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A Rural and Urban Study of the Food Environment in Select Nevada Geographies

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A RURAL AND URBAN STUDY OF THE FOOD ENVIRONMENT IN SELECT NEVADA GEOGRAPHIES

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Abstract

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National and county level examination of urban and rural food environments has taken place, but primary validation of venue existence and in-venue data are lacking. The literature show disparities in access to healthy foods through low density of large grocers/supermarkets, low variety and quality of produce and higher prices for a healthy diet in rural versus urban geographies. Rural areas are of unique concern due to poor health indicators such as higher obesity rates, higher diabetes rates, lower incomes and lower educations than urban residents. The goal of this study was to explore differences in the community and consumer level food environments between two Nevada geographies. Evidence was sought to test the hypotheses of venue density, the availability and quality of produce, and the price difference between standard and healthy items between rural and urban Nevada geographies. A cross-sectional study took place through direct quantitative and descriptive data collection in two rural Nevada counties and two urban census tracts in Las Vegas, NV. A Kruskal–Wallis, Mann–Whitney and a Bonferroni correction were performed on the quantitative store audit data to compare produce availability and quality scores, and the price differences between standard and healthy items between geographies. Primary data show a greater per-capita density of grocery and convenience venues in the rural area than the urban. A greater per-capita density of fast-food venues was found in the urban sample area. The variety and quality of produce in the rural grocer venues were lower than the urban supermarkets. No significant or functional price difference was found between the standard and healthier versions of select items within commonly purchased food groups, between rural and urban geographies.

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Chapter 1

Introduction

A diet of minimally processed foods close to nature and mainly plants is "decisively associated" with health and prevention of disease (Katz & Meller, 2014). Modern lifestyles have adopted the use and inclusion of processed and prepared foods as to become mainstream considerations and components of the American diet. Nationally, at least half our meals are eaten outside the home (Larson, Story, & Nelson, 2009). The quality of these prepared foods eaten outside of the home in the U.S. is poorer than meals prepared at home and "are associated with lower intakes of fiber, protein, higher saturated fat levels, free sugars, sodium and energy density" (Herforth & Ahmed, 2015). Meals consumed within the home can vary in healthfulness based on constructs of access.

Understanding barriers to access within the food environment is crucial to understanding deficiencies and excesses in diet (Sallis & Glanz, 2008). The ability to accurately measure aspects of the interaction between people and the food environment will contribute to valid associations between barriers to healthy food and diet. Rigorously examining the food environment must take place through instruments that measure geographic and in-venue constructs that are theoretically relevant to accessing venues that provide healthy foods (Caspi, Sorensen, Subramanian, & Kawachi, 2012). It is then that which represent facilitators and barriers to constructs of access that are linked to the diet-disease relationship can be addressed (Caspi et al., 2012). Instruments have been developed to examine associations between geographic, in-venue and subjective (personal) access measures, and population level variables, that when used together, have shown the strongest relationship to the diet-disease relationship

(Caldwell, Kobayashi, Dubow, & Wytinck, 2008; Caspi et al., 2012; Charreire, Hillier et al., 2011; Gustafson et al., 2011).

The first published studies on the modern food environment in the United States at the consumer level took place in the publications by Sallis, Nader, Rupp, Atkins & Wilson in 1986 in San Diego, CA and Cheadle, Psaty, Wagner et al. (1990) in Seattle, Washington (Glanz, 2007). Sallis et al. (1986) examined 24 food environments at the neighborhood level to seek out heart healthy foods by venue type. Cheadle et al. (1990) carried out an in-venue analysis of food product displays, the amount of healthy information they contained, and the proportion of the display devoted to healthy concepts. The proceeding literature show various in-venue instruments were utilized for each study based on the particular research questions, as well as the populations and environments of interest. Primary instruments took the form of checklists, market baskets, inventories, and in-store audits. Comparing studies with similar variables was difficult; a standardized instrument had been lacking. Karen Glanz and colleagues at the University of Pennsylvania developed a tool with high inter-rater reliability that focused on food item availability, healthy alternative availability, price and produce quality in 2008 with a finalized version the following year (Glanz, Sallis, Saelens, & Frank, 2009). The Nutrition Environment Measurement Survey (NEMS) was created to objectively audit the food environment. The first two tools were developed to audit Supermarkets and Restaurants, NEMS-S and NEMS-R respectively. The variety of tools have since expanded to evaluate Convenience Stores (NEMS-CS), Grab and Go venues, small venues such as those on college campuses (NEMS-GG), and a subjective survey of the food environment (NEMS-P).

Three main approaches of investigating the food landscape currently take place utilizing secondary and primary data. Cross-sectional analysis at the community/geographic level is the

most common empirical method of examination (Beaulac et al., 2009; Walker, Keane and Burke, 2010). The community level approach views the food environment at a broad level by accounting for, correlating and representing population variables through geographic mapping and citywide analysis (Caspi et al., 2012). Data at the community level have historically been derived from secondary sources, but is increasingly derived from primary data collected in person (Powell et al., 2011). At the consumer level, data is collected at and within the individual venues. The items sold within the venues are the primary data points. What the venues have to offer (availability), what compensation they seek (price) and measures of produce quality (acceptability) are what comprises the variables of interest (Glanz et al., 2009). Use of subjective data through surveys is also increasing in use and encouraged for future research in urban and rural food environments (Sharkey, Anding & McIntosh, 2009).

Subjective views framed within the community level explore access through availability, location, and utilization of venues. Interviews and questionnaires are the most common subjective tool (McKinnon et al., 2009). Inquiry about attributes related to physically accessing venues at the personal and household level consist of surveys and diary logs to assess views on the food environment and actual intake. Calls within the literature for future areas of study involve the incorporation of tracking technologies such as those used for cell-phone traffic mapping and/or personal level advertising. These methods are designed to assess physical movements over time and are anticipated to be a valuable objective data source of population movements throughout an area over time (Caspi et al., 2012; Charreire et al., 2010). At the consumer level, opinions on characteristics of food item price, affordability, item availability, and quality are the lines of inquiry most studied and linked to diet. Limited subjective food access studies have been performed when compared to the body of literature examining

geographic access, but when the two methods are merged, the resulting data form stronger links to purchasing habits and diet than with geographic measures alone (Aggarwal, et al., 2014).

This study explores issues of food access within the context of health and place. Place is becoming the focus of Public Health concern for their barriers and facilitators to a diet that is associated with the prevention of disease (Lytle, 2009). The complexities of the human psyche are such that singular straight-forward rationale for human behavior is not an option. Theories to explain, address and intervene into healthy behaviors complement these complexities. The social ecological model is one theory that postulates on multiple interacting levels of environmental factors framed in a social context that influence decisions about one's health (Herforth et al., 2007). When applied to the analysis of the food environment and the environment's ability to provide access and acquisition to healthy foods, each level is framed within the context of that level, and also draws upon and influences other levels within the model**.** The first level at the core of the model is the innate individual. Demographics such as age, gender, race, genetic and other biological factors comprise dynamics of the self that interact within our society to impact health outcomes. The intrapersonal level of the self is shaped by education, abilities and talents of the person. These aptitudes are a core focus of health education efforts. The next level is that of the interpersonal. Social groups, networks, and culture have large impacts on lifestyle and health related decisions. Both the interpersonal and intrapersonal have the ability to ameliorate barriers to a healthy diet such as income and education (Beaulac et al., 2009; Drewnowski et al., 2009; Morland, Wing, Diez-Roux, Poole, 2002; Walker et al., 2010). The institutional level are the places we spend large portions of our time. Home, school, and work are primary areas of study. View of the food environment at the community level explores the relationship of healthy venue existence within the proximity of the places we live and frequent. The last level

approaches the issue from the broadest level of conditions and policies that shape the context in which quality healthy foods are made available at a competitive price.

Statement of the Problem

Equitable access to and consumption of culturally appropriate foods at all times is of critical importance for prevention of disease and facilitation of an active lifestyle (Cannuscio et al., 2013; Larson et al., 2009). The literature show that many food environments currently provides ample geographic access to unhealthy venues and access barriers to health foods depending on where one lives (Caspi et al., 2012; Walker et al., 2010; Sharkey et al., 2009). An active lifestyle and healthy diet would prevent heart disease, some cancers, obesity and type-two diabetes (Bazzano, 2006). If equitable access to healthy foods were a common finding across geographies, it would be expected that such a population could consume at least five servings of fruits and vegetables a day, and maintain low consumption rates of saturated fats, sugars and processed foods. Additionally, purchasability characteristics of food items such as availability and acceptability/quality between different communities would be the same. The preferred food landscape would be one where the price difference between standard and healthier alternatives would be considered marginal or non-existent, the overall price of healthier foods was less than that of unhealthy foods, or that unhealthy foods were more expensive than healthy foods (Glanz & Yaroch, 2004).

Nationally, the evidence is strong showing that residents in low-income, urban, rural, and remote communities face access barriers to large grocer venues, a variety of quality produce and higher costs (Baker Schootman, Barnidge & Kelly, 2006; Zenk et al., 2005). An association exists between poverty and an urban or rural geography being termed a food desert, an area

lacking grocer venues (Morton & Blanchard, 2007). Rural and urban geographies face access barriers through the greater proportionality of unhealthy venues to healthy venues (Beaulac et al., 2008; Block & Kouba, 2006; Drewnowski et al., 2014; Hosler & Kammer, 2014). In rural areas, this is more pronounced as travel times are increased to expand opportunity in a different region maintaining additional venues. Rural populations face additional access barriers through distance and population demographics beyond income, such as age and disability (Arcury, Quandt, Bell, Mcdonald, & Vitolins, 1998; Falk, Bisogni, & Sobal, 1996).

Strong evidence show that grocer venues in rural and low-income rural areas offer a lower variety of high quality fruits and vegetables (Beaulac, Kristjansson & Cummins, 2009; Larson et al. 2009; Shanks et al., 2015; Walker et al. 2010). Rural residents incur higher costs and higher item prices when access is limited to small grocer venues (Pereira, Sidebottom, Boucher, Lindberg & Werner, 2014). Increased distances require additional economic and time resources (Shaw, 2006). Higher item prices in rural grocers are associated with lower shelf space and the inability to take advantage of economies of scale, discounts for larger purchases (Beaulac et al., 2009; Kaufman, MacDonald, Lutz & Smallwood, 1997; Mantovani, Daft, Macaluso, Welsh & Hoffman, 1997; Pereira et al., 2014).

Rural Nevada counties show barriers to healthy food access through venue desire and concerns with the availability, quality, and price of produce (Gatzke, Cowee & Harris, 2014). Disparities and similarities in constructs of access (distance, proportion) for urban populations are shown in Las Vegas that mirror national and regional evidence for several metropolitan cities (Coughenour & Burns, 2016; Drewnowski & Rolls, 2012; Nickelson, 2007, unpublished data; Zenk et al., 2005). The result of compounding personal, geographic and in-venue barriers to health promoting foods likely influence on local and national low consumption rates of healthy

foods such as fruits and vegetables (C.D.C. State Indicator Report on Fruits and Vegetables 2013, 2014; Coughenour et al., 2016; Gatzke et al., 2014;). The impact of low consumption rates of fruits and vegetables is directly related to the high population morbidity and mortality rates of cardiovascular disease, stroke, hypertension, diabetes, obesity, and certain types of cancers currently being experienced (Biazano, 2006; Ness & Poweles, 1997).

Background

A healthy diet is crucial for a healthy lifestyle and to reduce the development of certain diseases. The modern desire to and ability to detect the relationship between different constructs of access and a healthy diet has been taking place since the 1980s, with increased attention since 2000 (Glanz et al., 2009). During the past decades the economics of retail food as well as the grocer venues themselves have experienced changes in the industry resulting in the largest consolidated venues offering the most ideal constructs of access. Accessing a healthy diet consists of a range of constructs that act as facilitators and barriers in addition to distance based proximity to large venues/supermarkets. Primary facilitators linked to a healthy diet are education/experience, culture, income, and the availability of healthy venues with high quality produce. Primary barriers to a healthy diet are education, income, race, age, geographic residence, and omission of a variety of high quality produce choices in healthy venues.

Increased valid measurement of the food environment has been facilitated in the past decade through the development and widespread use of standardized tools and methods (Caspi et al., 2012; Charreire et al., 2010, Glanz et al., 2009). Data validity is increasing through venue identification measures that are more frequently taking place through primary data collection,

reducing reliability on often-flawed secondary data (Fleischhacker et al., 2012). The comparison of venue density rates per-capita is increasing. In urban and rural geographies, links to diet through subjective survey show that the variety/availability and quality of produce is strongly linked to the concept of a venues' "desirability" and the decision to shop at a particular venue (Charreire et al., 2010; Sharkey, 2009). In urban geographies, for those that own a vehicle and shop more than a mile from their residence, the desirability of a venue has been shown to impact venue choice less than that of geographic proximity (Charreire et al., 2010).

Through the literature and discussion of this dissertation, the venues with the highest reported availability and quality of produce, and the lowest price differences between standard and healthy items are national chains that have the largest venues by square footage (Bell & Maria, 1993; Sadler, Gilliland, & Arku, 2012). Some chains maintain smaller venues by square footage for esthetic/thematic purposes but retain the ability to capitalize on various economies of scale in order to offer items at competitive prices along with the physically largest venues/supermarkets. Larger (than supermarket) venues exist where items can be purchased at a lower cost through volume purchasing, but these venues maintain membership access through a paid fee. Mid-sized grocer venues have less shelf space and are often not part of a national chain and therefore cannot match prices on many items through a lack of purchasing volume and higher overhead costs per unit sold (Kaufman et al., 1997). New food venue formats are now present in the food retail landscape (Sharkey et al., 2009). Former non-food retailers are now carrying foods in drugstores, dollar stores and national stalwarts of industry such as Wal-Mart, Target, Walgreens, CVS, 99 cents only store, and many others (Berry, 2011). Attention to and inclusion of these new retail formats and their link to diet and health outcomes in nascent in the literature but cannot be omitted for a valid analysis of the food environment (McKinnon et al.,

2009). The purchasing power and implied bargain status of these venues work positively towards reducing access barriers when combined with increased geographic access through existing venue status, and an acceptable variety of quality produce offerings (Bustillos, Sharkey, Anding, & Mcintosh, 2009; Dubowitz, Ghosh-Dastidar, Cohen, Beckman, Steiner, Hunter, & Collins, 2015).

A source of maintaining a healthy diet or not, has traditionally been a learned experience through childhood (Falk, Bisogni, & Sobal, 1996; Furst, Connors, Bisogni, Sobal, & Falk, 1996). One's culture can have a significant impact on diet. Recent immigrants to the United States have been found to have better diets than both natural born citizens and those immigrants who have been in American longer. Kaplan, Huguet, Newsom and Mcfarland (2004) found a positive association between length of stay and obesity rates. Culture, education and experience have the ability to ameliorate barrier to access, particularly income limitations to a healthy diet (Carnahan et al., 2012). Education is strongly linked to income and diet related disease, such as obesity (Drewnowski, 2004). Some of the pathways for these linkages are attributed to intrapersonal aspects such as self-efficacy and delay gratification (Devaux, Sassi, Cecchini, Borgonovi, & Church, 2011). Experiences can be acquired throughout a lifetime with subsequent changes in perceptions or ethical beliefs that can alter diet from any point forward. This is exemplified by those who choose diets based on personal beliefs about the inputs required to create certain foods such as animals and ecological considerations.

For those concerned with personal or household expenditures on food, the price difference between a standard and healthy diet is one among several when considering purchases, but is a crucial construct of access to a healthy diet. The comparison of prices

between standard and healthier foods is a recent area of research due to the relatively fast change in the national diets since the early 1980's (Sturm & Yach, 2013). When considering a total food budget and not simply the price difference between select items, experimental interventions show some promise at increasing healthy food purchased when healthy foods are lowered in price (Epstein, Dearing, Roba, & Finkelstein, 2010).

Low-income individuals/households exist in all geographies nationally, both urban and rural. Seniors are particularly susceptible to a substandard diet due to a variety of influences (Falk et al., 1996). Economic, physical, and social limitations play primary roles in eating habits for the aged. Further detriments to diet can take place for rural elders with the additional burden of distance and isolation requiring added financial resources to a food budget (Arcury, 1998).

Venue availability and in-venue food-item characteristics show a relationship to consuming a healthy diet (Glanz et al., 2009). Study of venue availability most frequently centers on residential communities and the surrounding food environments, with emerging focus on environments around schools, places of work and the travel paths between them (Caspi et al., 2012). The location and types of venues are of primary concern at the broad geographic community level. Constructs of access within food venues show links to diet through the availability, price and acceptability of produce, and the availability and price differences between standard and healthy food items (Glanz et al., 2009).

Nationally, the evidence is strong showing that residents in low-income, low-income African American, rural and remote communities face access barriers to supermarkets and fresh fruits and vegetables (Baker et al., 2006; Zenk et al., 2005). Access to supermarkets/large grocer venues is associated with lower overweight and obesity prevalence, increased produce

consumption, and better diet quality among African Americans, and low-income households (Beaulac et al., 2009; Morland, et al., 2002; Zenk et al., 2005).

Produce quality measures and higher price differences for healthy options are mainly accounted for by a lack of access to a large venue (Caspi et al., 2012; Sharkey et al., 2009; Walker et al., 2010). Substantiation at the national level show strong evidence that low-income, low-income urban, rural, and minority residents pay more, and are offered lower quality foods (Beaulac et al. 2009; Larson et al. 2009; Walker et al. 2010). Rural environments show a growing body of study but the "overall availability of more healthful food choices" in a variety venues is largely unknown (Busitillos et al., 2009; Sharkey et al., 2009).

Rural areas are understudied with specific calls for inclusion (Boehmer et al., 2006 ; Caspi & Friebur, 2016). At the community level, the existing literature show a disproportionate presence of unhealthy venues to healthy venues (Sharkey et al., 2009). At the consumer level, an examination of the availability and quality of produce between urban and rural environments show differences in the literature with rural residents generally having poorer quality produce (Shanks et al., 2015). The question of whether or not it is less, the same, or more expensive to buy healthy items if one were to move between the two geographies has shown higher prices in rural areas through a lack of large grocers/supermarkets (Caspi et al., 2012; Sharkey et al., 2009; Walker et al., 2010).

Rates of consumption of fruits and vegetable by adults in Nevada are low. State level data mirror national rates exactly for 2013 (C.D.C. State Indicator Report on Fruits and Vegetables 2013, 2014). Nevadans reported eating 1.1 servings of fruit a day and 1.6 servings of vegetables

a day. The same data show that 27% and 24% of Nevadans consumed less than a single serving a day of fruits and vegetables respectively.

Coughenour et al. (2016) found that among a sample of primarily low-income Las Vegan's, adult respondents reported consuming slightly less than half the recommended daily servings of fruits and vegetables (2.2) with only 1.4% of the sample stating that they consumed the full (5 servings) recommended servings per day. Further responses indicated a higher self-serving priority over the samples' own children when it came to providing sustaining nutrients. Parents and guardians stated their children consumed fewer daily servings than they did, and not a single child (6-17 years old) of the sample met or exceeded the daily-recommended levels of fruits and vegetables.

Consumption patterns may be representative of or associated with purchasing habits. An economic analysis and survey of a rural Nevada sample show poor daily produce consumption habits, relatively low spending on produce, and strong support for a healthy food venue. Gatzke et al. (2014) found 54% of survey respondents stated consuming one or less fruits or vegetables a day. The responses also indicate that 70% of the sample spends less than $30 a week on produce; compared to 49% spending the same amount on produce each week in a Las Vegas, NV sample according to the same study.

