THE DETERMINANTS OF FRUIT AND VEGETABLES INTAKE IN ARIZONA

by

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Abstract

This paper studies the determinants of fruit and vegetables consumption in Arizona by evaluating the demographic and neighborhood factors; and it also investigates the impact of “food deserts” on fruit and vegetables intake in Arizona.

Two databases are examined to identify these characteristics and to describe the distribution of fruit and vegetables intake in 15 counties in Arizona State. The databases are the demographic data from 2005 Behavior Risk Factor Surveillance System Data (BRFSS) and neighborhood data from 2005 U.S. Bureau of the Census Zip Code File.

We implement an OLS regression model to ascertain the determinants of fruit and vegetables intake per day in Arizona. In addition, by estimating a logit model we predict the likelihood of consuming five or more servings of fruit and vegetables per day.

The results indicate that factors such as age, gender, race and ethnicity, employee status, education and income level, attitude towards life, number of children in a family and "food deserts" have significant effects on the fruit and vegetables intake per day among Arizona individuals.

Chapter 1
Introduction

We are what we eat. There is a wide agreement that dietary habit is a key factor for individuals' health outcomes. Currently, the noncommunicable disease (NCDs) such as cardiovascular diseases (CVDs), cancer, obesity and type 2 diabetes mellitus becomes the major cause of death in globe; the poor diet that is one of main factors in the epidemiology of these diseases is of overwhelming importance to public health (The report of Joint Food and Agriculture Organization (FAO) / World Health Organization (WHO) Workshop on Fruit and Vegetables for Health 2004: Fruit and vegetables are necessary components of a healthy diet). Eating a variety of fruit and vegetables clearly ensures an adequate intake of most micronutrients, dietary fibers and a host of essential non-nutrient substances. As well, increased fruit and vegetable intake can help displace foods high in saturated fats, sugar or salt. Therefore, the intake of fruit and vegetables is not only a prominent indicator of people's dietary behavior but public health outcomes. Hyson (2002) pointed out that there is a link between fruit and vegetables intake and major health problems, such as heart disease, stroke, some forms of cancer and pregnancy complications. According to the evidence of The World Health Report 2002, low intake of fruit and vegetables is estimated to cause about 31% of ischaemic heart disease, 19% of gastrointestinal cancer and 11% of stroke worldwide. Thus, if consumed fruit and vegetables daily in sufficient amount, it could help us prevent obesity and major diseases such as CVDs and certain

cancers. It is estimated that up to 2.7 million lives could potentially be saved each year with sufficient global fruit and vegetables intake, according to WHO report on Fruit, vegetables and NCD prevention.

What is the sufficient amount of fruit and vegetables daily intake? A recent WHO/FAO expert consultation report on diet, nutrition and prevention of chronic diseases, sets population nutrient goals and recommends intake of a minimum of 400 g of fruits and vegetables per day for the prevention of chronic diseases such as heart diseases, cancer, diabetes and obesity. Following requests by the World Health Organization to consume at least 400g of vegetables daily, in 1991 the National Cancer Institute and the Produce for Better Health Foundation jointly established the national 5 A Day for Better Health Program to encourage the consumption of at least five servings of fruit and vegetables each day (Serdula *et al*, 2004).

Although research proves that eating at least 5 portions of fruit and vegetables each day indeed has real health benefits, recent research shows that only 1 in 7 of people in the U.S. achieve the 5 a day quota. What is the current situation of fruit and vegetables consumption in Arizona? Which factors can explain whether Arizona's individuals consume five or more servings of fruits and vegetables per day? A necessary research should be conducted concerning checking the determinants of daily fruit and vegetables intake and the factors influenced the probability of consuming five or more servings of fruit and vegetables per day.

In order to estimate which characteristics are associated with consumption of fruit and vegetables in Arizona, besides individual/household characteristics, we should also consider the relationship between neighborhood factors and individual's dietary behaviors. Recently, neighborhood factors related to healthy foods recommended by the 2005 US Department of Agriculture Dietary Guidelines for Americans, sometimes termed the local food environment, have received increasing attention. Morland K. *et al*. (2002) found that access to affordable healthy foods in neighborhood is associated with promoting a healthy diet and that poor access always leads to poor diet and poor health outcomes. Along with the growing attention of "food environment", currently, "food deserts" were mentioned and explored frequently in many studies. The phenomenon of "food deserts" once was commented during the 1990s. "Food deserts" were defined, by the British Low Income Project Team in 1996, as 'areas of relative exclusion where people experience physical and economic barriers to accessing healthy food'. The studies that focus on the "food deserts" usually explored individuals' dietary patterns that lived in "food deserts". Evidence form the report of The Food Trust and The Philadelphia Health Management Corporation (PHMC) on How Food Access Affects Diet and Health suggested that lack of access to fresh food through supermarkets decreases the individuals' fruit and vegetables intake.

This paper contributes to an understanding of which factors, including both individual / household factors and the food environment factors, play more important role in daily fruit and vegetables intake in Arizona and in the probability of

consuming five or more servings of fruit and vegetables per day. To reflect the availability and accessibility of food stores which provide affordable, inexpensive and fresh fruit and vegetables in different zip code areas of Arizona, the food environment variables we included are different types of food stores density (ratios of number of different types of food stores in each zip code to the areas in square miles in each zip code), such as number of large supermarkets / areas in miles^2, number of convenience stores / areas in miles^2, and number of limited-service restaurants / areas in miles^2.

To achieve the goal of this study, we need to answer some specific research questions: Which individual/household characteristics are associated with greater daily fruit and vegetables intake and greater probability of consuming five or more servings of fruit and vegetables per day? Does neighborhood food stores density affect daily fruit and vegetables intake? In Specific, do more large supermarkets in a zip code neighborhood increase individuals' daily fruit and vegetables intake? Do more limited-service restaurants decrease the daily consumption of fruit and vegetables in Arizona?

Matched by the individual/household data from 2005 Behavior Risk Factor Surveillance System Data (BRFSS) and neighborhood data from 2005 U.S. Bureau of the Census Zip Code File, a representative sample with over 4600 respondents was collected to identify a multivariate regression analysis to answer the above questions. Using the matched data, an OLS regression model was implemented to explore which factors effect number of servings of fruit and vegetables intake in Arizona. In addition,

a logit model was used to predict the likelihood of consuming five or more servings of fruit and vegetables per day.

Previous studies usually explore the neighborhood effects on fruit and vegetables intake at a small census track level such as a specific district of a city. Researchers must either purchase the data that can be expensive or manually collect them relying on data from Geographic information system (GIS) and programming, using individual surveys of local shopping patterns. Therefore, the approach of collecting food environment data in previous studies is expensive and the sample size of the data is limited. It is difficult to compare the results in different studies because the geographic scope and measurement different among each study. In contrast to the disadvantages of previous studies, there are several advantages of using zip code data in this study. It is very convenient to obtain the zip code business pattern data because 2005 U.S. Bureau of the Census Zip Code File is released to the internet and downloadable. Matching the zip code business pattern data with BRFSS individual/household data allows for large sample estimation. Since the geographic scope and measurement are same for all regions, it provides a greater scope for replicating this approach in other areas or studies. Thus, it is easier to compare results when similar methods and data are used in different studies.

Chapter 2
Literature Review

Demographic Factors Affecting Fruit and Vegetables Intake

Individuals' demographic characteristics, especially, gender, age, race and education level, are among the most important and promising venues for exploring their fruit and vegetable intake. It seems that gender and age predominate in influencing consumption of fruit and vegetables. Male ate less fruit than female grocery shoppers and the vegetables consumption increases slightly with age (Pearson *et al*., 2005). Some results confirm the findings of other studies that have shown that being young or male are important determinants of low fruit and vegetable consumption. As well, education is a more important discriminator between low and higher consumers than occupation (Thompson *et al*., 1999). Many previous studies investigate the relationship between fruit and vegetables intake and demographic factors of individuals who are living in a specific "food desert" area. Researchers have identified African American or Hispanic neighborhoods face poor supermarket access within U.S. urban areas, especially compared to more affluent suburban and primarily white residential areas (Chung and Myers 1999; Weinberg 2000; Eisenhauer 2001; Morland, Wing, Diez Roux, and Poole 2002;).

Economic Factors Explaining Fruit and Vegetables Intake

Rising income, lower fruit and vegetables price, and improved policies and nutrition programs are all shaping individuals' fruit and vegetables consumption. Researchers found that there is indirect association between income and fruit and vegetable intake (Shannon Zenk et al, 2005). Daily fruit and fruit product consumption is twice as high in high-income households as in low-income households, with high-income households devoting 12 per cent of their average weekly food expenditure to fruit and fruit products, compared with just 7 per cent in the case of low-income households (Wrigley,2002). And low-income families in the United States are twice as likely as higher income families not to buy any fruit or vegetables in a given week (Blisard *et al*., 2004). Elderly and low-income households are identified to be at greater risk of malnutrition, food insecurity, type 2 diabetes, and other dietary diseases (Hux, Booth, and Laupacis 2002). Besides the income response of fruit and vegetables intake, researchers always consider the price response. Findings indicate that cost is one of the factors contributing to less fruit and vegetables consumption among low-income populations (Moshfegh, 2007). However, there are also some results show that vegetable price is not significantly associated with either fruit or vegetable consumption (Pearson *et al*., 2005). According to evidence presented in World Health Report 2003, low fruit and vegetable intake is among the top 10 risk factors contributing to attributable mortality. Thus, in some

developed countries fruit and vegetables promotion initiatives have been developed for several years. National fruit and vegetables programs such as 5 A Day in U.S. have now been set up in many countries worldwide. Research found that improving policy and changing price can increase the fruit and vegetables intake (Glanz and Hoelscher, 2004). The finding of previous researches suggest that the majority of fruit and vegetables promotion interventions lead to increased consumption at least in a short term. However, there is no review has conducted a meta-analysis quantifying the effectiveness of these promotion interventions (Pomerleau *et al*. 2004).

Local Food Access on Food Choice

Environmental factors are importantly related to dietary choice among low-income households (Donald and Rickelle, 2004). The access to inexpensive and fresh fruit and vegetables in a neighborhood is a vital factor of good food environment. The cost and availability of foods depend on types and number of local stores. Comparing with larger supermarkets and other grocery stores, the price of food tends to be higher and the availability tends to be poor at smaller stores. According to Rose et al. (2004), living close to a supermarkets leads to higher fruit and vegetables consumption among low-income household. Besides, Fik (1988) demonstrated that significant spatial relationships exist in markets prices and the degree of price dispersion in geographically competitive markets.

Recently, more and more researchers are accepting the "food deserts" as a

subject worthy of academic consideration on fruit and vegetables consumption. A food desert is an urban district with little or no access to foods needed to maintain a healthy diet, but often served by plenty of fast food restaurants. Besides poverty, lacking access to large supermarkets providing inexpensive, fresh and healthy food is a major barrier against individuals' fruit and vegetables intake in U.S. Usually, individuals without cars can not go to remote supermarkets selling fresh foods and instead uses local fast food outlets. Thus, research into "food deserts" in U.S. has focussed on the distance people have to travel to a store selling healthy food, and the lack of easy access by poor urban people to healthy food. However, the measurements for lacking food store access are different in each study.

Most previous studies collected neighborhood data from Geographic information system (GIS) and used both food store access variables and household characteristics as control variables. Karen E. *et al.* (2006) calculated spatial accessibility to supermarkets using both the minimum distance and coverage methods with ESRI's ArcView 3.2 GIS (2000). Zenk *et al.* (2005) analyzed the data from a sample of 266 African-American women living in 2001 in eastside Detroit, which had no supermarkets, using structural equation modeling to calculate a path model of direct and indirect effects. Through a postal survey of 1000 addresses (response rate 42%), Pearson *et al*. (2005) gathered information to derive road travel distance to nearest supermarket and deprivation index. Wrigley *et al.* (2002) explored a major retail provision on diet in a 'food desert' by checking the consumption patterns in the

highly deprived, previously poor food retail access area of Seacroft and Leeds where experienced a sudden and significant change in its food retail access as a result of the opening of a large superstore by the UK's leading food retailer. Through a Poisson regression, Moore *et al.* (2005) examined the association of food stores and liquor stores with racial/ethnic composition and income in selected census tracts in North Carolina, Maryland, and New York.

