

NUTRITION TRANSITION IN CALIFORNIA: EXAMINATION OF THE NUTRITION  
PROFILE

---

By

Desiree Rodriguez

Advised by

Dawn Neill, MS, PhD

ANT 461, 462

Senior Project

Social Sciences Department

College of Liberal Arts

CALIFORNIA POLYTECHNIC STATE UNIVERSITY

June 2014

## Table of Contents

Research Proposal.....	2
Annotated Bibliography.....	3
Outline .....	8
Introduction.....	9
Background.....	12
<i>Nutrition Transition</i> .....	12
<i>United States and Degenerative Disease (Pattern Four)</i> .....	12
<i>Focus on Nutrition Profile</i> .....	13
<i>Geographic Study Area</i> .....	15
<i>Local and Regional Policy Implications</i> .....	15
Methods .....	17
<i>Transition Indicators</i> .....	17
<i>Data Sources</i> .....	17
<i>Spatial Analysis</i> .....	18
<i>Statistical Analysis</i> .....	18
Results.....	19
<i>Diet</i> .....	19
<i>Nutritional Status</i> .....	20
<i>Obesity</i> .....	20
<i>Diabetes</i> .....	20
<i>Demographic Comparisons</i> .....	21
<i>Racial Bivariate and Multivariate Analyses</i> .....	21
<i>Socioeconomic Bivariate and Multivariate Analyses</i> .....	23
<i>Geographic Differences</i> .....	26
<i>Obesity</i> .....	27
<i>Diabetes</i> .....	29
Discussion.....	30
Policy Implications .....	32
Conclusion .....	32
Bibliography .....	34

## **Research Proposal**

Before the industrialization of agriculture, farming was inherently organic and locally supplied as food processing was in an incipient stage. Industrialization and the subsequent Green Revolution gave rise to the organic movement which protested the use of DDT and other synthetic pesticides and herbicides. Currently, the locavore movement in the United States has been gaining traction as interest in sustainability has been increasing. The purpose of this project is to assess whether this movement is indicative of a nutrition transition from a pattern of dietary-related degenerative disease to a pattern of behavioral change. The area of study will be the state of California and analyses will be at the county level, which will represent “community”.

Nutrition transition patterns are the result of a myriad of social and economic factors, but for the purpose of this project, the focus will be on the nutrition profile which includes diet and nutritional status. For comparative purposes, demographic data such as income, education, racial categories, and poverty will be included. Diet will be determined by utilizing per capita food availability as proxy data for consumption. Nutritional status will be evaluated by rates of obesity and diabetes. Aggregate data will be used for this paper’s analysis.

## **Annotated Bibliography**

Jarosz, L. (2008). The city in the country: growing alternative food networks in metropolitan areas. *Journal of Rural Studies*, 24, 231-244.

Jarosz conducts a qualitative case study on growing alternative food networks in metropolitan areas. Her study, focused on the Seattle metropolitan area, asserts that urbanization and rural restructuring are vital to the development of alternative food networks. She also discusses the difficulties and challenges of farming in such a network. This study will be useful to my project as it supports the notion that Popkin's nutrition transition pattern of behavioral change will emerge from, and be strongly noted in, urban rather than rural areas.

Morrison, K. T., Nelson, T. A., & Ostry, A. S. (2011a). Mapping spatial variation in food consumption. *Applied Geography*, 31, 1262-1267.

This article presents methods to map aspatial food consumption data of British Columbia while taking into consideration the spatial variability of a population, specifically age and gender. The resultant data is vital in the assessment of local food producers' ability to supply local demand. The article demonstrates how food consumption patterns are directed by age and gender. The methods presented will serve as a guide to my project's assessment of local food supply and demand.

Morrison, K. T., Nelson, T. A., & Ostry, A. S. (2011b). Methods for mapping local food production capacity from agricultural statistics. *Agricultural Systems*, 104, 491-499.

This article presents methods to estimate the local food production capacity of British Columbia utilizing Agricultural census and survey data. To obtain accurate agricultural

yields, the researchers also assessed yield stability over time. The implemented methodology was found to produce acceptable estimates of local scale food production. The methods presented will serve as a guide to my project's assessment of the feasibility of local producers to supply local demand.

Peters, C. J., Bills, N. L., Lembo, A. J., Wilkins, J. L., & Fick, G. W. (2008). Mapping potential foodsheds in New York State: A spatial model for evaluating the capacity to localize food production. *Renewable Agriculture and Food Systems*, 24, 72-84.

This article offers a method for mapping potential foodsheds by estimating the distribution of food production capacity in relation to population centers. The method was applied to New York State and utilizes geographic information systems. It was concluded that 34% of food needs could be provided within 49 km on average. This method will aid my project as it attempts to evaluate the capacity of local agriculture to meet local food needs.

Popkin, B. M. (1993). Nutritional patterns and transitions. *Population and Development Review*, 19, 138-156.

Popkin provides a framework of diet and its relationship to other facets of society. His work provides a description of broad dietary and health patterns, or nutrition transitions. He emphasizes the importance of understanding nutrition transitions in order to improve diet and health. This work will be vital to my project as it offers much detail of the nutrition transition framework, specifically the fifth pattern of behavioral change upon which my paper is based.

Popkin, B. M. (1999). Urbanization, lifestyle changes and the nutrition transition. *World Development*, 27, 1905-1916.

Popkin selects China and other countries to analyze the changes in diet and occupation associated with urbanization. The variables he explores include percent of urban population, household income, and occupation. Data presented in the article shows that urban areas in lower and middle income countries are shifting toward a more Western diet and sedentary lifestyle which bring with them increasing obesity. This work will be useful to my project because it will provide support as I explore the differences between urban and rural areas regarding production and consumption of food and obesity rates.

Popkin, B. M. (2006). Technology, transport, globalization and the nutrition transition food policy. *Food Policy*, 31, 554-569.

Popkin explores the connection between globalization and the nutrition transition in the developing world. His research indicates that negative dramatic change is occurring primarily in rural areas around the globe. He also identifies a shift in obesity to the poor. This work will assist my project as it reinforces the idea that Popkin's nutrition transition pattern of behavioral change will be slowest among the poor.

Popkin, B. M., & Gordon-Larsen, P. (2004). The nutrition transition: worldwide obesity dynamics and their determinants. *International Journal of Obesity*, 28, S2-S9.

This article concentrates on obesity as it delves into the significant changes in diet and physical activity patterns around the world. The article demonstrates how obesity rates and prevalence are affected by income, urban versus rural residence, and the increased consumption of fat, caloric sweeteners, and animal source foods. This work is useful to

my project as I will compare the obesity rates of a rural and an urban county in California. Additionally, the article has provided potential variables to include in the comparison, specifically regarding the production and consumption of fat, caloric sweeteners, and animal source foods.

