

## Food Access and Its Relationship to Diet and Health Outcomes

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Many factors contribute to an individual's overall diet, body weight, and the risk of developing diet-related diseases, such as diabetes or cardiovascular disease. Individual factors can explain some but not all of the differences in the rates in which different population groups experience these problems. Focus on food access has increased as researchers try to better understand the factors besides individual behaviors that may lead to differences in diet and health outcomes (Diez-Roux, 2009). Interest in the relationship of food access to diet and health is also rooted in a substantial body of literature that shows disparities in many health outcomes across race, ethnicity, and socioeconomic status (Institute of Medicine, 2003; National Research Council, 2004). It is hypothesized that differences in food access across race, ethnicity, and socioeconomic status may contribute to or reinforce these health disparities (Diez-Roux, 2009).

This chapter first considers different conceptual and methodological approaches to understanding how food access can affect diet and diet-related outcomes. It then briefly reviews what is known about the relationship between food access and diet, obesity, and diet-related problems. Evidence regarding what is known about effects of diet on health outcomes like obesity, diabetes, and other diet-related diseases is also considered. The chapter concludes with a discussion of research and data needs to advance knowledge of the effects of food access on diet and health.

### Conceptual Framework

In a simple conceptual model, it is hypothesized that individual (and family) characteristics as well as characteristics of the physical environment impact dietary decisions. Individual characteristics include demographics (age, sex, race/ethnicity), socioeconomic status (income, education, and employment), family characteristics (family size and composition, presence of children), and preferences for food and other goods. The physical environment includes the food environment (accessibility to stores and restaurants) along with characteristics of the built environment, such as parks, sidewalks, availability of public transportation, air pollution, and noise. It is also likely that the social environment faced by individuals and families (e.g., cultural and social norms, social support, and safety and violence) affects diet. Diet is a major determinant of BMI and obesity status, and it is also a factor in risks of such diseases as diabetes and cardiovascular disease. Some of the same individual factors and physical and social environments affect BMI and diet-related diseases as well.

The conceptualized model is an effective starting point, but it is oversimplified. Individuals are certainly impacted by their larger physical and social environments, but physical and social environments are also impacted by individuals. Individuals have some choice over which physical and social environments with which to interact. Diet-related outcomes and health conditions are affected by other factors besides diet, including genetic

makeup, exercise habits, and working conditions. The directions of these relationships are not necessarily one-way. Obese individuals may have difficulty exercising or engaging in an active lifestyle. Obesity has also been tied to lower wages among women, which could affect their family's economic situation (Averett and Korenman, 1996; Cawley, 2004). And health conditions themselves can impact diet; for example, those with high blood pressure or diabetes may need to adopt special diets.

These complicated relationships highlight the limitations of the cross-sectional studies that have dominated the research in this area. Such studies are important because they illuminate how food access and the larger environment potentially impact diet and diet-related problems. But the results can not be interpreted causally.

## Literature Review

In reviewing the literature on food access and diet and health outcomes, one must first distinguish between studies that attempt to examine causal links between food access and health outcomes and those that only consider cross-sectional correlations. Also, most of the studies examine the effects of food access on proximal outcomes, such as food shopping behavior and food consumption, often focusing on particular foods such as fruits and vegetables, whole grains, or low-fat milk. Other studies, however, focus on outcomes such as high BMI, obesity, and heart disease, which are not as proximate outcomes. The causes of these more distant outcomes are much broader than just food access, and, thus, other factors besides lack of access to some foods may help account for the rate of incidence of these health outcomes. To get a sense of this, the analysis includes a review of literature on the degree to which specific foods that may be lacking in some neighborhoods (such as fresh fruits and vegetables, low fat milk, and whole grains) are related to such health outcomes as obesity, diabetes, cardiovascular disease, and cancer.

### *Food access and dietary intake*

The majority of studies that have examined the relationship between store access and dietary intake find that better access to a supermarket or large grocery store is associated with healthier food intakes (Larson et al., 2009). The relationship between the availability of restaurants (both fast food and full-service) and dietary intake has also been studied. In general, these studies have found that greater availability of fast food restaurants and lower prices of fast food restaurant items are related to poorer diet. Access to full-service restaurants shows either no relationship or a positive relationship with healthy dietary intake.