Some findings indicate that food deserts do indeed impact nutritional intake. Residents of food deserts are less likely to consume five or more servings of fruit and vegetables per day (Troy C. Blanchard and Thomas A.Lyson, 2005). Residents lacking ready access to a major grocery chain often pay higher prices for lower selection, and in some cases pay more for lower quality as well (Sooman, Macintyre, and Anderson 1993; Chung and Myers 1999). Besides the accessibility of food stores, the price of fruit and vegetables is another factor of "food deserts". Cost is one of the factors often cited as contributing to less fruit and vegetable consumption among low-income populations (Moshfegh, 2007). However, there are also some results show that Deprivation, supermarket fruit and vegetable price, distance to nearest supermarket and potential difficulties with grocery shopping were not significantly associated with either fruit or vegetable consumption and lack of locally available supermarket was not factor influencing fruit or vegetable intake (Pearson *et al*.,2005). More positive perceptions of the selection/quality, but not affordability, of fresh produce at the retail outlet were positively associated with intake (Zenk *et al*, 2005).

Other researchers have identified poor supermarket access for low income, inner-city, and predominantly African American or Hispanic neighborhoods within U.S. urban areas, especially compared to more affluent suburban and primarily white residential areas (Cotterill and Franklin 1995; Curtis and McClellan 1995; Weinberg 2000; Eisenhauer 2001; Morland, Wing, and Diez Roux 2002; Morland, Wing, Diez Roux, and Poole 2002). Research in the United States has generally found poor access to supermarkets for urban, inner-city, low-income populations, particularly if they are also African American (Marion 1982; Turque 1992; Bell and Burlin 1993; Cotterill and Franklin 1995; Alwitt and Donley 1997; Weinberg 2000; Morland, Wing, Diez Roux, and Poole, 2002.).

Chapter 3
Data

Our representative sample is matched by two parts: individual / household data and food environment data.

To assess the level of fruit and vegetable consumption among adults by individual / household characteristics, data from the 2005 Behavioral Risk Factor Surveillance System (BRFSS) were analyzed. The Behavioral Risk Factor Surveillance System (BRFSS) is a state-based system of health surveys that collects information on health risk behaviors, preventive health practices, and health care access primarily related to chronic disease and injury. For many states, the BRFSS is the only available source of timely, accurate data on health-related behaviors. The BRFSS questions were developed as a valid assessment of fruit and vegetable consumption according to the National Cancer Institute (NCI) guidelines, and will be used as the basis for reporting the prevalence of the population consuming five servings a day or more, and other categories of consumption. Initially developed in 1984 by the Centers for Disease Control and Prevention (CDC) in collaboration with state health departments, BRFSS is currently conducted in all 50 states, the District of Columbia, and three United States territories. It is a random telephone survey of state residents aged 18 and older in households with telephones. To monitor state progress toward health objectives, the information of BRFSS is collected in a routine,

standardized manner at the state level on a variety of health behaviors and preventive health practices.

In 2005 more than 4600 Arizona respondents were asked about their daily fruit and vegetables intake and individual / household characteristics including gender, age, race, veteran status, pregnant status, education level, income, number of children, attitude towards life, health condition, and the zip codes of their living places. As for the respondents' daily fruit and vegetables intake, BRFSS provides us two kind of information: the number of servings of fruit and vegetables intake per day and whether the respondents consume five or more servings of fruit and vegetables. To measure the individuals' daily fruit and vegetables intake, 1 serving is equal to 1 medium piece of fruit (apple, orange, banana) / ½ cup fresh or canned cut-up fruit / ¼ cup dried fruit / ¾ cup 100% fruit juice / ¾ cup 100% vegetable juice / ½ cup raw or cooked vegetables / 1 cup raw leafy vegetables (lettuce, spinach) / ½ cup cooked peas or beans (lentils, pinto beans, kidney beans, etc.).

Obtaining the zip codes of respondents along with the individual / household data, over 400 observations of zip codes level neighborhood data are collected from 2005 U.S. Bureau of the Census Zip Code File. This file presents data on the total number of establishments, employment and payroll for more than 40,000 5-digit zip code areas nationwide. In addition, the number of establishments for nine employment-size categories is provided by detailed industry for each zip code. From this file we collect the number and size of different types of food stores and the areas

in square miles of each zip code in Arizona. Using these information, we conducted the different types of food stores density (ratios of number of different types of food stores in each zip code to the areas in square miles in each zip code), including the density of large supermarkets, small supermarkets, convenience stores, gasoline stations with convenience stores, fruit and vegetable markets, limited-service restaurants and snack and nonalcoholic beverage bars.

Since there is less change for individuals to purchase food outside of the zip code where they are living in, the different types of food stores density in the zip code level neighborhood data correctly reflect the availability and accessibility of inexpensive and fresh fruit and vegetables in each zip code area. Besides, the way of collecting the food environment data in this study is very easy and inexpensive because all zip code business pattern data are released to public domain and downloadable. In addition, matching the zip code level neighborhood data with individual / household data bring us more scope for using larger sample sizes and for replicating analyses across different areas. However, zip code areas can be very large in rural areas and we do not know for certain if that is where people purchase food, so the estimation results may not be correctly reflect the true situation.

Chapter 4

Econometric Methods

To explore which factors influence daily fruit and vegetables intake in Arizona and the probability of consuming five or more servings of fruit and vegetables a day, we develop an OLS regression model and a logit model respectively. The definitions of variables are reported in Table 1.

OLS Regression Model

$$
\begin{aligned}
FRTSERV_i = {} & \beta_0 + \beta_1 * SEX_i + \beta_2 * HISPANC_i + \beta_3 * PRACE\_2_i + \beta_4 * PRACE\_3_i \\
& + \beta_5 * PRACE\_4_i + \beta_6 * PRACE\_5_i + \beta_7 * PRACE\_6\&7_i + \beta_8 * VETERAN_i \\
& + \beta_9 * AGE_i + \beta_{10} * PREGNANT_i + \beta_{11} * EDUCAG\_1_i + \beta_{12} * EDUCAG\_3_i \\
& + \beta_{13} * EDUCAG\_4_i + \beta_{14} * INCOMG\_1_i + \beta_{15} * INCOMG\_2_i + \beta_{16} * INCOMG\_3_i \\
& + \beta_{17} * INCOMG\_4_i + \beta_{18} * EMPLOY\_3_i + \beta_{19} * EMPLOY\_4_i + \beta_{20} * EMPLOY\_5_i \\
& + \beta_{21} * EMPLOY\_6_i + \beta_{22} * EMPLOY\_7_i + \beta_{23} * EMPLOY\_8_i + \beta_{24} * CHLDCNT\_1_i \\
& + \beta_{25} * CHLDCNT\_2_i + \beta_{26} * CHLDCNT\_3_i + \beta_{27} * CHLDCNT\_3_i + \beta_{28} * CHLDCNT\_4_i \\
& + \beta_{29} * CHLDCNT\_5_i + \beta_{30} * DIABETE2_i + \beta_{31} * RFHYPE5_i + \beta_{32} * EMTSUPRT_i \\
& + \beta_{33} * LSATISFY_i + \beta_{34} * R\_445110\_A\_SMALL_i + \beta_{35} * R\_445110\_A\_LARGE_i \\
& + \beta_{36} * R\_445120\_A_i + \beta_{37} * R\_445230\_A_i + \beta_{38} * R\_447110\_A_i + \beta_{39} * R\_722211\_A_i \\
& + \beta_{40} * R\_722213\_A_i + \mu_i
\end{aligned}
\tag{4.1}
$$

By using the servings of respondents' daily intake of fruit and vegetables as dependent variable, the ordinary linear regression model was developed. According to the definition by BRFSS, 1 serving is equal to 1 medium piece of fruit (apple, orange,

banana) / ½ cup fresh or canned cut-up fruit / ¼ cup dried fruit / ¾ cup 100% fruit juice / ¾ cup 100% vegetable juice / ½ cup raw or cooked vegetables / 1 cup raw leafy vegetables (lettuce, spinach) / ½ cup cooked peas or beans (lentils, pinto beans, kidney beans, etc.). As a continuous dependent variable, the distribution of servings of fruit and vegetables intake per day in Arizona was shown in table2 and table3. Our data shows that the mean consumption of fruit and vegetables was almost four servings. Approximately 4.32% of Arizona adult population surveyed consumed less than one serving of fruit and vegetables per day; 83.96% ate three or more servings per day but only 26.31% eat five or more servings, However, there is also 2.28% of respondents consumed ten servings or more fruit and vegetables a day.

Logit Model

$$
\begin{aligned}
FV5SRV_i = {} & \beta_0 + \beta_1 * SEX_i + \beta_2 * HISPANC_i + \beta_3 * PRACE\_2_i + \beta_4 * PRACE\_3_i \\
& + \beta_5 * PRACE\_4_i + \beta_6 * PRACE\_5_i + \beta_7 * PRACE\_6\&7_i + \beta_8 * VETERAN_i \\
& + \beta_9 * AGE_i + \beta_{10} * PREGNANT_i + \beta_{11} * EDUCAG\_1_i + \beta_{12} * EDUCAG\_3_i \\
& + \beta_{13} * EDUCAG\_4_i + \beta_{14} * INCOMG\_1_i + \beta_{15} * INCOMG\_2_i + \beta_{16} * INCOMG\_3_i \\
& + \beta_{17} * INCOMG\_4_i + \beta_{18} * EMPLOY\_3_i + \beta_{19} * EMPLOY\_4_i + \beta_{20} * EMPLOY\_5_i \\
& + \beta_{21} * EMPLOY\_6_i + \beta_{22} * EMPLOY\_7_i + \beta_{23} * EMPLOY\_8_i + \beta_{24} * CHLDCNT\_1_i \\
& + \beta_{25} * CHLDCNT\_2_i + \beta_{26} * CHLDCNT\_3_i + \beta_{27} * CHLDCNT\_3_i + \beta_{28} * CHLDCNT\_4_i \\
& + \beta_{29} * CHLDCNT\_5_i + \beta_{30} * DIABETE2_i + \beta_{31} * RFHYPE5_i + \beta_{32} * EMTSUPRT_i \\
& + \beta_{33} * LSATISFY_i + \beta_{34} * R\_445110\_A\_SMALL_i + \beta_{35} * R\_445110\_A\_LARGE_i \\
& + \beta_{36} * R\_445120\_A_i + \beta_{37} * R\_445230\_A_i + \beta_{38} * R\_447110\_A_i + \beta_{39} * R\_722211\_A_i \\
& + \beta_{40} * R\_722213\_A_i + \varepsilon_i
\end{aligned}
$$

$$\varepsilon_i \sim iid \text{ logistic } (0, \pi^2 / 3) \quad (4.2)$$

Since eating at least the recommended five or more servings of fruit and vegetables a day is the most important element of any healthy eating plan and an essential part of a healthy and balanced diet, it is important to explore which factors can influence the five or more servings of fruit and vegetables daily intake. To predict the likelihood of consuming five or more servings of fruit and vegetables per day, a logit model was developed. The dependent variable in this analysis is a binary measure of fruit and vegetable intake coded 1 if the respondent consumes five or more servings of fruit and vegetables a day and 0 if the respondent consumes less than five servings. We chose five or more servings as our dependent variable based on recommended daily intakes of fruits and vegetables (Hyson 2002). Whether individuals consume five or more servings of fruits and vegetables is an important index to see whether they incept a sufficient amount of micronutrients and fiber that are needed to maintain their health. Table 2 and table 3 show that 26.31% respondents in the survey eating the recommended servings of fruits and vegetables, compared to 23.2% for the United States.

Considering the daily fruit and vegetables intake in Arizona is a function of both individual / household characteristics and density of different types of food establishments, there are some explanatory variables in both OLS regression model and logit model.