Salois, M. J. (2012). Obesity and diabetes, the built environment, and the 'local' food economy in the United States. *Economics and Human Biology*, 10, 35-42.

Salois investigates the relationship between county-level obesity and diabetes prevalence and local agriculture and the built environment. His research suggests that a robust local food economy plays a significant role in the prevention of obesity and diabetes. He demonstrates a negative relationship between the density of farmers' markets and direct sale farmers and obesity and diabetes. This research will be helpful to my project as it strengthens the validity of Popkin's nutrition transition pattern of behavioral change, which the paper endeavors to assess.

Wang, Y, & Beydoun, M. A. (2007). The obesity epidemic in the United States—Gender, age, socioeconomic, racial/ethnic, and geographic characteristics: A systematic review and meta-regression analysis. *Epidemiologic Reviews*, 29, 6-28.

The authors present an extensive delineation and analysis of sociodemographic and geographic variables and their relationship to the obesity epidemic in the United States. The review shows that some minority and low socioeconomic groups are affected more than others, but the overall trend across ethnic and socioeconomic groups is similar. The authors' results indicate that these individual characteristics are not the major factor

involved in the obesity epidemic. This research will be useful to my project as it will provide support for patterns of obesity across various populations.

## Outline

### Introduction

- a. Basic framing for problem statement
- b. Research question

### Background

- a. Nutrition Transition Framework
- b. United States and Degenerative Disease (Stage Four)
- c. Focus on Nutrition Profile
- d. Geographic Study Area
- e. Policy Implications

### Methods

- a. Transition Indicators
- b. Data Sources
- c. Spatial Analysis
- d. Statistical Analysis

### Results

- a. Diet – Consumption based on per capita food availability
  - i. Current Situation and Trends
- b. Nutritional Status
  - i. Prevalence of Obesity
    1. Current Situation and Trends
  - ii. Prevalence of Diabetes
    1. Current Situation and Trends
- c. Demographic Comparisons
  - i. Racial Bivariate and Multivariate Analysis
  - ii. Socioeconomic Bivariate and Multivariate Analysis
- d. Geographic Difference
  - i. Obesity
  - ii. Diabetes

### Discussion

### Policy Implications

### Conclusion

## **Introduction**

In many developed and developing nations, consumers are increasingly bombarded with a plethora of highly processed imported foods. The United Nations Food and Agriculture Organization (UNFAO) recently warned that the health of Pacific Islanders is increasingly affected by climbing sales of inexpensive imported processed foods which outcompetes healthier locally grown foods (2014). Similarly, the infiltration of processed foods throughout the United States can be easily verified by visiting any local supermarket. The UNFAO also stated that the rising rates of obesity, diabetes, and cardiovascular diseases could be somewhat reversed if islanders increased their consumption of local food and decreased imported processed food (2014). Essentially, the FAO is encouraging both policy and behavioral changes. In the Pacific Island case, local food consumption would promote greater food security and create economic opportunities. In the United States, however, reasons for encouraging local food consumption arise from several additional concerns which include environmental sustainability, reduction of transportation distances, and support of local economies.

A rising interest in sustainability has contributed to the momentum of the locavore movement. The online Oxford Dictionary defines a locavore as “a person whose diet consists only or principally of locally grown or produced food.” One organization that exemplifies this movement is Slow Food International which promotes the consumption of local, seasonal food that is produced sustainably. A number of authors have also drawn attention to the locavore movement with books such as *The 100-Mile Diet* by Alisa Smith and J.B. MacKinnon, *The Omnivore’s Dilemma* by Michael Pollan, and *Animal, Vegetable, Miracle* by Barbara Kingsolver. Further popularizing the movement are growing numbers of farm-to-table restaurants, renowned chefs such as Rick Bayless and Thomas Keller, and nonprofit networks

like the Chefs Collaborative which promotes a local sustainable food supply and support of the local economy. The locavore movement encourages behavioral change that could have a positive effect on reducing the widespread prevalence of obesity and diabetes. Since the movement is relatively new, research and relevant literature is lacking. By examining trends in national food availability and trends in county level obesity and diabetes prevalence, this paper serves to assess whether the locavore movement as a behavioral change may contribute to a decline in dietary-related disease, thus marking the transition from a pattern of dietary-related degenerative disease to a pattern of behavioral change.

If the locavore movement is indicative of a behavioral change pattern, then it may play a role in the development of local and regional policies aimed at the reduction of dietary-related diseases such as obesity, diabetes, and cardiovascular disease.

The terms 'local' and 'community' may be ambiguous as some people may think strictly in terms of Euclidian distance while others think in terms of political boundaries. For the purpose of this paper, both terms will refer to the geographic boundaries of counties. Given that counties vary in size and resources it is likely that neighboring counties may also be considered local by some people. However, local and regional policies, campaigns, and initiatives would be based upon county objectives which support the notion of a county by county assessment. Due to a limitation of time, this paper will restrict research to the counties of California.

In order to account for the great diversity of communities within California, statistical tests of county level aggregate demographic data will also be conducted. Median income, educational attainment, poverty, and race will be analyzed for statistically significant positive and negative relationships to prevalence rates of obesity and diabetes. Resultant information from these tests may prove valuable to researchers and the general public in evaluating whether

health programs and policies are addressing the most relevant sociodemographic variables regarding these particular health issues.

## **Background**

### *Nutrition Transition*

Diet and health status can be influenced by multiple variables including age, income, and level of food processing along with myriad additional variables. Amidst the plethora of potential variables to assess diet and health status it can be difficult to determine which combination would be the most relevant. However, Barry Popkin supplies a framework – the nutrition transition – that gives consideration to the ever changing nature of diet and its relationship to demographics, food processing, and the economy (1993). To understand the progression of the nutrition transition it is important to review two historically significant processes: the demographic transition and the epidemiologic transition. The demographic transition is the gradual change from a pattern of high fertility and mortality to a pattern of low fertility and mortality (Fellmann, et al. 2010). The epidemiologic transition is the gradual change from a pattern of high infectious disease prevalence (e.g. cholera and mumps) to a pattern of high degenerative disease prevalence (e.g osteoporosis and heart disease) (Omran, 1971). Both the demographic transition and the epidemiologic transition have bidirectional relationships with nutritional change – meaning nutritional change effects the epidemiologic transition and vice versa (Popkin, 1993). The five nutrition patterns identified by Popkin are summarized in Table 1 which has been edited to showcase the nutrition profile category.

