

# Designed for Disease

## The Link Between Local Food Environments and Obesity and Diabetes

### SUMMARY

**H**ealthy eating can help reduce the incidence of obesity and diabetes—increasingly common conditions that result in shortened lives, lowered productivity, and enormous economic costs. Although healthy eating habits are ultimately a matter of individual choice, local food environments influence the options available to individuals and families.

*Designed for Disease: The Link Between Local Food Environments and Obesity and Diabetes* examines the relationships between retail food environments, obesity and diabetes, and community income. The study demonstrates that people who live near an abundance of fast-food restaurants and convenience stores compared to grocery stores and fresh produce vendors, have a significantly higher prevalence of obesity and diabetes.

The highest rates of obesity and diabetes are among people who live in lower-income communities and have worse food environments. However, for people living in lower-income and higher-income communities alike, the higher the ratio of fast-food restaurants and convenience stores to grocery stores and produce vendors near home, the higher the prevalence of obesity and diabetes.

To help reduce the prevalence of obesity and diabetes, the authors urge state and local lawmakers to enact public policies to make healthy foods more readily available. These policies include providing retail incentives, promoting smaller-scale markets that sell healthy foods, maximizing the opportunities that come with the new WIC food package, using zoning to limit the number of fast-food restaurants in overburdened communities, and requiring nutritional information on restaurant menus.

### STUDY OVERVIEW

Increasingly, research suggests that the foods available in communities influence dietary behaviors and related health outcomes.<sup>1</sup> According to a 2007 study by the California Center for Public Health Advocacy, California has more than four times as many fast-food restaurants and convenience stores as grocery stores and produce vendors—suggesting that Californians have greater access to foods with lower nutritional values than to healthier foods.<sup>2</sup>

This policy brief, produced collaboratively by the California Center for Public Health Advocacy, PolicyLink, and the UCLA Center for Health Policy Research, builds on the 2007 study as well as on related research by all three organizations. It investigates whether there is an association between the retail food environment and the prevalence of obesity and diabetes in California and explores the effect of community income on that relationship.

### BACKGROUND

#### Obesity and Diabetes Rates Are Increasing

According to the 2005 California Health Interview Survey (CHIS 2005), 21 percent of California adults are obese and another 35 percent are overweight. The consequences of obesity are severe; they include increased risk for chronic conditions such as diabetes, heart disease, cancer, arthritis, stroke, and hypertension.<sup>3-5</sup> Each year in California, obesity is responsible for thousands of deaths<sup>6</sup> and costs families, employers, the health-care industry, and the government more than \$6 billion.<sup>7</sup> Due to the rapid rise in obesity, today's youth may—for the first time in modern history—live shorter lives than their parents.<sup>8</sup>

The prevalence of type 2 diabetes is also rising dramatically, and the human and financial costs are devastating. Diabetes is the leading cause of blindness, non-traumatic lower-limb amputation, and kidney failure.<sup>9</sup> In addition, two-thirds of people with diabetes will die from cardiovascular



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*The rising prevalence of diabetes is fueling increases in healthcare expenditures and insurance premiums, costing \$18 billion each year in California alone.*

### The California Health Interview Survey (CHIS)

CHIS is a telephone survey of adults, adolescents, and children from all parts of California. The survey examines public health and health care access issues. CHIS 2005 completed interviews with over 43,000 adults, drawn from every county in the state, in English, Spanish, Chinese (both Mandarin and Cantonese), Vietnamese and Korean. The CHIS sample represents the geographic diversity of California, and the available multi-language interviews accommodate the state's rich ethnic diversity. CHIS is a collaborative project of the UCLA Center for Health Policy Research, the California Department of Health Services, and the Public Health Institute. The survey has been conducted every two years since 2001. For more information about CHIS, please visit [www.chis.ucla.edu](http://www.chis.ucla.edu).

disease or stroke.<sup>10</sup> The rising prevalence of diabetes is fueling increases in healthcare expenditures and insurance premiums, costing \$18 billion each year in California alone.<sup>11</sup>

Rates of obesity and diabetes are highest and have risen the most rapidly among people of color and in lower-income communities.<sup>12,13</sup> Even after accounting for individual risk factors such as socioeconomic status and race/ethnicity, living in a lower-income community is associated with poor health outcomes, including higher rates of obesity and mortality.<sup>14,15</sup> Increasingly, public health researchers, policymakers, advocates, and health care providers have acknowledged the influence of community factors, including the local food environment, on health.<sup>16</sup>

### Food Environments Are Associated with Health

The availability of retail food outlets that sell high-quality, nutritious foods at affordable prices is an important factor for encouraging individuals to select a healthy diet and subsequently reduce their risk for obesity and diabetes.<sup>17,18</sup> People who live near grocery stores are more likely to eat recommended amounts of fruits and vegetables<sup>19</sup> and less likely to be obese or have a diagnosis of diabetes.<sup>20,21</sup> Alternatively, eating at fast-food restaurants is associated with higher caloric intake,<sup>22</sup> lower fruit and vegetable consumption,<sup>23</sup> greater consumption of sweetened beverages,<sup>24</sup> and higher rates of obesity and diabetes.<sup>25</sup> Most food sold at convenience stores is typically of similarly low nutritional quality.<sup>26</sup>

The food environments of lower-income communities and communities of color are of particular concern, given that obesity and diabetes rates are highest in these communities. Lower-income neighborhoods and communities of color have fewer grocery stores and an abundance of fast-food restaurants and convenience stores compared to higher-income and predominantly Caucasian neighborhoods.<sup>27-31</sup> When grocery stores are not accessible—when residents do not have access to a private vehicle or reliable public transportation, or when grocery stores are not located within short walking distance—residents

of these communities often resort to purchasing the generally higher-calorie, lower-nutrient foods sold at nearby convenience stores and fast-food restaurants. These disparities in food access contribute to subsequent chronic health conditions, including obesity, cancer, diabetes, and cardiovascular disease, as well as to higher mortality rates and years of potential life lost.<sup>32-34</sup>

## DATA AND METHODS

To examine the association of retail food environments with obesity and diabetes, we combined individual-level demographic and health outcome data from the 2005 California Health Interview Survey (CHIS 2005) with the locations of retail food outlets from the 2005 InfoUSA Business File. Using geographic information system (GIS) software, we calculated a Retail Food Environment Index (RFEI) for each adult CHIS respondent by dividing the total number of fast-food restaurants and convenience stores by the total number of grocery stores\* (including supermarkets) and produce vendors (including produce stores and farmers' markets) within a given radius around their home address (0.5 mile in urban areas, 1 mile in smaller cities and suburban areas, and 5 miles in rural areas).<sup>35,36</sup> Thus the RFEI is an indicator of the density of food outlets that are less likely to stock fresh fruits and vegetables and other healthy foods relative to those where such healthy options are more likely to be available. A higher RFEI indicates that a person lives near a larger number of fast-food restaurants and convenience stores relative to the number of grocery stores and produce vendors. For example, an individual with an RFEI of 2.0 has twice as many fast-food restaurants and convenience stores nearby compared to grocery stores and produce vendors.