Explanatory Variables in the models

According to the constitution of data in our representative sample, our explanatory variables are constituted by two parts: individual / household variables and neighborhood variables. These variables are not exactly the same as those used by previous theoretical and empirical relationships studies; instead, they were chosen from the survey data because of their correspondence and correlation with those previous variables.

Individual / Household Variables

There are thirteen individual/household variables are included in our models (table 1): a measure of age (in years); a binary indicator for sex (1=female, 0=male); binary indicators for race and ethnicity (white, black, Asian, native Hawaiian or Pacific Islander, American Indian or Alaska native and others); a binary indicator of whether the respondents are of Hispanic origin (1=yes, 0=no); a binary indicator of whether the respondents are veterans (1=yes, 0=no); binary indicators of education level (Did not from graduate high school, High school graduate, Attended college or technical school, College or technical school graduate); binary indicators of annual household income (less than $15,000, $15,000 to less than $25,000, $25,000 to less than $35,000, $35,000 to less than $50,000, $50,000 or more); binary indicators of

employment status (employed for wages, self-employed, out of work for more than 1 year, out of work for less than 1 year, a homemaker, a student, retired, unable to work); binary indicator of number of children in a family (1=no children, 2=1 children, 3=2 children, 4=3 children, 5=4 children, 6=5 or more children); a binary indicator of pregnancy status (1=yes, 0=no); a binary indicator of whether the respondents have high blood pressure (1=yes, 0=no); a binary indicator of frequency of getting emotional support (1=always,0=others); a binary indicator of satisfaction with life (1=very satisfied, 0=others) and a binary indicator of whether the respondents have diabetes (1=yes, 0=no).

Age is correlated with greater accumulated wealth and higher probability of getting illness. Previous researches show that younger men were likely to consume high-fat foods more frequently than older men and younger individuals were likely to consume fruit less frequently than older ones. Therefore, we expect that a positive relationship between age and fruit and vegetables intake.

When it comes to eating habits, men and women reinforce the old saying that they come from different planets: they have different tastes in food with men favoring meat and poultry while women tend to prefer fruits and vegetables. Women were more likely than men to be in the highest frequency category of fruit consumption (Margetts *et al*. 1998). Thus, we expect that women surveyed eat more fruit and vegetables than men do.

There have been studies in the literature on race and ethnicity differences in

fruit and vegetable consumption. Black participants reported greater social influences than did white participants, whereas white adolescents reported greater family environmental influences on fruit and vegetable intake. White participants reported a higher preference for vegetables than did black participants (Granner *et al*., 2004). Since there are differences of dietary culture, education and income level among different race and ethnicity, we expect that race and ethnicity is one of the determinants of fruit and vegetables intake in our survey.

In the United States Mexican-Americans comprise 60 percent of the Hispanic or Latino population. Arizona is one of the states where Mexicans predominantly live in and a state where has the fastest growing Hispanic population in the nation. The document of Arizona human capital shows that Hispanics have low levels of educational attainment and are overrepresented in low paying occupations in Arizona. In addition, the research indicates that Mexicans in the United States eat more meat and saturated fats than white, and use fewer low-fat dairy products and fruit and vegetables. Thus, in this study, we also expect that people who are of Hispanic origin consume less fruit and vegetables than others.

Generally, veterans are with lower education and income level in the United States. Some of them got illness, injury or disability during the military service. The U.S. Department of Labor reported that among men 18 to 24 years old, veterans had a higher unemployment rate than nonveterans (17.2 versus 10.4 percent) in August 2005. Some researchers also found out veterans, especially, women veterans do face a

barrier to find jobs. Therefore, we expect that the respondents who are veteran eat less fruit and vegetables than those who are not veterans,

The individuals' level of education of also has an inconclusive relationship with their fruit and vegetables intake because those who have more education generally also have higher incomes and more diet and health knowledge. With higher educational attainment, consumers are equipped with better dietary knowledge and hence consume more fruits and vegetables, except fried potatoes and chips (Lin, 2004). Therefore, we expect that the higher the education level, the more fruit and vegetables people consume.

People with low incomes face the challenges to pursue lifestyles that support healthy dietary habits. They generally know they should eat more fruit and vegetables but cannot afford such foods. Income is found to directly affect fruit and vegetable consumption, and it also affects eating out and dietary knowledge—which in turn affect fruit and vegetable consumption. Higher income leads to more eating out and better dietary knowledge. While knowledge leads to more fruit consumption, eating out lowers fruit consumption. On the other hand, eating out increases and knowledge decreases the consumption of fried potatoes and potato chips (Lin, 2004). Thus, we expect that income is positively correlated with fruit and vegetables intake.

People's employment status reflects their education and income level. Usually, a person who has a good job always received better education and have higher annually income than others. Thus, similar to the variables of education and income

level, employment status should also be one of the determinants of fruit and vegetables intake.

There are many reasons for children to enjoy eating a wide variety of fruit and vegetables. Fruit and vegetables provide important vitamins such as vitamin C and folic acid that are vital to the healthy growth of children. Therefore, we expect that the more numbers of children in the family, the more servings of fruit and vegetables were consumed in this family. However, eating habits begin to form early in life. Parents and increasingly day care providers play an important role, both as role models and gatekeepers of the foods available, in influencing what children eat. Among adults, habits, such as “eating lots of fruits and vegetables” during childhood was a significant positive predictor of their current fruit and vegetables intake (Dennison, Rockwell, and Baker, 1998), thus, it is hard to see whether this variable is correlated to the fruit and vegetables daily intake or not.

Pregnancy is a time when good nutrition is vital. Since ensure that women should have a well balanced diet with plenty of fresh fruit, vegetables (especially green vegetables) and wholegrain cereals, we expect that women during pregnancy consume more fruit and vegetables.

Eating fruit and vegetables can reduce high blood pressure and the risk of getting type II diabetes. Although certain type of fruit may not suit for people who have diabetes, they can still eat fruit that rank low on the glycemic index by doctors' recommendation. Previous research shows that the mean daily intake of fruits and

vegetables as well as the percentage of participants consuming five or more fruits and vegetables per day was lower among persons who developed diabetes than among persons who remained free of this disease (Ford and Mokdad, 2001). Therefore, we expect that people who had high blood pressure or Type II Diabetes eat more fruit and vegetables.

There is maybe a relationship between people' attitude towards life and their dietary habit. People with positive attitude towards life may have good and healthy dietary habit. Since always receiving emotional support or being quite satisfied with life reflects a positive attitude towards life, we expect that people with these characteristics consume more fruit and vegetables.

Neighborhood Variables

In order to examine the relationship between the "food deserts" and individuals' daily intake of fruit and vegetables in Arizona, we included neighborhood variables in our models. Through Behavior Risk Factor Surveillance System Data (BRFSS), we obtained the zip code of the place where each respondent lived in. We also get the information about the areas in square miles of each zip code and the numbers of different kinds of food stores from 2005 U.S. Bureau of the Census Zip Code File. The information obtained on food stores from 2005 U.S. Bureau of the Census Zip Code File also included name, address, NAICS code, number of annual

employees, approximate square footage, and type of business.

To reflect the availability, affordability and accessibility of food stores which provide affordable, inexpensive and nutritious foods and neighborhood need in different zip code areas of Arizona, the neighborhood variables we included are different types of food stores density (ratios of number of different types of food stores in each zip code to the areas in square miles in each zip code). They are number of supermarkets and other grocer (except convenience stores) with less than 50 employees / areas in miles², number of supermarkets and other grocery (except convenience stores) with 50 or more employees / areas in miles², number of convenience stores / areas in miles², number of gasoline stations with convenience stores / areas in miles², number of fruit and vegetable markets / areas in miles², number of limited-service restaurants / areas in miles², number of snack and nonalcoholic beverage bars / areas in miles².

Supermarkets and Other Grocery (except Convenience) Stores with 50 or more employees was defined as large supermarkets and grocery stores in this study because of their respectively larger capacity of employment compared with supermarkets and other grocery stores with less than 50 employees. In U.S. a wide variety of affordable, nutritious food, such as vegetables, fruits, whole grains and lean proteins, is often more available in the large supermarkets than other food stores. The prices of these foods are also lower than those in other food stores. A research shows that over 70% of the low-income population in the Delta traveled 30 or more miles to

purchase groceries at supermarkets in an effort to avoid high priced smaller grocers and inadequate quality food sold at convenience stores and gas stations (Blanchard and Lyson, 2003). Therefore, we expect that the bigger the ratio of number of large supermarkets and grocery stores to the area of a certain zip code neighborhood, the higher the probability that people living in this zip code neighborhood consume more fruit and vegetables.

Supermarkets and Other Grocer (except Convenience)Stores with less than 50 employees was defined as small supermarkets and grocery stores in this study which is opposite to large supermarkets and grocery stores. Lacking competitive incentives to reduce prices and facing higher in terms of retail space, insurance, and delivery (Macdonald and Nelson 1991; Bell and Burlin 1993), small supermarkets and grocery stores may provide fruit and vegetables but the quantity of these foods is smaller and prices are higher than those in large supermarkets and grocery stores. Therefore, bigger ratio of number of small supermarkets and grocery stores to the area of a certain zip code neighborhood may increase probability that people living in this zip code neighborhood consume more fruit and vegetables.

Convenience Stores typically sell a limited line of high-convenience items and food basics, such as milk, bread, beverages, and snacks. Some of them also offer readymade sandwiches and other prepared foods for immediate consumption along with an assortment of nonfood items, such as magazines. Consumers purchasing food at a convenience store pay a premium for access to food products. Additionally,

consumers choose from a smaller variety of food products that may not be suitable for the maintenance of a healthy diet. Lack of the supplement of fresh fruit and vegetables, larger convenience stores density may decrease the individuals' daily intake of fruit and vegetables.

Gasoline Stations with Convenience Store sells mainly gasoline, groceries, cigarettes, beer and wine, and prepared food. Just like convenience stores, the foods provided in gasoline stations with convenience store are lack of affordable, nutritious foods but combined with a plethora of inexpensive, unhealthy foods. Thus, the same to convenience stores density, the larger the gasoline stations with convenience store density, the lower the individuals’ consumption of fruit and vegetables.

Fruit and Vegetable Markets primarily engage in retailing fresh fruits and vegetables. Thus, if this kind of stores is available, affordable and accessible in a certain zip code neighborhood, the individuals' fruit and vegetables daily intake in this area should be high though the prices of the fruit and vegetables sold in this kind of store may be higher than those in large supermarkets and grocery stores.

Limited-Service Restaurants primarily engage in providing food services (except snack and nonalcoholic beverage bars) where patrons generally order or select items and pay before eating. Food and drink may be consumed on premises, taken out, or delivered to the customer's location. Since the most common type of a limited-service restaurants is a franchised operation of a nationwide restaurant chain that sells fast food, there are little foods supplied in this kind of restaurants are made

of fruit and vegetables. Thus, people who always to this kind of restaurants may not have many choices to have healthy diet.

Snack and Nonalcoholic Beverage Bars primarily engage in preparing and/or serving a specialty snack, such as ice cream, frozen yogurt, cookies, or popcorn or serving nonalcoholic beverages, such as coffee, juices, or sodas for consumption on or near the premises. It is similar to limited-service restaurants, the food supplied in this kind beverage bars are lack of fruit and vegetables.

Descriptive Statistics for Explanatory Variables

The descriptive statistics of the survey for all variables included in our models are summarized in the appendix. Table 2 respectively shows the distribution of age, gender, race or ethnicity (Hispanic or Latino information was not used to derive this variable), Hispanic origin, veterans, education level, income level, employment status, pregnancy status, high blood pressure, diabetes, emotional support and satisfaction with life.

For all respondents in the survey, the mean age was almost 53 years (Table 2). 24.23% were of Hispanic origin; 77.32% were white and 3.5% were American Indian or Alaska Native; 16.77% were veterans; 3.96% of the women were pregnant at that time; 30.27% attended colleges and also 30.27% graduated from colleges; 33.36%

earned $50,000 or more annually; 48.67% were employed for wages or self-employed; 73.11% had no children in the family; 9.83% had diabetes; 69.48% had high blood pressure; 49.49% always got emotional support and 48.18% were quite satisfied with their life.