### *United States and Degenerative Disease (Pattern Four)*

The United States is in Pattern Four as defined by Popkin. The Economic Research Service (ERS) of the United States Department of Agriculture (USDA) maintains a Food Availability Data System that will be utilized to assess the dietary trends of the nation as a whole. Specifically, the Loss-Adjusted Food Availability data set will be employed for this

paper. Two of the dietary characteristics of Pattern 4 (degenerative diseases) are the increase of fat and sugar in the diet. According to the loss-adjusted food availability estimates, the consumption of total fat and sugar has risen over the years. The estimates are calculated by measuring the food supply from production through to the domestic market and then adjusted for food spoilage, plate waste, and other losses. In 1984, per capita availability of total fat was estimated to be 43.0 lbs/year (Figure 1). Ten years later it rose to 48.3 lbs/year and in 2004 that number jumped to 63.5 lbs/year. Over the next six years it held relatively steady - in 2010 it was 63.4 lbs/year (USDA ERS, 2014). The trend for sugar (caloric sweeteners) is similar: 79.2 lbs/year in 1984, 89.0 lbs/year in 1994, and 90.1 lbs/year in 2004; however, in 2010 the number dropped to 84.5 lbs/ year (USDA ERS, 2014). The Centers for Disease Control and Prevention (CDC) reported heart disease (597,689 deaths), stroke (129,476 deaths), and diabetes (69,071 deaths) among the top ten leading causes of death in 2010 (2013c). However, according to the National Center for Health Statistics (NCHS) in 1984 heart disease accounted for 765,114 deaths while diabetes accounted for 35,787 deaths and stroke accounted for 154,327 deaths (Table 2). These three obesity-related conditions place the United States in Popkin's category of degenerative disease – Pattern 4 – with diabetes clearly on the rise.

#### *Focus on Nutrition Profile*

For the purpose of this project the focus will be restricted to the assessment of the nutrition profile: diet and nutritional status. Dietary trends will be evaluated based on national food availability data as a proxy for consumption. Specifically, food availability data regarding fat, carbohydrates (grains), fresh fruits, and fresh vegetables will be reviewed. Processed, canned, and frozen fruits and vegetables will not be evaluated as they would be less likely to be marketed at farmer's markets and/or by community supported agriculture (CSA). Nutritional

status trends will be evaluated with CDC data of age-adjusted obesity and age-adjusted diabetes prevalence.

Table 1. Summary characteristics of the nutrition profile for each dietary pattern (Popkin, 1993)

Transition profile	Pattern 1: Collecting food	Pattern 2: Famine	Pattern 3: Receding famine	Pattern 4: Degenerative diseases	Pattern 5: Behavioral change
<b>Economy</b>	Hunter-gatherers	Agriculture, animal husbandry, home-making begin; shift to monocultures	2 <sup>nd</sup> agricultural revolution (crop rotation, fertilizer); Industrial Revolution; women join labor force	Fewer jobs with heavy physical activity; service sector and mechanization; household technology revolution	Service sector mechanization, industrial robotization dominate; leisure exercise grows to offset sedentary jobs
<b>Nutrition profile: Diet</b>	Plants, low-fat wild animals; varied diet	Cereals predominant; diet less varied	Fewer starchy staples; more fruits, vegetables, animal protein; low variety continues	More fat (esp. from animal products), sugar, and processed foods; less fiber	Less fat and processing; increased carbohydrates, fruits, and vegetables
<b>Nutrition profile: Nutritional status</b>	Robust, lean, few nutritional deficiencies	Children, women suffer most from low fat intake; nutritional deficiency diseases emerge; stature declines	Continued MCH nutrition problems; many deficiencies disappear; weaning diseases emerge; stature grows	Obesity; problems for elderly (bone health, etc.); many disabling conditions	Reduced body fat levels and obesity; improved bone health

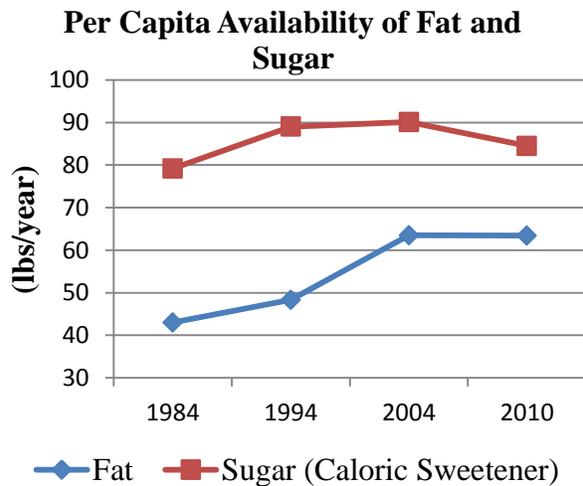


Figure 1. Per capita availability of fat and sugar in the U.S. from 1984 to 2010 (USDA ERS, 2014).

Table 2. Deaths in 1984 and 2010 caused by heart disease, stroke, and diabetes (CDC, 2013c and NCHS).

Cause of Death	1984	2010
Heart Disease	765,114	597,689
Stroke	154,327	129,476
Diabetes	35,787	69,071

### *Geographic Study Area*

This paper presents results from a study area consisting of the 58 counties of California. The county serves as a good spatial unit for research of this type due to the role of county public health departments in directing nutrition and health policy. This state was selected for its representation of a large and diverse population as well as its variety of soil and climate types. According to the U.S. Census Bureau's Annual Estimates of the Resident Population, California is the most populous state with 38,332,521 residents (2013). Furthermore, a comparison of racial population percentages between California and the United States as a whole attests to the diversity the state has with greater proportions of Hispanics, Asians, American Indians, and Pacific Islanders (U.S. Census Bureau, 2014). Four of the five major climate groups occur in California and based on the Koppen classification system they include: temperate/mesothermal (Mediterranean), highland, dry (desert and steppe), and continental/microthermal climates (Kauffman). A review of soil order distribution maps of the United States provided by the USDA's Natural Resources Conservation Service verifies that California contains all but three dominant soil orders (gelisols, oxisols, and spodosols are not found in the state). Climate and soil play important roles to the locavore movement as they may directly impact the variety of agricultural products available to the community.

### *Local and Regional Policy Implications*

One way to promote positive dietary change is to first understand the causes and consequences of dietary change. In order to do this, thorough research must be conducted to discover any patterns or associations between diet and economic, social, demographic, and health factors. For example, Popkin (1999) presents an association between high rates of urbanization in very low income countries and an increase of caloric sweetener and fat

consumption. In light of such research, nations that identify with this situation may choose to be proactive regarding their health policies or perhaps create a campaign to prevent or mitigate the negative consequences of high fat and sugar intake. Alternatively, if the nation's government chooses not to be proactive, then the research remains available to civil society (e.g. non-governmental/non-profit organizations) which can often effect policy and serve as a catalyst for change.

