five studies found that greater store availability of healthful products was related to higher intake or home availability of the same foods [91, 102, 103, 105]. One representative study measured the proportion of shelf space occupied by low-fat and high-fiber food products in 160 stores across 34 ZIP codes [103]. Individuals residing in these same communities were surveyed by phone about their usual diet, and correlations with food store availability were examined within ZIP codes. The study showed the availability of red meat, reduced-fat milk, and low-fat foods in local stores were significantly associated with the consumption of these foods among residents.

Restaurants and Fast Food

Food expenditures at US restaurants are expected to grow for the 17th consecutive year to a total of $558 billion in 2008 [106]. As a proportion of total US food expenditures, meals and snacks purchased at restaurants represent nearly half of all expenditures [106]. Many different types of restaurants (e.g., burger joints, cafeterias, fine dining, pizzerias, pubs, sub and sandwich shops) are available to consumers and provide diverse food options for eating away from home. Research in adults, adolescents, and children has examined whether the accessibility of restaurants may impact food choices as well as risk for obesity. In addition, research has examined whether the provision of

nutrition information in restaurants at the point of purchase may influence food choices. Most research studies have broadly categorized restaurants as either limited-service or full-service restaurants. Limited-service restaurants are typically defined to include quick-service and fast-food places that prepare bulk amounts of food in advance and have customers pick up and pay for their food order at a counter before eating [90, 107]. In contrast, full-service restaurants are characterized by having wait staff deliver customers' orders to their table [90].

Several studies in adults have found that frequently eating in a fast-food restaurant is associated with less healthful, higher-calorie dietary patterns and risk for obesity [108–111]. For example, one study in 891 women (20–45 years) found that increases in eating at fast-food restaurants over 3 years were related to increases in calorie intake, percentage fat intake, and intakes of energy-dense foods such as hamburgers, French fries, and soft drinks [111]. Other studies have additionally found that frequent eating at fast-food restaurants is related to lower intake of fruits, nonstarchy vegetables, milk, and key micronutrients. Only one study in adults was found that investigated relationships between neighborhood access to a fast-food restaurant and dietary intake [95]. No relationship was found between dietary intake measures and having a fast-food restaurant in the census tract of residence; however, the study showed that having access to a full-service restaurant was related to lower intake of saturated fat among black Americans. Compared to other black residents living in neighborhoods without a full-service restaurant, the proportion of residents meeting national recommendations for saturated fat intake was 26% higher among those living in neighborhoods with at least one full-service restaurant. A similar relationship was not found among white participants.

Although more research is needed to confirm the results of this one study, the findings suggest that the neighborhood proximity of fast-food restaurants to home may not have a great impact on frequency of fast-food consumption. Research completed in a sample of 1,033 Minnesota residents found that the number of fast-food restaurants within 2 miles of individuals' homes was not related to frequency of eating fast food or risk for obesity [112]. However, the number of fast-food restaurants within broader geographical areas may be important. Two nationally representative studies which examined the relationship between fast-food availability and adult obesity rates at the state and county level have reported direct associations [113, 114]. For example, one study using data from the 2002–2006 Behavioral Risk Factor Surveillance System and the 2002 US Economic Census determined the ratio of fast-food to full-service restaurants within 544 counties [113]. A 21% increase in the odds of being obese was observed between the fifth and 95th percentiles of the ratio distribution. In contrast, the total density of restaurants and the density of full-service restaurants within counties were associated with lower weight status and less risk for obesity.

Studies in children and adolescents have similarly found that frequently eating in a fast-food restaurant is associated with less healthful and higher-calorie dietary patterns [115, 116], but only one study has investigated whether neighborhood access to restaurants may impact food choices [117]. A nationally representative, school-based survey of 72,854 adolescents found that fruit and vegetable intake was unrelated to the density of fast-food restaurants and directly related to the density of full-service restaurants in school ZIP code areas [117]. The results of this study suggest that the price of fast food may be a more important determinant of dietary intake than the physical availability of restaurants. A 10% increase in the price of fast food was related to a 3% increase in the probability of regular fruit and vegetable consumption and a 6% decrease in the prevalence of overweight. Other studies in children and adolescents have also investigated whether there is a relationship between the availability of fast-food restaurants and risk for obesity. The results parallel findings in adult samples; the proximity of fast-food restaurants to home was unrelated to risk for obesity in one study [118], but another study has reported a positive association between obesity and state-level fast-food restaurant density [119].

Although restaurant meals tend to be more calorie dense and of poorer nutritional quality than foods and beverages prepared at home or school [120, 121], federal laws and most state laws do not currently require restaurants to provide nutritional information to consumers. Most restaurants do not provide nutrition information on menus or provide nutrition information for less than half of menu items [122, 123]. As 75% of adults and adolescents say they are trying to eat healthfully in restaurants, having access to nutrition information at the point of purchase may help some consumers to make better choices when dining out [106, 124–126]. The provision of nutrition information has been shown to greatly improve the selections of consumers who consider nutrition when ordering. A random-intercept study collected information on the lunch purchases of adult patrons at 11 fast-food chains in New York City [125]. Of the 11 restaurant chains, Subway was the only chain that posted nutrition information at the point of purchase on deli cases near registers. Among Subway patrons, those who reported seeing nutrition information purchased 52 fewer calories than those who reported they did not see calorie information. Patrons who reported seeing calorie information and that the nutrition information had an effect on their selection purchased 99 fewer calories than those who reported seeing the information and that it

had no effect. The provision of nutrition information as part of interventions in other types of restaurants has been found to similarly lead to increased sales of food items promoted as lower in fat, cholesterol, or calories [127].

Macroenvironments

Income and Socioeconomic Status

Much research has found that groups with lower incomes and levels of educational attainment (i.e., socioeconomic status) have higher levels of obesity, more diet-related disease, and poorer diets. National survey data show that the prevalence of obesity is 26% among US adults living in poverty compared to only 20% among those in the highest-income quartile [128]. Similarly, the prevalence of overweight is 50% higher among US youth (ages 15 to 17 years) in poor families compared to those in families with incomes above the poverty threshold [129]. Lower socioeconomic groups are at greater risk for type 2 diabetes, cardiovascular disease, osteoporosis, and some forms of cancer [130–133]. Studies in adults [128, 132, 134–137], adolescents [138–140], and children [139, 141–143] have reported socioeconomic group disparities in recommended food and micronutrient intakes. Although there is evidence that food support programs improve the diets of the poorest Americans, inequalities remain evident [141, 144]. These health and diet inequalities may be explained by factors such as neighborhood differences in the availability of healthy foods, economic barriers to purchasing food, and having limited time or resources for food preparation.

Despite some inconsistencies, most studies have shown that lower socioeconomic groups consume fewer whole grains [139], vegetables [128, 136], fruits [128, 136], low-fat milk [137, 143], and lean meats [137]. The diets of lower socioeconomic groups tend to be more energy dense [128] and, in some studies, have been found to include more added sugars [140], sweetened drinks [142], and frequent fast-food meals [111, 145]. One study using national survey data showed that US adults in the highest-income quartile have 1.6 times greater odds of consuming at least two fruits and three vegetables than adults living in poverty [136]. Likewise, US adults with more than 12 years of education have 1.9 times greater odds of consuming at least two fruits and three vegetables than adults who do not complete high school [136]. Disparities are also striking among young children. Research in a national random sample of 2,515 mothers, whose infants or toddlers were four to 24 months, found that completion of a college education was significantly associated with greater child consumption of fruit and lower consumption of sweets [142]. The percentage of children found to consume no sweetened drinks was 11 times greater among mothers with a completed college education (49.5%) compared to no high school degree (4.3%).