As for the neighborhood variables, both the means of small supermarkets density and those of large supermarkets density are about 0.11 (table 5); on average, the convenience stores density is close to 0.09, which is lower than the density of gasoline stations with convenience stores (almost 0.34); the mean of density of snack and nonalcoholic beverage bars is almost 0.19; the mean of fruit and vegetable markets density is quite small (less than 0.01), indicating that there are only few this type of fruit and vegetables markets exist in Arizona area; However, the limited service restaurants density is very high (about 0.94).

Among the respondents who consumed five or more servings of fruit and vegetables a day, their mean age were 54 years old; 70.07% were women and 4.32% of them were pregnant (table 4). Among racial or ethnic populations, white had the highest prevalence (77.33%) of consuming five or more servings of fruit and vegetables per day (table8), For another separated variable, 21.52% are of Hispanic origin among all the people who consumed five or more servings of fruit and vegetables. 13.71% of the people who consumed five or more fruit and vegetables are veteran. College graduates had the highest level (34.79%) of consuming five or more servings of fruit and vegetables per day compared with lower levels of education, as

did persons who earned $50,000 or more per year (30.67%) compared with those who earned less. Persons who were employed for wages or self-employed had the highest prevalence of consuming five or more servings of fruit and vegetables per day (46%), retired persons had the second highest prevalence(31.33%) and persons who were out of work for less than 1 year had the lowest prevalence (1.32%). The adults who had no children in the family had the highest prevalence (69.58%) of consuming five or more servings of fruit and vegetables compared with other categories. 53.22% of people who consumed five or more fruit and vegetables were always get emotional support compared with other categories. 52.63% were very satisfied with their life among the people who had five or more fruit and vegetables. 9.23% of the people who consumed five or more fruit and vegetables had diabetes and 68.76% had high blood pressure. Concerning the means and standard deviations of different types of food stores, those reported by the respondents who consume less than five servings of fruit and vegetables per day and those reported by ones who ate five or more servings, both of them are quite similar to those among the whole respondents surveyed, which are mentioned in previous paragraph (Tables 5, 6 and 7).

Table 1. **Variable Definitions**

Variables	Definition
FV5SRV	Servings of fruit & vegetables per day
FRTSERV	Five or more servings of fruit & vegetables per day
SEX	Sex
HISPANC	Hispanic
Preferred Race	
PRACE_1	White
PRACE_2	Black
PRACE_3	Asian
PRACE_4	Native Hawaiian or Pacific Islander
PRACE_5	American Indian, Alaska Native
PRACE_6&7	Other Race, No Preferred Race, Multiracial
VETERAN	Veteran
AGE	Age
PREGNANT	Pregnancy status
Education level	
EDUCAG_1	Did not graduate high school
EDUCAG_2	High school graduate
EDUCAG_3	Attended college or technical school
EDUCAG_4	College or technical school graduate
Income level	
INCOMG_1	Less than $15 ,000
INCOMG_2	$25,000 to less than $35,000
INCOMG_3	$25,000 to less than $35,000
INCOMG_4	$35,000 to less than $50,000
INCOMG_5	$50,000 or more
Employment status	
EMPLOY_1	Employed for wages
EMPLOY_2	Self-employed
EMPLOY_3	Out of work for more than 1 year
EMPLOY_4	Out of work for less than 1 year
EMPLOY_5	A homemaker
EMPLOY_6	A student
EMPLOY_7	Retired
EMPLOY_8	Unable to work
CHLDCNT_0	no children

CHLDCNT_1	1 child
CHLDCNT_2	2 children
CHLDCNT_3	3 children
CHLDCNT_4	4 children
CHLDCNT_5	5 or more children
DIABETE2	Diabete
RFHYPE5	High Blood Pressure
EMTSUPRT	Always get emotional support
LSATISFY	Very satisfied with life
Food stores density	
R_445110_A_SMALL	# of Small Supermarkets / Areas in mile²
R_445110_A_LARGE	# of Large Supermarkets / Areas in mile²
R_445120_A	# of Convenience Stores / Areas in mile²
R_445230_A	# of Fruit and vegetable Markets / Areas in mile²
R_447110_A	# of Gasoline Stations with Convenience Stores / Areas in mile²
R_722211_A	# of Limited-Service Restaurants/Areas in mile²
R_722213_A	# of Snack and Nonalcoholic Beverage Bars/Areas in mile²

Figure 1.

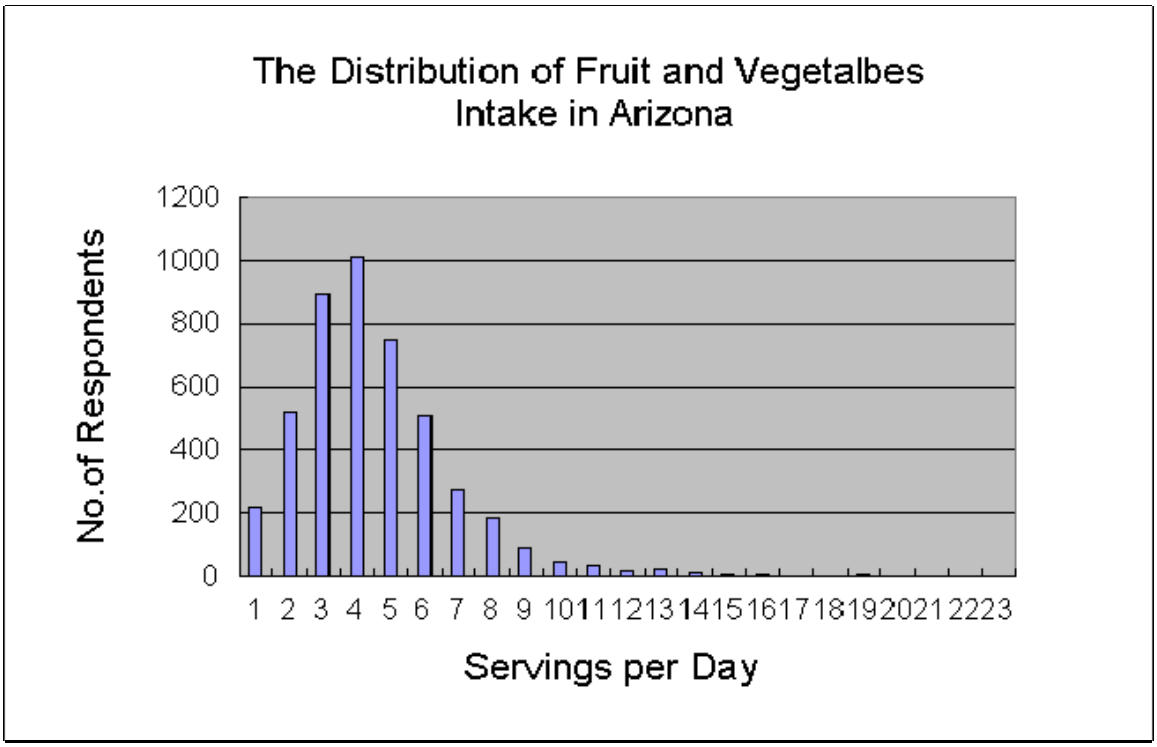

Figure 2.

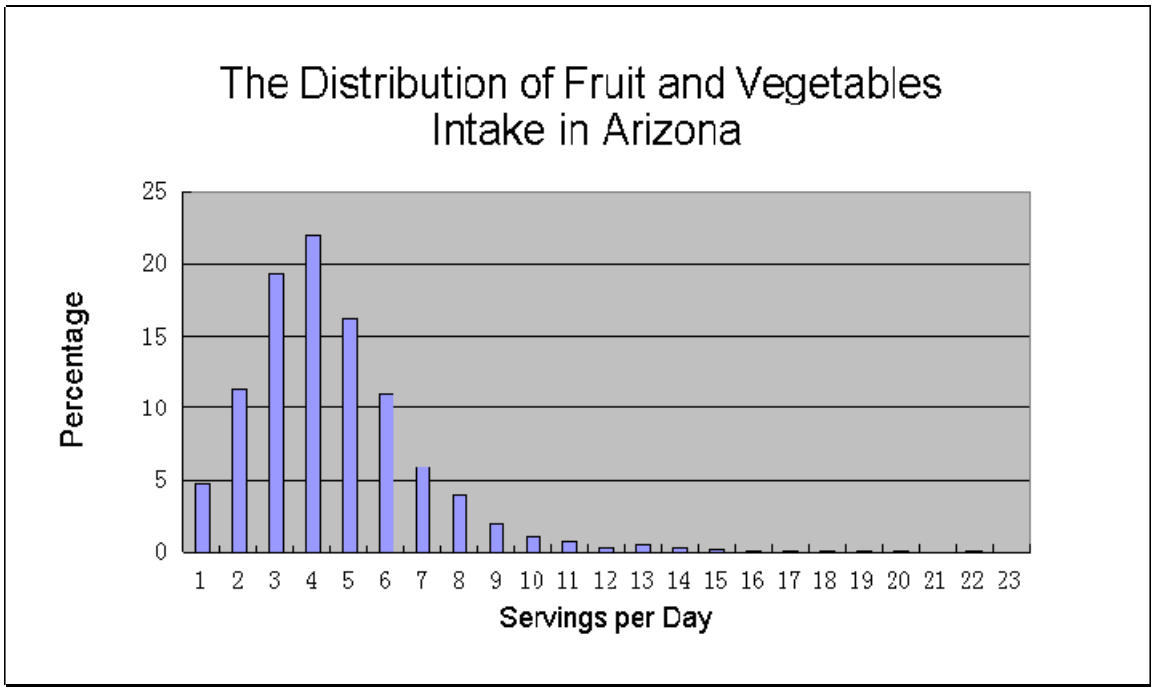

Table 2. Descriptive Statistics for Study Variables (All Observations)

Variable	N	Mean	Std Dev	Minimum	Maximum

FRTSERV	4606	3.9893205	2.3758039	0	22.1
FV5SRV	4606	0.2633521	0.4404996	0	1
SEX	4606	0.3725575	0.4835382	0	1
HISPANC	4578	0.2424640	0.4286202	0	1
PRACE_1	4516	0.7736935	0.4184861	0	1
PRACE_2	4516	0.0141718	0.1182120	0	1
PRACE_3	4516	0.0095217	0.0971243	0	1
PRACE_4	4516	0.0044287	0.0664083	0	1
PRACE_5	4516	0.0349867	0.1837665	0	1
PRACE_6&7	4516	0.1631975	0.3695867	0	1
VETERAN	4603	0.1672822	0.3732682	0	1
AGE	4569	52.7498359	17.5651718	18	99
PREGNANT	4606	0.0089014	0.0939368	0	1
EDUCAG_1	4595	0.1268770	0.3328714	0	1
EDUCAG_2	4595	0.2845286	0.4512377	0	1
EDUCAG_3	4595	0.2951034	0.4561389	0	1
EDUCAG_4	4595	0.2948857	0.4560410	0	1
INCOMG_1	3918	0.1294028	0.3356880	0	1
INCOMG_2	3918	0.2154160	0.411163	0	1
INCOMG_3	3918	0.1385911	0.3455635	0	1
INCOMG_4	3918	0.1830015	0.3867171	0	1
INCOMG_5	3918	0.3333333	0.4714636	0	1
EMPLOY_1	4586	0.4094303	0.4917812	0	1
EMPLOY_2	4586	0.0787284	0.2693431	0	1
EMPLOY_3	4586	0.0215874	0.1453480	0	1
EMPLOY_4	4586	0.0226777	0.1488901	0	1
EMPLOY_5	4586	0.1029219	0.3038900	0	1
EMPLOY_6	4586	0.0207152	0.1424448	0	1
EMPLOY_7	4586	0.2924117	0.4549200	0	1
EMPLOY_8	4586	0.0523332	0.2227223	0	1
CHLDCNT_0	4597	0.6482489	0.4775687	0	1
CHLDCNT_1	4597	0.1279095	0.3340254	0	1
CHLDCNT_2	4597	0.1250816	0.3308474	0	1
CHLDCNT_3	4597	0.0643898	0.2454728	0	1
CHLDCNT_4	4597	0.0217533	0.1458929	0	1