Limited study of the Las Vegas valley's food environment at the community level have been published but valley wide discrimination is currently underway. Existing empirical analysis show access limitations through healthy venue displacement, but similar venue per-capita density rates as regional metropolitan areas. Coughenour et al. (2014) revealed that in Las Vegas, unhealthy venues drastically outnumbered grocer venues, stating there are "…twice as many

convenience stores and nearly four times as many fast-food outlets than there are grocery stores". The authors also found that Clark County as a whole had similar per-capita density rates for supermarkets, convenience stores and fast-food outlets compared to Maricopa County, AZ and Salt Lake County, UT.

An unpublished 2006 community level analysis of the Las Vegas valley by this author was the first to identify food deserts in low and high-income communities at the tract level. Data show a statistically significant difference in access to supermarkets through the availability measure (distance/existence) between census tracts in income quintile one and three, and between quintiles one and five.

Significance

The community, Public Health and business interests may find this study's results informative. Effective intervention is built upon accurate and valid representation of the food environment (Sharkey et al., 2009). Understanding support structures and barriers to accessing certain foods is crucial for understanding how the food environment influences the diet-disease relationship (Caldwell, Kobayashi, Dubow, & Wytinck, 2008; Caspi et al., 2012; Gustafson et al., 2011). This study will add to a body of food environment literature that is currently limited to the extent that recommendations for action are being reserved for future dates. An advisory report from the United States Department of Agriculture (USDA) to the Secretary of Health and Human Services and the Secretary of Agriculture states that "the strength of the evidence supporting a specific conclusion statement" has yet to fully address the question of community food access (Millen, 2015). The evidence on food retail settings influencing dietary intake, dietary quality, and weight status was too limited or insufficient to evaluate.

Per-capita density rates of healthy food venues (with a regional comparison) would extend the national community level literature by adding to the existing per-capita density data of urban and rural venues of various healthfulness (Coughenour et al., 2016; Hosler et al., 2014; Tisone et al., 2014). Intrastate study of urban/rural food environments would meet a specific call in the literature by Boehmer et al. (2006). Investigation of high and low-income urban populations would buttress a small but growing body of evidence showing disparity in constructs of access through healthy venue omission/unhealthy venue proportion in low-income areas (Sharkey et al., 2009).

At the consumer level, a study of in-venue characteristics between urban and rural intrastate geographies and between intra-city urban census tracts would add to the recent growing body of research expanding investigation of food environment constructs more closely linked to diet (Glanz et al. 2009). Examining venue features of the largest grocers in a high and low-income urban food environment would add to the existing body of evidence showing additional barriers to accessing a healthy diet for low-income communities (Sharkey et al., 2009). Produce omission, poor quality produce, and higher prices for healthier choices are access construct barriers frequently found in low-income areas (Shanks et al., 2015).

Opportunities to improve population diet is a goal of many government agencies across the country. Nevada, County, and rural town agencies in Esmeralda and Lincoln Counties would benefit from this study. State and rural agencies may be interested to know if our state maintains trends in-line with the literature in regards to disparate access for specific populations of interest. Public Health budgets compete among many concerns and government leaders may show favor in support of efforts towards supporting different constructs of healthy food access. Awareness of how rural per-capita venue rates of any type compare to other rural counties in the same state

and region, as well as compared to two urban metropolitan areas in the same state may be of specific concern for rural health advocates and practitioners. Per-capita density rates of healthy food venues (with a regional comparison) would complement constitute concerns regarding the food environment such as lack of certain venues or cumulative totals of less desirable venues. For state health agencies, healthy venue per-capita rates could then be compared to regional results of different urban/rural geographies with differing diet-related disease rates.

The literature show food environment research used as a basis for identifying barriers to improving access within rural venues such as capital (structural) improvements or equipment purchases (Hosler et al., 2014; Larson et al., 2009; Smith, Schram, Tibbits, Wang, & Balluff, 2015; Zenk et al., 2012). Multiple interventions in rural areas to increase quality and variety of fresh foods focus on installation of costly cooling equipment.

Increased sales is a goal sought by the food-industry and consumption of healthy food is a goal of Public Health researchers. Those involved in the business of food are largely aware of market potential, stocking, and price structures of their industry (Berry, 2011). Business leaders in rural communities such as those involved directly or in-directly in the food industry would find value in a current analysis from a Public Health perspective. Capitalizing on consumer demand of competitively priced healthy foods and a variety of quality produce benefit all parties involved (community, Public Health and business).

Purpose of the Study

The first goal of this study was to test differences of the food environment between two geographies (urban-rural) and within an urban geography (high/low income) at the community level. Per-capita density reflects access through intensity of exposure to venues and follows best

practices of multi-dimensional assessment of the food environment (Sharkey, 2009; Thornton, Pearce & Kavanagh, 2011). The literature show specific concerns pointing to low-income and rural populations having reduced access through supermarket/large venue omission and low per-capita healthy food venues (Coughenour et al., 2016; Hosler et al., 2014; Liese, Weis, Pluto, Smith, & Lawson, 2007).

Using an evaluative method sourced from the literature, the cumulative opportunity of four venues types were selected from the total notation: Supermarkets/largest grocers, fast-food, convenience store, dollar store (Caspi et al., 2012, Hosler et al., 2009; Thornton et al., 2011). The literature show the common use of 'venues per 10,000 person population' (Bustillos et al., 2008; Hosler et al., 2008; Hosler et al., 2009; Liese et al., 2007; Thornton et al., 2011). Due to the small sample size of this study, consideration of measurement of venues per 1,000 persons follows precedent by Mantovani et al. (1997).

The second goal was to test the question of whether or not three consumer level constructs of the food environment are different between rural and urban samples, and two urban food environments (census tracts) of different incomes. This took place using the Nutrition Environment Measurement Survey (NEMS-S), an instrument designed to collect data specific to supermarkets and the items that those venues contain. The variety and acceptability (quality) of produce is shown in the literature through subjective inquiry to have moderate to strong relationships to diet and have been shown to differ by urban/rural geography (Caspi et al. 2012; Glanz et al., 2009; Sharkey et al., 2009). For price minded, low-income, or food insecure populations, the price difference between standard and healthy items is an economic construct of access to a healthy diet (Glanz et al., 2009). This study examines the price differences between standard and healthy versions of specific groups of foods. The groups of foods and the suggested

items within each category are the most purchased food groups and items nationally in grocer venues. The price differences between these items is important as the national diet has shifted towards energy dense and processed foods since the 1980's, and diets consisting of the recommended fruit and vegetable servings are not being carried out and may be considered unrealistic for some populations (Morland, et al., 2002).

Research Questions and Hypotheses

Research Questions and Hypothesis

Research question 1

Is there a difference between the per-capita density of supermarkets/large grocers, fast-food, convenience stores, and dollar store venues between two rural Nevada counties, one low-income urban and one high-income Las Vegas census tract?

Hypothesis 1

The rural Nevada geography sample will have a lower density (per-capita) of supermarkets/large grocers than the urban census tracts.

Hypothesis 1b

The rural Nevada geography sample will have a higher density (per-capita) of fast-food outlets than the urban census tracts in Las Vegas.

Hypothesis 1c

The rural Nevada geography sample will have a higher density (per-capita) of convenience stores than the urban census tracts in Las Vegas.

Hypothesis 1d

The rural Nevada geography sample will have a lower density (per-capita) of dollar store venues than the urban census tracts in Las Vegas.

Research question 2

Is there a difference in NEMS-S raw scores between two rural Nevada counties, one low-income urban and one high-income Las Vegas census tract?

Hypothesis 2

Grocer venues in the rural Nevada counties will have lower mean produce availability scores based on the NEMS-S produce availability measures, than urban geographies consisting of one low-income urban and one high-income Las Vegas census tract.

Hypothesis 2b

Grocer venues in the rural Nevada counties will have lower mean produce acceptability scores based on the NEMS-S produce acceptability measures, than urban geographies consisting of one low-income urban and one high-income Las Vegas census tract.

Hypothesis 2c

Grocer venues in the rural Nevada counties will have a higher price difference between standard and healthy alternative items based on the NEMS-S non-produce food categories, than venues in the urban Las Vegas census tracts.

Research question 3

Is there a difference in NEMS-S raw scores between a low-income urban census tract and a high-income urban census tract in Las Vegas, NV?

Hypothesis 3

Grocer venues in the urban high-income tract in Las Vegas will have a higher mean produce availability scores based on the NEMS-S produce availability measures, than the urban low-income tract in Las Vegas.

Hypothesis 3b

Grocer venues in an urban high-income tract in Las Vegas will have a higher mean produce acceptability score based on the NEMS-S produce acceptability measures, than an urban low-income tract in Las Vegas.

Hypothesis 3c

Grocer venues in an urban high-income tract in Las Vegas will have a lower price difference between standard and healthy items based on the NEMS-S non-produce food categories, than an urban low-income tract in Las Vegas.

Limitations

The question of which venues to include and exclude exists in order to collect data in a way that yields the clearest valid picture of rural and urban food acquisition options. The demarcation of county/census lines and the location of towns would influence the study's independent variable and need to be considered for a valid argument of food access by the raw sample. In this proposed study, a county line is drawn in a way that warrants inclusion of an additional town. The Esmeralda County line is drawn around Tonopah, NV (See Chapter 3, Figure 6: Rural Nevada Sample Geography Esmeralda (Westside) and Nye County Line (Eastside). As a result, the Esmeralda County focus maintains, but has been expanded to include Tonopah, NV. Further description can be found in Chapter 3 under the heading 'Sample Inclusions'.

Inherent to cross-sectional studies, a complete picture of a community's food landscape is not possible. Without repeated visits to the same areas throughout the year, capturing all sources of food access points such as produce stands and other seasonal venues cannot take place, thereby obscuring a complete representation of access.

While comparing rural and urban communities in terms of the food environment, what could be considered "access" will never be equal due to an urban resident's ability to go beyond their own community and access other food venues at a relatively marginal increase in cost and time. Rural residents can also go beyond their community but at an increased commitment of resources and time.

The results of this study may not be generalizable to other geographies. The sample size of this study's geographies and grocer venues was small. As a result, the ability to compare and

make predictions may be limited. Application of these results is likely not generalizable to Clark County, Nevada or nationally due to the small sample of food environments and audited grocer venues.

Delimitations

A scoring method for each NEMS-S audit currently exists. These audit scores are appropriate to report for large scale NEMS-S auditing studies where many stores are being compared or evaluated. Additionally, these cumulative scores can be used to characterize a specific chain or venue of a particular size in a defined area. This study aims to compile individual item data as the base of measurement and analysis, and will therefore not report the standard NEMS-S score result.

The audits proposed within the scope of this study were performed sequentially and as close in time to each other as possible. This effort was made to provide results during the same relative timeframe and avoid variations due to seasonal fluctuations in food items and produce availability.

The community level analysis of this study examining per-capita venue density by type will use supermarkets/grocers, fast-food, convenience, and dollar store. The venue type of fast-food will be merged with sit-down restaurant. A practical approach to venues in the food environment when convenience is a factor is to consider a venue based on the time to receive the ordered food. A common practice of sit-down restaurants has been to offer take-out and/or pickup service, as has been common in the pizzeria industry for example. Urban sit-down restaurants have been offering this service for many years and it would be expected that rural

venues do the same. Fast-food and sit-down restaurants are collectively referred to as fast-food venues for this study.

Definition of Terms

Audit – The term audit is used as the action of filling out the NEMS-S tool within the venue by researchers. The term refers to the process of investigating a venue and compiling select data-points of interest. The term is a technical one and its use is avoided through interaction with those in the sample geographies, specifically rural venue operators.

Availability – Availability in the context of the food environment can be applied at the community level and at the consumer level. When used at the community level it is often associated with the existence of food venues, but can also include the concept of venue variety. When used at the consumer level, availability refers to food items within the venues.

Access – The term access is derived from the Latin *accedere* “to come” or “to arrive.” Access is a multi-faceted and central construct within study of the food environment and herein. Specificity to situation is maintained throughout this proposed study. Further exploration of its meanings is explored in the literature review in regards to community and consumer level analysis reporting.

Food venue/venue – This term references any business that provides/sells food, ready to eat or not.

Food landscape/Food environment – These terms are used to reference an environment of interest, small or large, and all food venues within. It is often used with an evaluation or characterization of the entirety of food choices for a designated geographical area.

Grocer – Grocers are food venues that are designed to carry the widest variety of foods as the business can offer. Size is not relevant, although it is often used for the inclusion of moderate to small sized buildings/businesses. In the rural geographies, reference to grocers is focused on the largest venue in the sample.

Ground-truthing – Ground-truthing is a term for the direct physical act of food venue site visits. This method is the "Gold Standard" for food environment measurements due to the use of primary data rather than secondary data (Fleischhacker et al., 2012). Secondary data sources are collected through the use of lists, mapping sites, business listings, and/or directory databases.

Market – A market is similar to a grocer in that the business attempts to carry a wide range of food-categories. Markets are often moderate to small sized and offer a produce selection similar to a grocer as stated above but generally carry less non-food items.

Supermarket – For the purposes of this study, this term is used to regard any grocer venue that has the size, scale and capacity to sell a wide range of foods, most often in separate departments within the venue (Mantovani, 1997). The venue has the ability to take advantage of economies of scale due to an association with a national chain or purchasing volume (Kaufman et al., 1997).

Chapter 2 Literature Review

Background

The observation of our environment and its interrelationship to health has been taking place since Greek times (Adams, 1849). This association was a great turning point in Public Health as the first steps of separating effect from the divine. The shift from attributing disease or infirmity to exposure, temperament or imbalance, onto identifiable infectious diseases took root through the use of the microscope as an instrument of analysis in the 16th - 19th centuries (Nuland, 2003). Our contemporary focus on chronic disease is now largely focused on preventable diseases; the tools at hand are dynamic behavior constructs of ecological exposures to the built environment across a lifetime.

Adding modern theory-based research to our current understanding of Environmental Psychology can be sourced from the fields of psychology and human development in the mid-twentieth century. Contemporary views of the interaction between the environment and health are rooted in the field of psychology. Environmental Psychology evolved as a separate field of study in the 1950s and was first presented by name at a New York City conference in 1964 by William Ittelson (Cassidy, 1997. pp. 4-6). Various terms were used for the concept of environmental psychology prior to his presentation, owing to the inclusion of natural and built-environment concepts. The new psychological concept linking the external influences of the environment to behavior was referenced in several fields such as architectural psychology, psychological ecology, and ecological psychology. The nine basic principles of environmental psychology are an outline of what would develop into the Social Ecological Model, maintaining a holistic approach to multiple interacting levels of determinants. Public Health adopted these

constructs that shared a common theme, that of a reciprocal relationship between the person and the environment across a lifetime.

The complexity of human interactions with the environment and their fellow countryman cannot be conceptualized with consideration of a singular direct or indirect influence on health behavior. Examining healthy actions and being able to make valid inferences about populations and interventions requires accounting for and incorporation of multiple factors/levels. Maintaining the individual as the focus of diagnostics and intervention to study disease has its roots in a medical-biological model. Our ability to grasp basic biology led that type of science to prosper greatly due to the acute nature of infectious disease. An associated drawback was the disallowance for application to complex external systems at play. A model that focuses not on the individual or their internal systems was needed to help characterize long-term influences that impact health. Conceptualizing the person within their environment is demonstrated in the mid-twentieth century as thinkers of the time discussed what would be later termed ‘Ecology’, the study of living systems within their environments. The Social Ecological Theory is a behavior model that attempts to explain behavioral influences from multiple perspectives. For a given health behavior, the theory suggests that individual choice takes place through multiple levels and can be understood through the interaction with and between them across a lifespan.

Social Ecological Theory

Ecology Disambiguation

The study of ecological systems takes three forms; the ecological model, an ecological view, and an ecological approach (I.O.M., 2003). Each level builds upon the previous and frames actions going forward. The ecological model is a framework method approach, consisting of various levels of social and environmental determinants. These levels can be applied to health

directly through each level, and also the interactions and connections among levels. An ecological-view approaches the study from a prospective of knowledge of the ecological model, its relationship to determinants of health, and to comprehend the situation of interest through that lens. An ecological approach involves active intervention(s) that incorporate and impact the different levels/determinants.

What is discussed in this study falls under the ecological model and view. The relationship between select levels of interactions between populations and their food environments was examined. The ecological view is omni-present throughout the study. In chapters 4&5, various rationales are given within the conception of the ecological theory to interpret and explain the resulting data. The ecological approach will not be included in this study as it requires multiple strategies to impact determinants of health. No strategies, interventions or (direct) manipulation of variables took place and therefore no resulting impact took place on human samples.

Model Differentiation

Various social-ecological models (SEM) of differing complexities are used depending on the audience or project at hand. A basic presentation is offered to students studying the foundations of Public Health through Mary-Jane Schneider's "Introduction to Public Health" (2nd edition, 2016). The model includes; the intrapersonal, interpersonal, institutional, community, and public policy levels. The Institute of Medicine (IOM) model used the same determinants with an additional consideration of the innate (inborn), such as biologic, demographic or genetic traits at the narrowest level (2010). This model was adopted for use as an "Action Model to Achieve Healthy People 2020 Goals". The Healthy People 2020 model is laid out in a similar

fashion as the IOM model but also includes cyclical components in order to allow for the application of assessment of particular goals. For this study, the IOM model is used since there are no goals to be reached, but rather hypothesis to be tested. See Figure 1.

Figure 1. Institute of Medicine's Social Ecological Model (2010)

In the context of characterizing health and differentiating between institutional treatment of acute diseases and our approach to chronic illness, Fielding et al. (2010) describes the population health model as one that is broad in approach and takes a view that:

> "examines the relationship between the innate biologic characteristics of individuals and their interactions with their peer groups, families, communities, schools and workplaces, as well as the broad economic, cultural, social, and physical environmental conditions at the local, national, and global levels."

Personal Level Outline

At the core of the Social Ecological Model is the self. These are factors at the most personal level that are unchangeable. These include age, gender, race, genetic and other biological factors. For example, a strong genetic link has been found for obesity and waist circumference in a large scale twin study in the UK (Wardle, Carnell, Haworth, & Plomin, 2008). A similar view was observed with adoption studies that found genetics play a moderate to strong role in obesity, comparable to that of height (Bell, Walley, & Frogue. 2005). The review found studies that show a 78% heritability score, increasing to 81% at a 25 year follow up. This compared with an 80% influence for height, show that there is a strong, but not total, association with in-born factors.

Intrapersonal Level Outline

At the core of the personal level are the cognitions of the person. Their approach to the world is shaped by their knowledge and skills. These two components form their attitudes and preferences towards healthy behaviors and ultimately their values. Determinants at this level are highly dynamic and have the potential to change rapidly with new learned content. Physical activity and exercise, use/abuse of various chemicals, and diet are of particular current study (Fielding, Teutsch & Breslow, 2010). These core Public Health issues are complex and have multiple layers of influence, as is argued here, but also fall within the sphere of personal control to some degree.

Interpersonal Level Outline

The interpersonal level includes associations within social groups/networks such as family, community, or a close network of friends. These determinants have a high level of

impact on behavior since they are often the framework of learned behavior. Culture can act as a reference point and perspective from which one views the world and make decisions. These traditions interplay with peers and other social identities. For example, Rucker and Cash (1991) discussed differences in Caucasian and African American cultures regarding perceptions of fatness. They found that African American women are less inclined towards eating disorders than their Caucasian peers, in part due to the ameliorating influence of family and social networks. They cite Thomas (1989) showing that Black women had additional influences impacting body image such as family, and that these influences were not assimilated from Caucasian culture.