Only a few studies have used longitudinal data to measure how changes in access affect changes in diet. The few that exist focus on changes in shopping behavior and changes in dietary intake, not more distant outcomes such as obesity or other diet-related diseases. Two studies have examined the impact of the opening of a large supermarket in underserved areas in Leeds and Glasgow, UK (Wrigley et al., 2003; Cummins et al., 2005). The Leeds study used a pre-post intervention design, with survey interviews of participants about their shopping and food intake 5 months before and

7 months after a Tesco supermarket opened in the area. The Glasgow study used a pre-post study design to assess change in shopping and food intake behaviors surrounding a new store opening, but it also considered a comparison area that had similar neighborhood characteristics but did not have a new store open in the area. The comparison area was added to determine if any changes in shopping or diet could be due to secular changes in diet that were not due to a new store opening. Results of both studies showed that shopping behavior was affected by the openings of new stores—that is, a significant number of sampled individuals from the neighborhood switched their shopping to the new store. Both studies also show that average fruit and vegetable intake increased among surveyed individuals, but that the average increase was small (just over one-third of a serving). The average increase in fruit and vegetable intake among those who switched their main food shopping to the new store was larger, but still under one-half of a full serving size. The increase in fruit and vegetable intake in Leeds was statistically significant, but the increase in Glasgow was not. The Glasgow study, which used a control comparison area, shows that some of the increase in fruit and vegetable intake among sampled individuals could be due to overall increased consumption of these foods in both the control and study area—not due to the better accessibility to the store in the study area. Also noteworthy is that in both studies, respondents who switched to the new store reported better self-reported psychological health.

In contrast to opening new supermarkets, some areas have implemented programs to improve what is offered in small corner or convenience stores in underserved areas. Rather than build a whole new store, the idea is to work within the existing infrastructure to offer more healthy options and fewer less healthy options. Some of these interventions have measured the impact on shopping, sales, and food intake. Overall, results from these studies show that stocking and promoting healthier food items increases sales of the items. Some studies have also shown increases in healthy food consumption (Ayala et al., 2009; Gittelsohn, 2009). One intervention stocked prepared packs of fruits and vegetables (washed, cut, and bagged) at two tiendas (small stores) that served primarily Latino customers in North Carolina. Fruit and vegetable intake for customers at these two tiendas was compared with the fruit and vegetable intake of customers at two control group tiendas that did not offer the fruit and vegetable packs (Ayala et al., 2009). The study found that customers who shopped at stores where the packs were sold increased fruit and vegetable intake by one full serving. Customers who shopped in the two control tiendas exhibited no change in consumption.

These small store interventions show some promise, however, much of the research on the effectiveness of these interventions is formative. The studies are usually on very small and localized samples and often have very short followup periods from which changes can be observed. Further, there has also been little evaluative research to determine the cost effectiveness and sustainability of the changes in the stores and in consumers' diets.

### ***Food access and obesity***

Many studies have examined the link between store and restaurant access and BMI and obesity (see Larson et al., 2009, for a recent summary). In general, these studies find that better access to a supermarket is associated with

reduced risk of obesity and better access to convenience stores is associated with increased risk of obesity. Results with respect to restaurants are mixed. Some show that fast food availability is associated with increased risk of obesity for adults and children, but others find no association (Larson et al., 2009).

Currie et al. (2009) examine how school-level obesity rates among ninth graders in California are related to the distance between the school and fast food and full-service restaurants. The study also examines weight gain during pregnancy for women in Michigan, New Jersey, and Texas using Vital Statistics data and measuring distance from each woman's home to fast food and full-service restaurants. Results vary across the two samples. They find very localized effects in the sample of ninth graders in schools—the rate of obesity in the school increases 5.2 percent for schools located within 0.10 of a mile of a fast food restaurant (relative to schools that are within 0.25 of a mile). There is no relationship between the school obesity rate and distances of a quarter or half mile from a fast food restaurant and no effect of full-service food restaurant availability. For the sample of mothers, the studies find that living within half a mile of a fast food restaurant increases the probability of gaining more than 20 kilograms during pregnancy by 2.5 percent. The authors interpret the smaller effects on women as evidence that they are less constrained by travel than the ninth graders.

Another study examined the relationship between proximity to fast food restaurants and supermarkets to BMI for a sample of individuals from Marion County, Indiana (Indianapolis) (Chen et al., 2009). Unlike most previous studies, this study attempted to control for the fact that an individual's choice of where to live may be affected by the availability of different foodstores and restaurants.<sup>30</sup> Results of this study show that proximity to fast food restaurants has a small positive impact on BMI (Chen et al., 2009). In contrast, proximity to a grocery store has a small negative impact on BMI. The sizes of the total effects were less than half of a BMI point but were larger for people who lived very close to a store or restaurant.