CHLDCNT_5	4597	0.0126169	0.1116264	0	1
DIABETE2	4602	0.0980009	0.2973481	0	1
RFHYPE5	4600	0.3052174	0.4605495	0	1
EMTSUPRT	4393	0.4951059	0.5000330	0	1
LSATISFY	4445	0.4816648	0.4997199	0	1
R_445110_A_SMALL	4225	0.1110144	0.2437507	0	2.778827
R_445110_A_LARGE	4225	0.1097163	0.2107120	0	1.5446048
R_445120_A	4225	0.0890017	0.2003860	0	2.7788276
R_445230_A	4225	0.0057768	0.0243964	0	0.2181349
R_447110_A	4225	0.3387476	0.5868240	0	3.3981305
R_722211_A	4225	0.9431432	1.7767738	0	15.5243269
R_722213_A	4225	0.1889400	0.418732	0	4.1116730

Table 3. Descriptive Statistics for Study Variables (FV5SRV=0)

Variable	N	Mean	Std Dev	Minimum	Maximum
FRTSERV	3292	2.9156227	1.1555033	0	5
SEX	3292	0.3976306	0.4894827	0	1
HISPANC	3272	0.2448044	0.4300369	0	1
PRACE_1	3226	0.7730936	0.4188965	0	1
PRACE_2	3226	0.0145691	0.1198387	0	1
PRACE_3	3226	0.0086795	0.0927729	0	1
PRACE_4	3226	0.0040298	0.0633622	0	1
PRACE_5	3226	0.0306882	0.1724982	0	1
PRACE_6&7	3226	0.1689399	0.3747569	0	1
VETERAN	3291	0.1798845	0.3841496	0	1
AGE	3264	51.859375	17.2324738	18	97
PREGNANT	3292	0.0088092	0.0934574	0	1
EDUCAG_1	3287	0.1235169	0.3290796	0	1
EDUCAG_2	3292	0.2928311	0.4551307	0	1
EDUCAG_3	3287	0.3039246	0.4600204	0	1
EDUCAG_4	3287	0.2808032	0.4494599	0	1
INCOMG_1	2815	0.1250444	0.330828	0	1
INCOMG_2	2815	0.2152753	0.4110862	0	1
INCOMG_3	2815	0.1396092	0.3466427	0	1
INCOMG_4	2815	0.19254	0.3943648	0	1
INCOMG_5	2822	0.3291991	0.4700057	0	1
	2822	0.3291991	0.4700057		
EMPLOY_1	3288	0.5042579	0.5000579	0	1
EMPLOY_2	3279	0.020738	0.1425277	0	1
EMPLOY_3	3279	0.0262275	0.1598356	0	1
EMPLOY_4	3279	0.0972858	0.2963917	0	1
EMPLOY_5	3279	0.0195181	0.1383583	0	1
EMPLOY_6	3279	0.2796584	0.4488998	0	1
EMPLOY_7	3279	0.0536749	0.2254094	0	1
EMPLOY_8	3279	0.0536749	0.2254094	0	1
CHLDCNT_0	3283	0.6274749	0.4835508	0	1
CHLDCNT_1	3283	0.1373744	0.3442946	0	1
CHLDCNT_2	3283	0.1312824	0.3377603	0	1
CHLDCNT_3	3283	0.0685349	0.2527	0	1
CHLDCNT_4	3283	0.0234542	0.1513639	0	1

CHLDCNT_5	3283	0.0118794	0.1083598	0	1
DIABETE2	3288	0.0973236	0.0973236	0	1
RFHYPE5	3288	0.0118794	0.2989659	0	1
EMTSUPRT	3141	0.4791468	0.4996445	0	1
LSATISFY	3177	0.4674221	0.4990161	0	1
R_445110_A_SMALL	3098	0.1128479	0.2432397	0	1.641392
R_445110_A_LARGE	3098	0.1082369	0.2071949	0	1.5446048
R_445120_A	3098	0.0892624	0.1961473	0	1.5363103
R_445230_A	3098	0.0053778	0.023651	0	0.2181349
R_447110_A	3098	0.3408145	0.5860729	0	3.3981305
R_722211_A	3098	0.9473307	1.7855697	0	15.5243269
R_722213_A	3098	0.1878653	0.4195837	0	4.111673

Table 4. Descriptive Statistics for Study Variables (FV5SRV=1)

Variable	N	Mean	Std Dev	Minimum	Maximum
FRTSERV	1181	6.967409	2.3690173	5	22.1

SEX	1181	0.299746	0.4583407	0	1
HISPANC	1173	0.2131287	0.4096925	0	1
PRACE_1	1160	0.7887931	0.4083409	0	1
PRACE_2	1160	0.0112069	0.1053132	0	1
PRACE_3	1160	0.012931	0.1130258	0	1
PRACE_4	1160	0.0060345	0.0774806	0	1
PRACE_5	1160	0.0456897	0.2089012	0	1
PRACE_6&7	1160	0.1353448	0.3422391	0	1
VETERAN	1179	0.1382528	0.3453116	0	1
AGE	1172	54.2662116	17.9493771	18	99
PREGNANT	1181	0.0093141	0.0961	0	1
EDUCAG_1	1177	0.1028037	0.3038315	0	1
EDUCAG_2	1181	0.2582557	0.4378608	0	1
EDUCAG_3	1177	0.2871708	0.4526343	0	1
EDUCAG_4	1177	0.3542906	0.4785011	0	1
INCOMG_1	1019	0.1344455	0.3412979	0	1
INCOMG_2	1019	0.2080471	0.40611	0	1
INCOMG_3	1019	0.1295388	0.3359602	0	1
INCOMG_4	1019	0.1648675	0.3712431	0	1
INCOMG_5	1020	0.3637255	0.4813069	0	1
EMPLOY_1	1180	0.4669492	0.499118	0	1
EMPLOY_2	1176	0.0221088	0.1471001	0	1
EMPLOY_3	1176	0.0136054	0.1158955	0	1
EMPLOY_4	1176	0.1139456	0.3178803	0	1
EMPLOY_5	1176	0.0255102	0.1577358	0	1
EMPLOY_6	1176	0.3129252	0.4638814	0	1
EMPLOY_7	1176	0.0467687	0.2112329	0	1
EMPLOY_8	1176	0.0467687	0.2112329	0	1
RFHYPE5	1181	0.0152413	0.1225632	0	1
EMTSUPRT	1127	0.5456965	0.4981285	0	1
LSATISFY	1140	0.5342105	0.4990472	0	1
R_445110_A_SMALL	1124	0.1060368	0.2454439	0	2.7788276
R_445110_A_LARGE	1124	0.1136579	0.220104	0	1.5446048
R_445120_A	1124	0.0883063	0.2118909	0	2.7788276
R_445230_A	1124	0.0067495	0.0259496	0	0.1602353

R_447110_A	1124	0.3325782	0.5886695	0	3.3981305
R_722211_A	1124	0.9313797	1.7538845	0	9.2676287
R_722213_A	1124	0.1918344	0.4168175	0	2.6028368

Table 5. Characteristics of Individual/Household Variables (Total Observations (n=4610))

Variables		**Number**	**Percentage**
Sex	Male	1718	37.24
	female	2892	62.76
Hispanc	Yes	1110	24.23
	No	3471	75.77
Preferred Race	White	3495	77.32
	Black	64	1.42
	Asian	44	0.97
	Native Hawaiian or Pacific Islander	21	0.46
	American Indian, Alaska Native	158	3.5

	Other Race, No Preferred Race, Multiracial	738	16.32
Veteran	Yes	772	16.77
	No	3832	83.23
Pregnancy Status	Yes	41	3.96
	No	994	96.04
Education	Did not graduate high school	464	10.35
	High school graduate	1303	29.09
	Attended college or technical school	1356	30.27
	College or technical school graduate	1356	30.27
Income	Less than $15 ,000	508	12.96
	$15,000 to less than $25,000	844	21.53
	$25,000 to less than $35,000	543	13.85
	$35,000 to less than $50,000	718	18.31
	$50,000 or more	1308	33.36
Employment	Employed for wages	1873	40.78
Status	Self-employed	362	7.89
	Out of work for more than 1 year	99	2.16
	Out of work for less than 1 year	104	2.27
	A homemaker	472	10.28
	A student	95	2.07
	Retired	1343	29.26
	Unable to work	242	0.52
Number of	No children	2983	73.11
children	1 child	588	14.41
	2 children	575	14.09
	3 children	296	7.25
	4 children	100	2.45
	5 or more children	58	1.42
Diabete	Yes	453	9.83
	No	4153	90.17
Emotional	Always	2175	49.49
Support	Others	2220	50.51
Satisfaction with	Very Satisfied	2143	48.18
Life	Others	2305	51.82
High Blood	Yes	3198	69.48
Pressure	No	1405	30.52

Table 6. Characteristics of Individual/Household Variables (FV5SRV=1 (n=1213))

Variables		Number	Percentage
Sex	Male	363	29.93
	female	850	70.07
Hispanc	Yes	261	21.52
	No	944	77.82
Preferred Race	White	938	77.33
	Black	15	1.24
	Asian	15	1.24
	Native Hawaiian or Pacific Islander	7	0.58
	American Indian, Alaska Native	55	4.53

	Other Race, No Preferred Race, Multiracial	160	13.19
Veteran	Yes	166	13.71
	No	1045	86.29
Pregnancy Status	Yes	12	4.32
	No	265	95.32
Education	Did not graduate high school	133	10.96
	High school graduate	306	25.23
	Attended college or technical school	347	28.61
	College or technical school graduate	422	34.79
Income	Less than $15 ,000	145	11.95
	$15,000 to less than $25,000	218	17.97
	$25,000 to less than $35,000	135	11.13
	$35,000 to less than $50,000	170	14.01
	$50,000 or more	372	30.67
Employment Status	Employed for wages	442	36.44
	Self-employed	116	9.56
	Out of work for more than 1 year	28	2.31
	Out of work for less than 1 year	16	1.32
	A homemaker	140	11.54
	A student	30	2.47
	Retired	380	31.33
	Unable to work	55	4.53
Number of	No children	844	69.58
children	1 child	128	10.55
	2 children	134	11.05
	3 children	66	5.44
	4 children	22	1.81
	5 or more children	19	1.57
Diabete	Yes	112	9.23
	No	1101	90.77
Emotional Support	Always	628	53.22
	Others	528	44.74
Satisfaction with	Very Satisfied	620	52.63
Life	Others	550	46.69
High Blood	Yes	834	68.76
Pressure	No	377	31.08

Table 7. Characteristics of Individual/Household Variables (FV5SRV=0 (n=3397))

Variables		Number	Percentage
Sex	Male	1355	39.89
	female	2042	60.11
Hispanc	Yes	849	24.99
	No	2527	74.39
Preferred Race	White	2557	75.27
	Black	49	1.44
	Asian	29	0.85
	Native Hawaiian or Pacific Islander	14	0.41
	American Indian, Alaska Native	103	3.03

	Other Race, No Preferred Race, Multiracial	578	17.02
Veteran	Yes	606	17.86
	No	2787	82.12
Pregnancy Status	Yes	29	3.79
	No	729	95.29
Education	Did not graduate high school	451	13.28
	High school graduate	997	29.35
	Attended college or technical school	1009	29.7
	College or technical school graduate	934	27.49
Income	Less than $15 ,000	363	10.69
	$15,000 to less than $25,000	626	18.43
	$25,000 to less than $35,000	408	12.01
	$35,000 to less than $50,000	548	16.13
	$50,000 or more	936	27.55
Employment Status	Employed for wages	1431	42.13
	Self-employed	246	7.24
	Out of work for more than 1 year	71	2.09
	Out of work for less than 1 year	88	2.59
	A homemaker	332	9.77
	A student	65	1.91
	Retired	963	28.35
	Unable to work	187	5.5
Number of children	No children	2139	62.97
	1 child	460	13.54
	2 children	441	12.98
	3 children	230	6.77
	4 children	78	2.3
	5 or more children	39	1.15
Diabete	Yes	341	10.04
	No	3052	89.85
Emotional Support	Always	1547	46.82
	Others	1692	51.21
Satisfaction with Life	Very Satisfied	1523	46.11
	Others	1755	53.13
High Blood Pressure	Yes	2364	69.59
	No	1028	30.26

Chapter 5

Results

The findings from this survey study are reported in Table 8. The regression results we got from OLS regression are consistent with previous researches and our prior expectations of the variables except the American Indian or Alaska Native (one

category of race), veterans and number of limited-service restaurants / areas in miles^2. In addition to the above variables that are statistically significant in ordinary linear regression model**,** income level and number of children in a family also have relationship with the probability of consuming five or more servings of fruit and vegetables per day in logit model. People with $35,000 to less than $50,000 income level per year (the second highest income level in the study) have a negative effect on the probability of having five or more servings of fruit and vegetables a day. This is also opposite to previous researches and our prior expectation.