## **Methods**

The nutrition transition provides the framework for which this paper is built upon. According to Popkin's brief description of the diet that characterizes a behavioral change pattern in Table 1, increases in carbohydrate, fruit, and vegetable consumption should be observed while fat consumption should decrease. The first objective of this paper is to determine whether these consumption patterns are occurring via an examination of national food availability data. Additionally, Popkin expects the nutritional profile of the behavioral change pattern to reveal a reduction in obesity. As diabetes is also a dietary related disease it is included as a second dependent variable. The second objective of this paper is to determine whether these dietary related diseases (obesity and diabetes) have decreased in California. The third and final objective of this paper is a statistical exploration of diabetes and obesity for potential sociodemographic relationships and geographic patterns.

### *Transition Indicators*

Diet variables include total fat, grains (carbohydrates), fresh fruit, and fresh vegetables. A decrease in total fat and an increase in the remaining three variables will serve as an indication of transition from pattern four (degenerative diseases) to pattern five (behavioral change). The nutritional status variables will be comprised of age-adjusted obesity and age-adjusted diabetes prevalence by county. A decrease in these variables will serve as an indication of transition.

### *Data Sources*

Data utilized in this research is provided by several governmental agencies. The Centers for Disease Control and Prevention provided county level estimates of age-adjusted diabetes and age-adjusted obesity prevalence for the years 2004 through 2010 based upon data from the Behavioral Risk Factor Surveillance System (BRFSS). Demographic data by county is provided by the United States Census Bureau via Social Explorer. This data is compiled by the Census

Bureau as the American Community Survey (ACS) which has replaced the long form census. National loss-adjusted per capita food availability data was employed in lieu of consumption estimates and provided by the Economic Research Service (ERS) of the United States Department of Agriculture.

### *Spatial Analysis*

The GIS program, ArcGIS, is utilized to determine if county level obesity and diabetes data is random or clustered and for the visualization of diabetes and obesity prevalence. Global Moran's I was executed to determine the existence of a spatial pattern by generating a spatial autocorrelation report (random or clustered data). Subsequently, a Local Moran's I will be conducted with GeoDa software to provide visualization of clusters if clustering is determined by the Global analysis. Of particular interest will be the identification of counties with the lowest and highest prevalence rates as well as the greatest percent change over time in these health conditions.

### *Statistical Analysis*

Analyses were conducted with SPSS statistics software to explore the characteristics of obesity and diabetes prevalence. Simple linear regressions were utilized to individually examine obesity and diabetes. Specifically, bivariate and multivariate backward linear regressions were used to assess demographic relationships regarding race, income, and educational attainment. The models were regressed for ACS 3-year estimates for the period 2008 to 2010, either obesity or diabetes prevalence was set as the dependent variable and the independent variables consisted of different sociodemographic variables. It should be noted that the Census Bureau does not provide data within the 3 year estimates for the following seven counties – five of which are located along the Sierra Nevada: Alpine, Inyo, Mariposa, Modoc, Mono, Sierra, and Trinity.

## Results

### *Diet*

National loss-adjusted per capita food data showed that consumption trends are not indicative of the behavioral change pattern as described above. In 2010, total fat per year was estimated to be 63.4 lbs and would account for about 23% of the average daily calories available based on a 2,568 calorie diet (ERS, 2014). For the same year, total grains per year were estimated to be 134.0 lbs or 24% of total daily calories (ERS, 2014). Total fresh fruit was 47.6 lbs/year or 1.4% of daily calories while total fresh vegetables were 90.1 lbs/year or 1.8% of daily calories (ERS, 2014). The remaining 49.8% of calories consist of calories from dairy, sugar/sweeteners, meat, eggs, nuts, as well as fruit and vegetables in canned, frozen, dried, and juiced forms. The trends based on ERS data are shown in Figure 2. Between 2004 and 2010, fresh vegetables gradually decreased by 9.7 lbs/year from 99.8 to 90.1 lbs/year. During that same time period, grains increased by 2.6 lbs/year from 131.4 to 134.0 lbs/year. However, total fat and fresh fruit remained relatively steady.

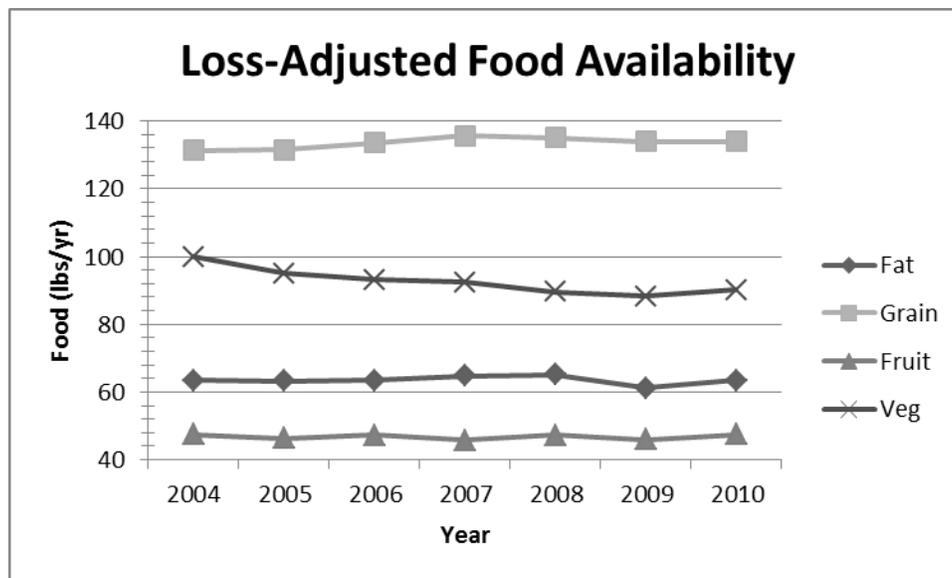


Figure 2. Trends in food availability for total fat, grains, fresh fruit and fresh vegetables (ERS, 2014).

### *Nutritional Status*

California's statewide average prevalence of both obesity and diabetes have increased from 2004 to 2010 which is not indicative of a behavioral change pattern. However, some individual counties did experience a reduction in both conditions and may potentially serve as hubs for which behavioral change radiates outward to surrounding areas.

#### *Obesity*

Based upon 2010 county-level estimates of obesity prevalence, California's statewide obesity rate was calculated to be approximately 24% ranging from 15% in Marin County to 31.1% in Merced County. In 2004, California's overall obesity prevalence was approximately 21% and ranged from 15.6% in San Francisco County to 26.1% in Stanislaus County. Between 2004 and 2010, the obesity prevalence for the state increased by about 3%; however, the percent change by county is wide ranging as some counties have seen a reduction while many others have experienced a significant increase. At one end, Marin County has seen a reduction of about 8.5% while at the opposite end Madera County has experienced an increase of nearly 47%.