To investigate the influence of community income on the relationship between the RFEI and health outcomes, this study uses data from the 2000 Census to describe community economic status. Lower-income communities are defined as census tracts in which at least 30 percent of households have incomes below 200

\*In the California Center for Public Health Advocacy 2007 study, *Searching for Healthy Food: The Food Landscape in California Cities and Counties*, this category of stores was referred to as supermarkets.

percent of the federal poverty level (FPL). At the time of the 2000 Census, 200 percent of the FPL was \$21,738 for a family of two and \$34,058 for a family of four.<sup>37,38</sup>

Ten nationally recognized experts with knowledge and experience in community nutrition, social marketing, health policy, consumer behavior, public health ethics, biostatistics, epidemiology, health disparities, neighborhood effects, and spatial analysis served as a Scientific Advisory

Panel for this study, reviewed the methodology and results and helped develop policy recommendations.

All statements in this report that compare rates for one group with another reflect statistically significant differences ( $p < 0.05$ ) unless otherwise noted.

For more information on the RFEI and the study methodology, please see [www.publichealthadvocacy.org/research](http://www.publichealthadvocacy.org/research).

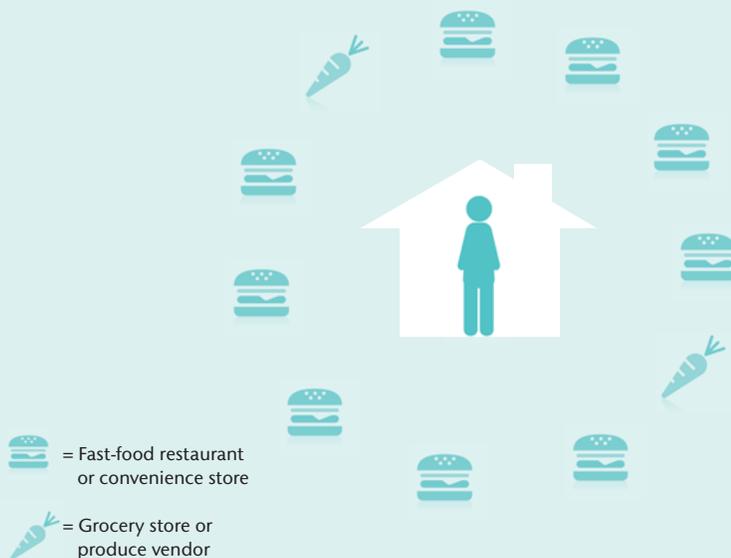
*A higher RFEI indicates that a person lives near a larger number of fast-food restaurants and convenience stores relative to the number of grocery stores and produce vendors.*

### The Retail Food Environment Index (RFEI)

The Retail Food Environment Index is constructed by dividing the total number of fast-food restaurants and convenience stores by the total number of grocery stores (including supermarkets) and produce vendors (produce stores and farmers' markets) within a radius around an individual CHIS respondent's home (0.5 mile in urban areas, 1 mile in smaller cities and suburban areas, and 5 miles in rural areas).

$$\text{RFEI} = \frac{\# \text{ Fast-Food Restaurants} + \# \text{ Convenience Stores}}{\# \text{ Grocery Stores} + \# \text{ Produce Vendors}}$$

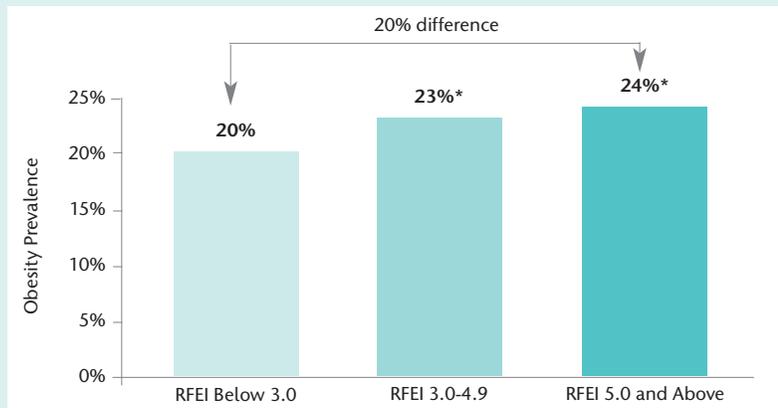
The result is the ratio of retail food outlets around an individual's home that are likely to offer little in the way of fresh fruits and vegetables or other healthy foods to those in which such products are likely to be more readily available. For example, an individual whose RFEI is 2.0 has twice as many fast-food restaurants and convenience stores nearby as grocery stores and produce vendors.



*The average local RFEI for California adults is approximately 4.5, meaning that for each grocery store or produce vendor around Californians' homes, there are more than four fast-food restaurants and convenience stores.*

FIGURE 1

### Obesity Prevalence by Retail Food Environment Index, Adults Age 18 and Over, California, 2005

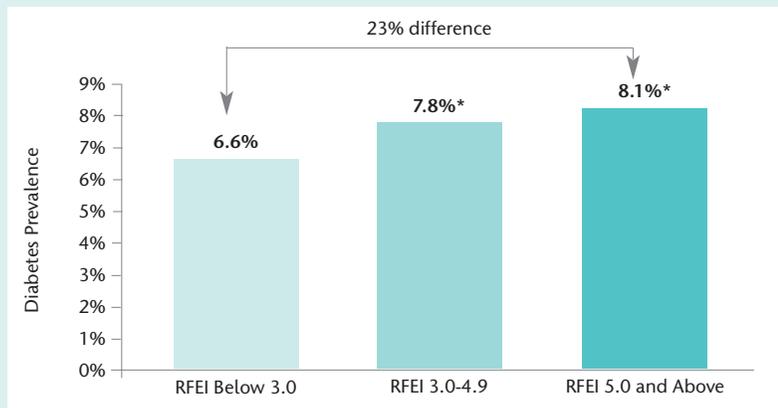


\*Significantly different from "RFEI Below 3.0";  $p < 0.05$ . RFEI was calculated using buffers of 0.5 mile for respondents in urban areas, 1 mile for respondents in smaller cities and suburban areas and 5 miles for respondents in rural areas. Obesity is defined as having a body mass index of 30.0 kg/m<sup>2</sup> or greater.

Source: 2005 California Health Interview Survey and 2005 InfoUSA Business File

FIGURE 2

### Diabetes Prevalence by Retail Food Environment Index, Adults Age 18 and Over, California, 2005



\*Significantly different from "RFEI Below 3.0";  $p < 0.05$ . RFEI was calculated using buffers of 0.5 mile for respondents in urban areas, 1 mile for respondents in smaller cities and suburban areas and 5 miles for respondents in rural areas.