Whereas research has not found consistent associations between socioeconomic status and macronutrient intakes, several studies have shown lower socioeconomic groups have lower intakes of fiber and essential micronutrients such as vitamins A and C, folate, calcium, and iron [132, 137, 138, 140]. In addition, research including plasma biomarkers has found lower socioeconomic groups tend to have poorer micronutrient status [146, 147]. A study in 4,746 Minnesota adolescents found large differences in meeting the recommendation for calcium intake across socioeconomic quintiles determined primarily by parental education [138]. For example, the results showed that only 22.3% of adolescent girls in families of low socioeconomic status were meeting the calcium recommendation compared to 37.6% of girls in families of high socioeconomic status. Disparities among women of reproductive age are a special area of concern given the influence of nutritional status on birth outcomes. Trend analyses (2002–2006) among participants aged 18 to 44 years in the California Women's Health Survey showed that, despite stability in the overall prevalence of using a folic-acid-containing supplement, the prevalence decreased among women with less than any college education [148]. The prevalence of using a folic-acid-containing supplement increased from 45.5% to 50.6% among women with any college education whereas it decreased from 27.5% to 24.2% among women with less than a high school education.

Poor dietary patterns have also been linked to neighborhood deprivation [149–151], and there is growing evidence that residential segregation by income may contribute to the many reports of disparities in diet and nutritional well-being described above. Compared to other food stores, supermarkets and chain grocery stores tend to offer the greatest variety of healthful food products at the lowest cost [152]. Several studies have found evidence that low-income communities are more often impacted than affluent communities by poor access to supermarkets, chain grocery stores, and the healthful foods available in these stores [153]. For example, a national study representing more than 28,000 ZIP codes found that, when compared to middle-income ZIP codes, low-income ZIP codes had only 75% as many chain supermarkets available [154]. Similar disparities have also been found in school environments. High school students of low socioeconomic status compared to students of higher socioeconomic status were found to attend schools where a less-healthy mix of food options is available to them from vending machines, school stores, and snack bars [155]. Additionally, research suggests that a greater number of convenience stores and fast-food restaurants are located near secondary schools in low- versus high-income census tracts [156, 157]. One study reported there were 50% fewer

convenience stores and 32% fewer fast-food restaurants near schools (within 0.5 mile) in high-income census tracts compared to low-income census tracts [156]. The findings are cause for concern given the considerable time that adolescents spend in and around schools and other research indicating greater access to convenience stores may contribute to more unhealthy food choices and greater risk for obesity among adolescents [98, 100].

The monetary and time costs of preparing healthy foods are additional barriers to good nutrition for low-income groups. In general, nutrient-dense foods cost more than foods that are higher in energy [158]. Research findings suggest that food costs are an obstacle to increasing consumption of nutrient-dense foods such as whole grains, fruits, and vegetables [159, 160]. When food budgets are limited, individuals tend to select lower-cost, energy-dense foods to meet their energy needs and prevent hunger [161–163]. Although some nutrient-dense foods may be purchased inexpensively, these food products tend to be less palatable and often require much time for preparation. The US Department of Agriculture Thrifty Food Plan (TFP) was developed to estimate the cost of a healthful, minimal-cost meal plan and serves as the basis for food stamp allotments. Although the TFP was recently updated to include some convenient and commercially prepared foods, the recipes developed to help low-income consumers prepare most foods on the plan require 80 min/day or 16 h/week [164, 165]. Devoting this amount of time to meal preparation may represent a significant barrier to following the TFP as, on average, full-time working women spend only 38 to 46 min/day preparing food and part-time women spend only 53 to 56 min [164].

Cultural Norms and Values

Cultural factors influence food and eating behaviors. Culture is a system of shared understandings and interactions that shapes and, in turn, is shaped by experience [166]. Shared values and beliefs are core aspects of all cultures and shape perceptions of food, health, and illness. In addition to shared belief and value systems, hallmarks of culture include language, social relationships, religious beliefs, dress, music, and foods. Culture embodies a socially grounded way of learning that shapes the way an individual views the world, how they interact with others, and how they expect others to behave [167]. Individuals learn to make sense of the outside world within a cultural framework and processes. Cultural behaviors, values, and beliefs are learned early in life, are transmitted from one generation to the next, and are often deeply held. However, culture is a dynamic construct that continues to evolve and change over time [167].

Food is an expression of cultural identity. Food behaviors are learned through enculturation, which is the process by which culture is transmitted from one generation to the next. Cultural food patterns influence food consumption in several ways; they shape food preferences and perceptions of what kinds of foods are healthy and unhealthy, and dictate what food is eaten, when it is eaten, and how it is prepared. Virtually all cultures use food during celebrations, and many use food for medicinal purposes.

Within every culture, intracultural variation exists that cuts across ethnic, regional, geographic, gender, and generational domains. Globalization and acculturation can impact cultural change and cultural homogeneity [166]. For example, media exposure such as television increases similarity across cultures and may influence food preferences, body image, and weight concerns [168]. The globalization of fast-food restaurants may promote common food tastes for certain foods across cultures [168]. The growing ethnic diversity in the US and influx of new immigrants have contributed to the introduction of many new foods to the mainstream culture and expansion of the American food repertoire [168].

Dietary acculturation (how or to what extent a group changes their eating patterns and/or food choices in a new environment) may occur uniquely for different groups and/or individuals. Some may retain traditional food choices yet others may assume the food choices and preparation methods of the dominant culture [169]. Therefore, dietary acculturation has the potential to be either beneficial or detrimental to health depending on what habits one retains and those that one changes [169]. Dietary acculturation may have age and generational effects. For example, immigrant youth, compared to their parents, have been more likely to adopt food patterns of the American culture. First-generation Latino adolescents have been found to have higher fruit and vegetable intakes and lower soft drink consumption than whites. With succeeding generations, fruit and vegetable consumption decreases while soft drink consumption increases so that by the third generation their diets are poorer than whites [166].

Cultural attitudes and norms not only influence food choices and diet but also perceptions of body image and how obesity is perceived. Refugees from war-torn countries where hunger, malnutrition, and child mortality were prevalent may view a fat child as a healthy child. Studies of Latinos have shown that some parents of obese children believe their children to be healthy and are unconcerned about their children's weight status [166]. Cultural factors for standards of female attractiveness based on a higher body weight can also can also serve as a protective buffer in promoting higher body satisfaction, such as the standards observed among African American adolescent girls and women, but at the same time present challenges for obesity prevention efforts [170]. Understanding the cultural context is the first step in designing successful health promotion interventions [167].

Food Marketing

Food and beverage marketing has enormous potential to influence eating behavior. A study conducted by the US Federal Trade Commission estimated that food and beverage companies spend more than $9.6 billion annually to promote their products [171]. Promotional campaigns employ a large spectrum of techniques that are designed to reach diverse consumer groups. Examples of commonly employed techniques include advertising on sponsored media channels (e.g., television, radio, Internet), premium offers, in-store displays, event and athletic sponsorships, celebrity endorsements, product placements, and character licensing. Research suggests that energy-dense, nutrient-poor products are heavily marketed, and the current marketing environment contributes to unhealthy food choices. A large proportion of promotional efforts are targeted to the youngest and most easily influenced consumers—children and adolescents. Nearly one fifth of marketing expenditures are specifically directed to influencing the eating behaviors of youth ages 2 to 17 years [171] and there is little external regulation of promotional content or marketing practices.

Promotions for energy-dense, nutrient-poor products represent the greatest share of marketing expenditures. Sixty-nine percent of the total marketing expenditures reported by the nation's largest food and beverage companies in 2006 were for the following product categories: carbonated beverages, restaurant foods, snack foods, and candy/frozen desserts [171]. In contrast, only 3.4% of expenditures were used to promote fruits, vegetables, and dairy products. Studies that have examined the types of foods and beverages advertised on television programming and websites geared to youth have reported similar findings [172–175]. For example, a 2005 analysis of food advertising during Saturday morning children's television programming found that nine out of ten advertisements shown were for foods or beverages high in fat, sodium, or added sugars or were low in nutrients (e.g., vitamin C, calcium, iron) relative to guidelines developed by nutrition and health experts [172]. The most heavily marketed product categories were ready-to-eat breakfast cereals and cereal bars, restaurant foods, candy, and snack foods such as cookies, chips, crackers, and fruit snacks. A review of food and beverage advertising on ten popular children's websites found nearly all advertisements (98%) were for candy (n=248), sweetened breakfast cereals (n=42), and quick-serve restaurants (n=9) [175].