Institutional, Living, and Working Level Outline

The institutional level looks at places of exposure such as home, school and work. Places of frequent food sources such as daycare centers, school districts or work cafeterias are also of concern. The food environment of the community and the institutions that comprise them are also determinants at this level. These settings are crucial due to the amount of time we spend in them considering the dramatic increase in meals eaten outside of the home. Lin et al. (1999) show that between 1977 and 1995, consumption outside the home increased from 17% to 22%. Recent data by Larson et al. (2009) show this figure has risen to nearly 50% for meals and snacks eaten outside of the home. Herforth et al. (2007) cite 3 studies showing that the quality of foods eaten outside of the home in the U.S. is poorer than meals prepared at home.

Conditions and Policies Level Outline

The last level “encompasses social, economic, cultural, health and environmental conditions and policies at the global, national, state, and local levels” (Institute of Medicine,

2003). Interventions at this broadest level by design have wide-ranging impacts on a variety of issues within and between determinants in various levels. Global policies include determinants of food insecurity when related to The Universal Declaration of Human Rights on food (1948) and The United Nations statements on the obligations of national policies to uphold the right to access healthy foods (U.N., 2009). National interventions can be associated with the programs or organizations that oversee them such as with the National School Lunch Program and The United States Department of Agriculture. These two agencies in conjunction with the Executive Branch have worked towards recent efforts to improve the quality of school lunches (USDA, 2016). State and local agricultural programs can also include regulations on food and the environment that can hinder or facilitate access to foods through education and certifications for producers.

Applicable levels

All six determinants in the model outlined in the 2003 Institute of Medicine and adopted by the HP2020 initiative are appropriate to use as a guide during the development and interpretation of results. Supermarkets and their contents, act as an institution with multiple layers of influence on availability, price, and quality. Rural populations often are older and Caucasian, making the personal level relevant (Befort, Nazir, & Perri, 2012). Examining aspects of the food environment from the perspective of the shopper, the Intrapersonal approach is also applicable. Venue access may be influenced to an unknown degree through social networks at the interpersonal level. Food is among the most regulated products on the market. National policies and economic forces of supply and demand influence what is available, the price charged and the condition it arrives to the venue.

Applicable Level Personal Innate and Intrapersonal

Personal level data of income, education and race are closely tied to diet (Beaulac et al., 2009; Drewnowski et al., 2009; Morland et al., 2002; Walker et al., 2010). The full interactions of income, education, and race are complex, with additional considerations for rural and elderly populations. Income, education, and race are main areas of study and interventions due to specific risk factors and health conditions associated with these demographics (Drewnowski & Eichelsdoerfer, 2010).

Formal education and race have strong associations with income. The Bureau of Labor Statistics Annual Report (2015) show that differences in income exist by race. Asian populations out-earn all other groups, with African Americans and Hispanics earning the least. The same data show that a formal education degree is positively associated with income and negatively associated with unemployment. The negative impacts of lacking access to higher education, being poor and falling within specific race constructs can be ameliorated to a degree through education, skill, experience and/or culture.

The intrapersonal is implied through the audit tool to represent what is presented to the sample/public. The actions taken to complete the audit act as a proxy for exposure while shopping. What the individual brings to the situation and what options are available to be made will result in access decisions that impact health. Shaping the environment so that the healthful choice is available is one component, but if the individual does not have the intent or ability due to a lack of knowledge, then the encouragement that the environment provides will be neutralized to a degree by ignorance. Evidence exists showing that education can act to assist in

mitigating the barriers of geography and economics. (Carnahan, Zimmermann & Peacock, 2016; (Handbury, 2015)

Income and wealth are different constructs. Income is (generally) a predictive recurring event. Wealth consists of a variety of assists such as physical possessions, knowledge and skill. Low-income populations that have acquired quality cooking instruments, appliances, or food preservation items have a form of wealth investment that does not generally incur a cost for its use. Additionally, high quality cooking tools can have a lifetime or more of functional use, thereby largely negating the need to repurchase items. Wealth has inherent value and applied value. Those who have quality utensils are likely to know their inherent worth through associated function within the kitchen. Skill also can influence diet through expansion of preparation techniques for secured food items. Just prior to the technologic advancements of the late 20th century, these skills were often learned through school, television, literature, periodicals and other. The common line outside of these modern methods is person to person transference of knowledge.

Life experience has the possibility of influencing diet separate from income through beliefs, experience, and culture. Ethical positions on our food system can impact diet through selective consumption choices such as omission of animal derived products (Lindeman & Väänänen, 2000). Lifetime involvement with the food system can affect diet through familiarity with growing, raising, and/or mining of our food sources. The term agriculture means the cultivation of the land. The etymology of the term ‘culture’ (circa 1550’s) has its origins from “the tilling of land” and “collective customs and achievements of a people” (Harper, 2001).

While typically framed at the interpersonal level, culture is included in the intrapersonal level here to represent cultural influence on in-venue choices, diet and health conditions. The link between food and the passing of that knowledge through generations is a core component of diet. Prior to the large-scale movement of people around the world circa 1600s, groups of people, what we now call race and ethnicity, each had unique diets composed of the foods that were accessible to them and preparation methods passed down and communicated throughout generations. Modern study of cultural influences on diet can be seen in the literature involving recent immigrants to the US and their exposure to their new food environments. Some immigrants had healthier diets prior to arriving in the United States. The literature show a positive association between length of residence in the US and obesity rates among recent immigrants (Kaplan, Huguet, Newsom, & Mcfarland, 2004; Park et al., 2011). Kapelan et al. (2004) found that immigrants who have lived in the US greater than 15 years had a four-fold increase in obesity rates as those maintaining residence less than 5 years. Park et al. (2011) studied 349 recent immigrant women in New York City to characterize differences in diet and find predictors based on neighborhood level factors. The researchers found two primary diets. Adherence to the healthier diets, one high in vegetables, legumes, potatoes, fish and other seafood was positively associated with maintaining their primary language.

In addition to the above socially constructed burdens of income, education and race, age is an additional influence that can negatively impact diet. Seniors in any geography have additional food access barriers related to physiologic and social considerations (Arcury et al., 1998; Falk, Bisogni, & Sobal, 1996). Arcury et al. (1998) found disruption of appetite due to (multiple) medication routines, oral health, and mental wellbeing, but also social aspects of omitting meals. They found in their qualitative study that respondents who lived alone resisted

the effort of creating a meal simply for themselves. Seniors who live independently cite lack of energy for cooking, preference for group meals away from the house and the preference for 'fresh' foods/meals. Arcury et al. (1998) is also in agreement with Falk et al. (1996) in that social frameworks influence diet for seniors. Social influences, food choice and diet have a dynamic interrelationship. Falk et al. (1996) found that for many seniors (over 65), retirement allows greater time for social events, with many of those events centered around food. Alternatively, social aspect may act as barriers as well. Arcury et al. (1998) found that the communal aspect of group meals is a deterrent. Their study of rural seniors from two North Carolina counties found reports of segregation by race, age and association at communal food events. The possibility of being in the minority at a particular event is stated as a negative factor when attendance is considered. Reports of line queuing based on race creates a difficult situation for those who are not part of the group putting on the event. Some seniors reported not wanting to be with other elderly people. If the food event is based on association with a particular community, going into a 'strange' environment is often considered. The statements on social barriers to food/meal event access were reported regarding both general social programs as well as faith based events.

Applicable Level Interpersonal

The other component of ourselves is our relationships we have with others. The interpersonal level will have limited applicability but will assist in framing the concept of social networks and food access.

Rural populations rely on each other to a greater degree than urban populations for a variety of reasons, often having to do with low population density, being older, primarily white non-Hispanic, and reporting lower income (Befort et al., 2012). Between rural and urban

populations, Morton, Bitto, Oakland, & Sand (2007) discovered that rural residents have a greater sense of responsibility to others than urban. With rural areas often having lower incomes and a lack of public transportation, the reliance on others for food access through transportation may be considerable (Sharkey, Johnson, & Dean, 2010). Thus, the lack of social-network support in rural geographies precluding the practice ride-sharing, may have a substantial negative impact on diet.

Morton et al. (2007) studied patterns of food access for low-income households in 256 urban food deserts and 958 rural environments. They found that two low-income sample populations utilized two access methods based on geography. Redistribution economies are cited as those such as government benefits, food banks and public/private charities. Low-income urban households were more likely to utilize the redistribution economy. Reciprocity economies are those based on a mutual exchange of household goods. Rural populations were more likely to source foods through the reciprocity economy, both giving and getting of food items. It was also found that living in the sample rural geography increased access to gardens, which increased the ability to meet fruit and vegetable recommendations and variety of produce within the diet.

Applicable Level Institutional

This study examined the built environment, for that, the institutional level was ideal. The presence and density of food venues, as well as their content are important components to address since certain constructs of access to various venues is now a widespread Public Health concern. At both the community and consumer level, the food venue institutions were the focus and main source of the primary and secondary data. Community level data will consisted of all of the sample geography's food-venue occurrence/existence placement and a categorization

code/grouping. Of these venues, supermarkets/largest grocer, fast-food, convenience stores, and dollar stores were compared to the literature findings. Consumer level data consisted of in-venue data on the availability, price, and quality of select items. Within the institution, what the venue carries to offer the shopper is a growing body of research and confronts questions of availability of healthy alternatives, whether or not eating a healthy diet is more expensive then eating standard one, and the quality of produce offerings.

Selling space and sufficient equipment are concerns for rural venue operators (Hosler et al., 2014; Larson et al., 2009; Smith et al., 2015; Zenk et al, 2012). Cooling equipment can be a substantial capital investment for a small venue, one that is paid off slowly over time. These costs are more difficult to pay off due to the lower annual sales and/or lack of non-chain status to spread costs. Chain supermarkets make up 95% of the current large-venue market. As a whole, the supermarket industry earns low profit-margins, generally 1-2%, with small grocers having similar earnings in 2010-2011 (Bailey, 2010).

Applicable Level Conditions and Policies

The influence of conditions and policies on the availability, price and quality of food items in supermarkets are many and complex. Addressing variation within and between environments is dictated by the interrelationship between broad scale social and cultural ways on the demand side, as well as global, national and local policies influencing the supply side. The national origin and movement of the U.S. population, government subsidies for certain crops and not others, plant copyrights, international monetary policies, food safety laws dictating many levels of production from farm to fork, environmental policy and many others factor into what

exists within a food venue (Pillsbury, 1998). These numerous influential policies are not the sole determinants at this level, but are beyond the scope of this study.

Basic supply/demand capitalistic economic theory plays a fundamental part of what items are available and the resulting price, but a reciprocal role involving the customer shapes what is available in a venue. The desires of the customers also shape stocking within a venue. These influences shape a storeowners purchasing and stocking behaviors, and as a result influence item availability and price to certain extent. Small grocers have a greater sensitivity to profit than a large chain (Bailey, 2010). While Baily et al. (2010) show profit margins are similar between supermarkets and small grocers (1-2%), the quantity, size and scale of the large retailers allows for accommodation of customer requests without jeopardizing the venues ability to be self-sustaining. This plays out differently across venues but suggests that smaller grocer venues may tend to be inflexible with their stock variety due to reduced gross sales.

This limited ability for the smaller venue to stock items associated with health such as whole and minimally processed foods impacts the choices offered to consumers. Streamlining business operations for the small business owner also influences purchasing and stocking behaviors. When an operator of a venue such as a convenience store or small grocer decides to build a business without previous stock, industry vendors offer inventory and display templates for the venue based on space. These templates consist of food items and graphical renderings or photographs for displaying stock items similar to other venues in the region of comparable size and venue theme. These templates save the operator from having to spend time strategically deciding on which products to carry or how to optimize and display their selling stock. These pre-fabricated methods are optional and the internet has facilitated alternative business arrangements based on cost and profit. The items that these vendors suggest stocking are high in

commodity crops and have a negative impact on weight. Additional discussion on consumption of commodity-based foods can be found below in the section ‘Literature Based Policy Recommendations.

Quality is a subjective term and is not the same concept as edible. The quality of the produce that arrives to the venue has many determinants throughout the production and delivery network system (Gunders, 2012). The quality of the produce that is presented to the customer is largely under the control of the venue operator. Large national supermarket chains actively market themselves as having the freshest and highest quality produce. Smaller grocers and discount retailers in rural and urban geographies may be less concerned with flawless items and may keep produce out longer than a larger venue (Berry, 2011).

Food Environment Literature Review

Approach

Food environment reviews published between 2013 and 2016 focused only on children or schools. The existing evidence is summarized in articles published mainly from 2008-2012. The most common design was that of a cross-sectional analysis (Beaulac et al., 2009; Walker et al., 2010). The main methods used at the community level were primarily geographic. At the consumer level, the instruments of evaluation were venue based characterizations or subjective impressions of the food environment. Beaulac et al. (2009) and Walker et al. (2010) both sought studies looking at food deserts with the former seeking out communities specifically in socioeconomically disadvantage areas.

Examination of the food environment at the community level involves various measures of accessibility to venues within defined geographic areas. The results are then often compared with population level variables in order to characterize discrepancies between communities. Research of this type has been taking place since the 1960s but has gained momentum in the literature starting in the 1990s with an increase since 2003, as technical tools have seen wider use among Public Health professionals. The following community level reviews examine the breadth of studies and reports on various types, methods used and recommendations for future research. Not all of the reviews contained outcomes of studies, some focused on the techniques of analysis and made suggestions for future studies to strengthen research on the food environment.

Food Environment Reviews – Community Level

A review by a team from Ontario, Canada of American food environments from 1966 through 2007 found results consistent with other U.S. reviews outlined here. Beaulac et al. (2009) selected 34 papers based on outcomes of store density by area or population, and mean distance to nearest food store. The study focused on reviewing articles that addressed socioeconomically disadvantaged areas and food deserts in the U.S. The main findings were that communities comprised of a mix of racial groups and areas that were primarily inhabited by low-income residents were found to have a reduced quantity of supermarkets, large and mid-sized grocers. In twelve studies, low-income populations also had low existence of supermarkets and large or midsize grocers. In nine of the papers, African American communities also had poor access through low existence of supermarkets and large or midsize grocers. Reduced access through increased distance disparities existed for areas that were primarily low-income and African Americans.

A collaborative review between The University of Pennsylvania and Harvard's School of Public Health, publish by Walker, Keane and Burke (2010) included 31 studies looking at the Food Deserts. The articles were grouped by focus area that included; access to stores, income, race, venue density, cost (price), location, venue type, availability, perception, and quality of venue items. Walker et al. (2010) found strong evidence for disparities in access by race, African Americans and Latinos, through existence and distance measures to supermarkets. Studies examining venues by income found low-income communities lacked 'chain-stores' and that affluent areas were likely to have chain supermarkets. The review lead to four outcome/summary statements on the food environment critical for future study: access to supermarkets (venue existence), racial/ethnic disparities in food deserts, SES of food desert populations, and differences in chain vs. non-chain food stores. The authors cite work focused on Philadelphia, PA to demonstrate the lack of supermarkets. Referencing work by Giang et al. (2008) examining supermarket existence by income, results show that nationally during the 1990's, low-income communities had nearly 30% as many supermarkets as the neighborhoods with the highest income. During the same time, Philadelphia had the second lowest supermarket count per capita, with the highest income areas holding 156% of the supermarkets as the lowest income areas.

A French team, Charreire et al. (2010) reviewed papers with the intent of outlining the instruments and methods used to better characterize the term 'access'. The approach was unique in that the articles reviewed assessed the food environment exclusively through the use of GIS. Charreire et al. (2010) reviewed 29 food environment studies through June 1st, 2009, but omitted outcomes in the body of the text. Findings were stated in a chart section with one-sentence statements of association between variables. Comparison variables fell into two categories, those that compared the food environment and measures of personal food behaviors, and those that

compared accessibility of food venues to neighborhood level characteristics. Community level measurements taken to characterize the venues of interest were density and proximity, and comprised 18 of the 29 articles. Findings of venue and area characteristics were associated with consumption of fruits and vegetables, perception of healthy food availability dietary patterns, and the overweight or obesity status. The relationship between access to venues and area demographics were primarily focused on supermarkets but did include all venues. The contexts of the residents mainly involved social-economic factors such as unemployment rates, single-parent rates, income, race, and vehicle ownership status.

The most recent review on the food environment comes from Caspi et al. (2012) out of Harvard's Center for Community Based Research. The review examined literature relating to community level study with a specific focus on diet outcomes. The authors found 38 international studies of the Food Environment with relationships to diet outcomes; 24 of which were U.S. based. The lens in which the food environment and diet connection was viewed was that of Penchansky and Thomas (1981) conceptual definition of 'food access'. This model of 'access' is comprised of five components: availability, accessibility, affordability, accommodation, and acceptability. The availability measure captures venues within a designated area and can be conveyed as a cumulative opportunity exposure. Accessibility is a purely distance based measure. Affordability is a subjective view on the price of food items interpreted through the lens of value. Accommodation refers to objective and subjective views regarding how venues operate such as hours and payment methods accepted. The latter three, being consumer level data. Acceptability can be objective or subjective referencing the venue itself or the items within. Objective measures, as discussed in Chapter 1, involve assignment of a quality

rating to produce. Subjective report on the venue or the items within are collected through interviews and surveys.

Availability and accessibility were investigated at the community level. The availability (component) measure was the most frequently used method in 20 of the 38 studies. The availability (component) measure examined dietary links to venue existence from the sample's residence within an inclusive buffer zone or the density of venues within census tract(s) or block(s). The studies examining the availability (component) measure showed "fairly consistent positive associations with a healthy diet".

The accessibility measure conceived access through a distance measure to a "food store", both supermarkets and fast-food outlets. Caspi et al. (2012) found a 'remarkably inconsistent' association between distance to a food store and diet outcomes. Of the thirteen studies using distance, seven found no association between a venue's distance and diet. Two of the remaining six studies found results in opposing directions.

Collaboration between the National Cancer Institute and The University of Minnesota yielded the review with the greatest number of article inclusions. Mckinnon, Reedy, Morrissette, Lytle, & Yaroch (2009) compiled 137 studies from 1990-2007 that looked at four aspects of the food environment including, accessibility, availability, affordability and quality. Only accessibility of venues is applicable at the community level. McKinnon et al. (2009) omitted results of the studies under review and only summed their approach and methods in order to make recommendations for future study. Work by McKinnon et al. (2009) is referenced in the proceeding section 'Literature Based Policy Recommendations'.

Community Level Findings

The following reviews on consumer level research reported approach, measurement methods and findings. The major findings are reported between geographic access and the diet/disease relationship, with race/income where present.

A concern to consider while interpreting the results of the proceeding review is the non-specific use of the term ‘access’ by Beaulac et al. (2009). Uses of the term are difficult to discern due to context, vague use when referencing existence, and the misinterpretation of a studies sample. The review points to several studies to make statements on the relationship between diet and obesity, in the context of access. For example, the statement regarding that, “increase access to supermarkets is associated with improved fruit and vegetable consumption and having a better diet quality among low-income households”, the authors of the cited study used a trichotomous variable to represent access but did not state that it was a subjective perception of access (Rose & Richards, 2004). These three variables consisted of a subjective response to “supermarket shopping”, travel time, and car ownership. When Beaulac et al. (2009) made the same statements regarding increase access to supermarkets being associated with improved fruit and vegetable consumption and having a better diet quality among pregnant women, Laraia et al. (2004) excluded the 62 pregnant women from the BRFSS data sample. Lastly, Beaulac et al. (2009) states that in the US, “increased access to supermarkets is associated with lower prevalence of overweight and obesity”. They cite research carried out by Morland, Diez-Roux, Wing (2006) examining data at the community level from Atherosclerosis Risk in Communities (ARIC), a large-scale multi-state prospective heart disease study of middle-aged adults and over. The access measure used by Morland et al. (2006) only includes venue prevalence rates within each geography (county, city and community levels.