Continuous Specification

Since using a statistical technique of ordinary least squares (OLS), a number of assumptions are typically made. One of these is that the error term has a constant variance. Based on the result of testing heteroscedasticity, we can assume the observations of the error term in our survey data are drawn from identical distributions. The analysis of variance indicates that the R-Square of is only 0.0528 and the adjusted R-Square is 0.0417.

Concerning the individual / household variables, men ate less fruit and vegetables, approx two fifth of a serving per day, than women (b= -0.38, p<0.0001). Consumption of fruit and vegetables increased slightly with age, by one percent of a serving per day per year age increment (b=0.01, p<0.01). American Indian or Alaska

Native consume more fruit and vegetables, greater than 1 serving a day than other races (b=1.15, p<0.0001). Veterans consume less fruit and vegetables, about one fifth serving a day than the people who were not veterans (b=-0.22, p<0.0869). People with college or technical school degree ate more fruit and vegetables, greater than a half of a serving per day, than those who had lower education level(b=0.56, p<0.0001). People who were out of work for less than one year consume nearly three fifth servings less fruit and vegetables a day than those with other employment status(b= -0.57, p<0.05) and students also ate almost three fifth servings more fruit and vegetables than others (b= -0.54, p<0.1). Always getting emotional support (b=0.28, p<0.01) and being very satisfied with life (b=-0.28, p<0.01) is positively statistically significant with fruit and vegetables intake. Hispanic origin, veteran, income, number of children, pregnancy status, diabetes and high blood pressure were not significantly associated with fruit and vegetable intake.

As for the neighborhood factors, the number of supermarkets and other grocery (except convenience stores) with 50 or more employees / areas in miles² is positively statistically significant with fruit and vegetables intake (b=0.79, p<0.05) and number of limited-service restaurants / areas in miles² is negatively statistically significant (b=0.76, p<0.1). The results of these two neighborhood variables indirectly show that "food deserts" do influence the fruit and vegetables intake among the individuals in Arizona. However, number of convenience stores / areas in miles² is positively

statistically significant with fruit and vegetables intake (b= -0.15, p<0.1), which is opposite to previous studies and our expectation.

The OLS estimation output reports a t-ratio for testing the null hypothesis that the true regression coefficient is zero. Besides this characteristic, The F-test, however, can test the null hypothesis that several coefficients or all slope coefficients are jointly equal to zero when the regression equation contains more than 1 explanatory variable. In our study, the results of the F test show that all statistically significant explanatory variables in the OLS regression model do significantly affect people's daily fruit and vegetables intake (Table 10). Since we are interested in the influence of "food deserts" on people's daily fruit and vegetables intake, we tested the null hypothesis that all neighborhood variables are jointly equal to zero. However, the F test statistic reports that we fail to reject the null hypothesis (F =1.25, p = 0.2692).

In order to explore the new statistically significant variables more deeply, we try to change the value of these variables to zero, their means and maximums to check the magnitude of the change of the predicted value of dependent variable (servings of fruit and vegetables intake). Table 9 shows that the mean of predicted value of servings of fruit and vegetables intake per day does not change a lot when we change the value of the variables of always getting emotional support and being very satisfied with life to zero, their means and maximums.

Although setting the value of the statistically significant neighborhood variables to their means, the mean of predicted value of dependent variable are very

close to that of the original predicted value of dependent variable, the means of the predicted value of dependent variable do have relative big changes when we set their values to their means and maximums. For the variable of large supermarkets density, when it equals zero, the mean of predicted value of dependent variable decreases by 0.08676 from that of the original predicted value of dependent variable; when it equals its maximum, the mean of the predicted value of dependent variable increases1.12870 from that of the original predicted value of dependent variable. The mean of the predicted value of dependent variable decreases 0.06799 by setting the value of convenience stores density to zero. However, it increases 2.03369 by setting the value of convenience stores density to its maximum. If the limited service restaurants density changes to zero, the mean of predicted value of dependent variable increases 0.13823. However, the value decreases 2.12212 when the value of service restaurants density equals its maximum.

Logit Specification

The results getting from logit model (Table 8) are quite similar to those we got from linear regression model. The chi-square statistic of the likelihood ratio test is 133.0455, rejecting the hypothesis that all coefficients of this model equal zero, which means that the overall model is statistically significant. In addition, the model is 62% concordant and 37.4% discordant, indicating that there is a relatively strong

relationship between the predicted value and the observed value.

Women are more likely to eat five or more servings of fruit and vegetables a day *(β*= -0.35, $p<0.001$). Higher age increases the probability of having five or more servings of fruit and vegetables a day (*β*=0.01, $p<0.1$). American Indian or Alaska Native are most likely to consume five or more servings of fruit and vegetables (*β*=0.69, $p<0.01$). In addition, people have a greater probability of having five or more servings of fruit and vegetables if their education level is higher, and those with college degree are most likely to have five or more servings of fruit and vegetables (*β*=0.47, $p<0.0001$). Always getting emotional support has positive effects on the likelihood of having five or more servings of fruit and vegetables (*β*=0.21, $p<0.05$). Two of eight variable categories about employment status owned by respondents are statistically significant, indicating that those who were out of work for less than one year are less likely to have five or more servings of fruit and vegetables a day (*β*= -0.74, $p<0.05$) but homemakers are most likely to have five or more servings of fruit and vegetables a day (*β*=0.26, $p<0.1$). This result is consistent to that of women are more likely to consume five or more servings of fruit and vegetables. However, compare with the people with lowest income level, those with $35,000 to less than $50,000 income level per year are less likely to consume five or more servings of fruit and vegetables per day (*β*= -0.24, $p<0.05$), which is in contrast with other studies. Similarly, The families which have one (*β*=-0.30, $p<0.05$) or two children (*β*= -0.24, $p<0.1$) are less likely to consume five or more servings of fruit and vegetables per day

than those which have no children. This result is not consistent with our prior expectation.

In addition, the regression results of neighborhood variables from logit model are same to those from ordinary linear regression model. The Number of Supermarkets and other Grocery (except convenience stores) with 50 or more Employees / areas in miles² (β=1.07, p<0.01) and Number of Convenience Stores / areas in miles² (β= 0.76, p<0.01) are positively statistically significant with the probability of five or more servings of fruit and vegetables. Number of Limited-Service Restaurants / areas in miles² is negatively statistically significant (β=-0.15, p<0.1).

The the coefficient with the explanatory variable in a logistic regression indicates the change in the mean of the probability distribution of dependent variable, the probability that a choice is made, per unit increase in the multiplicative exponent of the explanatory variable. Thus, the interpretation is not straightforward as is the interpretation for linear regression. However, we can use marginal effects of the explanatory variables to explain the logit model.

By inspecting the marginal effects for our logit model (Table 8), it is found that, on average, one year increase in the age lead to a 0.0016 increase in the probability of consuming five or more servings of fruit and vegetables per day, holding all else at means. The change in the probability of consuming five or more servings of fruit and vegetables per day that results from changing sex from female to

male, holding all other variables at means, is given by the difference -0.0652. By setting the other explanatory variables equal to their mean, if an individual is American Indian or Alaska Native the probability increases by 0.1306 from that of those who are of other origin; if an individual graduated from a college or technical school the probability increases by 0.0887 from that of those who have lower education levels; and if an individual is with $35,000 to less than $50,000 income level the probability decreases by 0.0458 from that of those who are with other income levels. A family who has one child and two children decreases the probability, holding all other variables at means, by 0.0564 and 0.0444 respectively from that of those who have other numbers of children. An individual who is out of work for less than one year decreases the probability of consuming five or more servings of fruit and vegetables per day by 0.1395 from that of those who are not. However, if an individual is a homemaker, the probability increases by 0.0493 from that of those who are not. Holding all other variables at means, an individual who always get emotional support increases the probability of eating five or more servings of fruit and vegetables per day by 0.0398 from those who are not. A unit (number of store per square miles) increases in the large supermarkets density and convenience stores density, holding all other variables at means, leads to a 0.2022 increase and 0.1429 increase respectively in the probability of consuming five or more servings of fruit and vegetables per day. However, a unit (number of stores per square miles) increases in the limited service restaurants density leads to a 0.0285 decrease in that probability.

Besides the logistic regression results, we are also interested in testing whether the estimates for certain parameters in the Logit model are significantly different from zero. By doing likelihood ratio tests, we get the results which are very similar to what we get in the OLS regression model (Table 11): we can reject the null hypothesis that education level, employment status, large supermarkets density, convenience stores density and limited service restaurants density are equal to zero. However, the null hypothesis that all food stores density is equal to zero is failed to be rejected.

Table 8. Regression Results

Variable	OLS	Logit	
	Parameter Estimate	**Parameter Estimate**	**Marginal Effect**
Intercept	3.19804	-1.5561	
SEX	-0.38369**	-0.3460**	-0.0652
HISPANC	0.16905	0.0399	0.0075
Preferred Race			
PRACE_2	0.09348	0.0683	0.0129
PRACE_3	0.68414	0.4904	0.0925
PRACE_4	-0.98509	-0.6632	-0.1251
PRACE_5	1.14610**	0.6924**	0.1306

PRACE_6&7	-0.13832	-0.0761	-0.0143
VETERAN	-0.21723+	-0.1832	0.0345
AGE	0.01124**	0.00862*	0.0016
PREGNANT	0.11529	0.1190	0.0224
Education level			
EDUCAG_1	-0.14127	-0.0166	-0.0031
EDUCAG_3	0.16297	0.1459	0.0275
EDUCAG_4	0.56134**	0.4705*	0.0887
INCOMG_1	-0.06270	0.1289	0.0243
INCOMG_2	-0.02449	-0.0102	-0.0019
INCOMG_3	-0.08289	-0.1014	-0.0191
INCOMG_4	-0.18605	-0.2431**	-0.0458
Employment status			
EMPLOY_3	0.20023	0.2975	0.0561
EMPLOY_4	-0.57489*	-0.7394*	-0.1395
EMPLOY_5	0.20096	0.2616+	0.0493
EMPLOY_6	0.53991+	0.3979	0.0750
EMPLOY_7	0.05470	-0.0575	-0.0108
EMPLOY_8	0.08349	-0.1490	-0.0281
Number of children			
CHLDCNT_1	-0.15570	-0.2990*	-0.0564
CHLDCNT_2	-0.14989	-0.2356+	-0.0444
CHLDCNT_3	-0.20837	-0.2597	-0.0490
CHLDCNT_4	0.02814	-0.2234	-0.0421
CHLDCNT_5	0.23943	-0.0758	-0.0143
DIABETE2	-0.07111	-0.0871	-0.0164
RFHYPE5	-0.09316	-0.0323	-0.0061
EMTSUPRT	0.27689**	0.2113*	0.0398
LSATISFY	0.28121**	0.1360	0.0256
Food stores density			
R_445110_A_SMALL	-0.32375	-0.4008	0.0756
R_445110_A_LARGE	0.78691*	1.0722**	0.2022
R_445120_A	0.75632+	0.7579+	0.1429
R_445230_A	-1.04623	0.3612	0.0681