Young people may be particularly susceptible to the influence of marketing. Brand awareness develops at an early age, and some research suggests that children are three times more likely to remember an advertised brand than are adults [176, 177]. However, the ability to recognize the persuasive intent of advertising messages is not fully developed nor consistently applied before youth reach 11 years of age [168]. The ability to recognize indistinct advertisements embedded in advergames and promotions which utilize interactive digital technologies make take even longer to develop. Most research which has examined the influence of marketing on attitudes and behavior has focused on television advertising and youth younger than the age of 12 years [168]. Although limited in scope, this body of research provides moderate to strong evidence that television advertising influences the attitudes (e.g., food preferences) and behaviors (e.g., purchase requests, food choices) of children ages 2 to 11 years [178, 179].

In light of this research, several countries have introduced strong regulatory measures to reduce the amount of advertising viewed by children. Belgium, Sweden, and Norway have completely banned television advertising directed to children less than 12 years of age and Australia prohibits advertisements during television programming targeted to preschool children [180]. The USA, in contrast, has few regulations in place to limit the promotion of energy-dense, nutrient-poor foods. Although two federal agencies have limited external regulatory powers, the US advertising industry is largely self-regulated [168]. The Children's Advertising Review Unit (CARU) is the self-regulatory body for the US food and beverage industry and reviews all forms of advertising directed to children. While the CARU guidelines encourage advertisers to promote the development of good nutritional practices, no specific nutritional standards for products are in place [181]. The US Federal Trade Commission (FTC) is authorized only to intervene when advertisements are clearly deceptive, misleading, or untruthful [168]. Commercial speech doctrine prohibits the FTC from blocking advertising solely because it may lead members of the public from making unhealthful choices. Similarly, the US Federal Communications Commission (FCC) has limited authority to regulate broadcast media [168]. Regulations enforced by the FCC require only that television broadcasters limit the duration of advertising shown and separate programs associated with a product from commercials for that product during programming for children ages 12 years or less.

Agricultural and Food Policy

Many dietary choices are influenced by market forces that are beyond the control or awareness of individual consumers [182]. The American food supply arises from a combination of domestic agricultural production and imported foodstuffs. What is actually produced and imported depends on business practices in the farming and production, purchasing, processing, distributing, and marketing of food, and these practices are influenced by

government policy and regulation. Consumer and institutional food purchases, in turn, create the markets to which businesses respond [168]. Government federal policies include farm polices such as farm-income support programs and commodity-price supports, and trade policies such as import quotas and tariffs, all of which may alter relative prices of major food product ingredients [182]. Consequently, some foods are relatively inexpensive and available in great supply, whereas others are more expensive and not widely available. For example, the relatively low prices of sweeteners have contributed to their increased use in foods [183].

It has been argued that US farm policies have contributed to the overproduction of certain crops, specifically commodity grain and oilseed crops (i.e., corn and soybeans), thereby creating artificially low prices, often below the cost of production [184]. US farm policy for commodity crops have made sugars and fats some of the most inexpensive food substances to produce and may have indirectly and inadvertently influenced food processors and manufacturers to expand their product lines to include more fats and sweeteners in their products [184]. High-fructose corn syrup, which became an inexpensive substitute for sugar in foods starting in the 1970s, and hydrogenated vegetable oils (high in trans fats) are now prevalent in foods, likely due to inexpensive corn and soybeans. Food companies were able to purchase these commodities at artificially cheap prices, contributing to the increased prevalence of added sugars and fats in our food supply. On the other hand, specialty crops such as fruits and vegetables receive little government support and it has been speculated that this may, in part, explain their higher cost. Between 1985 and 2000, fruits and vegetables led all other food categories in retail price increases, with price increases for fresh fruits and vegetables much higher than those for processed products [185]. For example, over this 15-year period, the percent change in food price increases was 118% for fruits and vegetables and only 35% for fats and oils, 46% for sugars and sweets, and 20% for carbonated soft drinks [185]. Interestingly, in 2004, less than 4% of total US cropland was planted with fruits and vegetables. About three fourths (74%) of US cropland are directed towards eight "commodity" crops (corn, wheat, cotton, soybeans, rice, barley, oats, and sorghum), which comprise 70–80% of all farm subsidies [186].

While agriculture and food polices can affect prices and production practices and thereby trigger shifts in the content and quality of the food supply, the influence of these policies on consumer prices, nutrition, and food choices is complex and not well understood. For example, while farm policies have had an effect on the price of corn-based sweeteners, agricultural economists have argued that that the effect of policy on ingredient prices has become less important over time and that the current link between US sweetener consumption and farm policy is weak [183]. The complex linkages between agricultural and food policies and diet and health outcomes is an understudied area and more research is needed.

Current agricultural policies have helped make food environments less healthy for Americans. Farm and food policy should be aligned with national public health and nutrition goals. The key purpose of our food and farming policies should be to advance the health and well-being of Americans. Some of the same reforms that could make our farm and food policy healthier would also benefit family farmers [184]. Every 5 to 7 years, there is an opportunity to change the system through the federal Farm Bill which addresses agricultural production, food and nutrition assistance, rural development, renewable energy, conservation policies, and research. US food policy should support and encourage the production of a healthy food system.

Future Research Directions

The aim of this review is to describe and evaluate research relating to the influence of social, physical, and macro-environmental contexts on food choices. While much progress has been made in the past 5 to 10 years in understanding and measuring the impact of the food environment on diet-related behavioral outcomes, this research is in its infancy. Numerous studies have identified associations between dietary intake and environmental factors; however, the majority of these studies have methodological limitations which limit their credibility to guide environmental interventions and policy changes. To advance the field, future research will need to emphasize rigorous study designs and multilevel investigations, examine how associations may vary according to age and other characteristics of population subgroups, develop and evaluate a standard set of measures for assessing food environments and policies, and improve on current dietary assessment methodologies [187]. Overall, a systems-oriented, multilevel framework is needed for advancing research on individual and environmental determinants of eating behaviors and interventions to positively impact food choices at a community or population level.

- The majority of completed studies have relied on cross-sectional designs. Studies using longitudinal and quasi-experimental designs are needed to investigate the causal pathways linking environmental factors and dietary intake. In particular, there is a need for multilevel studies to build greater understanding of the mechanisms by which environmental factors in multiple contexts interact with one another and with individual factors to influence eating behavior [188]. Vegetable

consumption, for example, may be improved among youth with few health concerns (individual factor) if food prices do not prohibit their family from regularly purchasing vegetables (macroenvironment factor), the family food shopper has convenient access to a supermarket (physical environment), and vegetables are served at regular family meals (social environment). As this research field is still relatively new and complex, designing informative studies will further require the development or refinement of existing theoretical models and the strengthening of cross-disciplinary collaborations [6].