Geographic Access and Diet/Disease Outcomes

Beaulac et al. (2009) presented mixed evidence in their review on the relationship between access to supermarkets and chain stores and positive diet behaviors and health outcomes. The review found that increased access to large chain grocers is associated with lower overweight and obesity prevalence, improved produce consumption, and better diet quality among African Americans, and low-income households.

The reviews by Caspi et al. (2012), and Walker et al. (2010) show that GIS based measures show mixed associations with diet. Caspi et al. (2012) state that the use of GIS to assess accessibility through distance (to venue) measures, were overwhelmingly unrelated to diet associated outcomes. The authors concluded that the evidence is weak among community/geographic level measures of distance and diet when measured alone and suggest perceived venue access as an appropriate additional measure due to subjective reports being associated with dietary outcomes. These specific relationships between access and diet were reported through an access model proposed by Penchansky and Thomas (1981) within the framework of the review by Caspi et al. (2012). Caspi et al. (2012) found the 'accessibility' component showed a remarkably inconsistent relationship with dietary outcomes. The accessibility measure of the model considers distance-based measures to venues. Alternatively, through availability, a significant relationship with dietary outcomes was found. The availability component measures access through the cumulative opportunity of venue exposure within one's residence or neighborhood (tracts/blocks) through the use of inclusion buffers.

Liese et al. (2009) discuss the link between measures of availability and diet/disease outcomes. They point to the literature showing that urban census tracts, those with a supermarket

had 9% lower prevalence of persons who are overweight and 24% rate of people who are obese in tracts without a supermarket. Additionally, they cite work showing that obesity is more common in areas with small corner grocery stores and convenience stores. Their data show that their rural sample was “heavily weighted towards convenience stores”. They comprised 74% of venues with 16% supermarkets and 10% grocery stores. Their urban sample was a stark contrast with 36% to 57% of venues being supermarkets or grocers stores and convenience stores representing 8% to 41%.

Race and Income Association with Access

Examination of the food environment by race is often reported with income-based results unless income is specifically controlled for. The data are strong showing that an access disparity is present between low and high income areas at various levels of geographic measurement. The data are strong showing an existence and distance disparity in supermarket access between African Americans and Latino communities.

The review by Beaulac et al. (2009) made a summary statement that of the reviews that reported outcomes, the studies conclude in U.S. environments that “clear evidence” of disparities for access based on income and race, and that evidence is both “abundant and robust”. This disparity is a result of reduced access through large venue/supermarket omission. Results for low-income communities and those with a high proportion of African Americans and Latinos had fewer supermarkets and chain stores and higher exposure to smaller independent food venues and convenience stores that charge more and have limited selection. The authors also found disparities in access based on distance measures to supermarkets. They cite Zenk et al. (2006) who used three measures of access: distance to the closest supermarket, a 3-mile inclusion buffer, and strait-line distances from the communities to all supermarkets. Zenk et al.

(2006) found no chain supermarkets, 13 independent grocery stores (9 large, 4 small), and 93 liquor stores for over 90,000 residents within an area of the sample geography. They found that among the 889 census tracts, the most impoverished Detroit, MI communities that were majority African American, had an additional 1.1 miles distance to the closest supermarket. The implications of these results were represented by citing qualitative focus group work done by Kieffer et al. (2004) in various sections of Detroit. Of the 97 participants, 59 were from within the same Detroit area as Zenk et al. (1999), and all were African American. African American residents cited time, cost and alternative options as access barriers at the community level. Under the qualitative coding theme, 'Lack of access to healthy foods/ready access to fast-foods', a representative response was "You've got to go out in the suburbs now to get some decent food. And therefore, it's not available for us in this community. By the time you get to that store and get some fresh fruits and vegetables, you're going to pass about 30 fast-food joints and about 100 liquor stores." Kieffer et al. (2004). Alternative convenience foods such as fast-food venues were "especially likely" to be chosen by east-side women as a substitute and savings of time and energy.

Beaulac et al. (2009) also cite Morland et al. (2002) for the claim that increased 'access' to supermarkets increases fruit and vegetable consumption for African Americans. Morland et al. (2002) demonstrated that the prevalence (existence) measure is associated with wealth (median house value) and race. Morland et al. (2002) suggest that their work strengthens the argument that race and wealth impact dietary outcomes through the work done by Diez-Roux et al. (1999). Diez-Roux et al. (1999) found that the same (ARIC) low-income sample population was "generally" associated with lower intakes of produce and fish, and increased intake of meat and meat products. The findings associating income and intake were small, but consistently

associated with diet. Additionally, Diez-Roux et al. (1999) found in their sample, low-income status at the personal level was more associated with these same diet outcomes than neighborhood measure of low-income.

Consumer Level Literature

The compliment to community and subjective level research is that of the consumer environment. At this level, it is the venues themselves, the items within them and venue characteristics with which focus is put upon. Consumer level research uses similar approaches and terminology, the venue and the items within them now the focus. A variety of instruments have been developed for specific aims within each study, with a greater prevalence of standardized tools appearing more recently such as the Nutrition Environment Measurement Survey.

Consumer Level Specific Terminology

Some components of access are clear-cut such as price, while similar terms for geographic based measures of access are used dependent on the aim of the study. As such, similar terminology is used such as *variety* and *availability*, but now focused on food items. Beaulac et al. (2009) describes v*ariety* as the number of different types or brands of the same food item and a*vailability* as the presence of a certain food item in question.

Two sets of terms are present in the literature to refer to similar constructs. *Price* and *affordability* are objective and subjective terms respectively, applied to what retailers charge for their items. Affordability is the impression upon the potential purchaser when considering additional personal situational forces such as value.

Quality and *acceptability* are two additional terms with similar subjective views and is dependent on each person regarding the food supply within a venue. The quality measure framework in Chapter 1 outlines an objective approach through use of a rubric. Subjective impressions of produce acceptability is dependent on personal experience, preference, skill, or intent. Caspi et al. (2012) and Charreire et al. (2010) cite 2 dimensions of community level access proposed by Penchansky and Thomas (1981), acceptability and accommodation. Acceptability is dependent upon personal preference and standards. Although acceptability is a subjective concept as a method to measure access, attempts to capture acceptability in the literature primarily take place through the objective quality measure.

How a store accommodates to the community is a reflection on its accessibility through what the venue allows. Accommodation refers at a broad level to the relationship venues want to have with their customers through amenities. Store hours, types of payments accepted and/or handicap motorbikes are examples of how welcoming the venue seeks to be and can be measured as part of the food environment.

Consumer Level Instrumentation

The core tools used throughout the reviewed literature to collect consumer level data have been checklists, market baskets, inventories, and in-store audits. The main subjective data has been that of interviews, questionnaires and surveys.

Checklists are a predefined list of indicator foods. Researchers seeking to compare venues on the availability or cost of specific dietary components such as fat or sodium show evidence in the literature (Baker et al., 2006; Hall, 1983; Zenk et al., 2007). Market baskets are a similar concept except that they represent a list of foods that comprise a common mix of foods

often purchased in combination to represent a total diet and include consideration of food purchase patterns (Chung et al., 1999). The market basket can focus on certain items, but the inclusion of complementary foods that would comprise meals are included. The inventory approach attempts to collect all items in question. These can be within specific categories of foods like the number of different varieties of tomatoes or apples, or a broader level of all items of a category such as milk or meat.

Subjective responses take the same view as primary data but from a personal perspective. Surveys and interviews rely on replies to inquires based on their perception of their food environment. The same core lines of inquiry are present throughout the literature when using subjective surveys to assess access: availability, item price, and quality (Caldwell, Kobayashi, Dubow, & Wytinck, 2008; Gustafson et al., 2011).

Consumer Level Outcomes

Reviews by Beaulac et al. (2009) and Walker et al. (2010) include results from 19 studies on availability, 15 on price, and 9 that merged price and quality. Beaulac et al. (2009) reviewed studies on food deserts that included geographic access and analysis of market baskets. Walker et al. (2010) reviewed articles on food access and food deserts. The reported findings by Beaulac et al. (2009) for availably and quality variation between venues and between communities is difficult to decipher due to poor description of the results as well as a merging of availability and quality into single statements. As a result, further review of the cited works by Beaulac et al. (2009) to define access was warranted.

Availability and Quality

The review by Beaulac et al. (2009) show worse availability and quality in "disadvantaged areas" in five of nine studies. The remaining four show between communities of varying income and racial mix generally had poorer availability and quality of food items but is stated as mixed. Sallis, Nader, Rupp, Atkins, and Wilson (1983) found that middle income communities had greater availability than low and high income study areas, but no data on quality. A comparison of two towns within Chicago by Block et al. (2006) show no difference in item availability between sample towns, but did find support that the low-income community had lower quality food options. Only the low-income area had lower quality produce and most often occurred in independent grocers and liquor stores. A study examining New York communities by Hall (1983) found that item availability, variety, and quality were lower in African American and areas of the city with a high proportion of seniors citizens. Lastly, Zenk et al. (2005) used supermarket venues as a proxy for availability and quality of healthier foods in their perception level analysis of African American women on the eastside of Detroit, MI. A positive relationship was found between the view of produce quality and intake. The discussion cited previous community level analysis and suggested indirect access and intake influences due to income.

Price

The literature show strong results on differential price based on area, but results were not perfectly consistent (Beaulac et al., 2009; Rogus, 2015). State and national research efforts show strong evidence that low-income and low-income urban residents pay more, and received lower quality foods (McKinnon et al., 2009). Alternatively, findings by Beaulac et al. (2009) regarding price between venues was reported as mixed and complex. They found mixed and null results for

both low-income areas and race. Studies showed higher and lower prices in low-income and African American communities. Prices for mixed income and mixed race areas showed various results of higher and lower prices.

Walker et al. (2010) state strong support that low SES communities pay more for their food and receive lower quality items. Findings support that the price of food is higher in smaller venues, urban areas (vs. suburban) and at non-chain stores. Walker et al. (2010) found results regarding price, quality, item availability and variety consistent with the literature. They cite work done by Hendrickson et al. (2006) finding higher prices and lower quality produce in "impoverished areas". They then link these results to multiple peer reviewed studies, a 1991 study of venues and surveys in New York by the State Consumer Affairs Department, and a report to the House of Representatives Select Committee on Hunger (1990), showing low-income urban residents and those in "areas that do not have a supermarket" pay more for the food they do acquire. The New York Consumer Affairs report consisted of a sample of 60 stores and 140 interviews with consumers and retailers. The report found that large venue movement from urban areas to the suburbs, transportation issues, and the absence of competitively priced venues causes low-income populations to pay more for less (Hendrickson et al., 2006).

When comparing metropolitan areas, Walker et al. (2010) cite work by Chung and Myers (1999) and their large, multi-city study in Minnesota that compared price differences between venue and area types. They found much higher prices in non-chain venues compared with chain venues. Chung et al. (1999) found strong support that living in a low-income area was associated with paying more; through the absence of chain venues, and low availability of items within existing venues in low-income areas.

Consumer level intervention into the price structure of different types of foods has been taking place since the mid-20th century, continues today, and has moved into the peer-reviewed literature. The direct impact of the price difference between the purchasing of standard and healthier alternatives is outlined through various measures such as income, food price and purchasing habits. The price difference between standard and healthy items, and the relationship to diet related disease outcomes are limited in the literature since federal dietary guidelines have only recommended healthier foods since the early 1980's (Glanz et al., 2005; Sturm et al., 2013). Historically, those with higher incomes spent less of their income on food and had a greater variety of foods within their diet as compared to low-income workers that spend more of their total income on food, and had consumption rates of smaller amounts of healthy foods, such as milk, eggs, and meats (Sydenstricker, 1915). More recent literature show, processed foods and those created and marketed towards convenience have become available in larger sizes and lower prices, both of which appeal to those with constrained food budgets. Processed foods largely consist of commodity crops such as corn and soy, and are directly implicated in diet-related disease outcomes (Bowman & Vinyard, 2004; Duffey, Gordon-Larsen, Steffen, Jacobs, & Popkin, 2009; Sharkey et al., 2011).

Variation in the supply and demand of commodity crops resulting from the Great Depression initiated intervention at the Federal Level (Philpot, 2007). Current estimates put the amount of subsidy into commodity crops from 2014 through 2023 at $200 billion (Patel, 2016). From 1985 to 2000, retail prices for produce crops rose 118% (Story et al, 2008). The price of foods created from commodity crops such as fats/oils, sugars/sweets, and soft drinks have risen an average of 34% over the same time.

Targeted research into price variations at within grocer venues have promising associations with price intervention/manipulation. The debate between lowing costs of healthy foods or imposing a greater cost on unhealthy foods that may deter those purchases is unsettled in the literature (Epstein et al., 2010). The price of healthier diets is suggested as a deterrent to healthy eating, especially among low-income shoppers (Drewnowski, Darmon, & Briend, 2004; Jetter & Cassady, 2006). When comparing a market basket of standard versus healthier alternatives, Jetter et al. (2006) found a 17 to 19 percent higher price for the healthier basket. A significantly positive association between price reductions and purchasing healthy foods has been demonstrated in the literature and suggest, "higher prices for healthier foods could be a formidable deterrent to consumers meeting dietary guidelines" (French, 2003; Jetter et al, 2006). Economic interventions to promote the purchasing of healthier food may have unintended consequences related to unhealthy foods. When Epstein et al. (2010) provided a sample of shoppers lower prices on healthier foods, the excess funds were used to purchase unhealthy foods. Alternatively, providing incentives at venues where unhealthy foods are less likely to be present has shown positive impacts on purchasing.

Coupons ("bonus dollars") for farmers market and economic incentives to shop at these venues are targeted at low-income populations through SNAP (USDA Food and Nutrition Service, 2016). Increased sales at farmers markets have been found through the addition of only five dollars (Freedman, Mattison-Faye, Alia, Guest, & Hébert, 2014). The researchers found that after implementing the intervention, sales at these venues increased 15%. Young et al. (2013) found that those who use these incentives were significantly more likely than nonusers to report increasing their produce consumption and trying new produce items. In a large (n=55,000) case-control study by the USDA Food and Nutrition Service, researchers found that by increasing

purchasing power at farmers markets for users of SNAP by 30%, daily produce consumption increased 25% over the control group (60% vegetables, 40% fruits).

Broad Recommendations for Future Research of Food Access

Recommendations for research between varying geographies focus on incorporating additional considerations into the framework of future studies. It is first pointed out by Caspi et al. (2012) that no perfect study design exists and that there is no gold standard for most of the tools measuring access. Further suggestions follow alignment with the Social Ecological model to incorporate a more dynamic and holistic approach that will assist in unveiling valid measures of geographic components (Herforth et al. 2015; Shaw, 2006; Zenk et al., 1999). Geographic data are unique to each environment under analysis and are needed to create stronger links between the food environment and dietary and health outcomes. Grounding on a theoretical framework, dynamic and multi-level measures, and ensuring that results accurately depict the food environment through a fully accurate representation of all venues in the study area are primary concerns within the literature (Caspi et al., 2012; Charreire et al., 2010; Flasichacker et al., 2012; Powel et al., 2011; Walker et al., 2010).

Theory

Incorporating multi-level measures from a theoretical standpoint is paramount so that the data that is collected can “truly represent those things that can enable or hinder healthy consumption patterns” (Caspi et al., 2012). The primary areas of focus within the food environment literature addressing components within the Social Ecological Theory at the personal level are income, race, and education (Baker et al., 2006; Dunn, Sharkey, Lotade-Manje, Bouhlal, & Nayga, 2011; Hall, 1983). A call for increased subjective perspectives,

walkability attitudes and practices, transportation utilization, as well as personally defining ones food environment are also made (Caspi et al., 2012; Rossen, Pollack, & Curriero, 2012). At the social, family and community networks level, concepts of culture, home and peer influences are highly relevant and have strong ties to diet related health outcomes (Carnahan et al., 2012). At the living and working conditions, geographic analysis of the home and work environment is suggested, but also common routes between those places is needed in order to get a stronger validity measure of realized access (Drewnowski, 2012; Lenardson et al., 2015; Oppert & Charreire, 2012). The highest level encompasses broad institutional influences at the local, state, national and global sectors. The literature addresses and makes recommendations for change in institutional influences on food environments such as global commodity prices, economic supports for specific crops over others and advertisement on behalf of the food-industry and Public Health (Caspi et al., 2012; Glanz et al., 1995; Herforth et al., 2015; Story et al., 2008; Walker et al., 2010).

Dynamic and Multi-Level Measures

Caspi et al. (2012) supports using dynamic and multi-level measures suggesting continued use of geographic/GIS analysis as one part of a multi-tool examination and subjective surveys. Its use should be closely aligned with the intent of the study and the theoretical frameworks. If the intent of the study was to examine venue access, multiple methods should be used outside of simple distance from residence. Multiple measures of access such as venue density, Kernal analysis, mean distance to the 3 closest venues of interest, and network analysis are the primary methods suggested, but also road speed, traffic density, traffic signals, road surface, and topography will represent access with greater validity (Thornton et al., 2011). Caspi et al. (2012) also point towards the issue that a simple network analysis to address walkability

lacks direct perspectives of the area regarding issues such as safety, lighting concerns, or neighborhood specific pedestrian throughway access. Primary data collection of these features with ground-truthed GPS data would strengthen study data and tool alignment when complimented with additional data such as resident surveys.

Venue validity

Not being able to accurately depict all venues of interest is a source of error. The literature show mixed and poor matching between primary and secondary data collection methods. A major challenge/recommendation stated by Beaulac et al. (2009), Caspi et al. (2012), Charreire et al. (2010), and Walker et al. (2010) was the poor reliability of venue databases to accurately depict the food environment. Through the use of ground-truthed data, Powell et al. (2011) found only moderate agreement between direct observation and commercial business lists for food stores and restaurants, but poor agreement on classification of venues on behalf of the data collection team, which may lead to undercounting venues of interest. National level analysis of food deserts through the use of secondary data has shown moderate predictive value, but use of the same methodology at a local level is discouraged due to poor validity between primary and secondary data (Ma et al., 2013). Both omission and incorrectly placed venues were issues of concern. Additional comparisons between primary and secondary data sources show both over and under representation of venues and is more pronounced for convenience stores and specialty markets (Fleischhacker, 2012).

Trans-disciplinary Research and Measurement Standardization

Findings by Boehmer, Lovegreen, Joshu and Brownson (2006), Charreire et al. (2010), Caspi et al. (2012), and Eyler et al. (2015) suggested a trans-disciplinary approach to modeling

the food environment. Closely linked are additional calls by Eyler et al. (2015) to improve both the internal and external validity of measurement tools that center on the concept of defining access and constructing instruments to compare across studies and environments.

It is suggested that various pertinent fields of study work together to strengthen the validity of the access measure (Caspi et al., 2012; Eyler et al., 2015). Those in Public Health (researchers) may be able to work with an instrument such as the NEMS, while GIS may require more analytical skills. The inclusion of professionals in traffic analysis and technology would be a valuable asset for the integration of data within GIS to greater refine the concept of, and estimate levels of access to a greater degree.