#### *Diabetes*

Based upon 2010 county-level data of diabetes prevalence estimates, California's mean was calculated to be approximately 7.4% and ranged from 4.6% in Marin County to 9.8% in Solano County. In 2004, California's mean diabetes prevalence was approximately 6.3% and ranged from 5.2% in Marin County to 7.7% in Solano County. Between 2004 and 2010, the diabetes prevalence for the state increased by about 1.1%; however, similar to obesity the percent change by county is wide ranging as some counties have seen a reduction while many others have experienced a significant increase. Marin County has seen a reduction of about 11.5% while San Joaquin County has experienced an increase of nearly 45%.

### *Demographic Comparisons*

Statistical analyses were conducted for the 51 counties of California that were included in the ACS 3-year estimates for the period 2008 to 2010. All socioeconomic variable data is county-level and variables assessed were race, median income by race, percentage of population in poverty, percentage of population with less than a high school education, and the percentage of population with some college or completion of a bachelor's degree or higher.

### *Racial Bivariate and Multivariate Analyses*

Racial categories utilized as variables include: White Non-Hispanic, Hispanic, Black, Asian, American Indian or Alaskan Native, and Pacific Islander or Native Hawaiian. Bivariate analyses of obesity and each racial category are predominantly not statistically significant except for Hispanics with a p-value of 0.031 (Table 3). However, the percentage of Hispanics in a county explains less than ten percent of the variance. In contrast, racial category is statistically significant for diabetes particularly for Whites and Blacks and to a lesser extent for Hispanics (Table 3). The relationship for Whites is negative and accounts for around 27 percent of variance while the relationship for Blacks and Hispanics is positive and accounts for about 7 percent and 33 percent, respectively.

Multivariate regressions performed for obesity and diabetes included all of the above racial categories as variables which highlighted slightly different sets of significant variables. For obesity, Hispanics were no longer a significant variable, but Whites and Asians were significant and both had negative relationships (Table 3). However, this model only accounts for about 20 percent of the variance. Diabetes was more consistent with the results for the bivariate analysis as Whites and Blacks continued to be significant with negative and positive relationships, respectively. However, the model also included American Indians as a significant

variable with a positive relationship. Thus far this model accounts for the greatest variance of diabetes with an adjusted  $R^2$  of 0.478.

**Table 3. Bivariate Summaries and Coefficients for Obesity**

Predictors	R	$R^2$	Adjusted $R^2$	Std. Error of the Estimate	Standardized Coefficients	Sig. (p-value)
	Year = 2010				Beta	
% White Non-Hispanic	.201	.041	.020	3.7905	-.201	.165
% Hispanic	.308	.095	.076	3.6813	.308	.031
% Black	.160	.026	.006	3.7519	.160	.261
% Asian	.270	.073	.054	3.6601	-.270	.056
% American Indian or Alaskan Native	.242	.059	.039	3.6881	.242	.087
% Pacific Islander or Native Hawaiian	.039	.002	-.019	3.7981	-.039	.784

**Bivariate Summaries and Coefficients for Diabetes**

% White Non-Hispanic	.528	.279	.264	.9036	-.528	.000
% Hispanic	.291	.085	.065	1.0180	.291	.042
% Black	.585	.343	.329	.8470	.585	.000
% Asian	.169	.029	.009	1.0297	.169	.236
% American Indian or Alaskan Native	.085	.007	-.013	1.0410	.085	.554
% Pacific Islander or Native Hawaiian	.211	.045	.025	1.0212	.211	.137

**Multivariate Summaries and Coefficients for Obesity and Diabetes (Race Only)**

Obesity – Final Model	.511	.261	.212	3.3999		
% White Non-Hispanic					-.451	.003
% Asian					-.376	.016
% American Indian or Alaskan Native					.249	.092
Diabetes – Final Model	.714	.510	.478	.7609		
% White Non-Hispanic					-.426	.001
% Black					.440	.001
% American Indian or Alaskan Native					.323	.006

### *Socioeconomic Bivariate and Multivariate Analyses*

Median household income by race is analyzed for the previously stated racial categories. Income and race data is based on the income and race of the householder. The bivariate analysis of race by income for obesity is significant – except for Pacific Islanders or Native Hawaiians – and all significant variables have a negative relationship accounting for variance between 9 and 31 percent (Table 4). Race by income for diabetes is only significant for Blacks which has a negative relationship and accounts for about 10 percent of variance (Table 4). However, median income of all racial categories assessed as one variable is also significant and has a negative relationship, but as above only accounts for a small portion of variance.

The multivariate regression analyses for median income by race calculated a few different significant variables as occurred in the multivariate analyses for race alone. Regarding obesity, the model accounted for 68 percent of variance and the set of significant variables included median income for Whites and Blacks (which had negative relationships) and Asians which had a positive relationship. The model for obesity accounted for a smaller percentage of variance (43%) and the set of significant variables included Hispanics and Asians with positive relationships and median income of all racial categories with a negative relationship (Table 4).

Bivariate analyses were conducted for the percentage of population living in poverty, the percentage of population with less than a high school education, and the percentage of population with some college or higher (bachelor's, master's, doctorate). The age range assessed for the population living in poverty is from 18 to 64 years. Both obesity and diabetes have significant positive relationships with the percent living in poverty and the percent with less than a high school education. In contrast, obesity and diabetes have significant negative relationships with the percentage of population with some college or greater (Table 5).

**Table 4. Bivariate Summaries and Coefficients for Obesity (Race by Median Income)**

Predictors	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Std. Error of the Estimate	Standardized Coefficients	Sig. (p-value)
	Year = 2010				Beta	
Median Income (All)	.614	.377	.365	2.9990	-.614	.000
White Non-Hispanic	.575	.331	.317	3.1092	-.575	.000
Hispanic	.409	.168	.151	3.4678	-.409	.003
Black	.358	.128	.105	3.8528	-.358	.023
Asian	.366	.134	.115	3.6558	-.366	.011
American Indian or Alaskan Native	.337	.113	.092	3.8261	-.337	.026
Pacific Islander or Native Hawaiian	.033	.001	-.033	4.2005	-.033	.858

**Bivariate Summaries and Coefficients for Diabetes**

Median Income (All)	.357	.128	.110	.9757	-.357	.010
White Non-Hispanic	.258	.067	.048	1.0092	-.258	.067
Hispanic	.167	.028	.008	1.0301	-.167	.243
Black	.348	.121	.098	1.0294	-.348	.028
Asian	.177	.031	.010	1.0663	-.177	.233
American Indian or Alaskan Native	.214	.046	.023	1.0674	-.214	.164
Pacific Islander or Native Hawaiian	.068	.005	-.030	1.1546	-.068	.718