- Special efforts should be made to conduct research among diverse subgroups, including different age groups, racial and ethnic minority populations, and economically disadvantaged communities [187]. It cannot be assumed that environmental factors will similarly impact different groups or all individuals within a group [189]. For example, several studies have shown that economically disadvantaged communities are more often impacted by poor access to supermarkets and chain grocery stores than affluent communities [153]. Research has documented the content of food advertisements in television markets with a high viewership of African American children includes a higher than average proportion of advertisements for energy-dense snack foods and soft drinks [190]. Expert groups have recommended that mixed methods, involving quantitative and qualitative data collection, be used to advance understanding among groups at the highest risk for poor dietary intake [187]. Combining quantitative and qualitative data collection may also be useful to aid in understanding why some individuals maintain healthful dietary patterns when living in environments that favor the selection of unhealthy food choices.
- Few measures of food environments or policies have been evaluated for validity or reliability and existing measures vary greatly in terms of scale and scope. For example, studies examining access to food stores have variously defined store categories according to the number of cash registers, the number of staff employed, the types of food sold, name recognition, and annual sales data [153]. Similarly, definitions of a relevant area to shop for food beyond one's neighborhood have ranged from one half mile to 15 miles [153]. Developing standard objective and perceived measures of environments would significantly advance the field by allowing for greater comparability of effect estimates across studies and population subgroups. Future research should evaluate the reliability and validity of measures, determine the sensitivity of measures to change and their utility in diverse population subgroups, and broadly disseminate high-quality measures [191].
- Finally, improving on currents methods of dietary assessment will help to ensure the accurate detection of relationships. Self-report measures are prone to measurement error but must be largely relied upon to investigate associations between environmental factors and dietary intake. Cohort studies that enroll large numbers of participants typically must use food frequency questionnaires or short tools due the time and monetary costs of assessment. However, these tools provide not only poor estimates of energy intake. There is a great need for the development and refinement of dietary assessment methods and tools, especially those that may be tailored for assessing dietary intake in youth and ethnic minority populations.
- Recently, new multilevel research paradigms have been proposed to transform efforts related to diet, physical activity, and energy balance to reverse the obesity epidemic [188, 192–194]. Huang and Glass have proposed a multilevel research approach, which frames food and physical activity behaviors as complex systems that are not only a matter of individual choice but also strongly influenced by multiple contexts at the interpersonal level (e.g., family, peers, social networks), community level (e.g., schools, worksites), and governmental level (local, state, national policies), and interactions with biological processes [188]. We need to know how these different levels interact to affect food and eating behaviors and what interventions are most effective in changing diet behaviors. A systems-oriented, multilevel research agenda to address food choices and their impact on health would need to be cross-disciplinary and bring together expertise across different disciplines and fields to develop and test hypotheses [193, 194]. For this to occur, there is a need for new research funding to address multilevel and cross-disciplinary work on diet and food choices.

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References

1. World Health Organization. *Diet, nutrition, and the prevention of chronic diseases. Report of a joint WHO/FAO expert consultation*. Geneva: World Health Organization; 2003. Available at ftp://ftp.fao.org/docrep/fao/005/ac911e/ac911e00.pdf. Accessed December 2, 2008.
2. Swinburn B, Egger G, Raza F. Dissecting obesogenic environments: The development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Prev Med*. 1999; 29: 563-570.
3. Sallis J, Owen N. Ecological models of health behavior. In: Glanz K, Rimer B, Lewis F, eds. *Health behavior and health*

education: theory, research, and practice. San Francisco: Jossey-Bass; 2002: 462-484.
4. Brug J, van Lenthe F, eds. *Environmental determinants and interventions for physical activity, nutrition and smoking: a review*. Zoetermeer: Speed-Print; 2005: 378-389.
5. Kremers S, de Bruijn G, Visscher T, van Mechelen W, de Vries NK, Brug J. Environmental influences on energy balance-related behaviors: A dual-process view. *Int J Behav Nutr Phys Act*. 2006; 3: 9.
6. Ball K, Timperio A, Crawford D. Understanding environmental influences on nutrition and physical activity behaviors: Where should we look and what should we count? *Int J Behav Nutr Phys Act*. 2006; 3: 33.
7. van der Horst K, Oenema A, Ferreira I, et al. A systematic review of environmental correlates of obesity-related dietary behaviors in youth. *Health Educ Res*. 2007; 22: 203-226.
8. Baranowski T, Cullen K, Baranowski J. Psychosocial correlates of dietary intake: Advancing dietary intervention. *Annu Rev Nutr*. 1999; 19: 17-40.
9. Shaikh A, Yaroch A, Nebeling L, Yeh M-C, Resnicow K. Psychosocial predictors of fruit and vegetable consumption in adults: A review of the literature. *Am J Prev Med*. 2008; 34: 535-543.
10. Kremers S, Visscher T, Seidell J, van Mechelen W, Brug J. Cognitive determinants of energy balance-related behaviors: Measurement issues. *Sports Med*. 2005; 35: 923-933.
11. Feunekes G, deGraaf C, Meyboom S, van Staveren WA. Food choice and fat intake of adolescents and adults: Associations of intakes within social networks. *Prev Med*. 1998; 27: 645-656.
12. Fisher J, Mitchell D, Smiciklas-Wright H, Birch L. Maternal milk consumption predicts the tradeoff between milk and soft drinks in young girls' diets. *J Nutr*. 2000; 131: 246-250.
13. Patterson T, Rupp J, Sallis J, Atkins C, Nader P. Aggregation of dietary calories, fats, and sodium in Mexican–American and Anglo families. *Am J Prev Med*. 1988; 4: 75-82.
14. Hannon P, Bowen D, Moinpour C, McLerran D. Correlations in perceived food use between the family food preparer and their spouses and children. *Appetite*. 2003; 40: 77-83.
15. Savage J, Orlet Fisher J, Birch L. Parental influence on eating behavior: Conception to adolescence. *J Law Med Ethics*. 2007; 35: 22-34.
16. Jago R, Baranowski T, Baranowski J. Fruit and vegetable availability: A micro environmental mediating variable? *Public Health Nutr*. 2007; 10: 681-689.
17. Kratt P, Reynolds K, Shewchuk R. The role of availability as a moderator of family fruit and vegetable consumption. *Health Educ Behav*. 2000; 27: 471-482.
18. Chandon P, Wansink B. When are stockpiled products consumed faster? A convenience–salience framework of postpurchase consumption incidence and quantity. *J Mark Res*. 2002; 39: 321-325.
19. Baranowski T, Watson K, Missaghian M, et al. Social support is a primary influence on home fruit, 100% juice, and vegetable availability. *J Am Diet Assoc*. 2008; 108: 1231-1235.
20. Fisher J, Mitchell D, Smiciklas-Wright H, Birch L. Parental influences on young girls' fruit and vegetable, micronutrient, and fat intakes. *J Am Diet Assoc*. 2002; 102: 58-64.
21. Wardle J, Carnell S, Cooke L. Parental control over feeding and children's fruit and vegetable intake: How are they related? *J Am Diet Assoc*. 2005; 105: 227-232.
22. Hanson NI, Neumark-Sztainer D, Eisenberg ME, Story M, Wall M. Associations between parental report of the home food environment and adolescent intakes of fruits, vegetables and dairy foods. *Public Health Nutr*. 2005; 8: 77-85.
23. Young E, Fors S, Hayes D. Associations between perceived parent behaviors and middle school student fruit and vegetable consumption. *J Nutr Educ Behav*. 2004; 36: 2-12.
24. Arcan C, Neumark-Sztainer D, Hannan P, van den Berg P, Story M, Larson N. Parental eating behaviors, home food environment and adolescent intakes of fruits, vegetables, and dairy foods: Longitudinal findings from Project EAT. *Public Health Nutr*. 2007; 10: 1257-1265.
25. Bante H, Elliott M, Harrod A, Haire-Joshu D. The use of inappropriate feeding practices by rural parents and their effect on preschoolers' fruit and vegetable preferences and intake. *J Nutr Educ Behav*. 2008; 40: 28-33.
26. Galloway A, Fiorito L, Francis L, Birch L. "Finish your soup": Counterproductive effects of pressuring children to eat on intake and affect. *Appetite*. 2006; 46: 318-323.
27. Patrick H, Nicklas T, Hughes S, Morales M. The benefits of authoritative feeding style: Caregiver feeding styles and children's food consumption patterns. *Appetite*. 2005; 44: 243-249.
28. Rhee K, Lumeng J, Appugliese D, Kaciroti N, Bradley R. Parenting styles and overweight status in first grade. *Pediatrics*. 2006; 17: 2047-2054.
29. Haapalahti M, Mykkanen H, Tikkanen S, Kokkonen J. Meal patterns and food use in 10- to 11-year-old Finnish children. *Public Health Nutr*. 2003; 6: 365-370.
30. Videon T, Manning C. Influences on adolescent eating patterns: The importance of family meals. *J Adolesc Health*. 2003; 32: 365-373.
31. Neumark-Sztainer D, Hannan PJ, Story M, Croll J, Perry C. Family meal patterns: Associations with sociodemographic characteristics and improved dietary intake among adolescents. *J Am Diet Assoc*. 2003; 103: 317-322.
32. Larson N, Neumark-Sztainer D, Hannan P, Story M. Family meals during adolescence are associated with higher diet quality and healthful meal patterns during young adulthood. *J Am Diet Assoc*. 2007; 107: 1502-1510.
33. Burgess-Champoux T, Larson N, Neumark-Sztainer D, Hannan P. Are family meal patterns associated with overall diet quality during the transition from early to middle adolescence? *J Nutr Educ Behav*. 2009; 41: 79-86.
34. Fisher J, Mitchell D, Smiciklas-Wright H, Mannino M, Birch L. Meeting calcium recommendations during middle childhood reflects mother–daughter beverage choices and predicts bone mineral status. *Am J Clin Nutr*. 2004; 79: 698-706.
35. Wansink B, Cheney M. Super bowls: Serving bowl size and food consumption. *JAMA*. 2005; 293: 1727-1728.
36. Wansink B, Van Ittersum K, Painter J. Ice cream illusions: Bowl size, spoon size, and serving size. *Am J Prev Med*. 2006; 31: 240-243.
37. Fisher J, Rolls B, Birch L. Children's bite size and intake of an entree are greater with large portions than with age-appropriate or self-selected portions. *Am J Clin Nutr*. 2003; 77: 1164-1170.
38. Boutelle K, Birnbaum A, Lytle L, Murray D, Story M. Associations between perceived family meal environment and parent intake of fruit, vegetables, and fat. *J Nutr Educ Behav*. 2003; 35: 24-29.
39. Coon K, Goldberg J, Rogers B, Tucker K. Relationships between use of television during meals and children's food consumption patterns. *Pediatrics*. 2001; 107: E7.
40. Feldman S, Eisenberg M, Neumark-Sztainer D, Story M. Associations between watching TV during family meals and dietary intake among adolescents. *J Nutr Educ Behav*. 2007; 39: 257-263.
41. O'Dea J. Why do kids eat healthful food? Perceived benefits of and barriers to healthful eating and physical activity among children and adolescents. *J Am Diet Assoc*. 2003; 103: 497-500.
42. Kubik M, Lytle L, Fulkerson J. Fruits, vegetables, and football: findings from focus groups with alternative high school students regarding eating and physical activity. *J Adolesc Health*. 2005; 36: 494-500.