Source: 2005 California Health Interview Survey and 2005 InfoUSA Business File

## FINDINGS

The average Retail Food Environment Index (RFEI) for California adults included in this study is 4.5, meaning that the average California adult has more than four times as many fast-food restaurants and convenience stores near home as they do grocery stores and produce vendors.<sup>39</sup> For 25 percent of California adults the RFEI is 5.0 and above; for 21 percent, it is between 3.0 and 4.9; and for 26 percent it is below 3.0. An additional 28 percent of California adults have no grocery stores or produce vendors within the buffer around their homes. The RFEI cannot be calculated for these individuals; therefore they were not included in the analyses for this study.

### Higher RFEIs Are Associated with Higher Prevalence of Obesity and Diabetes

#### Obesity

Obesity prevalence is highest for California adults who have the most fast-food restaurants and convenience stores near their homes relative to grocery stores and produce vendors. Nearly one in four adults with local RFEIs of 5.0 and above is obese, compared to one in five adults with local RFEIs below 3.0, representing a 20 percent difference between the lowest and highest RFEI groups presented here (Figure 1).

#### Diabetes

Similarly, California adults with the most fast-food restaurants and convenience stores near their homes relative to grocery stores and produce vendors have the highest prevalence of diabetes. Approximately 8 percent of adults with local RFEIs of 5.0 and above have been diagnosed with diabetes, compared to 6.6 percent of those with RFEIs below 3.0, representing a 23 percent difference between the lowest and highest RFEI groups presented here (Figure 2).

### Residents of Lower-Income Neighborhoods Have Higher Local RFEIs

The RFEI is related to community income. Statewide, the average RFEI is 20 percent higher for people living in lower-income communities (average RFEI of 4.9) compared to those in higher-income areas (average RFEI of 4.1) (Figure 3).

### Obesity and Diabetes Prevalence Are Highest for Adults with Higher Local RFEIs Who Live in Lower-Income Communities

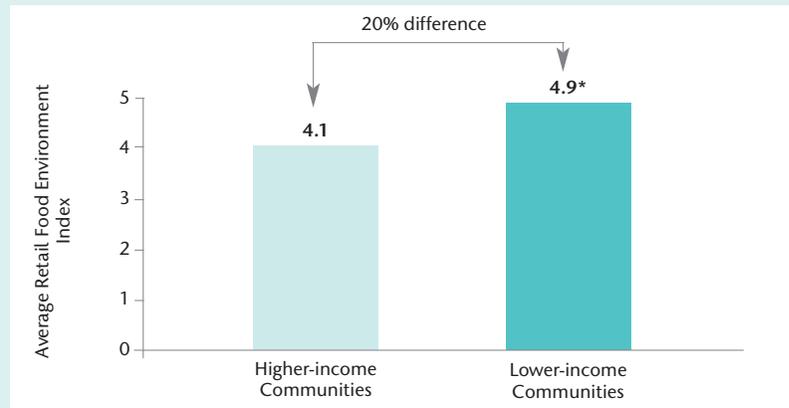
As with having higher local RFEIs, living in lower-income communities is associated with higher rates of obesity and diabetes.<sup>40</sup> However, obesity and diabetes prevalence are highest among adults who live in lower-income communities and who *also* have local RFEIs of 5.0 or greater.

#### Obesity

In lower-income communities, obesity prevalence is 17 percent higher among adults whose local RFEI is 5.0 or greater compared to those whose local RFEI is below 3.0 (28 percent vs. 24 percent) (Figure 4). Similarly, in higher-income communities, obesity prevalence is 19 percent higher among adults whose local RFEI is 5.0 or greater compared to those whose local RFEI is below 3.0 (19 percent vs. 16 percent). Although the relationship between RFEI and obesity is consistent in lower-income and higher-income communities, obesity prevalence is highest for those who live in lower-income communities *and* have RFEIs of 5.0 or greater (28 percent).

FIGURE 3

### Average Retail Food Environment Index by Community Income, Adults Age 18 and Over, California, 2005

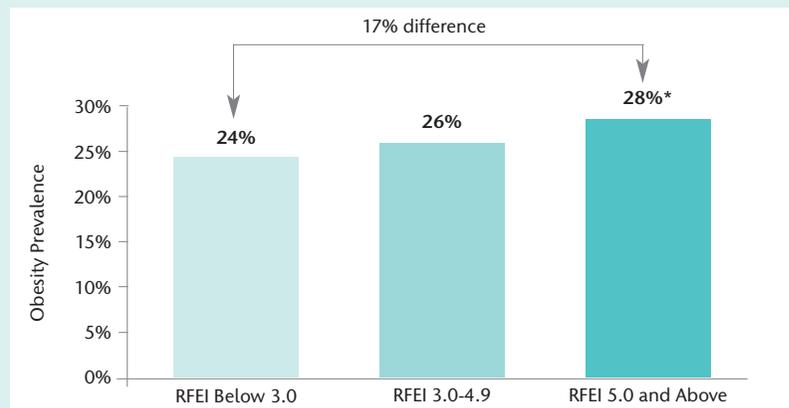


\* Significantly different from "Higher-Income Communities";  $p < 0.05$ . RFEI was calculated using buffers of 0.5 mile for respondents in urban areas, 1 mile for respondents in smaller cities and suburban areas and 5 miles for respondents in rural areas. Survey respondents were characterized as living in lower-income communities if more than 30% of households in their census tract had incomes below 200% of the federal poverty level.

Source: 2005 California Health Interview Survey, 2000 Census, and 2005 InfoUSA Business File

FIGURE 4

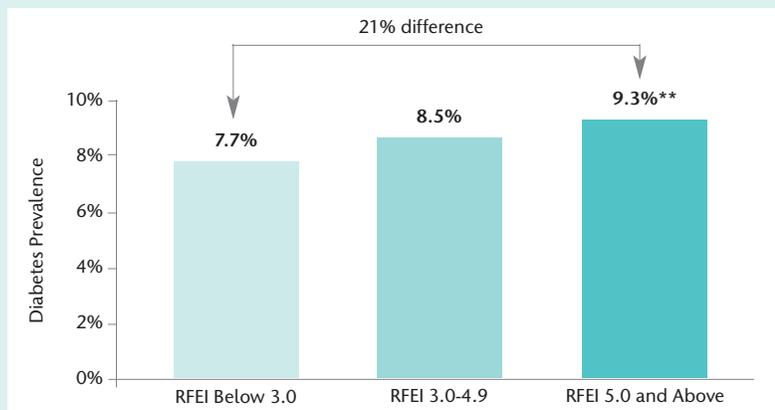
### Obesity Prevalence by Retail Food Environment Index, Adults Age 18 and Over Living in Lower-Income Communities, California, 2005



\* Significantly different from "RFEI Below 3.0";  $p < 0.05$ . RFEI was calculated using buffers of 0.5 mile for respondents in urban areas, 1 mile for respondents in smaller cities and suburban areas and 5 miles for respondents in rural areas. Obesity is defined as having a body mass index of  $30.0 \text{ kg/m}^2$  or greater. Survey respondents were characterized as living in lower-income communities if more than 30% of households in their census tract had incomes below 200% of the federal poverty level.