**Multivariate Summaries and Coefficients for Obesity and Diabetes (Race by Income Only)**

Obesity – Final Model	.853	.728	.680	2.4377		
White Non-Hispanic					-1.327	.000
Black					-.347	.013
Asian					.770	.002
Pacific Islander or Native Hawaiian					.229	.069
Diabetes – Final Model	.717	.514	.430	.9003		
Median Income (All)					-1.508	.000
Hispanic					.714	.023
Black					-.296	.089
Asian					.655	.044

**Table 5. Bivariate Summaries and Coefficients for Obesity**

Predictors	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Std. Error of the Estimate	Standardized Coefficients	Sig. (p-value)
	Year = 2010				Beta	
% In Poverty	.571	.327	.313	3.1194	.571	.000
% Less Than High School	.507	.257	.242	3.2755	.507	.000
% Some College or Greater	.696	.484	.474	2.7293	-.696	.000

**Bivariate Summaries and Coefficients for Diabetes**

% In Poverty	.377	.142	.124	.9678	.377	.006
% Less Than High School	.486	.236	.221	.9129	.486	.000
% Some College or Greater	.585	.343	.329	.8470	-.585	.000

The final multivariate linear regression includes all of the previously explored variables with the exclusion of the percentage of population with less than a high school education as the percentage of population with some college accounted for greater variance regarding both dependent variables. The final models for these regressions account for 80 percent of obesity variance and about 83 percent of diabetes variance. The significant set of variables for obesity include median income for both Whites and Blacks with negative relationships, percentage with some college or above also negatively related, and median Asian income and percentage of Asians both with positive relationships (Table 6). The significant set of variables for diabetes includes the percentage of Whites and Hispanics and the median income of Whites all of which are negatively related. The only variable in the set that was positively related was the median income for the entire population (Table 6).

**Table 6. Multivariate Summaries and Coefficients for Obesity and Diabetes (All Variables)**

Predictors	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Std. Error of the Estimate	Standardized Coefficients	Sig. (p-value)
	Year = 2010				Beta	
Obesity – Final Model	.925	.856	.805	1.9021		
% Asian					.271	.036
White Non-Hispanic Income					-1.286	.000
Black Income					-.226	.047
Asian Income					.556	.010
American Indian or Alaskan Native Income					.254	.091
Pacific Islander or Native Hawaiian Income					.208	.059
% Some College or Greater					-.384	.007
Diabetes – Final Model	.923	.852	.826	.4974		
% White Non-Hispanic					-1.317	.000
% Hispanic					-.523	.000
Median Income (All)					1.060	.010
White Non-Hispanic Income					-1.798	.000

***Geographic Differences***

ArcGIS’s Global Moran’s I analysis determined that 2010 obesity prevalence is clustered with a z-score of 3.71 and a p-value of 0.0002. A clustered pattern was also confirmed for the 2010 diabetes prevalence which reported a z-score of 1.78 and a p-value of 0.073. The univariate Local Moran’s I was performed with GeoDa software to visualize the clustering of obesity and diabetes (Figure 3). Although the clusters of high prevalence are located in the Central Valley for both maps, they do not mirror each other.

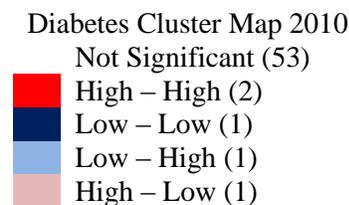
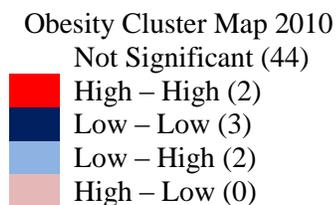


Figure 3. Local Moran’s I cluster maps of obesity and diabetes in California based on CDC data for 2010 (2013 a,b); all clusters have a significance (p-value) of at least 0.05. Maps created by Desiree Rodriguez.

### *Obesity*

The 2010 CDC data reveal considerable differences in the prevalence of obesity across counties. In general, counties in the Central Valley have higher prevalence rates than counties along the coast and in the Sierra Nevada mountain range. In 2010, eight counties had obesity prevalence rates of less than 20 percent, while 21 counties had prevalence rates of 25 percent or higher. In three counties (San Joaquin, Yuba, and Stanislaus) – all located in the Central Valley – prevalence was 30 percent, while one county (Merced) ranked highest at 31.1 percent.

The regional differences became clear over time between 2004 and 2010 (Figure 4). In 2004, the regional differences were nascent as the only two counties with an obesity prevalence rate of 25 percent or higher were located in the San Joaquin Valley. In 2006, the counties with the lowest prevalence rates below 20 percent were located along the coast and in the Sierra

Nevada range near Lake Tahoe. In 2008 and 2010, obesity had clearly taken root in the Central Valley. In 2004, twenty counties had obesity prevalence rates below 20 percent. In 2006, only 12 counties continued to have an obesity prevalence rate below 20 percent. In 2008, 47 counties had obesity prevalence rates of 20 percent or higher. In 2008, 47 counties had obesity prevalence rates of 20 percent or higher. In 2010, only 8 counties had rates below 20 percent, while 21 counties had a prevalence rate of 25 percent or higher, and four had a prevalence of 30 percent or higher.