43. Contento I, Williams S, Michela J, Franklin A. Understanding the food choice process of adolescents in the context of family and friends. *J Adolesc Health*. 2006; 38: 575-582.
44. McGee B, Richardson V, Johnson G, et al. Perceptions of factors influencing healthful food consumption behavior in the Lower Mississippi Delta: Focus group findings. *J Nutr Educ Behav*. 2008; 40: 102-109.
45. Stanton C, Green S, Fries E. Diet-specific social support among rural adolescents. *J Nutr Educ Behav*. 2007; 39: 214-218.
46. Steptoe A, Perkins-Porras L, Rink E, Hilton S, Cappuccio F. Psychological and social predictors of changes in fruit and vegetable consumption over 12 months following behavioral and nutrition education counseling. *Health Psychol*. 2004; 23: 574-581.
47. Emmons K, Barbeau E, Gutheil C, Stryker J, Stoddard A. Social influences, social context, and health behaviors among working-class, multi-ethnic adults. *Health Educ Behav*. 2007; 34: 315-334.
48. Sorensen G, Stoddard A, Dubowitz T, et al. The influence of social context on changes in fruit and vegetable consumption: Results of the healthy directions studies. *Am J Public Health*. 2007; 97: 1216-1227.
49. Salvy S, Kieffer E, Epstein L. Effects of social context on overweight and normal-weight children's food selection. *Eat Behav*. 2008; 9: 190-196.
50. Herman C, Polivy J, Roth D. Effects of the presence of others on food intake: A normative interpretation. *Psychol Bull*. 2003; 129: 873-886.
51. Leone T, Pliner P, Herman C. Influence of clear versus ambiguous normative information on food intake. *Appetite*. 2007; 49: 58-65.
52. Salvy S-J, Coelho J, Kieffer E, Epstein L. Effects of social context on overweight and normal-weight children's food intake. *Physiol Behav*. 2007; 92: 840-846.
53. Salvy S-J, Romero N, Paluch R, Epstein L. Peer influence on pre-adolescent girls' snack intake: Effects of weight status. *Appetite*. 2007; 49: 177-182.
54. Schutz H, Paxton S. Friendship quality, body dissatisfaction, dieting, and disordered eating in adolescent girls. *Br J Clin Psychol*. 2007; 46: 67-83.
55. Eisenberg ME, Neumark-Sztainer D, Story M, Perry C. The role of social norms and friends' influences on unhealthy weight-control behaviors among adolescent girls. *Soc Sci Med*. 2005; 60: 1165-1173.
56. Lieberman M, Gauvin L, Bukowski W, White D. Interpersonal influence and disordered eating behaviors in adolescent girls: the role of peer modeling, social reinforcement, and body-related teasing. *Eat Behav*. 2001; 2: 215-236.
57. Haines J, Neumark-Sztainer D, Eisenberg ME, Hannan PJ. Weight teasing and disordered eating behaviors in adolescents: Longitudinal findings from Project EAT (Eating Among Teens). *Pediatrics*. 2006; 117: e209-e215.
58. Gerner B, Wilson P. The relationship between friendship factors and adolescent girls' body image concern, body dissatisfaction, and restrained eating. *Int J Eat Disord*. 2005; 37: 313-320.
59. Christakis N, Fowler J. The spread of obesity in a large social network over 32 years. *N Engl J Med*. 2007; 357: 370-379.
60. Trogdon J, Nonnemaker J, Pais J. Peer effects in adolescent overweight. *J Health Econ*. 2008; 27: 1388-1399.
61. Cohen-Cole E, Fletcher J. Is obesity contagious? Social networks vs. environmental factors in the obesity epidemic. *J Health Econ*. 2008; 27: 1382-1387.
62. Wing R, Jeffery R. Benefits of recruiting participants with friends and increasing social support for weight loss and maintenance. *J Consult Clin Psychol*. 1999; 67: 132-138.
63. Jelalian E, Mehlenbeck R, Lloyd-Richardson E, Birmaher V, Wing R. 'Adventure therapy' combined with cognitive-behavioral treatment for overweight adolescents. *Int J Obes*. 2006; 30: 31-39.
64. National Research Council, Institute of Medicine. *Working families and growing kids: Caring for children and adolescents*. Washington, D.C: National Academies Press; 2003.
65. Story M, Kaphingst KM, French S. The role of child care settings in obesity prevention. *Future Child*. 2006; 16: 143-168.
66. Ball S, Benjamin S, Ward D. Dietary intake in North Carolina child-care centers: Are children meeting current recommendations? *J Am Diet Assoc*. 2008; 108: 718-721.
67. Food Research Action Center. State of the states: 2007. A profile of food and nutrition programs across the nation. 2007. Available at http://www.frac.org/SOS%202007%20Report.pdf. Accessed December 2, 2008.
68. Gleason P, Suitor C. *Children's diets in the mid-1990s: Dietary intake and its relationship with school meal participation. Special nutrition programs: Report no CN-01-CD1*. Alexandria: US Department of Agriculture Food and Nutrition Service; 2001. Available at http://www.fns.usda.gov/oane/MENU/Published/CNP/FILES/ChilDiet.pdf. Accessed December 4, 2008.
69. Institute of Medicine. *Nutrition standards for foods in schools: Leading the way toward healthier youth*. Washington, D.C.: National Academies Press; 2007.
70. O'Toole T, Anderson S, Miller C, Guthrie J. Nutrition services and foods and beverages available at school: Results from the school health policies and programs study 2006. *J Sch Health*. 2007; 77: 500-521.
71. Gordon A, Fox M. School Nutrition Dietary Assessment Study-III: summary of findings. 2007. Available at http://www.fns.usda.gov/oane/menu/Published/CNP/FILES/SNDAIII-SummaryofFindings.pdf. Accessed November 28, 2008.
72. Finkelstein D, Hill E, Whitaker R. School food environments and policies in U.S. public schools. *Pediatrics*. 2008; 122: e251-e259.
73. Story M, Kaphingst K, French S. The role of schools in obesity prevention. *Future Child*. 2006; 16: 109-142.
74. United States Department of Labor, Bureau of Labor Statistics. The employment situation: September 2008. Available at http://www.bls.gov/news.release/archives/empsit_10032008.pdf. Accessed November 1, 2008.
75. Sorensen G, Linnan L, Hunt MK. Worksite-based research and initiatives to increase fruit and vegetable consumption. *Prev Med*. 2004; 39: S94-S100.
76. Engbers L, van Poppel MNM, Paw M, van Mechelen W. Worksite health promotion programs with environmental changes: A systematic review. *Am J Prev Med*. 2005; 29: 61-70.
77. Kruger J, Yore M, Bauer D, Kohl H. Selected barriers and incentives for worksite health promotion services and policies. *Am J Health Promot*. 2007; 21: 439-447.
78. Shimotsu S, French S, Gerlach A, Hannan P. Worksite environment physical activity and healthy food choices: measurement of the worksite food and physical activity environment at four metropolitan bus garages. *Int J Behav Nutr Phys Act*. 2007; 4: 17.
79. Thompson S, Smith B, Bybee R. Factors influencing participation in worksite wellness programs among minority and underserved populations. *Fam Commun Health*. 2005; 28: 267-273.
80. French S, Harnack L, Toomey T, Hannan P. Association between body weight, physical activity and food choices among metropolitan transit workers. *Int J Behav Nutr Phys Act*. 2007; 4: 52.
81. Jeffery RW, French SA, Raether C, Baxter JE. An environmental intervention to increase fruit and salad purchases in a cafeteria. *Prev Med*. 1994; 23: 788-792.
82. Pratt C, Lemon S, Fernandez I, et al. Design characteristics of worksite environmental interventions for obesity. *Obesity*. 2007; 15: 2171-2180.