Source: 2005 California Health Interview Survey, 2000 Census, and 2005 InfoUSA Business File

FIGURE 5

**Diabetes Prevalence by Retail Food Environment Index, Adults Age 18 and Over Living in Lower-Income Communities, California, 2005**

\*\* Significantly different from “RFEI Below 3.0”;  $p < 0.10$ . RFEI was calculated using buffers of 0.5 mile for respondents in urban areas, 1 mile for respondents in smaller cities and suburban areas and 5 miles for respondents in rural areas. Survey respondents were characterized as living in lower-income communities if more than 30% of households in their census tract had incomes below 200% of the federal poverty level.

Source: 2005 California Health Interview Survey, 2000 Census, and 2005 InfoUSA Business File

*Even after accounting for individual characteristics and community income, adults with a higher Retail Food Environment Index (RFEI) are more likely to be obese and to have diabetes than those with lower local RFEIs.*

**Diabetes**

As with obesity, higher local RFEIs are associated with higher diabetes prevalence in both higher-income and lower-income communities; however, diabetes prevalence is highest among adults who live in lower-income communities and also have the highest RFEIs.

In lower-income communities, diabetes prevalence is 21 percent higher among adults with a local RFEI of 5.0 and above compared to those with a local RFEI below 3.0 (9.3 percent vs. 7.7 percent;  $p < 0.10$ ) (Figure 5). Similarly, in higher-income communities, diabetes prevalence is higher among individuals with RFEIs above 5.0 compared to those with RFEIs below 3.0 (6.8 percent vs. 5.8 percent), although this difference is not statistically significant.

Again, although the association between RFEI and diabetes is consistent for Californians living in lower-income and higher-income communities, diabetes prevalence is highest among those who live in lower-income communities and have RFEIs of 5.0 or greater (9.3 percent).

**The Association Between RFEI and Health Outcomes Remains Even After Controlling for Individual Characteristics and Community Income**

People of color and lower-income individuals have higher local RFEIs. A greater proportion of African Americans (30 percent), Latinos (29 percent), and people of mixed race/ethnicity (31 percent) have RFEIs of 5.0 or greater compared to Caucasians (23 percent). In addition, a greater proportion (30 percent) of adults from lower-income households have RFEIs of 5.0 or greater compared with those from higher-income households (23 percent). However, the Retail Food Environment Index remains associated with both obesity and diabetes after accounting for these individual characteristics (race/ethnicity and household income) as well as for age, gender, physical activity, and community income. After controlling for these factors, adults with local RFEIs of 5.0 and above are 18 percent more likely to be obese and 24 percent more likely to have been diagnosed with diabetes than adults with local RFEIs below 3.0.

**CONCLUSIONS**

This study demonstrates a link between the retail food environment and the prevalence of obesity and diabetes in California adults. Even after accounting for individual characteristics and community income, adults with a higher Retail Food Environment Index (RFEI)—that is, with greater availability of fast-food restaurants and convenience stores relative to grocery stores and produce vendors near their homes—are more likely to be obese and to have diabetes than those with lower local RFEIs.

The highest prevalence of both obesity and diabetes is among adults who have higher local RFEIs and live in lower-income communities. However, for people living in lower-income and higher-income communities alike, the higher the ratio of fast-food restaurants and convenience stores to grocery stores and produce vendors near home, the greater the prevalence of obesity and diabetes.

These findings suggest that improving the retail food environment—in both lower- and higher-income California communities—may be a promising strategy for decreasing the prevalence of obesity and diabetes in California adults.

## POLICY RECOMMENDATIONS

To date, many efforts to reduce obesity and diabetes have focused on encouraging individuals to change their eating habits. However, given the association shown in this study between the retail food environment and health outcomes, additional measures should be aimed at improving the retail food environment to support individuals in making such changes.

Although healthy eating habits are ultimately a matter of individual choice, local food environments influence those choices. It is difficult to follow recommended dietary guidelines in a food environment characterized by an abundance of fast-food restaurants and few grocery stores—a situation faced by many Californians, particularly those in lower-income communities. Reversing obesity and diabetes trends in California requires a range of interventions, including a systematic approach to improving local food environments.

Environmental and policy interventions can improve conditions for large numbers of people. Directing resources toward communities most in need, such as lower-income communities, can maximize the impact of such interventions.

Food environments can be made healthier by increasing the availability of grocery stores and produce vendors relative to fast-food restaurants and convenience stores, by improving the availability of healthy foods relative to unhealthy foods in existing retail outlets, and by increasing consumer awareness of the nutritional content of restaurant food. Based on the findings presented in this brief, insights gained from the national Scientific Advisory Panel convened for this study, and existing policy initiatives in other parts of the country,<sup>41</sup> policymakers are urged to consider the following strategies for improving local food environments:

- **Increase access to healthy foods by providing incentives for retail store development and improvement.** Because grocery chains have historically been less likely to locate in lower-income communities and communities of color,<sup>42</sup> new policies and market-based incentives are needed to reverse these trends. New funding could be used to stimulate development of retail projects by offering technical assistance and financing options, such as

low-interest loans or seed grants for the purchase of refrigeration equipment and other supplies necessary to store and preserve fresh fruits and vegetables.

- **Promote retail innovations, including smaller-scale markets selling healthy foods.** Attention should be given to smaller-scale community innovations, such as mobile vendors, vending machines, farmers' markets, co-operatives, community-supported agriculture, and improved transportation to existing retailers. For example, farmers' markets and mobile vendors typically need less time to transition from vision to operation and can produce added benefits by supporting local farmers.
- **Maximize the opportunities presented by the changes in the WIC food package.** The inclusion of fresh fruits and vegetables, whole grains, and low-fat dairy products in the updated WIC food package is expected to increase demand for these healthy foods. Policymakers should adopt measures to ensure that the expanded food package is accessible in lower-income communities by building the capacities of existing WIC-authorized stores, expanding the number of authorized WIC vendors, and facilitating grocery store expansion.
- **Implement zoning designed to limit fast-food restaurants in overburdened communities.** The health implications of fast-food restaurants should be considered in the community planning and development permitting process. Local governments should strive to achieve a balance of retailers that supports community health.
- **Require menu labeling.** Restaurants should be required to provide consumers with nutritional information on in-store menus and menu boards for all standard menu items. Given the proliferation of fast-food restaurants and the high fat and calorie content of many items on their menus, prominent posting of the nutrient content of items for sale can help consumers make healthier choices.