Another study found that neighborhood environment could be an important determinant of BMI and obesity (Katz et al., 2007). The Moving-to-Opportunity demonstration project from the U.S. Department of Housing and Urban Development (HUD) used a random assignment methodology to study the effects of different public housing policies on families. Families living in high poverty public housing projects in five U.S. cities were randomly assigned to one of three groups: 1) an experimental group that received mobility counseling and a Section 8 public housing voucher that could only be used in census tracts with low poverty rates; 2) another experimental group that received a Section 8 voucher that could be used in the traditional way, without any geographic restriction; and 3) a control group that received no new assistance. Results showed that adults in the treatment groups had lower probabilities of obesity relative to the control group (Katz et al., 2007). While this study indicates there may be some neighborhood effects on obesity, it does not directly show an effect of food access on obesity. The reduction in obesity could have been due to other neighborhood or personal effects that were correlated with the move to a better neighborhood (e.g., better access to parks or less psychological distress).

<sup>30</sup>The study also accounts for spatial dependence across administrative units.

## The Relationship Between Consumption of Specific Foods, Obesity, and Diet-Related Diseases

Part of the goal of improving access to healthy and affordable food is to reduce obesity and diet-related diseases among populations that are adversely affected by these health conditions. With respect to obesity, it may be counterintuitive to think that a lack of access to any food is related to obesity—clearly the problem is too much food. The hypothesized causal pathway between lack of access and body weight is that some populations cannot get healthy food options and thus rely on energy-dense options that may cause weight gain. If healthier food is as available and as inexpensive as energy-dense food, it is hypothesized that consumers will substitute away from energy-dense foods to healthier foods and reduce the risk of obesity. As noted earlier, there is scant causal evidence to either support or refute this hypothesis. There are, however, a number of studies that explore the relationship between consumption of specific foods (fruits and vegetables, whole grains, low-fat milk, and beverages) and obesity and diet-related diseases. Since these specific foods are often the foods lacking in underserved areas (with the exception of beverages), this research is relevant to the question of how lack of access affects obesity and diet-related diseases.

### *Consumption of specific foods and their effects on obesity*

It is hypothesized that because of their high fiber content and, in the case of whole grains, their improved glycemic control, fruits, vegetables, and whole grains could increase satiety so that consumers who increased their intake of these foods would substitute away from other foods that may be more energy-dense. Such a substitution would either stabilize total caloric intake or possibly reduce it. With respect to the fat content of milk, it is hypothesized that consumers who choose low-fat milk instead of milks with higher fat content would have lower caloric intake and lower BMI.

There is only weak support for these hypothesized relationships in the literature.<sup>31</sup> In the case of fruit and vegetable consumption, cross-sectional data show that people who eat more fruits and vegetables have lower BMI. But cross-sectional data cannot distinguish whether consuming more fruits and vegetables causes lower BMI since those who eat more fruits and vegetables may be more health conscious, more likely to exercise, and more likely to have lower BMI relative to those who do not. Intervention and longitudinal studies have shown that increased fruit and vegetable intake may lead to small decreases in BMI, but some studies even show that increases in body weight can occur with increased consumption of fruits and vegetables because total caloric intake increased.

The case of whole grains is similar to that of fruits and vegetables. Relative to refined grains, greater intake of whole grains provides little or no benefit for weight management.

Cross-sectional evidence with respect to consumption of low-fat versus whole milk shows differences in preference across race and ethnicity that do not seem to be explained by availability or price. Hispanic and Black consumers are more likely to drink whole milk and White consumers are more likely to drink low-fat milk. The evidence also suggests that low-fat

<sup>31</sup>This section draws heavily on a review of the literature presented by Dr. Richard Mattes, Purdue University, at the IOM Workshop on the Public Health Effects of Food Deserts (Mattes, 2009).

milk consumption is not associated with lower BMI. In fact, among children, consumption of low-fat milk was linked to weight gain.

The relationship between beverage consumption and obesity has also been extensively studied. Calories consumed from beverages as a portion of Americans' total energy intake have almost doubled in the past 40 years, so much so that in 2002, 21 percent of total energy intake is from beverages (Duffey and Popkin, 2007). It is hypothesized that beverages provide less satiety than solid foods. As a result, increased calories consumed as beverages may not lead to reductions in calories from solid food and in fact may be consumed in addition to whatever calories come from solid foods leading to increased energy intake and weight gain. A summary of research suggests that beverage consumption is associated with increased energy intake, weight gain, and BMI. But there is less research from longitudinal studies or randomized controlled trials to establish the causality of beverage consumption and weight gain.