83. Story M, Smyth M, School of Public Health Nutrition Faculty and Staff. Guidelines for offering healthy foods at meetings, seminars, and catered events. Available at http://www.sph.umn.edu/img/assets/9103/Nutrition_Guide_2008.pdf. Accessed November 1, 2008.
84. Sorensen G, Thompson B, Glanz K, et al. Work site-based cancer prevention: Primary results from the working well trial. *Am J Public Health*. 1996; 86: 939-947.
85. Sorensen G, Stoddard A, Peterson K, et al. Increasing fruit and vegetable consumption through worksites and families in the Treatwell 5-a-Day Study. *Am J Public Health*. 1999; 89: 54-60.
86. Beresford S, Thompson B, Feng Z, Christianson A, McLerran D, Patrick D. Seattle 5 a day worksite program to increase fruit and vegetable consumption. *Prev Med*. 2001; 32: 230-238.
87. Sorensen G, Barbeau E, Stoddard A, Hunt M, Kaphingst K, Wallace L. Promoting behavior change among working-class, multiethnic workers: Results of the healthy directions-small business study. *Am J Public Health*. 2005; 95: 1389-1395.
88. Sorensen G, Stoddard A, Macario E. Social support and readiness to make dietary changes. *Health Educ Behav.* 1998; 25: 586-598.
89. Buller D, Morrill C, Taren D, et al. Randomized trial testing the effect of peer education at increasing fruit and vegetable intake. *J Natl Cancer Inst*. 1999; 91: 1491-1500.
90. US Census Bureau. North American Industry Classification System. 2007. Available at http://www.census.gov/eos/www/naics/. Accessed November 28, 2008.
91. Bodor J, Rose D, Farley T, Swalm C, Scott S. Neighborhood fruit and vegetable availability and consumption: The role of small food stores in an urban environment. *Public Health Nutr.* 2008; 11: 413-420.
92. Zenk SN, Schulz AJ, Israel BA, James SA, Bao S, Wilson ML. Fruit and vegetable access differs by community racial composition and socioeconomic position in Detroit, Michigan. *Ethn Dis*. 2006; 16: 275-280.
93. Laraia BA, Siega-Riz AM, Kaufman JS, Jones SJ. Proximity of supermarkets is positively associated with diet quality index for pregnancy. *Prev Med*. 2004; 39: 869-875.
94. Rose D, Richards R. Food store access and household fruit and vegetable use among participants in the U.S. Food Stamp Program. *Public Health Nutr.* 2004; 7: 1081-1088.
95. Morland K, Wing S, Diez-Roux A. The contextual effect of the local food environment on residents' diets: The Atherosclerosis Risk in Communities Study. *Am J Public Health*. 2002; 92: 1761-1767.
96. Moore L, Roux AD, Nettleton J, Jacobs D. Associations of the local food environment with diet quality—A comparison of assessments based on surveys and Geographic Information Systems: The Multi-ethnic study of atherosclerosis. *Am J Epidemiol*. 2008; 167: 917-924.
97. Timperio A, Ball K, Roberts R, Campbell K, Andrianopoulos N, Crawford D. Children's fruit and vegetable intake: Associations with the neighborhood food environment. *Prev Med*. 2008; 46: 331-335.
98. Jago R, Baranowski T, Baranowski J, Cullen K, Thompson D. Distance to food stores and adolescent male fruit and vegetable consumption: Mediation effects. *Int J Behav Nutr Phys Act*. 2007; 4: 35.
99. Morland K, Diez Roux AV, Wing S. Supermarkets, other food stores, and obesity: The atherosclerosis risk in communities study. *Am J Prev Med*. 2006; 30: 333-339.
100. Powell L, Auld C, Chaloupka F, O'Malley P, Johnston L. Associations between access to food stores and adolescent body mass index. *Am J Prev Med*. 2007; 33: S301-S307.
101. Liu G, Wilson J, Qi R, Ying J. Green neighborhoods, food retail and childhood overweight: Differences by population density. *Am J Health Promot*. 2007; 21: 317-325.
102. Fisher BD, Strogatz DS. Community measures of low-fat milk consumption: Comparing store shelves with households. *Am J Public Health*. 1999; 89: 235-237.
103. Cheadle A, Psaty BM, Curry S, et al. Community-level comparisons between the grocery store environment and individual dietary practices. *Prev Med*. 1991; 20: 250-261.
104. Edmonds J, Baranowski T, Baranowski J, Cullen K, Myres D. Ecological and socioeconomic correlates of fruit, juice, and vegetable consumption among African–American boys. *Prev Med*. 2001; 32: 476-481.
105. Auchincloss A, Diez-Roux A, Brown D, Erdmann C, Bertoni A. Neighborhood resources for physical activity and healthy foods and their association with insulin resistance. *Epidemiol*. 2008; 19: 146-157.
106. Grindy B, Karaer A, Riehle H, National Restaurant Association. 2008 Restaurant industry forecast. 2007. Available at http://www.restaurant.org/research/forecast.cfm. Accessed November 2, 2008.
107. Wikipedia. Fast food restaurant. 2008. Available at http://en.wikipedia.org/wiki/Fast_food_restaurant. Accessed November 29, 2008.
108. Bowman S, Vinyard B. Fast food consumption of U.S. adults: Impact on energy and nutrient intakes and overweight status. *J Am Coll Nutr*. 2004; 23: 163-168.
109. Pereira M, Kartashov A, Ebbeling C, et al. Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. *Lancet*. 2005; 365: 36-42.
110. Duffey K, Gordon-Larsen P, Jacobs D, Williams O, Popkin B. Differential associations of fast food and restaurant food consumption with 3-y change in body mass index: The coronary artery risk development in young adults study. *Am J Clin Nutr*. 2007; 85: 201-208.
111. French S, Harnack L, Jeffery R. Fast food restaurant use among women in the Pound of Prevention study: Dietary, behavioral and demographic correlates. *Int J Obes*. 2000; 24: 1353-1359.
112. Jeffery RW, Baxter J, McGuire M, Linde J. Are fast food restaurants an environmental risk factor for obesity? *Int J Behav Nutr Phys Act*. 2006; 3: 2.
113. Mehta N, Chang V. Weight status and restaurant availability: A multilevel analysis. *Am J Prev Med*. 2008; 34: 127-133.
114. Maddock J. The relationship between obesity and the prevalence of fast food restaurants: State-level analysis. *Am J Health Promot*. 2004; 19: 137-143.
115. Schmidt M, Affenito S, Striegel-Moore R, et al. Fast-food intake and diet quality in black and white girls. *Arch Pediatr Adolesc Med*. 2005; 159: 626-631.
116. Bowman S, Gortmaker S, Ebbeling C, Pereira M, Ludwig D. Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics*. 2004; 113: 112-118.
117. Powell L, Auld M, Chaloupka F, O'Malley P, Johnston L. Access to fast food and food prices: Relationship with fruit and vegetable consumption and overweight among adolescents. *Adv Health Econ Health Serv Res*. 2007; 17: 23-48.
118. Burdette HL, Whitaker RC. Neighborhood playgrounds, fast food restaurants, and crime: Relationships to overweight in low-income preschool children. *Prev Med*. 2004; 38: 57-63.
119. Chou S-Y, Rashad I, Grossman M. *Fast-food restaurant advertising on television and its influence on childhood obesity.* Cambridge: National Bureau of Economic Research; 2005. Available at http://www.aeaweb.org/annual_mtg_papers/2007/0106_1015_2004.pdf. Accessed December 1, 2008.
120. O'Donnell S, Hoerr S, Mendoza J, Goh E. Nutrient quality of fast food kids meals. *Am J Clin Nutr*. 2008; 88: 1388-1395.
121. Prentice AM, Jebb SA. Fast foods, energy density and obesity: A possible mechanistic link. *Obes Rev*. 2003; 4: 187-194.