R_447110_A	-0.10499	-0.0811	-0.0153
R_722211_A	-0.14560+	-0.1510+	-0.0285
R_722213_A	0.26861	0.1399	0.0264

** p<0.01, *p<0.05, + p<0.1

Table 9. The Predicted Value of FRTSERV

Variables Predicted Value of FRTSERV		**N**	**Mean**	**Std Dev**	**Min**	**Max**
All variables	=original value	3384	4.0196013	0.5435376	1.9750005	6.0795079
EMTSUPRT	= 0	3384	3.8822200	0.5115057	1.9750005	5.9675258
	= mean	3384	4.0193099	0.5115057	2.1120904	6.1046157
	= max	3384	4.1591100	0.5115057	2.2518905	6.2444158
LSATISFY	= 0	3384	3.8819879	0.5042104	1.7136273	6.079507

	= mean	3384	4.0174369	0.5042104	1.8490762	6.2149568
	= max	3384	4.1631979	0.5042104	1.9948373	6.3607179
Food stores density						
R_445110_A_SMALL	= 0	3384	4.0555496	0.5418904	2.1518998	6.079507
	= mean	3384	4.0196087	0.5418904	2.115958	6.0435670
	= max	3384	3.1559043	0.5418904	1.2522546	5.1798626
R_445110_A_LARGE	= 0	3384	3.9328450	0.5642654	1.8858859	6.0732041
	= mean	3384	4.0191819	0.5642654	1.9722227	6.1595409
	= max	3384	5.1483100	0.5642654	3.1013508	7.2886690
R_445120_A	= 0	3384	3.9516119	0.5694147	1.5467483	6.079507
	= mean	3384	4.0189257	0.5694147	1.6140621	6.1468216
	= max	3384	6.0532948	0.5694147	3.6484312	8.1811908
R_445230_A	= 0	3384	4.0257670	0.5444576	1.9750005	6.0795079
	= mean	3384	4.0197231	0.5444576	1.9689567	6.0734640
	= max	3384	3.7975477	0.5444576	1.7467812	5.851288
R_447110_A	= 0	3384	4.0553722	0.5429748	2.0967060	6.0820310
	= mean	3384	4.0198071	0.5429748	2.0611409	6.046465
	= max	3384	3.6986025	0.5429748	1.739936	5.725261
R_722211_A	= 0	3384	4.1578274	0.5927240	2.2879031	6.7192544
	= mean	3384	4.0205058	0.5927240	2.1505814	6.5819327
	= max	3384	1.8974854	0.5927240	0.0275611	4.4589124
R_722213_A	= 0	3384	3.9685984	0.5511032	1.2129643	6.0795079
	= mean	3384	4.0193496	0.5511032	1.2637154	6.1302590
	= max	3384	5.0730349	0.5511032	2.3174007	7.1839444

Table 10. F Test for OLS Regression Model

Hypothesis	Source	DF	Mean Square	F Value	Pr > F
Education level = 0	Numerator	3	55.88726	10.41	<.0001
	Denominator	3344	5.36660		
Income level = 0	Numerator	4	3.74735	0.70	0.5931
	Denominator	3344	5.36660		
Employment status = 0	Numerator	6	9.66480	1.80	0.0949
	Denominator	3344	5.36660		
R_445110_A_SMALL= 0	Numerator	1	7.27919	1.36	0.2442
	Denominator	3344	5.36660		

R_445110_A_LARGE= 0	Numerator	1	23.95017	4.46	0.0347
	Denominator	3344	5.36660		
R_445120_A= 0	Numerator	1	19.49070	3.63	0.0568
	Denominator	3344	5.36660		
R_445230_A= 0	Numerator	1	1.88026	0.35	0.5539
	Denominator	3344	5.36660		
R_447110_A= 0	Numerator	1	1.31995	0.25	0.6200
	Denominator	3344	5.36660		
R_722211_A= 0	Numerator	1	16.74011	3.12	0.0775
	Denominator	3344	5.36660		
R_722213_A= 0	Numerator	1	10.88172	2.03	0.1546
	Denominator	3344	5.36660		
All Food Stores Density Variables = 0	Numerator	7	6.73169	1.25	0.2692
	Denominator	3344	5.36660		

Table 11. Likelihood Ratio Test for Logit Model

Hypothesis	DF	Wald Chi-Square	Pr > ChiSq
Education level = 0	3	20.4723	0.0001
Income level = 0	4	7.0440	0.1336
Employment status = 0	6	12.5347	0.0510
R_445110_A_SMALL= 0	1	2.0842	0.1488
R_445110_A_LARGE= 0	1	7.8750	0.0050
R_447110_A= 0	1	0.1400	0.7083
R_445120_A= 0	1	3.5637	0.0591
R_722211_A= 0	1	2.9887	0.0838
R_445230_A= 0	1	0.0452	0.8316
R_722213_A= 0	1	0.5355	0.4643

All Food Stores Density Variables = 0	7	10.5834	0.1578

Chapter 6
Discussion

In this study, we use an Arizona survey data that include both individual/household characteristics and neighborhood characteristics of respondents in the survey. This paper contributes to both checking if the new factors affect fruit and vegetables intake and finding out the exact determinants of fruit and vegetables

intake in Arizona. The new findings of both OLS regression model and logit model indicate that food stores density, quality of life, veteran status, race, income level and number of children in family do influence fruit and vegetables intake per day.

Implications of Results

An important aim of this study is to test whether the "food environment" or "food desert" influences the daily fruit and vegetables intake in Arizona. Based on the regression results from both OLS model and logit model, we can say that the food stores density do affect individuals' daily fruit and vegetables intake and the probability of consuming five or more servings of fruit and vegetables per day: The more large supermarkets in a specific zip code area, the more servings of fruit and vegetables were consumed per day, and the greater the probability of eating the recommended servings of fruit and vegetables. Besides, a greater limited-service restaurants density indicates a less consumption of fruit and vegetables and a smaller probability of eating five or more servings of fruit and vegetables a day. Although the regression result shows that there is a positive relationship between convenience stores density and the daily fruit and vegetables consumption, which is opposite to previous studies and our expectation, we need to concern whether the pattern of goods sold in these kinds of stores changed or is changing. According to Jeff Lenard, Alexandria, Va., director of communications for the National Association of

Convenience Stores, "With slimmer profit margins on gasoline and cigarette sales, and both categories facing very uncertain futures, convenience stores are looking for new ways to boost revenue and differentiate themselves from competitors. One is the addition of fresh-cut fruit and vegetables to their foodservice menus". Thus, the increasing supplement of fresh fruit and vegetables may be a reason that the more convenience stores in the area, the more probability people consume more fruit and vegetables.

In addition, we found that individuals' life quality and their attitude towards life aslo affect their fruit and vegetables intake. If an individual is very satisfied with his or her life and always gets emotional support, he or she usually holds a positive attitude towards life and leads a high quality life. When people are sad, lonely, afraid, tired, distraught, or stressed, many of them rely on large quantities of junk foods, to fill their emotional need rather than rely on emotional support (Johnston, 1991). Furthermore, low consumption of both fruits and vegetables was associated with unfavorable nutrient profiles: higher percentage of energy from fat and lower intakes of antioxidant nutrients and dietary fiber (Wallstrom *et al*. 2000). In contrast, if a person is willing to share a problem with a trusted person, he or she does not rely on eating junk food to cope with negative feeling. Therefore, people who always get emotional support are more likely to eat fruit and vegetables instead of a large quantity of junk food. According to Johnston et al.(1998), psychological wellbeing is a factor which may affect fruit and vegetables consumption, according to Johnston *et*

al.(1998). Since life satisfaction is an important part of psychological wellbeing, people who are very satisfied with their life may consider a lot of the importance of having a balanced diet, then consume more fruit and vegetables.

Limited research has examined the association of veterans with fruit and vegetables consumption. The regression result of this study shows that veterans eat less serving of fruit and vegetables per day than those who are not even when controlling for age and gender, which is consistent to our prior expectation. Besides the lower education and income level, physical problem and job seeking barrier, the alcohol consumption and problem drinking is another factor that reduces the veterans' daily fruit and vegetables intake. Richards *et al*. (1989) reported that White male veterans take a greater proportion of heavy drinkers than white male nonveterans; further, veterans consistently reported a high daily consumption level compared to nonveterans.

Based on the finding of Pérez (2003), the frequency of eating fruits and vegetables in women is positively related to not being alcohol-dependent. As well according to WallstroÈm *et al*. (2000), high alcohol consumers had low fruit consumption. Therefore, the frequent alcohol consumption of veterans may have a negative effect on fruit and vegetables consumption.

In addition, we also found that the effect of some variables are opposite to previous researches and our prior expectation: People with $35,000 to less than $50,000 income level per year (the second highest income level in the study) have a

negative effect on the probability of having five or more servings of fruit and vegetables a day; The family with one or two children is more likely to consume the recommended servings of fruit and vegetables.

Although the result that the price of fruit and vegetables is one of the determinants of fruit and vegetables intake had the prevalence among the previous researches, the opposite opinion still existed in some studies. Under the situation that price has no effect on intake of fruit and vegetables, it is not necessary to say that people with high income level are surely with higher probability to consume more fruit and vegetables. In addition, people with high income level usually are very busy with their work and have enough time to cook themselves. In order to save time they may choose to order some fast food containing less fruit and vegetables. Therefore, it is also reasonable that high income level has a negative effect on the probability of taking five or more servings of fruit and vegetables a day.

Compare with the family with no children, the families which has one child or two children are less likely to have five or more servings of fruit and vegetables per day.

Limitations (Future Research Questions)

As the new results were found by doing the regressions, a new question also appeared. Did we include some endogenous repressors to the models? By analyzing

the regression result, we got the conclusion that food environment do influence the fruit and vegetables intake. However, the variables of neighborhood choice can be endogenous in the model. Using variables for food store prevalence studies as instruments, further studies are need to weaken the high relation between the neighborhood choice and the error term of the models.

The OLS regression result reports a low R-square and adjusted R-square of this model, indicating that we may neglect other variables which should also contribute to this model. To improve the goodness of fit of this OLS model, further researches are needed to include more other variables from BRFSS. In addition, we should consider whether the interaction terms existed among the explanatory variables such as age and gender.

Besides the new findings which have talked in previous paragraph, being Native Americans is also positively related with fruit and vegetables consumption in Arizona. Examining the data from USDA's Continuing Survey of Food Intakes by Individuals (CSFII), Putnam *et al*. (2002) found that fruit and vegetable intake among Native Americans was higher than intake from other racial or ethnic groups. But, because Native Americans made up a small share of the total sample, the authors could not access the statistical significance of this relationship.

However, the situation is different in Arizona State. Native Americans have inhabited what is now Arizona for thousands of years. The state is home to over 250,000 Native Americans (2000 Census). It remains a state with one of the largest

percentages of Native Americans in the United States, and has the second largest total Native American population of any state. In addition, over a quarter of the area of the state is reservation land. The traditional Native American food style was very healthy and reasonable. The three staples of traditional Native American food are corn, squash, and beans. Other foods that have been used widely in Native American culture include greens, Deer meat, berries, pumpkin, squash, and wild race. Corn, beans, squash, berries, nuts, and melons were the fruit and vegetables that were consumed. However, the low fruit and vegetables intake and high percentage of heart disease, high blood pressure and diabetes among Native American population in the United States were observed by previous studies. As many as half the Pima and Tohono O'odham (formerly Papago) Indians now develop diabetes by the age of 35, an incidence 15 times higher than for Americans as a whole. Yet before World War II, diabetes was rare in this populatio. Preliminary studies have indicated that a change in the Indian diet back to the beans, corn, grains, greens and other low-fat, high-fiber plant foods that their ancestors depended upon can normalize blood sugar, suppress between-meal hunger and probably also foster weight loss (Brody,1991). Since the modern North American diet style has changed the traditional diet style of Native American little by little since 1940's, the above evidence shows that besides poverty and lower education level, the changing of dietary style may be another very important reason of low fruit and vegetables intake among Native American. There is also a concern about the neighborhood factors of Native American in Arizona. Do they have the availability,

affordability and accessibility of food stores which provide affordable, inexpensive and nutritious foods to them? Some information indicates that almost all large tribes in Arizona are much modernized, and the small ones have at least one convenience market and grocery store. Meanwhile, agriculture still plays an important factor in these communities's economy. Thus, in regard to explaining why Native American living in Arizona has a positive relationship with fruit and vegetables intake per day, there are two possible reasons: firstly, Arizona Native American are changing their dietary style back to the traditional desert foods; and secondly, even though under the condition of lacking large supermarkets and other grocery stores in the tribes, Native American in Arizona still have the resources to plant fruit and vegetables themselves. However, our finding just shows that the Native Americans in Arizona have a high consumption of fruit and vegetables. Does this vary by location? Further replications for other states or years are needed to answer this question.