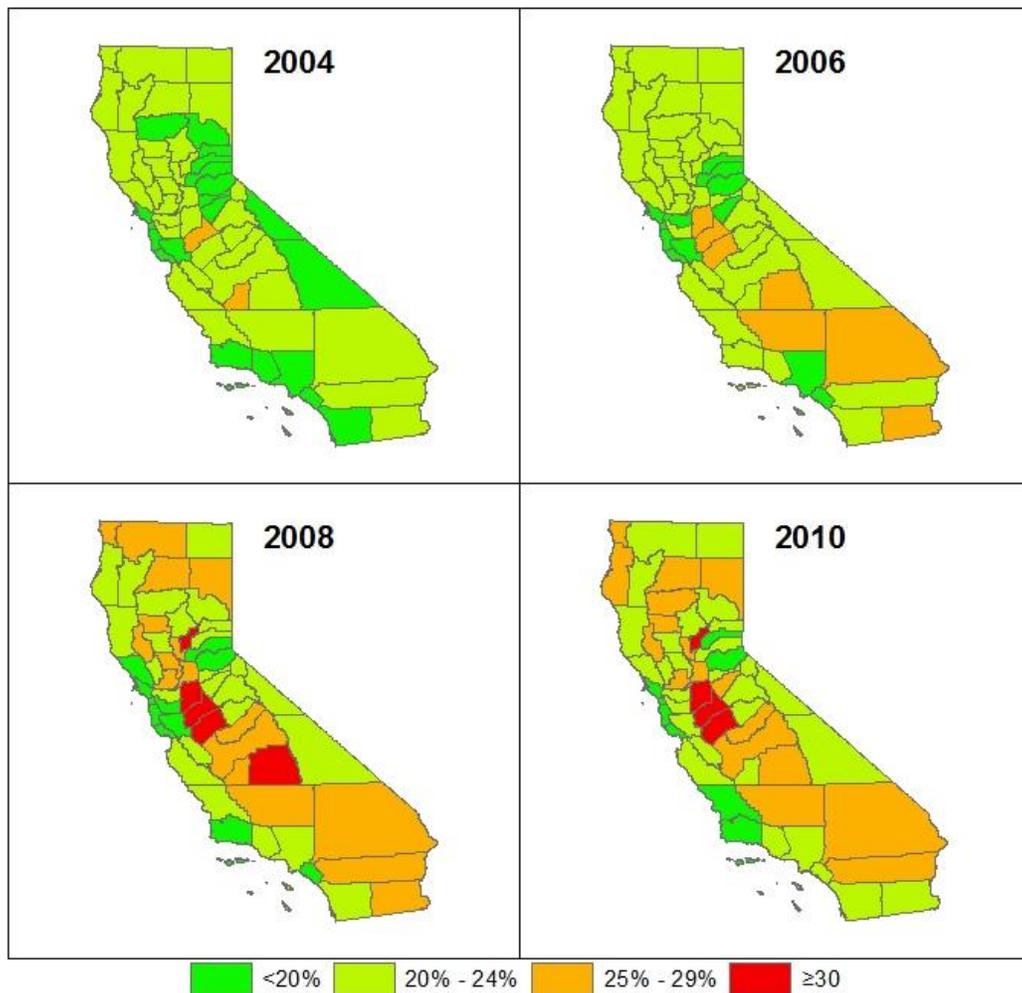


Figure 4. Trends in regional differences in the prevalence of obesity in California. Map created by Desiree Rodriguez based upon data from CDC (2013b).

## Diabetes

The diabetes prevalence data for 2010 highlights the extent to which it has spread geographically across California. Overall, counties in the Central Valley have experienced the greatest increase in prevalence rates than counties along the coast and in the Sierra Nevada mountain range – a pattern which closely mirrors that of obesity. In 2010, only four counties had diabetes prevalence rates of less than 6 percent (Nevada, Sonoma, Marin, and Santa Cruz), while 36 counties had prevalence rates greater than 7 percent. In four counties (San Joaquin, Fresno, Solano, and Riverside), prevalence was greater than 9 percent and the highest rate 9.8 percent belonged to Solano.

The regional differences seem to be present in the 2004 data (Figure 5). However, upon close inspection four of the eight counties with prevalence rates greater than 7 percent are actually part of the San Francisco Bay Area while three are located in the Central Valley. In 2004, the counties with the lowest prevalence rates below 6 percent were located along the coast and in the Sierra Nevada range near Lake Tahoe. By 2010, diabetes had increased throughout the Central Valley and Southern California. In 2004, eighteen counties had diabetes prevalence rates below 6 percent. In 2010, only four counties continued to have a diabetes prevalence rate below 6 percent.

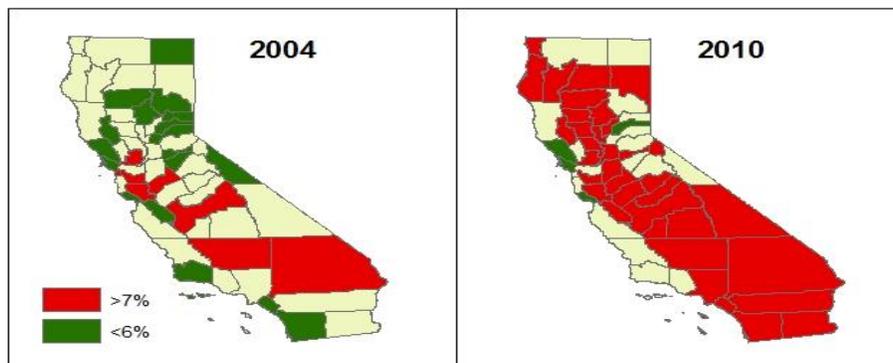


Figure 5. Trends in regional differences in the prevalence of diabetes in California. Map created by Desiree Rodriguez based upon data from CDC (2013a).

## **Discussion**

The notion that the locavore movement is a catalyst for the nutrition transition in California from a pattern of degenerative disease to behavioral change can be neither supported nor rejected based upon the findings of this research. Neither the consumption proxy nor the mean prevalence of obesity and diabetes within California were consistent with the changes expected for this particular transition. However, some individual counties did show improvement regarding obesity, diabetes, or both. The multivariate linear regression of all demographic variables provided insight into particular sets of variables accounting for obesity and diabetes variance while the spatial analyses revealed the clustering patterns of these conditions.

The statistical analyses of this research have served to demonstrate that significant variables differ for obesity and diabetes which is important for the purpose of devising specific health campaigns. Furthermore, it has also been demonstrated that a relationship may change for a specific variable. For example, as median income increases for Blacks there is a decrease in obesity prevalence; however, as median income increases for Asians there is an increase in obesity prevalence (Table 5). Another interesting variable was education which was found to be significant for obesity but not for diabetes. Regarding diabetes, as overall median income increases there is also an increase in diabetes prevalence which is important if perhaps a diabetes prevention program is solely focusing on the lower income population.

In 2004, Popkin and Gordon-Larsen reiterated that the developing world's poor population has taken on the burden of obesity. Their finding holds true for obesity in California as the research of this paper presents decreasing prevalence of obesity with increasing education and increasing median income of some racial categories. It is also confirmed by Wang and

Beydoun (2007) that less educated people in general have higher prevalence of obesity. Earlier research conducted by Popkin found that greater levels of obesity are in urban rather than rural areas of developing countries (1999). Unlike the above example, this does not hold true for California as can be seen on the cluster map for obesity which indicates that the highly urban county of San Francisco and neighboring counties are hotspots for low obesity prevalence (Figure 3) likely due to high incomes and high educational attainment. In contrast, Fresno County with its surrounding highly rural areas is found to be the hotspot for high obesity prevalence. Regarding the locavore movement, Salois (2012) found “a negative association between local food indicators and county prevalence rates of obesity and diabetes.” However, a simple bivariate analysis was not statistically significant for the independent variable of number of farmers markets by county in California.