122. Wootan M, Osborn M. Availability of nutrition information from chain restaurants in the United States. *Am J Prev Med*. 2006; 30: 266-268.
123. Harnack L. Availability of nutrition information on menus at major chain table-service restaurants. *J Am Diet Assoc*. 2006; 106: 1012-1015.
124. Yamamoto J, Yamamoto J, Yamamoto B, Yamamoto L. Adolescent fast food and restaurant ordering behavior with and without calorie and fat content menu information. *J Adolesc Health*. 2005; 37: 297-402.
125. Bassett M, Dumanovsky T, Huang C, et al. Purchasing behavior and calorie information at fast-food chains in New York City, 2007. *Am J Public Health*. 2008; 98: 1457-1459.
126. Gerend M. Does calorie information promote lower calorie fast food choices among college students? *J Adolesc Health*. 2009; 44: 84-86.
127. Seymour J, Yaroch A, Serdula M, Blanck H, Khan L. Impact of nutrition environmental interventions on point-of-purchase behavior in adults: A review. *Prev Med*. 2004; 39: S108-S136.
128. Kant A, Graubard B. Secular trends in the association of socioeconomic position with self-reported dietary attributes and biomarkers in the US population: National Health and Nutrition Examination Survey (NHANES) 1971–1975 to NHANES 1999–2002. *Public Health Nutr*. 2007; 10: 158-167.
129. Miech R, Kumanyika S, Stettler N, Link B, Phelan J, Chang V. Trends in the association of poverty with overweight among US adolescents, 1971–2004. *JAMA*. 2006; 295: 2385-2393.
130. Robbins J, Vaccarino V, Zhang H, Kasi S. Socioeconomic status and diagnosed diabetes incidence. *Diabetes Res Clin Pract*. 2005; 68: 230-236.
131. Muenning P, Sohler N, Mahato B. Socioeconomic status as an independent predictor of physiological biomarkers of cardiovascular disease: Evidence from NHANES. *Prev Med*. 2007; 45: 35-40.
132. Ma J, Johns R, Stafford R. Americans are not meeting current calcium recommendations. *Am J Clin Nutr*. 2007; 85: 1361-1366.
133. Kinsley T, Jemal A, Liff J, Ward E, Thun M. Secular trends in mortality from common cancers in the United States by educational attainment, 1993–2001. *J Natl Cancer Inst*. 2008; 100: 1003-1012.
134. Krebs-Smith S, Cook D, Subar A, Cleveland L, Friday J. U.S. adults' fruit and vegetable intakes, 1989-1991: A revised baseline for the Healthy People 2000 Objective. *Am J Public Health*. 1995; 85: 1623-1629.
135. Ervin R. Healthy Eating Index scores among adults, 60 years of age and over, by sociodemographic and health characteristics: United States, 1999–2002. *Adv Data*. 2008; 395: 1-16.
136. Casagrande S, Wang Y, Anderson C, Gary T. Have Americans increased their fruit and vegetable intake? The trends between 1988 and 2002. *Am J Prev Med*. 2007; 32: 257-263.
137. Shimakawa T, Sorlie P, Carpenter M, et al. Dietary intake patterns and sociodemographic factors in the Atherosclerosis Risk in Communities Study. *Prev Med*. 1994; 23: 769-780.
138. Neumark-Sztainer D, Story M, Hannan P, Croll J. Overweight status and eating patterns among adolescents: Where do youths stand in comparison with the *Healthy People 2010* objectives? *Am J Public Health*. 2002; 92: 844-851.
139. Harnack L, Walters S, Jacobs D. Dietary intake and food sources of whole grains among U.S. children and adolescents: Data from the 1994–1996 Continuing survey of food intakes by individuals. *J Am Diet Assoc*. 2003; 103: 1015-1019.
140. Xie B, Gilliland F, Li Y, Rockett H. Effects of ethnicity, family income, and education on dietary intake among adolescents. *Prev Med*. 2003; 36: 30-40.
141. Kranz S, Findeis J, Shrestha S. Use of the revised children's diet quality index to assess preschooler's diet quality, its sociodemographic predictors, and its association with body weight status. *J Pediatr (Rio J)*. 2008; 84: 26-34.
142. Hendricks K, Briefel R, Novak T, Ziegler P. Maternal and child characteristics associated with infant and toddler feeding practices. *J Am Diet Assoc*. 2006; 106: S135-S148.
143. Johnson R, Panely C, Wang M. Associations between the milk mothers drink and the milk consumed by their school-aged children. *Fam Econ Nutr Rev*. 2001; 13: 27-36.
144. Winicki J, Joliffe D, Gundersen C. How do food assistance programs improve the well-being of low-income families? Food Assistance and Nutrition Research Report #26-9. 2002. Available at http://www.ers.usda.gov/publications/fanrr26/fanrr26-9/fanrr26-9.pdf. Accessed October 19, 2008.
145. Larson N, Neumark-Sztainer D, Story M, Wall M, Harnack L, Eisenberg M. Fast food intake: Longitudinal trends during the transition to young adulthood and correlates of intake. *J Adolesc Health*. 2008; 43: 79-86.
146. Alaimo K, Olson C, Frongillo E. Low family income and food insufficiency in relation to overweight in US children. *Arch Pediatr Adolesc Med*. 2001; 155: 1161-1167.
147. Ford E, Sowell A. Serum alpha-tocopherol status in the United States population: Findings from the third national health and nutrition examination survey. *Am J Epidemiol*. 1999; 150: 290-300.
148. Herrndorf A, Haydu S, Takahashi E. Trends in folic acid supplement intake among women of reproductive age—California, 2002–2006. *Morb Mortal Wkly Rep*. 2007; 56: 1106-1109.
149. Diez-Roux AV, Nieto FJ, Caulfield L, Tyroler HA, Watson RL, Szklo M. Neighbourhood differences in diet: The Atherosclerosis Risk in Communities (ARIC) Study. *J Epidemiol Community Health*. 1999; 53: 55-63.
150. Stimpson J, Nash A, Ju H, Eschbach K. Neighborhood deprivation is associated with lower levels of serum carotenoids among adults participating in the third national health and nutrition examination survey. *J Am Diet Assoc*. 2007; 107: 1895-1902.
151. Dubowitz T, Heron M, Bird C, et al. Neighborhood socioeconomic status and fruit and vegetable intake among whites, blacks, and Mexican Americans in the United States. *Am J Clin Nutr*. 2008; 87: 1883-1891.
152. Block D, Kouba J. A comparison of the availability and affordability of a market basket in two communities in the Chicago area. *Public Health Nutr*. 2006; 9: 837-845.
153. Larson N, Story M, Nelson M. Neighborhood environments: Disparities in access to healthy foods in the U.S. *Am J Prev Med*. 2009; 36: 74-81.
154. Powell L, Slater S, Mirtcheva D, Bao Y, Chaloupka F. Food store availability and neighborhood characteristics in the United States. *Prev Med*. 2007; 44: 189-195.
155. Delva J, O'Malley P, Johnston L. Availability of more-healthy and less-healthy food choices in American schools. A national study of grade, racial/ethnic, and socioeconomic differences. *Am J Prev Med*. 2007; 33: S226-S239.
156. Zenk S, Powell L. U.S. secondary schools and food outlets. *Health & Place*. 2008; 14: 336-346.
157. Sturm R. Disparities in the food environment surrounding US middle and high schools. *Public Health*. 2008; 122: 681-690.
158. Jetter K, Cassady D. The availability and cost of healthier food alternatives. *Am J Prev Med*. 2006; 30: 38-44.
159. Ard J, Fitzpatrick S, Desmond R, et al. The impact of cost on the availability of fruits and vegetables in the homes of schoolchildren in Birmingham, Alabama. *Am J Pub Health*. 2007; 97: 367-372.
160. Chase K, Reicks M, Smith C, Henry H, Reimer K. Use of the think-aloud method to identify factors influencing purchase of bread and cereals by low-income African American women and implications for whole-grain education. *J Am Diet Assoc*. 2003; 103: 501-504.