At the same time the call for a variety of fields to have input on the framework studying the food environment, the need for measurements that are able to be used across studies is discussed for researchers by Caspi et al. (2012) and for practitioners by Eyler et al. (2015). Caspi et al. (2012) argue for a better method of determining access through (inclusion) buffer zones that aligns with others in the literature calling for a measure of 'cumulative opportunity' within a designated area (Davis et al., 2010; El-Geneidy & Levinson, 2006 ;Sharkey, 2009). Specificity to the desired outcomes when deciding on distances during the study's development should be sourced through the literature. Purely geographic measures of proximity, specifically distance to the closest supermarket/venue, has shown poor relationship to diet (Charreire et al., 2010). Surveys of the perceived food environment that uncover the distances people are willing to travel would strengthen aspects of access and have been inconsistently measured throughout the literature. Eyler et al. (2015) take their research recommendations to the field. Close work during study development between researchers and practitioners would assist in broader scale assessments being carried out. In order to advance the field of environmental assessment they

also call for standardization of measures, as well as adapted and simplified tools and training materials. Instrument development from a variety of fields and perspectives will allow future reviews to compare studies across environments. Eyler at al. (2015) state that this multi-disciplinary effort would allow for the possibility of dissemination and use of the tools by a wider audience. The training obtained by researchers on the food environment is excessive compared to skills and talents necessary to carry out valid assessments of an environment.

Comprehensively Defined Access

The characterization of access was a prime component in every review. Recommendations are to move away from solely relying on distance-based measures and use a multi-dimensional approach (Charreire et al., 2010; Sharkey et al., 2012). Subjective data and GIS are called for to be used in tandem, along with more sophisticated modeling of geographic access and more comprehensive lines of inquiry about actions and impressions of food access (Caldwell, Kobayashi, Dubow, & Wytinck, 2008; Gustafson et al., 2011). The merging of subjective data with geographic measures has shown to have a greater association with diet than when defining access through distance based data alone (Caspi et al., 2012).

GIS analysis is needed to compliment and strengthen the validity of the access measure beyond that of simple proximity. Importing census tracts, community level demographics and geocoding venues within GIS is relatively simplistic when compared to the totality of what the program can accomplish. Additional measures such as network analysis that include traffic flow patterns and primary data collection on walkability is recommended (Caspi et al., 2012; Eyler et al., 2015).

Properly formatted, the use of crowd sourced data integrated within the GIS analysis can be used to refine measures of access in real world conditions. At the community level, traffic data may reveal patterns of vehicle use and barriers to access. At the neighborhood community level, data has the possibility to reveal walking rates and previously unknown walking routes. Data at both levels of analysis could be collected with a single device, possibly with a device many may already have. One example in current use is a computer program that runs on the personal phone. An Israeli developed program called Waze Mobile allows people to submit their personal movements in geographic space, across time. The program's use was supported in 2013 by another large technology company purchasing and integrating it within an existing mapping system. Recent merging of data from Waze Mobile and ESRI, the company that created GIS, will allow real world data to be integrated and projected visually through GIS (Stauffer, 2016). Temporal level of study has been called for by Caspi et al. (2012) and Charreire et al. (2010) for its ability to link behavior and diet outcomes as a prospective study.

A greater use of more complex modeling within GIS was recommended in reviews by Caspi et al. (2012) and Charreire et al. (2010). Another method of analysis within GIS that is present in a small number of reviewed studies, but has the potential to find significant relationships between built environment features and diet outcomes may be the use of Kernel Density Estimation. Kernel analysis is the use of weighted components of the built environment. This method borrowed from the field of Geography and based on a statistical theory, show that points of interest that are closer to each other have greater influence and/or relationship on/to other variables of interest. Food venues may be weighted more heavily depending on additional characteristics in the environment being studied. Weighting of a specific distance measure may

be added or the venue types may represent a stronger reference point due to more or less pre-determined venues within a set proximity.

Lines of Subjective Inquiry

A study reviewed by Caspi et al. (2012) pointed out that the strongest association of physical access to venues and diet existed in a study by Rose et al. (2004) that also measured respondents' travel time to the venue. Caspi et al. (2012) suggests additional lines of inquiry to further refine the measure in a more holistic method revolving around the experience of shopping, such as how people get to venues. This measure of access would include factors such as vehicle use, time, and barriers. Charreire et al. (2010) go further and suggests surveying the distance in which respondents would be willing to cover for food needs. Both subjective measures suggested by Caspi et al. (2012) and Charreire et al. (2010) have the potential to utilize Kernel Density Estimation since each respondent would be applying different weights to variables under study.

Literature Based Policy Recommendations

Beaulac et al. (2009) and Walker et al. (2010) discuss the need to address policy issues surrounding what the data show as the greatest need in the literature. These center on increasing supermarket existence, impacting healthy food prices and dissemination of key findings. Walker et al. (2010) cites public/private partnerships in Boston, MA, New York, NY and Pittsburgh, PA that led to the development of supermarkets in underserved communities. These partnerships secured the development of infrastructure through many various efforts. Most prominent were government incentives, political leadership, and local non-profits acting as 'cultural ambassadors' (Pothukuchi, 2005). Walker et al. (2010) and Beaulac et al. (2009) endorse

facilitating the entry of supermarkets into low-income areas would increase certain aspects of access. Story et al. (2008) makes the same claim but admits, at that time, that little research has been done into that process. Beaulac et al. (2009) and Story et al. (2008) also encourage governments at various levels to be more involved in assisting the advertisement of healthy foods, encouraging local food projects such as grocery cooperatives and community producers channeling their output into stores and onto shelves.

Beaulac et al. (2009) and Story et al. (2008) suggest a much more difficult endeavor. They recommend work towards decreasing the disparities in price between healthy and unhealthy foods. Story et al. (2008) discusses subsidies specifically. They reiterate calls by Drewnowski et al. (2012), that calories are cheap and nutrients are more expensive. They also point towards government intervention, manipulation and economic support for certain crops such as grains, oil and sugars, while others such as fruits, nuts and vegetables are not supported. Work by Siegel et al. (2015) show crops with the greatest subsidies from 1995-2010: corn, soybeans, wheat, rice, and sorghum, were found to consist of more than half the diet in their sample of 11,811 US adults. Further work by the same authors show consumption of these same commodities is associated with having a body mass index of at least 30, with the overweight and obese threshold being 29.9 and 30 respectively (Siegel et al., 2016). The proportion of foods eaten away from home has been increasing for the past 40 years for children and now account for the majority of calories consumed (Poti & Pomkin, 2011). Adults also are shifting consumption patterns "…away from meals to snacks and from at-home to away-from-home consumption" (Guthrie, Lin & Frazao, 2002; Nielsen, Siega-Riz & Popkin, 2002).

Strengthening measures of the food environment are called for by Beaulac et al. (2009), Eyler et al. (2015) and McKinnon et al. (2009) in order to make effective interventions that can

then be disseminated and promoted to lawmakers. Eyler et al. (2015) call upon Public Health practitioners to use media resources to effectively disseminate key findings to various outlets and stakeholders. Circulation to local, state and national policy makers encourages a common conversation on crucial food environment and access issues. Engaging community leaders with the results can foster change from a different route. Change often comes from the people, and informed community involvement can initiate and facilitate change (Orleck, 2005).

Rural Food Environment

Limited examination of rural areas at the community and consumer level exists. Reviews of rural food environments are few but do include a 2009 comprehensive summation of access to healthy foods nationwide and a 2015 analysis of rural food environments with links to determinants of obesity. As such, an additional review of the existing literature's introduction sections and a snowball approach through reference lists was completed.

Rural Community Level Access

Due to the unique nature of rural geographies, the food environment is structurally different. As such, analysis of access at the community level includes different approaches to geographic evaluation to capture the range of venue types in this unique geography (Caspi et al., 2016). A range of venue types are available in rural geographies. The literature show the quantity of food venues in rural areas is less, as would be expected with smaller populations, but that variety can be similar. Standard venues such as supermarkets/grocer, fast-food, convenience stores, and dollar stores are common, but venues such as meat and fish markets, produce stands and farmers' markets, bakeries, and natural food stores have also been found, but open venue operation in rural areas may be limited throughout the year (Liese et al., 2009).

Similar to that of urban geographies, the proportion of unhealthy venues outnumbers venues with a greater selection of healthy foods at competitive prices (Lenardson et al., 2015; Liese et al., 2007). Story, Kaphingst, O'Brien and Glanz (2008) cite a Morton and Blanchard (2007) brief of nationwide secondary data that revealed the majority of counties determined to be food deserts also had high poverty rates. Hosler et al. (2008) cite research showing that low SES rural communities lack nutritionally important foods. The authors attribute this lack of nutritious foods to reduced prevalence access through omission of venues that carry a wide selection of health promoting items. Vilaro et al. (2013) found in their study of Florida rural communities that convenience stores comprised 72% of the food venues. This also parallels work by Liese et al. (2007). Their study examined a 1,106 square mile sample area in Orangeburg County, South Carolina, with urban, rural and mixed urban/rural census tracts. The majority of the population is African American and rural. Of the 77 venues identified through ground-truthing, 74% were convenience stores. Nearly half of all convenience stores identified in the study areas were in rural tracts, with 21% in urban tracts.

The community level analysis of residential location of rural populations to food venues is scarce in the literature. As per recommendations to capture multiple dimensions of access, Sharkey et al. (2010) examined a rural sample of rural seniors. The research team merged community, consumer (venue audit), and self-reported fruit and vegetable intake. The researchers determined the increase or decrease, down to the thousandths of a serving of fruit, vegetables, or both, per mile distance to two types of supermarkets. A greater reduction in intake per mile existed for venues that were identified as having "a good selection" of fresh and processed fruit, vegetables, or both, as compared to the closest supermarket. When the sample

were farther away from a venue identified as preferential, produce consumption suffered by approximately 55%.

Rural Consumer Level Availability, Price and Quality Access

Studies of rural food environments are more prevalent starting in 2008, but even at that time, Busitillos et al. (2009) found evidence in the literature to support the statement that "little is known about spatial access to food venues and even less is understood about within venue availability of healthy food items" (Liese et al., 2007; Sharkey & Horel, 2008).

Rural Consumer Level Availability

Agreement in findings are reported that like urban food environments, large food venues in rural areas such as supermarkets and grocers have higher availability of healthy items than smaller markets, convenience stores and some non-traditional food selling venues (Pereira et al., 2014; Vilaro et al., 2013). Similar to urban findings, Hosler et al. (2008) and Larson et al. (2009) found that rural venues carrying healthy food items varied by area demographics including race and low-income status of the population. Ahern, Brown, & Dukas (2011) found agreement with the literature, that some rural areas have reduced access through less fruit and vegetable availability in convenience stores vs grocery stores in rural areas. Shanks et al. (2015) collected primary data in 12 rural Montana counties and found that between them, availability of healthy alternatives did not vary.

Rural Consumer Level Price

Vilaro et al. (2013) found that within rural supermarkets, half of the healthy items collected were significantly higher priced than the standard options, and that the other half of the items were "generally priced higher". It was also found that prices are significantly higher in

convenience stores compared to the supermarkets. Using the NEMS-S audit tool, Pereira et al. (2014) found that both grocery stores and convenience stores generally scored lower than supermarkets on all items regarding price, with the convenience stores lacking the healthier alternatives in which to score. The findings were mixed on lower prices for healthy vs. standard options. Some of the healthier items within the NEMS-S were lower than their standard options such as milk, cereal, and baked goods, but bread, chips, beef and hot dogs were priced higher. Beaulac et al. (2009) found similar evidence in rural areas linking to many of the same barriers to lower prices through less shelf space leading to low item variety, thereby concentrating profit margins on less items. The Economic Research Service found in 1997 that grocery venues in rural areas are often smaller, fewer, have higher costs per unit sold and are unable to take advantage of economies of scale (Kaufman et al., 1997). Alternatively, Shanks et al. (2015) found no association between rurality and price across 12 rural counties.

Rural Consumer Level Quality

Multiple findings on the measure of (produce) quality are similar across the literature in that rural areas tend to have poorer quality produce. Vilaro et al. (2013) and Pereira et al. (2014) found the highest quality scores in supermarkets using the NEMS-S tool, while convenience stores scored half the total points for quality. Shanks et al. (2015) found a negative association between rurality and quality across 12 rural counties. Distance, food storage, and delivery frequency are cited by Kaufman et al. (1997) and Walker et al. (2010) as barriers related to maintaining quality produce in very rural areas.

Rural and Urban Comparison Literature Alternative Measures

Limited examination comparing urban and rural food environments exists. In addition to the studies directly comparing food access in the two geographies, alternative constructs of access were compiled and reported.

Measuring Access Through Exposure

A common finding across the literature is that rural environments have more convenience stores and small grocers than supermarkets (Ahern, Brown & Dukas, 2011; Kaufman et al., 1997; Hosler et al., 2008; Sharkey et al., 2009). Larson et al. (2009) found multiple studies linking rural areas with poor access to supermarkets, chain grocers, and health food products. They further cite a national data analysis of secondary zip code data showing that rural and farm areas had 14% fewer supermarkets than urban. Ahern et al. (2011) found agreement with the literature, in that reduced rural access through less supermarket presence (availability). Beaulac et al. (2009) found evidence in a single small study showing greater grocery stores per capita in 2 rural areas then 2 urban.

Measuring Access Through Utilization

Kaufman et al. (1997) characterized access of low-income Americans through the use of Supplemental Nutrition Assistance Program redemption behaviors. Benefit use at supermarkets nationwide comprised 84% of total use, while redemption in rural area supermarkets only accounted for 59% of use. In low-income rural areas, slightly over half of all benefit use takes place in supermarkets. Monthly benefit allotments only represent a portion of diet costs as they are only a supplement, yet these data show that in low-income rural areas, half of benefit grocer expenditures are being spent at non-supermarket venues. These purchasing behaviors are

facilitated by the larger proportion of smaller grocers, convenience stores, “mom and pop” venues, and drug stores now prevalent in food retail across the US. These smaller venues have been shown to have less selling space and therefore less variety of food choices, higher prices, and lower quality produce (Block et al., 2006; Hendrickson et al., 2006).

Price Differentiation by Geography

Price data and quality data comparisons are nascent in the literature. Broad economic analysis and consumer level primary data are the main methods of reporting price. Ambrose (1979) examined inner-city, suburban and rural food environments in and around Omaha, NE through the use of a market-basket approach. His analysis found that rural populations were in the “upper extreme of the price spectrum”, with inner-city venues having the lowest prices. Kaufman et al. (1997) show that rural populations face higher prices than suburban supermarkets, which have the lowest prices nationwide. They cite Mantovani et al. (1997) showing a 4% difference between rural and suburban supermarket price differences, with rural populations seeing higher prices and suburban areas having the lowest. Beaulac et al. (2009) found higher prices in rural compared to urban areas with one study showing mixed results. Alternatively, Shanks et al. (2015) in 12 rural Montana counties using the NEMS-S audit tool, found that price of items did not vary by geography. While not directly comparing urban and rural food environments, the study did include a purposeful random selection of a range of rural counties by USDA rural-urban coding scheme and also included an urban control county.

Quality Variation by Geography

Findings from Shanks et al. (2015) in Montana did find varying results on produce quality between rural food environments. A negative association between rurality and produce

quality existed in their findings with the least rural counties having the highest quality. Tisone et al. (2014) examined 111 WIC vendors across Texas comparing venues based on geographic characteristics such as boarder/non-boarder and urban vs. rural. No significant difference in produce quality was found between urban and rural areas.

Literature Recommendations for Rural and Urban Food Environments

Recommendations for food environment analysis between urban and rural communities are as limited as the studies including both geography types. In addition to the preceding suggestions for future research of the broad food environment, the literature point towards research specific to rural/urban food environment analysis (Boehmer et al., 2006; Lenardson et al., 2015).

All venue inclusion/venue discrimination/venue citation method

Due to the unique nature of rural environments, Sharkey (2009) states that a cumulative opportunity (venue variety) should be examined so that all food venues within an area can be reported. The food environment of rural areas has seen change in venue types/formats such as the introduction of food items and produce into chain-retailers that previously did not carry food such as discount and hard discount retailers, dollar stores, and pharmacies (Berry, 2011). The collection and merging of community and consumer level data should be a standard for providing the most robust evidence for the concept of access. Item availability and price should be included with various distance measurements. A second stated standard to be employed in rural areas is that of ground-truthed data collection (Sharkey, 2009).

Comprehensive examination

A specific call is made by Boehmer et al. (2006) to buttress rural-specific analysis with studies that compare both rural and urban communities, "…perhaps within the same state or featuring similar demographic features…". For unexplored food environments, this would allow for a direct comparison to seek out varying characteristics between urban and rural landscapes.

In order to conceptualize links between the food environment and obesogenicity of communities, Boehmer et al. (2006) call for an evaluation across various levels of urbanization. Full comprehension of the community that is in need of assistance is crucial to accurately depict the food environment for policy makers and community planners who want to know where and how to address gaps (Lenardson et al., 2015). Both Boehmer et al. (2006) and Sharkey (2009) call for rural food environments to be examined exclusively through primary data collection. The shortfalls of secondary data outlined above are reiterated with ground-truthed data eliminating validity issues.

Methods/Instrumentation

Rigorous measures outlined by Lytle (2009) are those that move from simplistic cross-sectional studies to those that test hypotheses. At the same time, minimizing threats to internal validity are crucial. Use of standardized and validated instruments is reiterated by Lytle (2009) and Glanz et al. (2016) specifically addressing urban/rural comparison studies. Data collection instruments that collect data on a mix of standard and healthy food items across environments is needed in order to allow for "benchmarking across studies" since evidence suggests "…access to produce may not result in overall healthier diets." (Glanz et al., 2016). An appropriate instrument exists and has gained increased use since its development in 2009. The NEMS-S audit tool has high validity and inter-rater reliability, is able to be adapted for a range of inquiry directed

towards varying venues, and has accompanying training materials (Andreyeva et al., 2008; Glanz et al., 2009)

Study Alignment and Contribution

The current study under proposal will complement the existing literature through the examination of data consistent with previous empirical work and rigorous measures of food environments that test hypothesis. Consumer level analysis of the availability, price and quality of venue items are complimentary to community level examination of venue presence and associations with population characteristics. These measures closely align to conclusions by Zenk et al. (2006) that "…direct measurement and comparison of the availability, selection, quality, and cost of healthy foods at retail outlets by neighborhood racial and economic characteristics is an important objective for future research."

Community Level Availability Data Fit

The literature show the quantity of food venues in rural areas is less but that the proportion of unhealthy venues outnumbers venues with a greater selection of healthy foods at competitive prices (Lenardson et al., 2015; Liese et al., 2007). Counts of large venues/supermarkets in the rural samples will act to represent access through the availability/existence measure. Of all venues, Supermarkets/largest grocers, fast-food, convenience stores, and dollar stores were examined and compared to the literature.

A relationship between fast-food venues and convenience stores exists. A double exposure to unhealthy food is increasingly taking place with the operation of fast-food venues within convenience store and grocer venues and was exemplified in all sample geographies. Sharkey et al. (2011) point to the Literature and their own findings that opportunities to access

foods from these venues are greater in convenience store, grocery and supermarket venues. A grocer venue in the high-income urban tract maintained a fast-food venue within it and mirrors coverage in the literature by Sharkey (2009) that found of 205 fast-food venues, 53.2% were located within convenience stores and 5.8% were inside grocer venues. Convenience store venues in the rural Nevada sample consistently maintained chain and non-chain fast-food outlets. Building new facilities in rural geographies are costly endeavors and the co-habitation of these spaces is not a recent development. The impact of fast-food venues within healthy venues such as supermarkets/grocers and the impact of fast-food venues within unhealthy venues such as convenience stores have yet to be comprehensively evaluated in the literature at this time. The ameliorating or compounding effect of within-venue venues on purchasing habits, diet and chronic disease has yet to be fully addressed and evaluated at this time but restricting analysis to singular venue type may limit the full impact of unhealthy venue exposure. This study will add to the literature through confirmation of any type venue within another type in the sample geographies.