A glaring limitation to this study’s assessment of food consumption is the reliance on national food availability data when the consumption proxy should have been derived at the state level. Another limitation of this research was the lack of a comprehensive set of variables that would be indicative of penetration of local foods into the community such as the percent of farms with direct sales, the value of direct farm sales per capita, farm to school programs, etc. Furthermore, in assessing these additional local variables the analysis itself would be further limited by lack of local producer characteristics. Jarosz (2008) described how farm size, household composition and ages, crop mix, and changes in weather and plant disease patterns influence how and where local producers market their product; some producers are even forced into driving over 200 miles to sell their goods. Given that the statistics presented in this study were based upon California-specific demographic values, the results are not generalizable, but rather have served an exploratory role regarding the dynamics unique to this state.

## **Policy Implications**

The research conducted in this study has highlighted geographic patterns and associations between health (obesity and diabetes prevalence) and economic, social, and demographic factors. These associations serve to inform our approach to promote positive dietary change. For example, the positive relationship between obesity and median income for Asians highlights how a program or policy may overlook a significant subset of the population if their focus is solely on low income families or communities. The geographic clustering of obesity and diabetes is an indication that perhaps program and policy changes should commit additional resources to rural regions such as the Central Valley. Alternatively, rural areas may require an entirely different approach based on their specific region and set of demographic variables. Popkin (2006) agrees with a multi-pronged approach to health policy and has stated, “[...] one shoe will not fit all. There will need to be many different policy responses for different regions and countries to improve their dietary and physical activity patterns in a marked manner.”

## **Conclusion**

My research has attempted to assess whether the locavore movement has sparked a nutrition transition from degenerative disease to behavioral change. Though the study was inconclusive much was gained through the research process. In assessing consumption it became clear that state level food availability data would need to be produced as it would provide a more accurate picture for the state. The California Crop Reports provide aggregate production data, but do not detail the type and amount of agricultural products that are destined for the domestic market. The usage of data from these reports as a consumption proxy would have resulted in values grossly inflated due to California’s status as an international agricultural exporter. The

research process also brought to the fore significant sets of sociodemographic variables specific to California. Underlying these sets of variables is the complexity of their interactions and relationships that provide an area for further research, particularly with respect to an in-depth look at the various ethnic categories that comprise the larger racial categories. Unexpected results include the association of educational attainment with obesity, but not for diabetes. Additionally, median income was positively related for diabetes, but the relationship was mixed for obesity depending on racial category. The importance of this research despite its inconclusiveness is its support of the notion that one policy will not fit all situations and much more regional and local research is needed.

## Bibliography

- Centers for Disease Control and Prevention. (2013a, February). *Diagnosed diabetes prevalence* [Excel file]. Retrieved from [http://www.cdc.gov/diabetes/atlas/countydata/County\\_EXCELstatelistDM.html](http://www.cdc.gov/diabetes/atlas/countydata/County_EXCELstatelistDM.html)
- Centers for Disease Control and Prevention. (2013b, February). *Obesity prevalence* [Excel file]. Retrieved from [http://www.cdc.gov/diabetes/atlas/countydata/County\\_EXCELstatelistOBESITY.html](http://www.cdc.gov/diabetes/atlas/countydata/County_EXCELstatelistOBESITY.html)
- Centers for Disease Control and Prevention. (2013c, December). *Leading causes of death*. Retrieved from <http://www.cdc.gov/nchs/fastats/lcod.htm>
- Economic Research Service (ERS), U.S. Department of Agriculture. (2014, April). *Loss-adjusted food availability*. Retrieved from [http://www.ers.usda.gov/data-products/food-availability-\(per-capita\)-data-system/.aspx#.U1MPJfldXWZ](http://www.ers.usda.gov/data-products/food-availability-(per-capita)-data-system/.aspx#.U1MPJfldXWZ)
- Fellmann, J. D., Bjelland, M. D., Getis, A., & Getis, J. (2010). Population: World patterns, regional trends. *Human geography: Landscapes of human activities* (11<sup>th</sup> ed.). New York, NY: McGraw-Hill.
- Jarosz, L. (2008). The city in the country: growing alternative food networks in metropolitan areas. *Journal of Rural Studies*, 24, 231-244.
- Kauffman, E. (n.d.). Climate and topography. *Atlas of the Biodiversity of California*. Retrieved from [http://www.dfg.ca.gov/biogeodata/atlas/pdf/Clim\\_12b\\_web.pdf](http://www.dfg.ca.gov/biogeodata/atlas/pdf/Clim_12b_web.pdf)
- Locavore. (n.d.). In *Oxford Dictionary online*. Retrieved from [http://www.oxforddictionaries.com/us/definition/american\\_english/locavore?q=locavore](http://www.oxforddictionaries.com/us/definition/american_english/locavore?q=locavore)
- National Center for Health Statistics, National Vital Statistics System. (n.d.). *10 leading causes of death, United States, 1984*. Retrieved from <http://webappa.cdc.gov/cgi-bin/broker.exe>
- Omran, A. R. (1971). The epidemiologic transition: A theory of the epidemiology of population change. *Milbank Memorial Fund Quarterly*, 49(4), 509-538.
- Popkin, B. M. (1993). Nutritional patterns and transitions. *Population and Development Review*, 19, 138-156.
- Popkin, B. M. (1999). Urbanization, lifestyle changes and the nutrition transition. *World Development*, 27, 1905-1916.
- Popkin, B. M. (2006). Technology, transport, globalization and the nutrition transition food policy. *Food Policy*, 31, 554-569.

- Popkin, B. M., & Gordon-Larsen, P. (2004). The nutrition transition: worldwide obesity dynamics and their determinants. *International Journal of Obesity*, 28, S2-S9.
- Salois, M. J. (2012). Obesity and diabetes, the built environment, and the 'local' food economy in the United States. *Economics and Human Biology*, 10, 35-42.
- United Nations Food and Agriculture Organization. (2014, March 11). *Pacific island countries urged to produce more healthy local foods at competitive prices*. Retrieved from <http://www.fao.org/news/story/en/item/216189/icode/>
- U.S. Census Bureau. *American Community Survey, 2008-2010*. Prepared by Social Explorer. <http://www.socialexplorer.com/>
- U.S. Census Bureau, Population Division. (2013, December). *Annual estimates of the resident population: April 1, 2010 to July 1, 2013*. Retrieved from <http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk>
- U.S. Census Bureau. (2014, March 27). *State and county quickfacts*. Retrieved from <http://quickfacts.census.gov/qfd/states/06000.html>
- U.S. Department of Agriculture, Natural Resources Conservation Service. (n.d.). *Distribution maps of dominant soil orders*. Retrieved from [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/class/?cid=nrcs142p2\\_053589](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/class/?cid=nrcs142p2_053589)
- Wang, Y., & Beydoun, M. A. (2007). The obesity epidemic in the United States—Gender, age, socioeconomic, racial/ethnic, and geographic characteristics: A systematic review and meta-regression analysis. *Epidemiologic Reviews*, 29, 6-28.