161. Dietz W. Does hunger cause obesity? *Pediatrics*. 1995; 95: 766-767.
162. Darmon N, Ferguson E, Briend A. Do economic constraints encourage the selection of energy dense diets? *Appetite*. 2003; 41: 315-322.
163. Stewart H, Blisard N. The thrifty food plan and low-income households in the United States: What food groups are being neglected? *Food Policy*. 2006; 31: 469-482.
164. Mancino L, Newman C. Who has time to cook? How family resources influence food preparation. Economic Research Service Report #40. 2007. Available at http://www.ers.usda.gov/publications/err40. Accessed October 19, 2008.
165. Carlson A, Lino M, Juan W-Y, Hanson K, Basiotis P. Thrifty food plan, 2006. Center for Nutrition Policy and Promotion (CNPP-19). 2007. Available at http://www.cnpp.usda.gov/Publications/FoodPlans/MiscPubs/TFP2006Report.pdf. Accessed October 19, 2008.
166. Caprio S, Daniels S, Drenowski A, et al. Influence of race, ethnicity, and culture on childhood obesity: Implications for prevention and treatment. *Diabetes Care*. 2008; 31: 2211-2221.
167. Institute of Medicine. *Speaking of health: Assessing health communication strategies for diverse populations*. Washington D.C: National Academies Press; 2002.
168. McGinnis J, Gootman J, Kraak V, eds. *Food marketing to children and youth: Threat or opportunity?*. Washington, D.C.: The National Academies Press; 2006.
169. Satia-Abouta J. Dietary acculturation: Definition, process, assessment, and implications. *Int J Human Ecol*. 2003; 4: 71-86.
170. Kumanyika S, Grier S. Targeting interventions for ethnic minority and low-income populations. *Future Child*. 2006; 16: 187-208.
171. Federal Trade Commission. *Marketing food to children and adolescents: A review of industry expenditures, activities, and self-regulation*. Washington, D.C.: Federal Trade Commission; 2008. Available at http://www.ftc.gov/os/2008/07/P064504foodmktingreport.pdf. Accessed August 3, 2008.
172. Batada A, Seitz M, Wootan M, Story M. Nine out of 10 food advertisements shown during Saturday morning children's television programming are for foods high in fat, sodium, or added sugars, or low in nutrients. *J Am Diet Assoc*. 2008; 108: 673-678.
173. Harrison K, Marske AL. Nutritional content of foods advertised during the television programs children watch most. *Am J Public Health*. 2005; 95: 1568-1574.
174. Powell L, Szczypka G, Chaloupka F, Braunschweig C. Nutritional content of television food advertisements seen by children and adolescents in the United States. *Pediatrics*. 2007; 120: 576-583.
175. Alvy L, Calvert S. Food marketing on popular children's web sites: A content analysis. *J Am Diet Assoc*. 2008; 108: 710-713.
176. Robinson T, Borzekowski D, Matheson D, Kraemer H. Effects of fast food branding on young children's taste preferences. *Arch Pediatr Adolesc Med*. 2007; 161: 792-797.
177. Lindstrom M, Seybold P. *Brand child: Remarkable insights into the minds of today's global kids and their relationships with brands*. London: Kogan Page; 2003.
178. Institute of Medicine, Committee on Food Marketing and the Diets of Children and Youth, Food and Nutrition Board, et al. *Food marketing to children and youth: Threat or opportunity?*. Washington, D.C: The National Academies Press; 2006.
179. Buijzen M, Schuurman J, Bomhof E. Associations between children's television advertising exposure and their food consumption patterns: A household diary-survey study. *Appetite*. 2008; 50: 231-239.
180. Hawkes C. *Marketing food to children: The global regulatory environment*. Geneva: World Health Organization; 2004. Available at http://whqlibdoc.who.int/publications/2004/9241591579.pdf. Accessed July 19, 2008.
181. Children's Advertising Review Unit. Self-regulatory guidelines for children's advertising. 2006. Available at http://www.caru.org/guidelines/guidelines.pdf. Accessed December 5, 2008.
182. Golan E, Unnevehr L. Food product composition, consumer health, and public policy: Introduction and overview of special section. *Food Policy*. 2008; 33: 465-469.
183. Beghin J, Jensen H. Farm policies and added sugars in U.S. diets. *Food Policy*. 2008; 33: 480-488.
184. Schnoonover H, Muller M. *Food without thought: How US farm policy contributes to obesity*. Minneapolis: Institute for Agriculture and Trade Policy; 2006. Available at http://www.iatp.org/iatp/publications.cfm?accountID=421&refID=80627. Accessed December 3, 2008.
185. Putnam J. Major trends in the US food supply. *FoodReview*. 2000; 23: 13.
186. Muller M, Schnoover H, Wallinga D. *Considering the contribution of US food and agriculture policy to the obesity epidemic: Overview and opportunities*. Minneapolis: Institute for Agriculture and Trade Policy; 2007. Available at http://www.iatp.org/iatp/publications.cfm?accountID=421&refID=99607. Accessed December 2, 2008.
187. Sallis J, Story M, Lou D. Study designs and analytic strategies for environmental and policy research on obesity, physical activity, and diet: Recommendations from a meeting of experts. *Am J Prev Med*. 2009; 36: S72-S77.
188. Huang T, Glass T. Transforming research strategies for understanding and preventing obesity. *JAMA*. 2008; 300: 1811-1813.
189. Kumanyika S. Environmental influences on childhood obesity: Ethnic and cultural influences in context. *Physiol Behav*. 2008; 94: 61-70.
190. Outley C, Taddese A. A content analysis of health and physical activity messages marketed to African American children during after-school television programming. *Arch Pediatr Adolesc Med*. 2006; 160: 432-435.
191. Story M, Giles-Corti B, Yaroch A, et al. Work Group IV: Future directions for measures of the food and physical activity environments. *Am J Prev Med*. 2009; 36: S182-S188.
192. McKinnon R, Orleans C, Kumanyika S, et al. Considerations for an obesity policy research agenda. *Am J Prev Med*. 2009; 36: 351-357.
193. Huang T, Drewnoski A, Kumanyika S, Glass T. A systems-oriented multilevel framework for addressing obesity in the 21st century. *Prev Chronic Dis*. 2009;6:A97. Available at http://www.cdc.gov/pcd/issues/2009/jul/09_0013.htm. Accessed July 3, 2009.
194. Huang T. Solution-oriented research: Converging efforts of promoting environmental sustainability and obesity prevention. *Am J Prev Med*. 2009; 36: S60-S62.