Consumer level Availability Data Fit

Collection of the availability of a mix of standard and healthy food items across environments is called for specifically in the literature (Glanz et al. 2016). Availability counts of the healthier alternative item from each category of the NEMS-S audit tool will compare geographies for a disparity in item access. This study compared data results with the literature that found, that like urban food environments, large food venues such as supermarkets and grocers have higher availability of healthy items than smaller markets, convenience stores and some non-traditional food selling venues (Pereira et al., 2014; Vilaro et al., 2013). This study's data will also be able to compare with findings that the availability and variety of produce can be

lower in impoverished areas (Hendrickson et al., 2006). Alternatively, Shanks et al. (2015) collected primary data in 12 rural Montana counties and found that between them, availability did not vary.

Price Data Fit within the Literature

This study seeks to expand the literature showing whether food is more expensive in urban vs. rural geographies. The literature show mixed results. Beaulac et al. (2009) found higher prices in rural compared to urban areas with one study showing mixed results. Ambrose (1979) examined inner-city and rural food environments. His analysis found that rural populations were in the "upper extreme of the price spectrum", with inner-city venues having the lowest prices. Kaufman et al. (1997) and Mantovani et al. (1997) compared rural and suburban supermarket prices and found rural prices higher. Alternatively, Shanks et al. (2015) collected primary data in 12 rural Montana counties and found that between them, price did not vary.

Price differences between standard and healthy items between urban and rural communities

This study seeks to expand the literature showing whether healthy items are more expensive in urban vs. rural geographies. The body of literature is small but Rimkus et al. (2015) found the price of low-fat milk was more expensive in grocery stores located in rural and suburban communities compared to urban. Alternatively, Shanks et al. (2015) found no difference in price across 12 Montana rural counties and a rural inclusion sample.

Price Differences by Venue Association

The price of all items will uncover whether or not food items are more expensive between chain and non-chain supermarkets. These actions are sought to find commonality in the literature

showing higher prices in non-chain venues compared with chain venues (Chung et al., 1999; Walker et al., 2010).

Price Differences by Area Income

Data show higher prices in areas where poverty is the highest compared to more affluent areas. Hendrickson et al. (2006) found that food prices are higher in areas where poverty is the highest, compared to more affluent areas. These findings are consistent with other studies that show that residents living in areas that do not have a supermarket pay more for their food through the omission of large venues (Chung and Myers, 1999; Freedman, 1991; Hendrickson et al., 2006; Kaufman et al., 1997; U.S. House of Representatives Select Committee on Hunger, 1990).

Produce Quality Data Fit

The quality of fruits and vegetables have been shown to differ based on geography and area income. For rural geographies, Shanks et al. (2015) collected primary data in 12 rural Montana counties and found a negative association between rurality and quality. Evidence is present showing that the poor residing in urban areas received poorer quality foods (Chung and Myers, 1999; Freedman, 1991). Hendrickson et al. (2006) found that food quality is poorer, "often inedible", in areas where poverty is the highest, compared to more affluent areas. Vilaro et al. (2013) and Pereira et al. (2014) found the highest quality scores in rural supermarkets, while convenience stores scored half.

Density Data Fit

The density of venues of various healthfulness to population counts has shown variation with geography and population demographics in the literature (Lendardon et al., 2015; Liese, Weis, Pluto, Smith, & Lawson, 2007; Vilaro et al., 2013). Hosler et al. (2008) for example found a higher prevalence of venues carrying a variety of produce in rural than urban-minority environments. Vilaro et al. (2013) found in rural communities that convenience stores comprised 72% of the food venues. Liese et al. (2007) found in that of all venues in a sample of urban, rural and mixed urban/rural census tracts, that 74% were convenience stores. Of all the tracts, nearly half of the convenience stores were found in rural areas and 21% in urban tracts.

Varying characteristics of the population have also been shown to be associated with the density of venues that carry healthy food items and price. Hosler et al. (2008), Larson et al. (2009), and Zenk et al. (1999) found the density of venues that carry healthy food items varied by area demographics including race and low-income status of the population.

Data Opportunity Fit

Lastly, the results of this study will add to the body of literature through opportunity. Powell et al. (2011) found only moderate agreement between direct observation and commercial business lists for food stores and restaurants. Primary and secondary data sources show both over and under representation of venues and is more pronounced for convenience stores and specialty markets (Fleischhacker et al., 2012). Ground-truthed data collection is considered the gold standard of community level venue confirmation, with secondary data showing moderate to poor data accuracy (Fleischhacker et al., 2012). The comprehensive ground-truthed data of food

venues from two rural Nevada counties and a rural Utah town will provide the ability for future researchers to compare primary and secondary data from the same geographic region.

Select Characteristics of the Sample Populations

The following synopsis of population and geographic data is intended to characterize the sample environments and its inhabitants. The following select sample characterizations are derived from multiple sources. Basic historic, background and geographic description of Nevadan samples are sourced from 'Nevada Handbook' by Deke Castleman 5th ed. (1998). Population data is derived from five sources. Data on the percent of native born residents residing in rural Nevada counties is provided by The Nevada Rural and Frontier Health Data Book (7th ed., 2015), a comprehensive state level analysis by the Nevada State Office of Rural Health reporting 2012 data. The 2010 annual Census data is cited in order to demonstrate a comparison of populations between geographic areas within a state or to report urban or rural environments with greater accuracy. The American Community Survey 2010-2014 estimates are used for the population level variables of population counts, income, age, race, education and poverty (American Community Survey 2014, 5 year estimates). The non-profit Feeding America is a national network of food banks that also produces annual research for the nation at the state, county and congressional geographic levels (Gundersen, Dewey, Crumbaugh, Kato & Engelhard, 2016). The study sources data from 60,000 clients from a sample of over 200 food banks within their service areas. Within Las Vegas, a local food bank partners with an analytics firm to produce annual food insecurity maps of Las Vegas at the zip code level (Applied Analysis, 2010-2015). Tables 1-8 are sourced through 2010 and 2010-2014 Census estimates (American Community Survey 2014, 5-year estimates).

Table 1: Percent Population over 65 years of age nationally, Nevada, Utah, and study Geographies Consisting of 2 rural counties, 2 urban census tracts, an Inclusion Town and Comparison County

Geography	% over 65 years old
United States	13.7
Nevada	13.1
Clark County, Nevada	12.3
Census Tract 10.04 (low)	29
Census Tract 28.14 (high)	13.2
Esmeralda County, Nevada	25.3
Tonopah, NV	13.3
Lincoln County, Nevada	17.5
Utah	9.5
Garfield County, Utah	17.6

Source: American Community Survey 2014, 5 year estimates

Table 2: Population Median Age nationally, Nevada, Utah, and study Geographies Consisting of 2 rural counties, 2 urban census tracts, an Inclusion Town and Comparison County

Geography	Median Age
United States	37.4
Nevada	36.9
Clark County, Nevada	36.1
Census Tract 10.04 (low)	46.2
Census Tract 28.14 (high)	39.5
Esmeralda County, Nevada	47.6
Tonopah, NV	40
Lincoln County, Nevada	35.8
Utah	29.9
Garfield County, Utah	39.8

Source: American Community Survey 2014, 5 year estimates

Table 3: Population Rates, Area and Density Rates nationally, Nevada, Utah, and study Geographies Consisting of 2 rural counties, 2 urban census tracts, an Inclusion Town and Comparison County

Location	Population	Area in sq. miles	Density (Persons per square mile)
United States	314,107,084	3,790,000	82.9
Nevada	2,761,584	110,567	25
Clark County, Nevada	2,003,613	7,891	254
Census Tract 10.04, (low)	6,200	1.08	5,741
Census Tract 28.14 (high)	5,316	.87	6,110
Esmeralda County, Nevada Esmeralda County and Tonopah	1,041 3,767	3,582 3,598.2	.29(alone) 1.04 (combined)
Tonopah, Nevada	2,726	16.2	168
Lincoln County, Nevada	5,282	10,633	.5
Utah	2,858,111	84,899	34
Garfield County, Utah	5,150	5,208	1.1

Source: American Community Survey 2014, 5 year estimates

Table 4: Percent of the Adult (25 Years Old and Over) Population with Less than High School Attainment nationally, Nevada, Utah, and study Geographies Consisting of 2 rural counties, 2 urban census tracts, an Inclusion Town and Comparison County

Geography	Less than high school graduate
United States	13.6
Nevada	15.1
Clark County, Nevada	15.7
Census Tract 10.04 (low)	18.8
Census Tract 28.14 (high)	10.2
Esmeralda County, Nevada	14.6
Tonopah, NV	16.4
Lincoln County, Nevada	13
Utah	9
Garfield County, Utah	7.9

Source: American Community Survey 2014, 5 year estimates

Table 5: Percent Population with Some College or Higher nationally, Nevada, Utah, and study Geographies Consisting of 2 rural counties, 2 urban census tracts, an Inclusion Town and Comparison County

Geography	Total; Estimate; Some college or higher
United States	58.4
Nevada	53.3
Clark County, Nevada	55.1
Census Tract 10.04 (low)	46.3
Census Tract 28.14 (high)	68.5
Esmeralda County, Nevada	43.9
Tonopah, NV	44.5
Lincoln County, Nevada	51.1
Utah	67.8
Garfield County, Utah	60.3

Source: American Community Survey 2014, 5 year estimates

Table 6: Population Race Constructs nationally, Nevada, Utah, and study Geographies Consisting of 2 rural counties, 2 urban census tracts, an Inclusion Town and Comparison County

Area	Caucasian	Hispanic/Latino	AA	Native	Asian
United States	74%	17%	12.6%	.8%	5%
Nevada	73.5%	27.2%	9.7%	1.9%	9.4%
Clark County, Nevada	65%	30%	11%	.6%	9%
Census Tract 10.04 (low)	70%	40%	7.5%	.6%	5%
Census Tract 28.14 (high)	61%	19%	7%	.15%	12.5%
Esmeralda County, Nevada	87%	15%	0%	3.7%	0%
Tonopah, NV	92.3%	10.5%	1.4%	1.3%	0%
Lincoln County, Nevada	92%	9%	2.4%	4%	0%
Utah	90.2%	13.3%	1.6%	1.7%	3.0%
Garfield County, Utah	95.5%	5.3%	.65%	.6%	1%

Source: American Community Survey 2014, 5 year estimates

Table 7: Median Household Income nationally, Nevada, Utah, and study Geographies Consisting of 2 rural counties, 2 urban census tracts, an Inclusion Town and Comparison County

Sample Area	Median Household Income
United States	$53,482
Nevada	$52,205
Clark County, Nevada	$52,070
Census Tract 10.04 (low)	$31,108
Census Tract 28.14 (high)	$74,214
Esmeralda County, Nevada	$31,528
Tonopah, NV	$53,088
Lincoln County, Nevada	$40,550
Utah	$59,846
Garfield County, Utah	$44,914

Source: American Community Survey 2014, 5 year estimates

Table 8. Percent of Adults (Over 18 Years Old) Living Below the Poverty Level Nationally, Utah, Nevada, and study Geographies Consisting of 2 rural counties, 2 urban census tracts, an Inclusion Town and Comparison County

Geography	Population for whom poverty status is determined
United States	15.6%
Nevada	15.6%
Clark County, Nevada	11.5%
*Census Tract 10.04 (low)	17.7%
**Census Tract 28.14 (high)	11.7%
Esmeralda County, Nevada	23%
Tonopah, NV	14.5%
Lincoln County, Nevada	16.2%
Utah	15.7%
Garfield County, Utah	13.6%

***Low-income tract chosen at random from first quintile, range $22,309 - $37,632, mean $31,863**
**** High-income tract chosen at random from fifth quintile, range $73,266 - $142,000, mean $85,060**
Source: American Community Survey 2014, 5 year estimates

Nevada

Nevada was instituted as a state in 1864. Reno and Carson City in the north and Las Vegas in the south were the major population centers through the end of the nineteenth century. The nineteenth and twentieth centuries saw the state capitalize on its vast open desolate spaces by the U.S. Military, mining, tourism, and renewable energies. Of State residents, 24.7% are native Nevadans. These economies in part led to the State's population growth each decade from 1960 to 2000 of between 50% and 71%. The 2010 census reported a 38% increase over the previous decade with 2,700,551. Current estimates for 2010-2014 are 2,761,584, which demonstrates a 2.3% increase. Clark County in the south had 72.25% of the State's population in 2010 with the counties containing Reno and Carson City comprising 17.65%. The state's remaining 86.6% land area in 2010 contained 9.52% (272,601) of the population. State level density rates are 24.9 people per square mile. Estimated median household income (2010-2014) at the state level was $52,205. The median age was 36.9, with 13.1% of the population being over 65. Estimated rates show Caucasians represented 76.3% of the residents, Hispanic or Latinos of any race were 16.9%, African Americans at 13.7%, and Native Americans at 5.9%. Of adults over 25, educational attainment estimates show that 15.1% of Nevadans have less than a high school education, with 53.3% having at least some college. At the adult per-capita level, 15.6% of the population is below the poverty level. The 2016 Feeding America report stated that 423,210 (14.9%) people in Nevada lacked consistent ability to feed themselves in 2014 and that $216,359,000 would secure food-access for every person in the state.

Lincoln County, Nevada

Populations settled in Lincoln County due to the lush vegetation, ranching and mining opportunities discovered from the 1860's through the end of the century. Nearly a third (30%) of

Lincoln County's population was born in Nevada. The 2010 census show a total population of 5,345 people. Lincoln County had a population of 5,282 within 10,633 square miles; a density of .5 persons per square mile. Modern economies are based on the single remaining active mine as of 2014, tourism, farming, ranching, dairy, and the military presence to some degree (Knapp, 2014; Muntean, & Davis, 2014). American Community Survey (2010-2014) data show residents of the county have a median household income of $40,550. The estimated median age was 35.8 with 17.5% of the population aged over 65. Lincoln County is primarily Caucasian at 93.2%, Hispanics represent 5.4%, Asians 2% and African Americans and Native Americans combined reported as .5%. Of adults over 25, educational attainment estimates show that 26% of Lincolnites have less than a high school education, with 22.9% having at least some college. At the adult per-capita level, 16.2% of the population is below the poverty level. The 2016 Feeding America report stated that 805 (15.2%) people in Lincoln County lacked consistent ability to feed themselves in 2014 and that $433,000 would secure food-access for every person in this rural county.

Esmeralda County, Nevada

Esmeralda County lays in the south-west of Nevada and is within the two direct routes of road travel to the state's capital Carson City and Reno, Nevada. The area's population increased throughout the middle to end of the nineteenth century by miners, farmers and ranchers, and those looking for different lives. Only 11.8% of the population is native-state born. The county by itself had a population of 1,041 in 2014, a 33% increase from 2010 when the community numbered 783. With the inclusion of the town of Tonopah, the total in this sample is 3,767. Esmeralda County's populace are spread across a vast desert landscape of 3,582 square miles; a density of .29 persons per square mile. Modern economies are based on the local military, solar

energies and the four remaining active mines as of 2014 (Muntean, & Davis, 2014). American Community Survey (2010-2014) data show residents of the county have a median household income of $31,528. The median age was 47.6 with 25.26% of the population aged over 65. Esmeralda County is primarily Caucasian at 87%, Hispanics represent 15%, and Native Americans reported as 3.7%. Of adults over 25, educational attainment estimates show that 1% of Esmeraldans have less than a high school education, with 56% having at least some college. At the adult per-capita level, 23% of the population is below the poverty level. The 2016 Feeding America report stated that 150 (14.7%) people in Esmeralda County lacked consistent ability to feed themselves in 2014 and that $90,000 would secure food-access for every person in this rural population.

Tonopah, Nevada

The town of Tonopah, Nevada was founded on mining by Jim Butler in the spring of 1900. The population dropped from the 2010 count of 2,478 to 2,726, a 10% increase. The community lays within 16.2 square miles; a density of 168 people per square mile. The modern economies of the community rely largely on The Department of Energy, The Department of Defense, as well as tourism and gaming. American Community Survey (2010-2014) data show residents have a 68% higher median household income than Esmeralda County at $ 53,088. Adults in the town have a poverty rate of 14.5%. The town is mainly Caucasian at 92.3%, Hispanic/Latino at 10.5%, African Americans are 1.4% and Native Americans comprised 1.3%. Of Tonopahans over 25, 16.4% have yet to attain a high school diploma or equivalent. Those who have at least attended college represent 44.5% of the population.

Clark County, Nevada

Clark County was instituted in 1909. The subsequent evolution of Clark County throughout the twentieth century was based on railroad development, gaming, energy development, World War II defense, and divorces that provided a draw to the state from around the country and for international audiences (Moehring, 2000). Clark County maintain a strong Nevada born population at 23%. The County population for 2010 was 1,951,269, with 2000-2010 estimates show a slight increase to 2,003,613. Clark County's area is 7,891 square miles, with a density rate of 247 people per square mile. American Community Survey (2010-2014) data show estimated median household income (2010-2014) was $52,070. The median age was 36.1, with 12.3% of the population being over 65. Estimated rates show Caucasians represented 68.5% of the residents, Hispanic or Latinos of any race were 29.8%, African Americans at 12.3%, Asians at 11.2, and Native Americans at 1.4%. Of adults over 25, educational attainment estimates show that 15.7% of Nevadans have less than a high school education, with 55.1% having at least some college. At the adult per-capita level, 11.5% of the population is below the poverty level. The 2016 Feeding America report stated that 288,520 (14.4%) people in Nevada lacked consistent ability to feed themselves in 2014 and that $151,973,000 would secure food-access for every person in the county.

Census tract 10.04, Low-income

Census tract 10.04 lays within Clark County, Nevada and within The City of Las Vegas. This community is among the oldest in the city as it is 1 mile from a spring that provided water for people, animals and crops and is on a main east/west corridor to downtown Las Vegas and is approximately 2.2 miles from Las Vegas Boulevard. The built environment initiated in the

1960s, with the Clark County Assessor's office showing residential development in the community dating to the 1950's. According to the 2010 census, the population was 6,368, with 2014 estimates showing a slight decrease in population to 6,200. The tract's populaces are spread across an urban landscape of 1.08 square miles; a density of 5,741 people per square mile. American Community Survey (2010-2014) data show the tract community had a median household income of $31,108. The 2014 estimated median age was 46.2 with 29% of the population aged over 65. The tract is primarily Caucasian at 78.4%, African Americans are present with 7.5%, Hispanic or Latino (of any race) represent 40.2%, Asians are at 10.9%, and Native Americans reported as 1.1%. Educational attainment estimates show that 46.3% of those over 25 have less than a high school education, with 56% having at least attended college. At the adult per-capita level, 17.7% of the population is below the poverty level. The 2016 Feeding America report only reported county level food security data and reported 14.4% of Clark County residents do not have regular consistent access to food. The local Las Vegas Food Bank, 'Three Square' has released annual food security maps of Las Vegas at the zip code level since 2010 (Applied Analysis, 2010-2015). The zip code 89102 is approximately four times the size of the census tract 10.04. For zip code 89102, rates in 2010 (2009 data) show 16.2%, rising each year to 26.2% in 2012 to be the highest food insecure zip code that year. Successive drops following the 2012 high showed 89102 maintaining twice the rate as the lowest zip code in 2013, and nearly twice the rate the following year.