Obesity is a complex problem with many causes. Evidence presented here suggests that while some studies find a correlation between food accessibility and BMI and obesity, the causal pathways are not well understood. Lack of access to specific nutritious foods may be less important than relatively easy access to all other foods. "Food swamps" may better explain increases in BMI and obesity than "food deserts."<sup>32</sup> Increasing access to specific foods like fruits and vegetables, whole grains, and low-fat milk alone may not make a dent in the obesity problem. Many of the stores that carry these nutritious foods at low prices also carry all the less healthy foods and beverages as well. Without also changing the dietary behaviors of consumers, interventions aimed at increasing access to healthy foods may not be successful in addressing obesity.

### ***Consumption of specific foods and their effects on diet-related disease***

Not all of the relationships between specific healthy foods and diet-related diseases like diabetes, cardiovascular disease and cancer are well-understood, but some broad conclusions can be drawn.<sup>33</sup> First, plant-based foods like fruits, vegetables, and nuts and whole grains are linked to reduced risk of cardiovascular disease. Diets high in saturated fat, trans fat, or refined sugars are linked with higher risk of diabetes and cardiovascular disease. Sugar-sweetened beverages increase the risk of obesity, diabetes, and cardiovascular disease. The evidence of how these foods relate to risks of cancer are not as clear cut and varies across types of cancers. For example, consumption of nonstarchy vegetables and fruits probably protect against cancers of the mouth, pharynx, and larynx and of the esophagus and stomach (see IOM, 2009, for a more thorough discussion).

The link between plant-based foods and whole grains to lower risk of CVD is relevant to questions about food accessibility. The lack of these foods in consumers' diets due to lack of access could plausibly contribute to increased risk of CVD, especially if other foods high in saturated and trans fat are relatively more accessible and inexpensive.<sup>34</sup> The link between sugar-sweetened beverages and increased risk of obesity, diabetes, and CVD may be less of a question about food access since these beverages are almost

<sup>32</sup>Rose et al. (2009) introduced the term "food swamp" to characterize areas with an abundance of less healthy food options in contrast to "food deserts" that lack healthy food options.

<sup>33</sup>This section draws heavily from a presentation by Dr. Frank Hu, Harvard University, at the IOM Workshop on the Public Health Effects of Food Deserts.

<sup>34</sup>This is a hypothesis that could be empirically tested.

omnipresent—in supermarkets, corner stores, vending machines, and many other food and nonfood retailers.

## Summary

There is clear evidence that the food environment is associated with the kinds of foods that people eat. But most studies are cross-sectional and cannot make causal links. A few studies have examined food intake before and after healthy options for food become available (either within existing stores or because new stores open). These studies show mixed results. Some show a small but positive increase in consumption of fruits and vegetables and other nutritious food, while others show no effect.

There is little evidence that shows that increased consumption of healthy foods such as fruits and vegetables, low-fat dairy, or whole grains leads to lower BMI or reduced risk of obesity. Stronger evidence suggests that the consumption of beverages, especially sweetened beverages, is linked with increases in BMI and obesity. Several studies find that the proximity of fast food restaurants and supermarkets are correlated with BMI and obesity, but most of these are cross-sectional studies. One study that attempts to control for the correlation between individual's preferences for foods and their choice of residential location shows that the proximity to a large grocery store is negatively linked to BMI and the proximity to fast food restaurants is positively linked to BMI, but both of these effects are small. In the case of obesity, easy access to all food may be a more important factor than lack of access to specific relatively nutritious foods. Increased access to healthy foods alone, without decreased consumption of all other foods, will likely have little impact on obesity among subpopulations of concern.

Studies that go beyond correlation and try to map out causal relationships between the food environment and diet and health outcomes are rare. In order to disentangle these relationships and to ultimately improve the design of interventions that may reduce the impact of access barriers, improvements in research are needed. Better models that relate the food environment to diet and health are needed to disentangle causal relationships and define tests of which factors may be most important in explaining the relationships (e.g., availability or price). Experimental studies that can isolate the effects of changes in the food environment to diet and health outcomes could help. Taking advantage of natural experiments or quasi-experiments where naturally occurring comparison groups or areas can be used to uncover causal pathways would be useful. Longitudinal data that can be used to determine changes in diet and health over time are also needed to improve what is known about the relationships between food environment and dietary health.

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