*Although healthy eating habits are ultimately a matter of individual choice, local food environments influence those choices.*

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35. Fast-food restaurants were defined following the National Restaurant Association's distinction between "table service" and "quick service (fast-food)" restaurants. In addition to counter service, fast-food restaurants are characterized by meal service (vs. snacks, dessert, coffee) and lower price (less than \$7/meal). We began with businesses with a North American Industry Classification System (NAICS) code for restaurants (72211002, 72211011, 72211012, 72211013, 72211016, 72211020, 72221101, 72221103, 72221104, and 72221105). From these businesses, we selected restaurants with five or more locations with the same name and that provided counter-service meals. Major fast-food chains were included (e.g., McDonald's, Taco Bell, Carl's Jr.), as were smaller, regional, or locally owned chains. Convenience stores were defined as businesses with NAICS code 44512001 that do not sell gasoline or other fuel. This list includes primarily 7-Elevens and other chains. In order to include smaller chains and family-owned convenience stores, we included businesses with NAICS codes for supermarkets and grocery stores (44511001, 44511002, 44511003, 44511004, and 44511005) that had two or fewer employees. Supermarkets and grocery stores (referred to collectively as grocery stores in this study) were identified based on a modification of the Food Marketing Institute (FMI) definition of a supermarket. FMI defines supermarkets and grocery stores as businesses that earn annual revenues of \$2 million or more each year; however, in this study, we defined supermarkets and grocery stores as those that earn annual revenues of \$1 million. We made this modification to include smaller markets that sometimes play an important role in urban communities. Members of a chain (either a national chain, such as Safeway, Albertsons, Trader Joe's, or a regional chain, such as La Superior, Nugget, Henry's, and Ranch 99) or stores with the word "supermarket" in the business name were included. NAICS codes included 44511001, 44511002, 44511003, 44511004, and 44511005. Produce vendors were defined as produce stores and farmers' markets. Produce stores included all businesses with NAICS codes 44523001 and 44523003. Farmers' markets included all certified farmers' markets listed on the website of the California Federation of Certified Farmers' Markets ([www.cafarmersmarkets.com](http://www.cafarmersmarkets.com)). We adjusted the number of farmers' markets to include only markets in unique places. For example, the Davis Farmers' Market is held both Wednesdays and Saturdays; we included only a single location record for this market. This information was then geocoded in ArcGIS 9. Actual physical locations (which were provided in downloadable files from the website) were used instead of mailing addresses.
36. Claritas, a marketing information resources company, assigns ZIP codes to urbanization categories based on the analysis of population density grids of 1990 geoboundaries, 2000 redistricting updates, and 2001 population estimates. The following four classes were identified: 1) Urban areas have population density scores mostly between 85 and 99. They include both the downtowns of major cities and surrounding neighborhoods. Households within this classification live within the classic high-density neighborhoods found in the heart of America's largest cities. While almost always anchored by the downtown central business district, these areas often extend beyond city limits and into surrounding jurisdictions to encompass most of America's earliest suburban expansions. 2) Smaller cities are less densely populated than urban areas, with population density scores typically between 40 and 85, and are the population centers of their surrounding communities. This category also includes thousands of satellite cities—higher-density suburbs encircling major metropolitan centers. 3) Suburbs have population density scores between 40 and 90. Unlike smaller cities, they are not the population center of their surrounding community, but rather a continuation of the density decline moving out from the city center. 4) Rural areas, collapsed into a single urbanization category, have population density scores under 40. This category includes exurbs, towns, farming communities, and other sparsely populated portions of the state.
37. Bishaw A, Iceland J. *Poverty: 1999*. U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau; 2003.
38. Analysts have used cutoffs of 20, 30, and 40 percent to determine whether or not a given neighborhood is low-income. See Jargowsky PA. *Stunning progress, hidden problems: The dramatic decline of concentrated poverty in the 1990s*. The Brookings Institution Center on Urban and Metropolitan Policy, 2003; Kingsley GT, Pettit KLS. *Concentrated poverty: A change in course*. Urban Institute, 2003; and Bishaw A. *Areas with concentrated poverty: 1999*. U.S. Census Bureau, 2005.
39. In its 2007 study, CCPHA reported a statewide RFEI of 4.18, calculated by dividing the total number of fast-food restaurants and convenience stores in California by the total number of grocery stores and produce vendors in California. In the current study, the average RFEI of 4.48 was calculated by taking an average of all RFEIs for CHIS respondents for whom an RFEI could be calculated, based on the number of fast-food restaurants, convenience stores, grocery stores, and produce vendors within the appropriate buffer around their home addresses.
40. Obesity prevalence is 25 percent among adults living in lower-income communities compared to 18 percent among adults in higher-income communities. Diabetes prevalence is 8.4 percent among adults living in lower-income communities compared to 5.8 percent among adults in higher-income communities. Source: 2005 California Health Interview Survey and 2000 Census.
41. Examples include menu labeling legislation passed in New York City and under consideration in a number of additional cities and states nationwide, and The Food Trust's Supermarket Campaign, which seeks to improve access to supermarkets in underserved communities through leveraging economic development resources, active public/private partnerships, research, and policy advocacy to address the negative impacts related to the lack of food retail choices in communities across the country. More information about the Supermarket Campaign can be found at [www.thefoodtrust.org/php/programs/super.market.campaign.php](http://www.thefoodtrust.org/php/programs/super.market.campaign.php). Retrieved March 27, 2008.
42. *Healthy food, healthy communities: Improving access and opportunities through food retailing*. PolicyLink; 2005.

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**California Center for Public Health Advocacy** is an independent, nonpartisan, non-profit organization that raises awareness about public health issues and mobilizes communities to promote the establishment of effective health policies.

**PolicyLink** is a national research and action institute advancing economic and social equity. The PolicyLink Center for Health and Place conducts research, builds the capacity of local leaders, and develops policy alternatives to eliminate disparities and promote healthy communities.

**UCLA Center for Health Policy Research** serves to improve the public's health by advancing health policy through research, public service, community partnership, and education. Established in 1994, the UCLA Center for Health Policy Research is based in the School of Public Health and affiliated with the School of Public Affairs.

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### Detailed Methodology

#### INTRODUCTION

This study analyzed data from the 2005 California Health Interview Survey, the 2005 InfoUSA Business File, and the 2000 US Census. Geographic Information System (GIS) software was used to examine the association of the retail food environment with obesity and diabetes in California, with consideration for the effect of community income on that relationship. This document describes the data sources used, refinements to those data sources, the mapping of the retail food outlets, and the construction of a local Retail Food Environment Index (RFEI), which describes the relative density of different types of retail food outlets around individuals' homes.

#### DATA SOURCES

**Individual health outcomes and demographics.** Individual-level data were drawn from the 2005 California Health Interview Survey (CHIS 2005). CHIS is a biennial, random-digit-dial (RDD) telephone survey that collects information from a representative sample of California's non-institutionalized population. Survey topics include individual health behaviors, health outcomes, and socio-demographic characteristics. CHIS 2005 completed interviews with more than 43,000 adults drawn from every county in the state, in English, Spanish, Chinese (both Mandarin and Cantonese), Vietnamese, and Korean. CHIS 2005 includes geocoded home addresses for approximately 90 percent of the adult sample. The CHIS sample represents the geographic diversity of California, and the available multi-language interviews accommodate the state's rich ethnic diversity. CHIS is a collaborative project of the UCLA Center for Health Policy Research, the California Department of Health Services, and the Public Health Institute. The survey has been conducted every two years since 2001. For more information about CHIS, please visit [www.chis.ucla.edu](http://www.chis.ucla.edu). The following health outcomes were analyzed in this study:

- **Obesity.** Obesity was defined as having a Body Mass Index ( $\text{kg}/\text{m}^2$ ) of 30 or greater. Body mass index (BMI) was calculated based on CHIS 2005 respondents' self-reported height and weight values. Obesity, rather than overweight, was studied because it is an established risk factor for chronic illness and mortality. Although BMI calculated from self-reported height and weight is highly correlated with measured BMI, self-reporting may underestimate the actual prevalence of obesity due to social desirability bias.