Table 9. Percent Food Insecurity Rates in Las Vegas, Nevada 2009-2014, for Zip Code 89102

Year	89102	% Range Insecure that Year
2010	16.2%	7.6-25.7
2011	17.6%	8.5-27.6
2012	16.4%	7-27.6
2013	26.2%	5.7-26.2
2014	22.4%	9.9-28.5
2015	20.6%	11.9-27.5

Source: Applied Analysis, 2010-2015

Census tract 28.14, High-income

Census tract 28.14 lays within unincorporated Clark County, Nevada, adjacent to the City of Henderson. Estimates in 2014 show a population of 5,316. The tract's populace are spread across a landscape of .87 square miles; a density of 6,110 people per square mile. American Community Survey (2010-2014) data show the tract community had a median household income of $74,214. The 2014-estimated median age was 39.5 with 13.2% of the population aged over 65. The tract is primarily Caucasian at 61%, African Americans are present with 7%, Hispanic or Latino (of any race) represent 19%, Asians are at 12.5%, and Native Americans reported as .15%. Educational attainment estimates show that 10.2% of those over 25 have less than a high school education, with 68.5% having at least attended college. At the adult per-capita level, 11.7% of the population is below the poverty level. The 2016 Feeding America report only included county level food security data and reported 14.4% of Clark County residents do not have regular consistent access to food. The local Las Vegas Food Bank, 'Three Square' has released annual food security maps of Las Vegas at the zip code level since 2010 (Applied

Analysis, 2010-2015). The zip code 89123 is approximately four times the size of the census tract. For zip code 89123, rates in 2010 (2009 data) show 10.7%, rising each year to 15.5% in 2015 with the exception of 2013 when it dropped to 8.8%.

Table 10: Percent Food Insecurity Rates in Las Vegas, Nevada 2009-2014, for Zip Code 89123

Year	89123	% Range Insecure that Year
2010	10.7%	7.6-25.7
2011	11.3%	8.5-27.6
2012	12%	7-27.6
2013	8.8%	5.7-26.2
2014	15.2%	9.9-28.5
2015	15.5%	11.9-27.5

Source: Applied Analysis, 2010-2015

Garfield County, Utah

Garfield County, Utah lays in the central-southern region of Utah. The county was settled by religious migrants in 1864 and includes mountains, valleys, and desert geographies at 6,600 feet above sea level. Farming and natural resources were initial industries in the region with the modern economy provided largely through tourism and the establishment of Bryce Canyon National Park in 1928. The county population for 2010 was 5,105 and 2,858,111 for the state. The area of Garfield County is 5,208 square miles and 84,899 square miles at the state level, with a density rate of 1.02 and 33.66 persons people per square mile. American Community Survey (2010-2014) data show residents of the county have a median household income of $44,914,

while median income at the state level was $59,846. The median age of Garfield was 39.8, with 17.6% of the population aged over 65. At the state level, estimation was a mean age of 29.9, with 9.5% of the population aged over 65. The county is primarily Caucasian at 95.5%, Hispanics represent 5.3%, Native Americans reported as .6%, African Americans at .65% and Asians at 1%. Utah is also primarily Caucasian at 90.2% of the population. A larger share of minority residents are represented at the state level with African Americans showing 1.6%, Native Americans at 1.7%, Asians at 3.0%, and Hispanics or Latinos of any race being 13.3% of the population. Of adults in the county over 25 years of age, educational attainment estimates show that 7.9% have less than a high school education, with 60.3% having at least some college. At the adult per-capita level, 13.6% of the county is below the poverty level, with the state rate at 15.7%. The 2016 Feeding America report stated that 870 (17.1%) people in Garfield County lacked consistent ability to feed themselves in 2014 and that $449,000 would secure food-access for every person in this rural population. The same report found that 14.2% of the state's population was food insecure for that same year.

Chapter 3 Methods

This study compared constructs of the food environment through community and consumer level analysis. Community level data is reported through per-capita venue counts of supermarkets/largest grocers, fast-food venues, convenience stores, and dollar stores. Methods of analysis at the community level involved quantitative venue counts and descriptive characterization. The consumer level investigation of the food environment took place within supermarkets or the largest venues in the sample environments. In-venue data was used to test hypothesis between urban and rural geographies, and the low and high-income urban tracts. The outcome variables at the consumer level for each geography were raw Nutrition Environment Measurement Survey – Supermarket (NEMS-S) scores for produce availability and acceptability, and the price difference between standard and healthy options.

Research Design

A cross-sectional analysis took place through direct quantitative and descriptive data collection of the food environment in the areas of interest. To address Research question 1 at the community level, an exhaustive examination of all food venues as points of data took place through notation. To address Research question 2 and 3 at the consumer level, the main instrument is the NEMS-S audit. The tool merges raw data of the availability and quality of produce items, the availability and the price difference between standard and healthy alternative items to produce a single score for each venue. To test this study's hypotheses, the raw data of the three measures of will used.

Sampling

Locations/Geographies

The selection of rural/urban geographies is intended to represent a sample of heterogeneous food environments in a range of population-dense and income varying communities in Nevada. The choice of an out of state county as a comparison group was initiated by committee suggestion and best practices within the literature, and guided by research into comparable samples within the framework of this study. These selections represent different food environments/communities in which the three research questions are addressed. The USDA Rural-Urban Continuum Codes guided the rural Nevada county choice. According to the USDA "Rural-Urban Continuum Codes form a classification scheme that distinguishes metropolitan (metro) counties by the population size of their metro area, and nonmetropolitan (non-metro) counties by degree of urbanization and adjacency to a metro area or areas." (Parker, 2013).

Code	Description
1	Counties in metro areas of 1 million population or more
2	Counties in metro areas of 250,000 to 1 million population
3	Counties in metro areas of fewer than 250,000 population
Nonmetropolitan Counties	
4	Urban population of 20,000 or more, adjacent to a metro area
5	Urban population of 20,000 or more, not adjacent to a metro area
6	Urban population of 2,500 to 19,999, adjacent to a metro area
7	Urban population of 2,500 to 19,999, not adjacent to a metro area
8	Completely rural or less than 2,500 urban population, adjacent to a metro area
9	Completely rural or less than 2,500 urban population, not adjacent to a metro area

The population centers of the State are in the north and the south. The two rural counties are appropriate due to their similar isolation from the next largest city (150-175 miles). Esmeralda County on the west side of southern Nevada, is situated between the State Capitol, Reno and Lake Tahoe to the north and Las Vegas to the South. Despite this proximity to large

population centers, Esmeralda registered a 9 on the USDA rural/metro coding, indicating that it is completely rural and not adjacent to a metro area. To access the three areas of interests to the north from Las Vegas, Esmeralda including Tonopah must be crossed through when utilizing road transportation.

Garfield County was chosen to represent a comparison rural food environment in the west/southwest region as per literature recommendations (Boehmer et al., 2006). The two densest areas by population in the state are in the north and south, Salt Lake City region and St. George region respectively. Garfield County, UT also registers a rural code of 9. Within Utah, Garfield County is in the south central region. Garfield County is approximately 3 hours (200 miles) south of Salt Lake City, UT, and 2 hours (100 miles) northeast of St. George, UT. It is approximately 2 hours (100 miles) from the closest Nevada State line. It is adjacent and east of US95 and its expanse is not required or convenient to traverse in order to progress through the state due to geological formations and lack of high-speed roadways.

The two urban sample selections were facilitated by an existing database of quintile median household incomes at the census tract level (U.S. Census Bureau, 2015). A low-income tract was sought from within the first (lowest) quintile and was guided by the rural sample county with the lower median household income. One of the identified low-income tracts was then chosen at random. See Figure 2. The median household income of Esmeralda County is $120 higher than the urban tract 10.04. Due to this author's familiarity with the Las Vegas valley, a random tract from among the 20 tracts in the fifth (highest) quintile was chosen. Tract 28.14 has a median household income of $74,214. See Figure 3. (Blue markers in Figures 2 and 3 indicate different tracts)

Figure 2. Sample Low-income Urban Census Tract 10.04 located in Clark County, NV for Per-capita Community Level Analysis

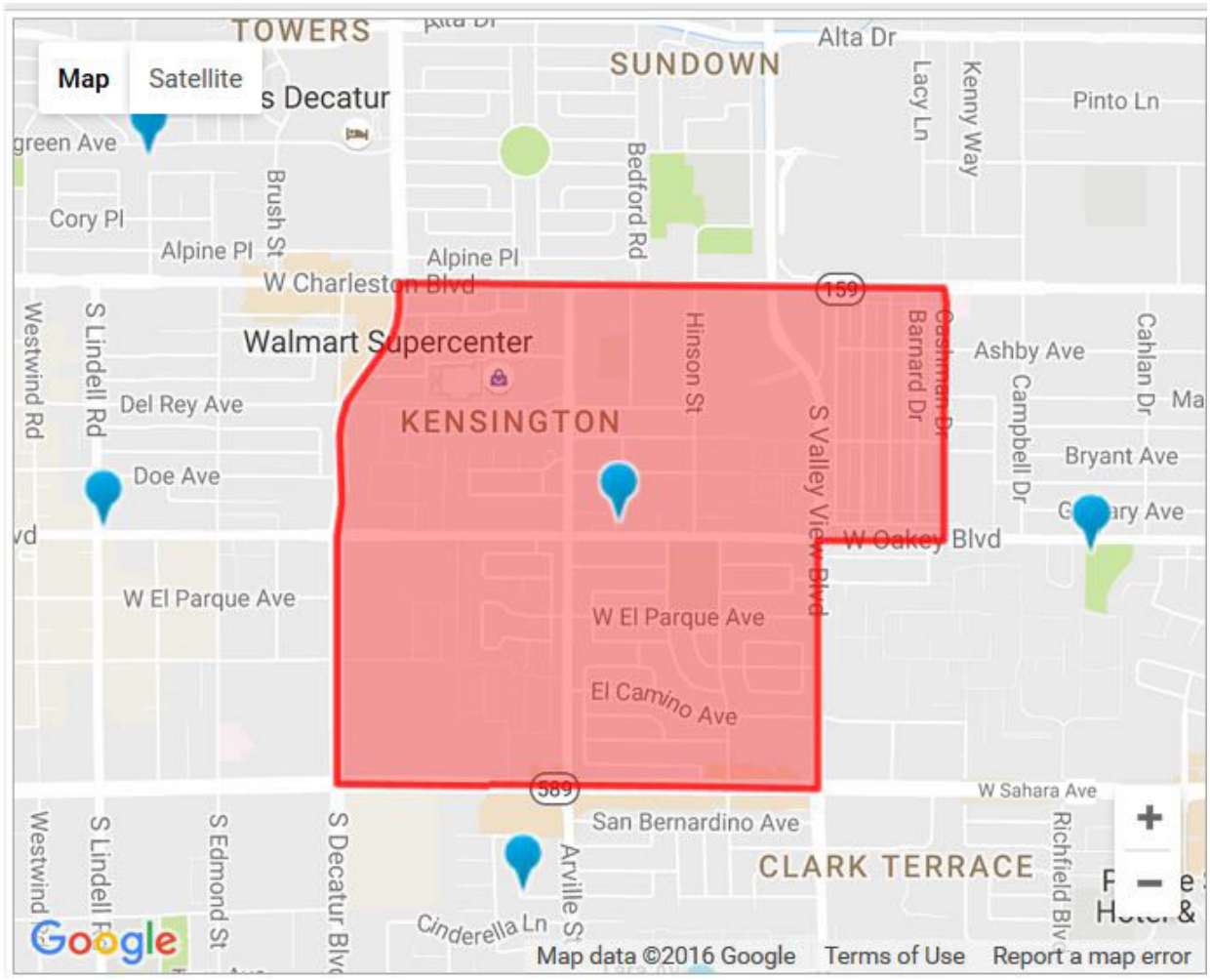
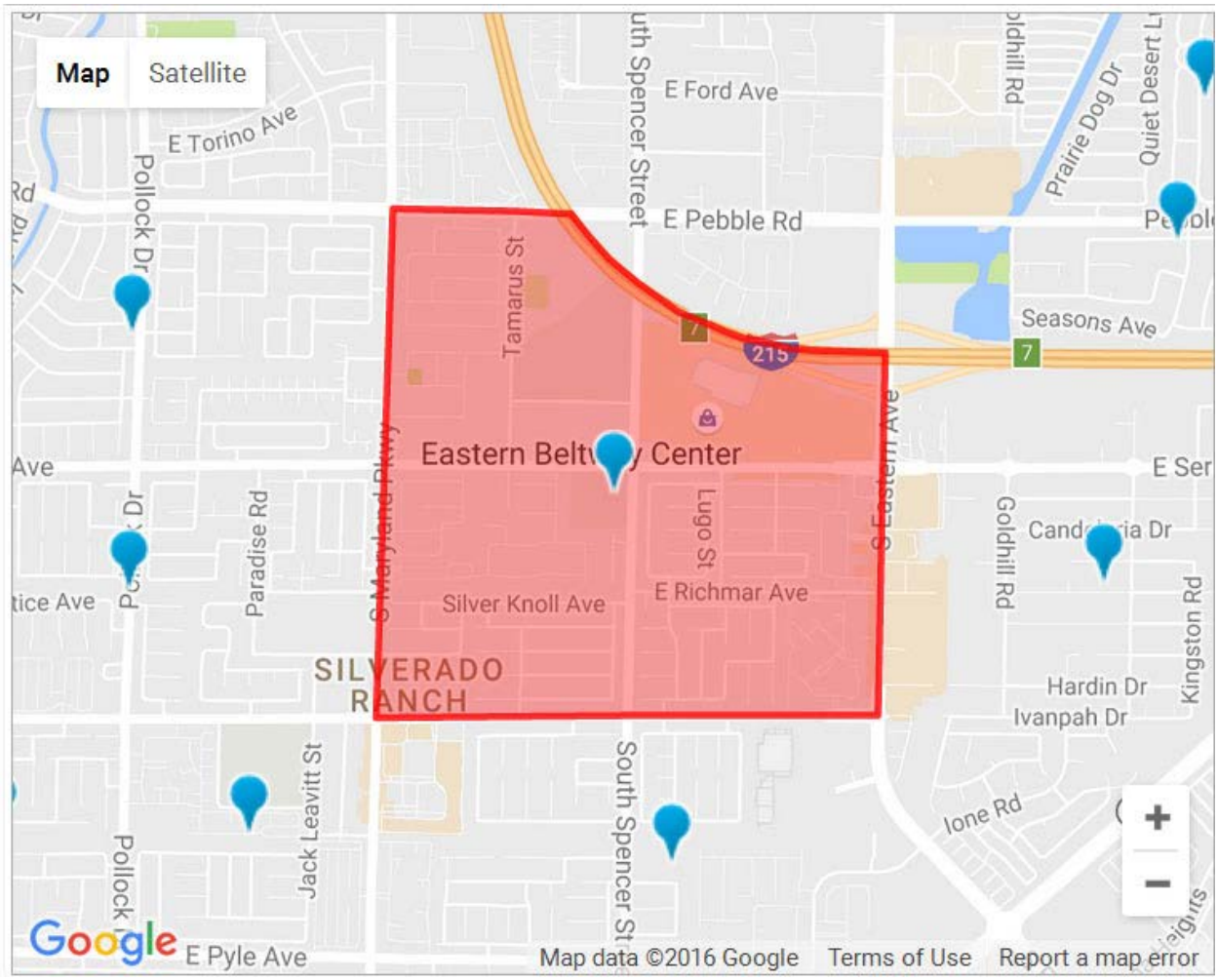


Figure 3. Sample High-income Urban Census Tract 28.14 located in Clark County, NV for Per-capita Community Level Analysis



Additional Sample Inclusions

Urban

The supermarkets within the two census tracts were audited. Additional venues to audit in the urban food environment was guided by Apparicio, Cloutier and Shearmur (2007), Caspi et al. (2012) and Penchansky and Thomas (1981). Apparicio et al. (2007) work at the community level of Montreal's food deserts used a measure of variety in which the three closest different chain-name supermarkets were included for their sample. Caspi et al. (2012) cite Penchansky and Thomas (1981) linking an inclusion buffer of venues to stronger associations with diet. For this study, supermarkets within the tracts and the three closest different chain-name supermarkets outside the two tracts were included within the audit sample in order to align as closely as possible to constructs of access associated with diet outcomes. The urban analysis and reporting at the community level to address the per-capita venue density in Research Question 1 was limited to the supermarket venues that were contained within the census tract lines. The urban analysis and reporting at the consumer level to address in-venue item characteristics included the three closest different chain supermarkets. See Figure 4: Outside Sample Grocer Audit Selection in the Low-income Urban Census Tract 10.04 located in Clark County, NV and Figure 5: Outside Sample Grocer Audit Selection in the High-income Urban Census Tract 28.14 located in Clark County, NV.