Besides these factors in our study give a very concrete understanding of what play important role for individuals' fruit and vegetables intake in Arizona State. More research needs to be done about digging out other factors which may play important roles. Maybe cross-state comparisons that take into account policy differences would be useful. Comparison of the intake of fruit and vegetables with that of the other important components of a healthy diet such as whole grains and dairy might also be interesting.

Chapter 7

Conclusion

The analysis result confirm most of the findings of other studies that have indicated that age, gender, race and ethnicity, education and income level, number of children in a family and "food deserts" had significant effect on the fruit and

vegetables intake. There are also new findings in this study which are in contrast with other studies. For example, Native American are more likely eat five or more servings of fruit and vegetables; high income level has a negative relationship with the probability of consuming five or more servings of fruit and vegetables; and the more convenience stores in a neighborhood, the more fruit and vegetables are consumed by individuals living this area.

These conclusions are relevant to further studies of fruit and vegetables intake in Arizona or other states. They are also instructive to future strategies for improving intake of fruit and vegetables. Awareness raising strategies should be targeted appropriately to young men, and to the people with lower education level or those without jobs. Meanwhile, to eliminate the effect of "food deserts", the Arizona Department of Health Services and the policy makers may increase the availability, affordability and accessibility of food stores which provide affordable, inexpensive and nutritious foods in Arizona.

References

Angela E. Johnson, Angela J. M. Donkin, Kevin Morgan, Roger J. Neale, Robert M. Page, Richard L. Silburn. "Fruit and vegetable consumption in later life." *Age and Ageing* 27 (Nov, 1998):723-728.

Alwitt, Linda F., and Thomas D. Donley. "Retail stores in poor urban neighborhoods." *Journal of Consumer Affairs* 31.1 (1997): 139–64.

Barbara A. Laraia, Anna Maria Siega-Riz, Jay S. Kaufman and Sonya J. Jones. "Proximity of

Supermarkets is Positively Associated with Diet Quality Index for Pregnancy." *Preventive Medicine* 39.5 (2004):869-75.

Barbara A. Dennison, Helen L. Rockwell, and Sharon L. Baker. "Fruit and Vegetable Intake in Young Children." *Journal of the American College of Nutrition* 17.4 (1998): 371-378.

Bell, Judith, and Bonnie M. Burlin. "In urban areas: Many of the poor still pay more for food." *Journal of Public Policy & Marketing* 12 .2 (1993): 268–70.

Biing-Hwan Lin. "Fruit and Vegetable Consumption Looking Ahead to 2020." A*griculture Information Bulletin* (2004): 972-7.

Blisard, N., H. Stewart, and D. Joliffe. "Low-Income Households' Expenditures on Fruits and Vegetables." U.S. Department of Agriculture, ERS Research Brief, May 2004. http://www.ers.usda.gov/publications/aer833/aer833_researchbrief.pdf

BM Margetts, RL Thompson, V Speller and D McVey. "Factors which influence 'healthy' eating patterns: results from the 1993 Health Education Authority health dand lifestyle survey in England." *Public Health Nutrition* (1998): 1.

Catherine Cubbin and Marilyn A Winkleby "Food availability, personal constraints, and community resources" *J. Epidemiol. Community Health* (2007): 61; 932.

Cheadle A, Psaty BM, Curry S, Wagner E, Diehr P, Koepsell T, Kristal A. "Community-Level Comparisons between the Grocery Store Environment and Individual Dietary Practices." *Preventive Medicine* 20.2 (1991): 250-61.

Chung, Chanjin, and Samuel Myers. "Do the poor pay more for food?An analysis of grocery store availability and food price disparities." The Journal of Consumer Affairs 33.2 (1999): 276–96.

Claudio E. Pérez."Fruit and vegetable consumption in relation to risk factors for cancer: a report from the MalmoÈ Diet and Cancer Study." *Public Health Nutrition* 3.3 (March 2000):263-271.

Cotterill, RonaldW, and AndrewW. Franklin. "The urban grocery store gap." *Food Marketing Issue Paper* 8 (1995): 82.

Curtis, Karen A., and Stephanie McClellan. "Falling through the safety net: Poverty, food assistance and shopping constraints in an American city." *Urban Anthropology and Studies of Cultural Systems andWorld Economic Developments* 24 (1995): 93–135.

Donald Rose and Rickelle Richards. "Food store access and household fruit and vegetable use among participants in the US Food Stamp Program."*Public Health Nutrition*7.8 (June 2004):1081–1088.

Eisenhauer, Elizabeth. "In poor health: Supermarket redlining and urban nutrition". *GeoJournal* 53 (2001):125–33.

Ford E.S. and Mokdad A.H. "Fruit and Vegetable Consumption and Diabetes Mellitus Incidence among U.S. Adults." *Preventive Medicine* 32.1 (January 2001):33-39.

Granner ML, Sargent RG, Calderon KS, Hussey JR, Evans AE, Watkins KW. "Factors of fruit and vegetable intake by race, gender, and age among young adolescents." *Journal of Nutrition Education and Behavior* 36.4. (Jul-Aug2004) :173-80.

Hux, J., G. Booth, and A. Laupacis. "The ICES practice atlas: Diabetes in Ontario. Institute for Clinical Evaluative Sciences (ICES), and the Canadian Diabetes Association." 2002. http://www.ices.on.ca/ (last accessed 24 March 2008).

Jane E. Brody."To Preserve Their Health and Heritage, Arizona Indians Reclaim Ancient Foods. " *The New York Times.* May 21, 1991.

Judy Putnam, Jane Allshouse, and Linda Scott Kantor. "U.S.per capita food supply trends:more calories, refined carbohydrates, and fats."*Food Review*25.3 (2002):2-15.

J Pomerleau, K Lock, C Knai, M McKee - Geneva. "Effectiveness of interventions and programmes promoting fruit and vegetables intake." *World Health Organization*(September 2004).

Karen E, Smoyer-Tomic, John C. Spence and Carl Amrhein. “Food Deserts in the Prairies? Supermarket Accessibility and Neighborhood Need in Edmonton, Canada.” *The Professional Geographer* 58.3 (August 2006): 307.

Karen Glanz and Amy L. Yaroch.. "Strategies for Increasing Fruit and Vegetable Intake in Grocery Stores and Communities: Policy, Pricing, and Environmental Change." *Preventive Medicine* 39.2 (2004):S75-S80.

Karen Glanz and Deanna Hoelscher."Increasing fruit and vegetable intake by changing environments, policy and pricing: restaurant-based research, strategies, and recommendations." *Preventive Medicine* 39.2 (September 2004):88-93

Kimberly Morland, Steve Wing, and Ana Diez Roux. "The Contextual Effect of the Local Food Environment on Residents' Diets: The Atherosclerosis Risk in Communities Study." *American Journal of Preventive Medicine* 92.2 (2002):1761-67.

Latetia V. Moore and Ana V. Diez Roux. “Associations of Neighborhood Characteristics with the Location and Type of Food Stores.**”** *American Journal of Public Health* 96.2 (February 2006): 325-331.

MacDonald, James M., and Paul E. Nelson Jr."Do the poor still pay more? Food price variations in large metropolitan areas." *Journal of Urban Economics* 30 (1991):344–59.

May C Wang, Soowon Kim, Alma A Gonzalez, Kara E MacLeod and Marilyn A Winkleby. “Socioeconomic and food-related physical characteristics of the neighborhood environment are associated with body mass index.”*J. Epidemiol. Community Health* 61 (2007): 491-498.

Marion, Donald R."Toward revitalizing inner-city food retailing." *National Food Review* 19 (1982): 22–25.

Mary K. Serdula, MPH, Cathleen Gillespie, Laura Kettel-Khan, Rosanne Farris, Jennifer Seymour, and Clark Denny. "Trends in Fruit and Vegetable Consumption among Adults in the United States: Behavioral Risk Factor Surveillance System, 1994–2000." *American Journal of PublicHealth.* 94.6 (June 2004):1014–1018.

M S Richards, J Goldberg, M B Rodin, and R J Anderson. "Alcohol consumption and problem drinking in white male veterans and nonveterans." American Journal of Public Health. 79.8 (August, 1989): 1011–1015.

Morland, Kimberly, SteveWing, Ana Diez Roux, and Charles Poole."Neighborhood characteristics associated with the location of food stores and food service places." American Journal of Preventative Medicine 22.1 (2002): 23–29.

Moshfegh, Alanna. "Research to advance understanding of the interrelationship of poverty and nutrition." *Journal of the American Dietetic Associatio*107.11 (November 2007):1882-1885.

Neil Wrigley, Daniel Warm, Barrie Margetts and Amanda Whelan. “Assessing the Impact of Improved Retail Access on Diet in a ‘Food Desert": A Preliminary Report.” *Urban Studies* 39.11 (2002):2061 – 2082.

N Wrigley. “Food Deserts’ in British Cities: Policy Context and Research Priorities”, *Urban Studies* 39.11 (2002): 2029 – 2040.

P . Guenther , K . Dodd , J . Reedy , S . Krebs-Smith. "Most Americans Eat Much Less than Recommended Amounts of Fruits and Vegetables." *Journal of the American Dietetic Association* 106.9 (Sep 2006):1371-9.

Patricia K. Johnston, 'What influences your food choice? - parental and psychological influences - includes related diet modification suggestions", *Vibrant Life.* (July-August,1991).

Peter Wallstrom, Elisabet Wirfalt, Lars Janzon, Irene Mattisson, Solve Elmstahl, Ulla Johansson and Goran Berglund. "Fruit and vegetable consumption in relation to risk factors for cancer: a report from the Malmo Diet and Cancer Study." Public Health Nutrition3.3 (March 2002):263-271.

RL Thompson, BM Margetts, VM Speller and D McVey. **“**The Health Education Authority's health and lifestyle survey 1993: who are the low fruit and vegetable consumers?” *J. Epidemiol. Community Health* 53 (1999): 94-299.

Stephanie B. Jilcott, Barbara A. Laraia, Kelly R. Evenson, Lisa M. Lowenstein and Alice S. Ammerman. “A Guide for Developing Intervention Tools Addressing Environmental Factors to Improve Diet and Physical Activity**.”** *Health Promot Pract* 8 (2007):192.

S.Zenk, A.Schulz, T.Hollis-Neely, R.Campbell, N.Holmes, G.Watkins, R.Nwankwo, A.Odoms-Young. "Fruit and Vegetable Intake in African Americans: Income and Store Characteristics." *American Journal of Preventive Medicine* 29.1 (2005): 1-9.

Timothy J. Fik. "Spatial Competition and Price Reporting in Retail Food Markets."*Economic Geography* 64.1 (Jan.1988): 29-44

T Pearson, J Russell, MJ Campbell, ME Barker. “Do 'food deserts' influence fruit and vegetable consumption?--A cross-sectional study.” *Appetite* 45.2 (Oct 2005):195-197.

Troy C. Blanchard and Thomas A.Lyson. “Retail Concentration, Food Deserts, and Food Disadvantaged Communities in Rural America”

Turque, B. "Where the food isn’t." *Newsweek* 119 (1992):36–37.

Weinberg, Zy. "No place to shop: Food access lacking in the inner city." *Race, Poverty & the Environment, Winter* (2000):22–24.