- **Diabetes.** Estimates of diabetes were based on responses to the question, "Other than during pregnancy, has a doctor ever told you that you have diabetes or sugar diabetes?" Diabetes rates may be underestimated or underreported in underserved populations that do not have adequate access to healthcare and in whom the disease has therefore not been diagnosed.

**Food retailers.** The InfoUSA Business File was purchased from ESRI (Redlands, CA), a private vendor, in the spring of 2005. It included more than 88,000 food retailers in California. Since other commonly used food retail data sources, such as phonebooks, are known to be flawed, a data-cleaning process was employed to minimize error in the ESRI dataset. For a description of the quality-control process, see "Detailed Methodology" for the brief, *Searching for Healthy Food: The Food Landscape in California Cities and Counties* (<http://www.publichealthadvocacy.org/RFEI/expanded%20methods.pdf>). From this dataset, the following four types of food retailers were selected for inclusion in this study:

- **Fast-food restaurants.** Fast-food restaurants were defined following the National Restaurant Association's distinction between "table service" and "quick service (fast-food)" restaurants. In addition to counter service, fast-food outlets are characterized by meal service (vs. snacks, dessert, coffee) and lower price (less than \$7/meal). We began with businesses with a North American Industry Classification System (NAICS) code for restaurants (72211002, 72211011, 72211012, 72211013, 72211016, 72211020, 72221101, 72221103, 72221104, and 72221105). From these businesses, we selected restaurants with five or more locations with the same name and that provided counter-service meals. Major fast-food chains were included (e.g., McDonald's, Taco Bell, Carl's Jr.), as were smaller, regional, or locally-owned chains.

- **Convenience stores.** Convenience stores were defined as businesses with NAICS code 44512001 that do not sell gasoline or other fuel. This list includes primarily 7-Elevens and other chains. In order to include smaller chains and family-owned convenience stores, we included businesses with NAICS codes for supermarkets and grocery stores that had two or fewer employees (44511001, 44511002, 44511003, 44511004, and 44511005).



• **Grocery stores.** Supermarkets and grocery stores (referred to collectively as grocery stores in this study) were identified based on a modification of the Food Marketing Institute (FMI) definition of a supermarket. FMI defines supermarkets and grocery stores as businesses that earn annual revenues of \$2 million or more each year; however, in this study, we defined supermarkets and grocery stores as those that earn annual revenues of at least \$1 million. We made this modification to include smaller markets that sometimes play an important role in communities. Members of a chain (either a national chain, such as Safeway, Albertsons, Trader Joe's, or a regional chain, such as La Superior, Nugget, Henry's, and Ranch 99) or stores with the word "supermarket" in the business name were included. NAICS codes included 44511001, 44511002, 44511003, 44511004, and 44511005.

• **Produce vendors.** Produce vendors were defined as produce stores and farmers' markets. Produce stores included all businesses with NAICS codes 44523001 and 44523003. Farmers' markets included all certified farmers' markets listed on the website of the California Federation of Certified Farmers' Markets ([www.cafarmersmarkets.com](http://www.cafarmersmarkets.com)). We adjusted the number of farmers' markets to include only markets in unique places. For example, the Davis Farmers' Market is held both Wednesdays and Saturdays; we included only a single location record for this market. Actual physical locations (which were provided in downloadable files from the website) were used instead of mailing addresses.

**Community Income.** Community income data were taken from the 2000 US Census. Lower-income communities were defined as census tracts in which at least 30 percent of households have incomes below 200 percent of the federal poverty level (FPL).<sup>1</sup> At the time of the 2000 Census, 200 percent FPL was \$21,738 for a family of two and \$34,058 for a family of four.<sup>2,3</sup> Using these definitions, approximately 46 percent of our sample lived in lower-income communities.<sup>4</sup>

#### DATA ANALYSIS

This study used Geographic Information System (GIS) software to examine the distribution of retail food outlets in California communities relative to the geocoded home addresses of CHIS respondents. Census tracts were used as proxies for neighborhoods in order to identify lower- and higher-income communities.

#### **Construction of the Retail Food Environment Index (RFEI).**

The local food environment of individual CHIS respondents was characterized by the relative availability of fast-food restaurants and convenience stores compared to grocery stores and produce vendors around respondents' home addresses. The size of the local food environment (i.e. the buffer, or radius, used to draw a circle around an individual's home) varied by the type of community in which the respondent lived. Different community types were identified using an

urbanicity variable provided by Claritas Inc., a marketing research firm that assigns zip codes to one of four categories based on population density and location relative to a Census-designated population center.<sup>5</sup> The four categories include: urban, smaller city, suburban, and rural/small town. Smaller city (small or "second" cities that are population centers) and suburban (adjacent to major metropolitan areas) zip codes both have moderate population densities, while urban density is high and rural/small town density is low. Our urbanicity-specific buffers (0.5 mile in urban areas, 1 mile in smaller cities and suburban areas, and 5 miles in rural areas) were selected based on sample size, food retail density, transportation expectancies, and conventional trade area size for food retailers.<sup>6</sup>

The number of each type of food retailer within the urbanicity-specific buffer around the home address of each CHIS respondent was used to calculate the Retail Food Environment Index (RFEI). The numerator of the RFEI comprised the sum of the number of convenience stores and fast-food restaurants, while the denominator comprised the sum of the number of grocery stores and produce vendors. A higher RFEI indicates that a respondent lives near a larger number of fast-food restaurants and convenience stores relative to the number of grocery stores and produce vendors. For example, an individual with an RFEI of 2.0 has twice as many fast-food restaurants and convenience stores as grocery stores and produce vendors nearby.

Twenty-eight percent of California adults do not have any grocery stores or produce vendors within the specified buffers around their homes; therefore, the RFEI could not be calculated for these individuals. This population includes two subgroups: 18 percent who only have fast-food restaurants and convenience stores near home (but no grocery stores or produce vendors), and 10 percent who have none of the food outlets examined in this study near their homes. Individuals with no grocery stores near home are demographically heterogeneous, including affluent individuals who may have chosen to live farther away from commercial areas as well as lower-income individuals living in places with limited food options. Therefore, it is difficult to draw conclusions about the association between the retail food environment and health outcomes for these groups.

Construction of the RFEI assumes that fast-food restaurants and convenience stores are less likely to stock fresh fruits and vegetables and other healthy foods while grocery stores and produce vendors provide more healthy food options. The RFEI was used to assess the relative availability of different types of food retailers, as the absolute numbers of fast-food restaurants or grocery stores taken alone may describe local food environments less fully. While other studies have targeted "food deserts" (areas where there is no food access at all), this investigation was focused primarily on the implications of the balance of retailers in one's local food environment.

The exclusion of convenience stores associated with gas stations from the analyses leads our study to undercount the total number of convenience stores around respondents' homes. This will tend to bias the numerator of the RFEI downward. The use of an annual sales cutoff of \$1 million to define grocery stores rather than the industry standard of \$2 million leads our count of grocery stores to include small neighborhood stores as well as larger supermarkets. This will tend to bias the denominator of the RFEI upward. These two points, taken together, lead to a downward bias in our RFEI estimate for California adults.

**Statistical analyses.** We used descriptive and inferential statistics to analyze the relationships between the local food environment, community income, and individual health outcomes. Frequency tables were used to determine the prevalence of obesity and diabetes, and chi-square tests were used to detect significant differences. The average RFEI was also calculated for lower-income and higher-income communities, and two-tailed *t*-tests were used

to detect significant differences. To examine the association of the RFEI with the prevalence of obesity and diabetes while adjusting for other factors, weighted logistic regression models were conducted using SAS and SUDAAN to account for the survey design of CHIS 2005.

To examine mean RFEIs at the county level, individual's RFEIs were averaged for residents of California counties with populations over 250,000. These counties represent over 90% of the state's population. These average RFEIs characterize the food environment for a typical adult in each of these counties. Corresponding data on obesity prevalence and age-adjusted diabetes prevalence for each of these counties was obtained from CHIS 2005.

All findings in the policy brief that are based on comparisons between groups or express probability are statistically significant ( $p < 0.05$ ) except where otherwise noted. The cross-sectional nature of these data precludes conclusions regarding causality.

## Notes

1. 200 percent FPL was used instead of 100 percent to account for the higher cost of living in California.
2. <http://www.census.gov/prod/2003pubs/c2kbr-19.pdf>
3. Analysts have used cutoffs of 20, 30, and 40 percent to determine whether or not a given neighborhood is low-income. See Paul Jargowsky, *Stunning Progress, Hidden Problems: The Dramatic Decline of Concentrated Poverty in the 1990s* (Washington, D.C.: The Brookings Institution, 2003); Tom Kingsley et al., *Concentrated Poverty: A Change in Course* (Washington, D.C.: The Urban Institute, 2003); Alemayehu Bishaw, *Areas With Concentrated Poverty: 1999* (Washington, D.C.: US Census, 2005; available at <http://www.census.gov/prod/2005pubs/censr-16.pdf>).
4. 2000 Census and 2005 California Health Interview Survey.
5. Claritas assigns zip codes to urbanization categories based on the analysis of population density grids of 1990 geoboundaries, 2000 redistricting updates, and 2001 population estimates. The following four classes were identified: 1) Urban areas have population density scores mostly between 85 and 99. They include both the downtowns of major cities and surrounding neighborhoods. Households within this classification live within the classic high-density neighborhoods found in the heart of America's largest cities. While almost always anchored by the downtown central business district, these areas often extend beyond city limits and into surrounding jurisdictions to encompass most of America's earliest suburban expansions. 2) Smaller cities are less densely populated than urban areas, with population density scores typically between 40 and 85, and are the population centers of their surrounding communities. This category also includes thousands of satellite cities—higher density suburbs encircling major metropolitan centers. 3) Suburbs have population density scores between 40 and 90. Unlike smaller cities, they are not the population center of their surrounding community, but rather a continuation of the density decline moving out from the city center. 4) Rural areas, collapsed into a single urbanization category, have population density scores under 40. This category includes exurbs, towns, farming communities and other sparsely populated portions of the state.
6. Two miles is the conventional trade area for most large grocery stores (>50,000 ft<sup>2</sup>); e.g. suburban residents travel an average of 1.1 miles to go grocery shopping (this may not necessarily be the distance between their home and the closest store, as some are willing to travel farther if they have access to convenient transport options). See Susan L. Handy and Kelly J. Clifton. Local shopping as a strategy for reducing automobile travel. *Transportation*. 2001;28:317–346.

While not included in the policy brief, *Designed for Disease*, findings for California's largest counties are described here to help provide a local context for the study.

### Average RFEI, and Obesity and Diabetes Prevalence for CHIS Respondents in Most Populated Counties<sup>1</sup>

County	Population	RFEI <sup>2</sup>	Obesity Prevalence <sup>3</sup> (%)	Diabetes Prevalence <sup>4</sup> (%)
San Bernardino	1,950,806	5.60	27.2	7.7
Stanislaus	505,352	5.48	31.5	9.8
Kern	757,882	5.23	28.2	10.2
Solano	420,307	5.11	23.9	8.1
Fresno	883,650	5.01	23.0	8.4
Orange	3,047,054	4.99	17.3	5.8
Tulare	411,701	4.85	29.4	10.1
Los Angeles	10,166,417	4.85	20.7	7.2
San Diego	3,039,277	4.76	18.4	5.7
Contra Costa	1,019,101	4.67	24.9	5.1
Sacramento	1,366,937	4.56	21.8	5.8
San Joaquin	655,319	4.53	28.8	9.1
San Francisco	792,952	4.47	14.8	5.7
Ventura	810,763	4.42	19.5	6.3
Alameda	1,500,228	4.24	16.5	6.5
Riverside	1,888,311	4.23	25.5	7.5
Placer	308,431	4.16	18.7	4.1
Santa Barbara	417,988	3.90	22.2	8.0
Santa Clara	1,752,653	3.54	18.2	7.8
Sonoma	477,697	3.29	24.2	4.7
San Luis Obispo	261,310	2.85	17.2	4.2
San Mateo	719,655	2.80	17.1	5.5
Santa Cruz	260,339	2.24	12.1	3.4
Marin	251,820	2.06	11.4	3.0
California	33,665,950	4.48	21.2	6.8

Orange represents counties with an RFEI above 5

Green represents counties with an RFEI below 3

1. The California Health Interview Survey (CHIS) is a telephone survey of adults from all parts of California. CHIS 2005 completed interviews with over 43,000 adults from every county in the state. This chart provides data for counties with populations over 250,000 which represent over 90 percent of the state's population.
2. Average RFEI was calculated based on data from the 2005 California Health Interview Survey and 2005 InfoUSA Business File. The RFEI was calculated for each adult CHIS respondent by dividing the total number of fast-food restaurants and convenience stores by the total number of grocery stores and produce vendors within a given radius (a half-mile in urban areas, one mile in smaller cities and suburban areas and five miles in rural areas) around the respondent's home address. These RFEIs were then averaged for each county presented here. This methodology differs from that used in the 2007 study conducted by the California Center for Public Health Advocacy because that study calculated the RFEI ratio by including all fast-food restaurants, convenience stores, grocery stores and produce vendors in the entire county (rather than only those around CHIS respondents' homes).
3. 2005 California Health Interview Survey
4. Diamant AL, Babey SH, Hastert TA and Brown ER. *Diabetes: The Growing Epidemic*. Los Angeles: UCLA Center for Health Policy Research, 2007. Diabetes prevalence is age-adjusted.

*Designed for Disease: The Link Between Local Food Environments and Obesity and Diabetes* is available at [www.publichealthadvocacy.org/designedfordisease.html](http://www.publichealthadvocacy.org/designedfordisease.html). The project was undertaken by CCPHA, PolicyLink and the UCLA Center for Health Policy Research. PolicyLink and CCPHA's work on the project was supported by a grant from the California Vitamin Cases Consumer Settlement Fund and the UCLA Center for Health Policy Research's work was supported by a grant from The California Endowment.

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While not included in the policy brief, *Designed for Disease*, findings for California's largest counties are described here to help provide a local context for the study.

### Obesity and Diabetes Prevalence for CHIS Respondents in Most Populated Counties<sup>1</sup>

County	RFEI <sup>2</sup>	Ranked by Obesity Prevalence <sup>3</sup> (%)
Stanislaus	5.48	31.5
Tulare	4.85	29.4
San Joaquin	4.53	28.8
Kern	5.23	28.2
San Bernardino	5.60	27.2
Riverside	4.23	25.5
Contra Costa	4.67	24.9
Sonoma	3.29	24.2
Solano	5.11	23.9
Fresno	5.01	23.0
Santa Barbara	3.90	22.2
Sacramento	4.56	21.8
Los Angeles	4.85	20.7
Ventura	4.42	19.5
Placer	4.16	18.7
San Diego	4.76	18.4
Santa Clara	3.54	18.2
Orange	4.99	17.3
San Luis Obispo	2.85	17.2
San Mateo	2.80	17.1
Alameda	4.24	16.5
San Francisco	4.47	14.8
Santa Cruz	2.24	12.1
Marin	2.06	11.4
California	4.48	21.2

County	RFEI <sup>2</sup>	Ranked by Diabetes Prevalence <sup>4</sup> (%)
Kern	5.23	10.2
Tulare	4.85	10.1
Stanislaus	5.48	9.8
San Joaquin	4.53	9.1
Fresno	5.01	8.4
Solano	5.11	8.1
Santa Barbara	3.90	8.0
Santa Clara	3.54	7.8
San Bernardino	5.60	7.7
Riverside	4.23	7.5
Los Angeles	4.85	7.2
Alameda	4.24	6.5
Ventura	4.42	6.3
Sacramento	4.56	5.8
Orange	4.99	5.8
San Francisco	4.47	5.7
San Diego	4.76	5.7
San Mateo	2.80	5.5
Contra Costa	4.67	5.1
Sonoma	3.29	4.7
San Luis Obispo	2.85	4.2
Placer	4.16	4.1
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2. Average RFEI was calculated based on data from the 2005 California Health Interview Survey and 2005 InfoUSA Business File. The RFEI was calculated for each adult CHIS respondent by dividing the total number of fast-food restaurants and convenience stores by the total number of grocery stores and produce vendors within a given radius (a half-mile in urban areas, one mile in smaller cities and suburban areas and five miles in rural areas) around the respondent's home address. These RFEIs were then averaged for each county presented here. This methodology differs from that used in the 2007 study conducted by the California Center for Public Health Advocacy because that study calculated the RFEI ratio by including all fast-food restaurants, convenience stores, grocery stores and produce vendors in the entire county (rather than only those around CHIS respondents' homes).
3. 2005 California Health Interview Survey
4. Diamant AL, Babey SH, Hastert TA and Brown ER. *Diabetes: The Growing Epidemic*. Los Angeles: UCLA Center for Health Policy Research, 2007. Diabetes prevalence is age-adjusted.

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# Designed for Disease

## The Link Between Local Food Environments and Obesity and Diabetes

### Policy Recommendations

To date, many efforts to reduce obesity and diabetes have focused on encouraging individuals to change their eating habits. However, given the association shown in this study between the retail food environment and health outcomes, additional measures should be aimed at improving the retail food environment to support individuals in making such changes.

Although healthy eating habits are ultimately a matter of individual choice, local food environments influence those choices. It is difficult to follow recommended dietary guidelines in a food environment characterized by an abundance of fast-food restaurants and few grocery stores—a situation faced by many Californians, particularly those in lower-income communities. Reversing obesity and diabetes trends in California requires a range of interventions, including a systematic approach to improving local food environments.

Environmental and policy interventions can improve conditions for large numbers of people. Directing resources toward communities most in need, such as lower-income communities, can maximize the impact of such interventions.

Food environments can be made healthier by increasing the availability of grocery stores and produce vendors relative to fast-food restaurants and convenience stores, by improving the availability of healthy foods relative to unhealthy foods in existing retail outlets, and by increasing consumer awareness of the nutritional content of restaurant food. Based on the findings presented in this brief, insights gained from the national Scientific Advisory Panel convened for this study, and existing policy initiatives in other parts of the country,<sup>41</sup> policymakers are urged to consider the following strategies for improving local food environments:

**Increase access to healthy foods by providing incentives for retail store development and improvement.** Because grocery chains have historically been less likely to locate in lower-income communities and communities of color,<sup>42</sup> new policies and market-based incentives are needed to reverse these trends. New funding could be used to stimulate development of retail projects by offering technical assistance and financing options, such as low-interest loans or seed grants for the purchase of refrigeration equipment and other supplies necessary to store and preserve fresh fruits and vegetables.

**Promote retail innovations, including smaller-scale markets selling healthy foods.** Attention should be given to smaller-scale community innovations, such as mobile vendors, vending machines, farmers' markets, cooperatives, community-supported agriculture, and improved transportation to existing retailers. For example, farmers' markets and mobile vendors typically need less time to transition from vision to operation and can produce added benefits by supporting local farmers.

**Maximize the opportunities presented by the changes in the WIC food package.** The inclusion of fresh fruits and vegetables, whole grains, and low-fat dairy products in the updated WIC food package is expected to increase demand for these healthy foods. Policymakers should adopt measures to ensure that the expanded food package is accessible in lower-income communities by building capacities of existing WIC-authorized stores, expanding the number of authorized WIC vendors, and facilitating grocery store expansion.

**Implement zoning designed to limit fast-food restaurants in overburdened communities.** The health implications of fast-food restaurants should be considered in the community planning and development permitting process. Local governments should strive to achieve a balance of retailers that supports community health.

**Require menu labeling.** Restaurants should be required to provide consumers with nutritional information on in-store menus and menu boards for all standard menu items. Given the proliferation of fast-food restaurants and the high fat and calorie content of many items on their menus, prominent posting of the nutrient content of items for sale can help consumers make healthier choices.

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41. Examples include menu labeling legislation passed in New York City and under consideration in a number of additional cities and states nationwide, and The Food Trust's Supermarket Campaign, which seeks to improve access to supermarkets in underserved communities through leveraging economic development resources, active public/private partnerships, research, and policy advocacy to address the negative impacts related to the lack of food retail choices in communities across the country. More information about the Supermarket Campaign can be found at [www.thefoodtrust.org/php/programs/super.market.campaign.php](http://www.thefoodtrust.org/php/programs/super.market.campaign.php). Retrieved March 27, 2008.

42. Healthy food, healthy communities: Improving access and opportunities through food retailing. PolicyLink; 2005.