Figure 4. Outside Sample Grocer Audit Selection in the Low-income Urban Census Tract 10.04 located in Clark County, NV for Consumer Level Analysis

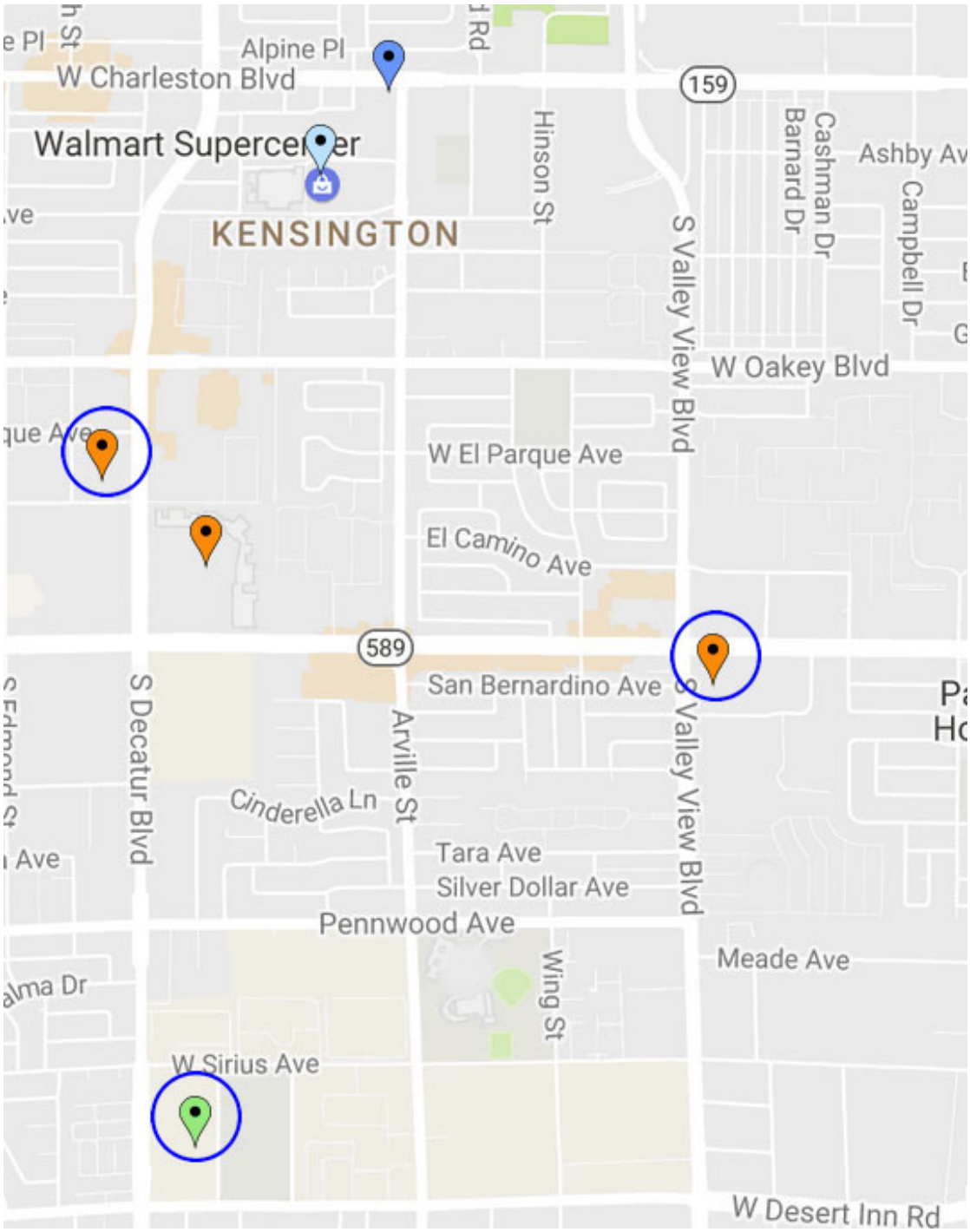
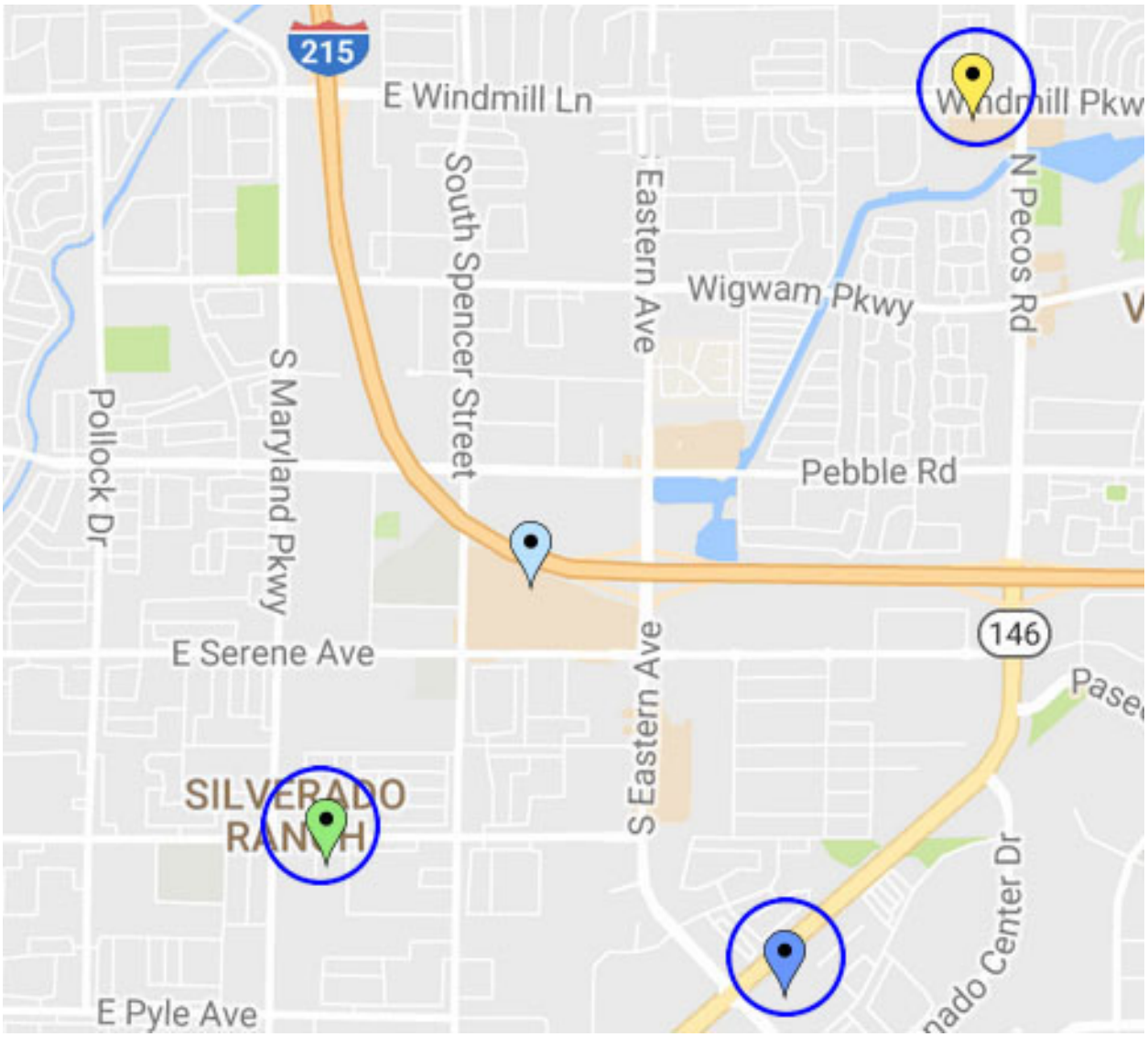


Figure 5. Outside Sample Grocer Audit Selection in the High-income Urban Census Tract 28.14 located in Clark County, NV for Consumer Level Analysis



Rural

To maintain internal validity, the addition of a proximal food environments (town) is included in the rural analysis. Inclusion of Tonopah, NV in Nye County to the rural sample of Esmeralda Country was appropriate due to the unique county line that excludes the town from Esmeralda County and places it in Nye County. Additionally, Tonopah, NV must be crossed through to pass through Esmeralda County in the most expedient way. See Figure 6: Rural Nevada Sample Geography Esmeralda (Westside) and Nye County Line (Eastside.

Figure 6: Rural Nevada Sample Geography Esmeralda (Westside) and Nye County Line (Eastside)

Esmeralda and Nye County Demarcation Line, Google Maps, 2017

Urban and Rural Food Venue Pre-Identification/Confirmation

Urban

An existing database of supermarkets within the greater Las Vegas area was created, refined through departmental collaboration during fall and spring 2015/16, and a working definition of a supermarket was determined. For the greater Las Vegas valley and this study, a supermarket was defined as a grocer venue that is among the physically largest venues and able to take advantage of economies of scale through chain-associated purchasing power, but did not need to be chain grocer to qualify (Kaufman et al., 1997). All compiled supermarket venues but two (168Market and Seafood City Supermarket) had more than a single store in operation within the greater Las Vegas area. 168Market and Seafood City Supermarket are associated with a regional multi-state chain. The physically smallest venues are Walmart Neighborhood Markets. This chain venue is able to take advantage of the parent venue's cost savings. Additional guidance was sourced through the literature that these categories represent existing groups of food venues showing supermarkets and large grocers ($500,000 - $2,000,000 gross annual sales) representing the first and second tiers respectively (Mantovani, 1997).

Rural

Large format, chain and non-chain supermarkets and grocers were initially compiled through business listing databases, business listings from mapping sites and then reviewed for accuracy by personal communication with health educators/researchers Juliana Baker-Tingey and Holly Gatzke who work with the University of Nevada Cooperative Extension and live in rural Nevada. Baker-Tingey and Gatzke confirmed and corrected the rural Nevada draft supermarket list. See Table 11: Preliminary Summation the Largest Grocer Venues (Supermarket

& large-format Grocery) in 2 Rural Nevada Counties, 2 Urban Census Tracts, and Comparison Utah County.

Table 11: Preliminary Summation the Largest Grocer Venues (Supermarket & large-format Grocery) in 2 Rural Nevada Counties, 2 Urban Census Tracts, and Comparison Utah County

County	Within Study Area	Outside Study Area Inclusion	Total
Rural NV	6	4	10
High-income tract 28.14	1	3	4
Low-income tract 10.04-NV	2	3	5
Garfield County, UT	2	0	2
Total			21

Source: Supermarkets and Grocer Venue Listings, Google Maps (2016)

Instruments

Community Level Measure

At the community level, the pre-venue identification through mapped business listings and rural contacts served as a starting point of secondary data. These data were then followed with ground-truthing (passive observation) of the food venues. At the consumer level, the NEMS-S tool was the main instrument of measurement used within the largest grocer venues in the sample areas. The NEMS-S has shown strong validity and reliability (Glanz et al., 2009).

To answer Research Question 1 at the community/geographic level, data was collected while at the venue of interest. Data consisted of venue name, location, and venue type. See

Appendix C: “Community Level Food-Venue Notation”. The categories of anticipated venue types chosen were: Supermarket, Grocery Store, Fast-Food, Health Food/Nutrition, Butcher, Bakery, Sit down Restaurant, Discount Retailer, Dollar Store, Mass Merchandiser, Mass Merchandiser (Club), General Merchandise, Convenience, Food Stand/Cart, Food-Truck, Farmers Market, Bar, Casino/Hotel, Brothel, Other/Misc. These categories incorporate best practices by Sharkey (2009), to recognize the fluidity of venue formats. It is anticipated that the likelihood of unknown venues may have existed prior to ground-truthing (Fleischhacker, 2012). These additional venues were discovered and added through an exhaustive exploration of the food environment through a-priori mapping, social and visual means (ground-truthing).

For the purposes of this study, notation of sit-down restaurants were included as fast-food outlets. This was decided due to the desire to capture the food environment in the sample geographies from a pragmatic view of the public. The practice and inclination of sit-down restaurants to offer take out service similar to that of fast-food venues lends towards an expected tendency for populations to utilize sit-down restaurants as fast-food/take-out if the venues offered the option due to the limited total variety of quick-service options in a rural area. In the urban sample areas, large chain sit-down restaurants have been advertising and offering take-out service for many years. Smaller sit-down restaurants (independently owned/mom and pop), with the exception of some buffets, also maintain a common practice of take-out service.

Food preparation methods in sit-down restaurants are fundamentally different from fast-food venues (Schlosser, 2001, p. 71). The development of the fast-food venue has relied on profits through service efficiency. This efficiency has come through the development of culinary instruments for employees that have little to no experience preparing food. The equipment found in fast-food venues is developed specifically for the food (shape, size, and cooking duration) that

it will be cooking and is complimentary to the processing of the food prior to the foods' arrival at the venue. The difference between the two preparation methods and kitchen staff may lend toward the types and healthfulness of the foods being sold. Lee et al. (2010) utilizing the NEMS-Restaurant instrument found healthier sides in all sit-down venues and "rarely" in fast-food venues in a low-income urban area of Baltimore City.

To answer Research Question 2 and 3 at the consumer level, the NEMS-S, was the instrument to collect in-venue data. The instrument contains 11 categories. Two of the categories consist of produce items (fruits and vegetables), with nine comprised of food categories (milk, ground beef, hot dogs, frozen dinners, baked goods, beverages, bread, chips, cereal) that are based on items/food groups that are the highest selling at the national level (Glanz et al., 2009). The composite score represents a conversion of the raw data into one that takes availability of all items, the price difference between standard and healthy alternatives, and the quality of produce into account. To test this study's hypotheses, the raw data of each food category was summed for each venue. See Appendix A: "NEMS-S Audit Tool".

Produce Availability Measure

To answer Research Question 2 and 3, and Hypotheses H2 and H3 for produce quality, no changes took place using the original NEMS-S produce items. The maximum score per venue is 20, one point per item and will act as the data point for analysis.

Produce Quality Measure

To answer Research Question 2 and 3, and Hypotheses H2b and H3b for produce acceptability, no changes took place using the objective measure from the original NEMS-S. The Maximum score per venue is 20, one point per item, but is only equal to or less than the availability score. For this study, the standard NEMS-S definition was used as follows:

- Acceptable = peak condition, top quality, good color, fresh, firm and clean. Green and under ripe are acceptable.
- Unacceptable = bruised, old looking, mushy, dry, overripe, dark sunken spots in irregular patches or cracked or broken surfaces, signs of shriveling, mold or excessive softening.
- The rating is based on the majority (>50%) of fruits. If it seems difficult to decide whether to mark “A” or “UA”, mark “UA” and describe in comments.

Price Difference Between Standard and Healthy Items Between Samples

To answer Research Question 2 and 3, and Hypotheses H2c and H3c for price differences between standard and healthy items between samples, no changes took place using the original NEMS-S. The summed differences for all items will served as the data point for that venue.

In-Venue Item Choice Approach

Within each category, the tool provides a brand suggestion that represents the highest selling option within that category. The intent was to compare the same items between venues. See Appendix B: “Rationale for Store Measures Criteria”.

Data Output

Data to test Hypothesis 1, 1b, 1c and 1d is reported as a summation table for venues (supermarkets/largest grocer, fast-food, convenience store, and dollar store), for each of the sample areas (rural NV, two urban census tracts, a rural county in Utah).

Data to test Hypotheses 2, 2b, 2c, 3, 3b, and 3c, is reported as summed/meaned raw scores of the NEMS-S audit tool. Produce availability and acceptability ratings are comprised of a single point for each item totaling 20 items per venue. The data is reported as merged produce for a maximum score of 10 points per venue/geography. The price difference between the standard and healthy items within each food category served as the measure of price between the different sample areas. See Appendix D, 'NEMS-Scoring Sheet'.

Data Analysis

This cross-sectional comparison of rural and urban food environments consists of the categorical independent variable of geographic/sample communities environment types (rural vs. urban and urban high-income vs. urban low-income). The outcome variables consist of per-capita venue data to test Research Question 1, venues (supermarkets/largest grocer, fast-food, convenience store, and dollar store) per 1,000 persons between rural and urban environments. The per-capita comparison were evaluated through the use of a greater or less than determination. To test Research Questions 2 and 3, the outcome variables of in-venue food item data (produce availability and acceptability scores, and price differences between select food items) were analyzed with a Kruskal-Wallis rank test.

Protection of Human Subjects

This study's approval falls under the approved study "Evaluating the urban food environment". Due to the nature of this study and its marginal interaction with people, this study has been approved to be exempt from review. A second follow up inquiry on 7.21.16 with the UNLV Office of Research Integrity confirmed inclusion of this study under the proceeding Project Title.

Project Title: [821105-1] Evaluating the urban food environment
Principal Investigator: Courtney Coughenour, PhD
Submission Type: New Project
Date Submitted: October 22, 2015
Action: EXEMPT
Effective Date: October 26, 2015
Review Type: Exempt Review

Chapter 4 Data Results

Hypotheses Data

Hypothesis 1

Rural and Urban per 1,000 persons Data Analysis Method

To address Research Question 1 regarding a difference in venue density of four food venues types (supermarket/largest grocer, fast-food, convenience store and dollar store) between rural and urban Nevada samples, a venues per 1,000 persons comparison takes place through a greater/less than analysis. A parametric test was unable to be run on the data due to the distribution being unknown for per-capita density rates for a particular sample size. See Table 12: Grocer, Fast-Food, Convenience, and Dollar Store Venue Density Rate Results per 1,000 Persons in the 2 County Rural Sample, 2 Census Tract Urban Sample, Rural Towns, and Comparison Utah County.

Table 12: Grocer, Fast-Food, Convenience, and Dollar Store Venue Density Rate Results per 1,000 Persons in the 2 County Rural Sample, 2 Census Tract Urban Sample, Rural Towns, and Comparison Utah County

Sample Area	Supermarkets Largest Grocers	Fast-Food	Convenience Store	Dollar Store
Rural, NV	0.66	3.76	2.21	0.00
Urban, NV	0.35	4.95	0.61	0.00
Urban high-income	0.19	3.57	0.75	0.00
Urban low-income	0.48	6.13	0.48	0.00
Esmeralda County	0.00	12.49	6.72	0.00
Esmeralada & Tonopah	0.53	2.92	3.98	0.00
Lincoln County	0.76	1.89	1.33	0.00
Garfield County,UT	0.97	2.72	4.66	0.00

Rural and Urban Per-capita Hypotheses Tests for H1, H1b, H1c & H1d

The outcome data show evidence to both support an alternative hypothesis and reject null hypotheses. The construct of food access measured through this study of density per 1,000 persons found anticipated per-capita rates for one of the four venue types (convenience store) investigated.

The alternative hypothesis was not demonstrated for H1. The rural Nevada sample did not have a lower per-capita supermarket/grocer density than the urban tracts. Rural Nevada had a density rate of .66 venues compared to the urban rate of .34.

The alternative hypothesis was not demonstrated for H1b. The rural Nevada sample did not have a higher per-capita fast-food density than the urban tracts. Rural Nevada had a density rate of 1.44 venues compared to the urban rate of 3.44.

The data show evidence to support the alternative hypothesis for H1c. The rural Nevada sample did have a higher per-capita convenience store density than the urban tracts. Rural Nevada had a density rate of 2.21 venues compared to the urban rate of .62.

Venues comprising H1d data were not present in the sample geographies. Rural Nevada did maintain a Family Dollar venue. Upon inspection the venue did not maintain a dollar price theme. While dollar stores are prevalent in the greater Las Vegas valley, these particular urban samples did not contain any.

Hypothesis 2

NEMS-S Data Input and Analysis Methods

Availability, acceptability and price difference data input into SPSS (v.24) for analysis allowed for Hypotheses 2 and 3 testing. Based on the data being analyzed as ranked data, the statistical method best suited to find differences in these three measurements between geographies was the Kruskal-Wallis Test (KW). To determine which geography's mean data was significantly different, additional KW ran the groups as pairs. Redundant verification of data integrity and validity by the performance of a Mann-Whitney U Test yielded identical p-value scores. The Mann-Whitney U Test is able to analyze two sample means of ranked data from the same population. A Bonferroni post hoc correction reduced the p-value by dividing the significance threshold by the number of sample-groups being run. The correction increased the breakpoint of significance by reducing .05 to .0167 in order to prevent p-value inflation.

Item prices for standard and healthy alternatives within the nine non-produce food categories (milk, beef, hot dogs, frozen dinners, baked goods, beverage, bread, chips, and cereal) of the NEMS-S instrument represent the data from each venue. Not all items existed within each venue. The price differences for each food category with the standard and healthy alternative items that were available represent the price difference data.

Availability, Acceptability and Item Price Difference Results for Nevada Samples

The data show a evidence not to support the alternative hypothesis for H2 and H2b. The mean produce availability data show that the low-income tract reflected the highest score (9.92) and the rural Nevada sample show the lowest (5.83). Similar results for produce acceptability data show the highest mean score for the low-income tract (9.77) and rural Nevada having the

lowest mean acceptability score (5.75). See Table 13: Mean Produce Availability & Acceptability Scores the 2 County Rural Sample, 2 Census Tract Urban Sample, and Comparison Utah County.

Table 13: Mean Produce Availability & Acceptability Scores the 2 County Rural Sample, 2 Census Tract Urban Sample, and Comparison Utah County

Availability	Mean Score	Acceptability	Mean Score
Rural NV	5.83	Rural NV	5.75
Urban NV	9.55	Urban NV	9.45
High-Income	9.00	High-Income	9.00
Low-income	9.92	Low-income	9.77
Utah County	7.20	Utah County	4.70

The rural Nevada geography show the lowest price difference between standard and healthy items, with the high-income sample showing the highest difference. See Table 14: Difference in Cents Between non-produce Standard and Healthy Item Choices in 2 County Rural Sample, 2 Census Tract Urban Sample, and Urban Tracts.

Table 14: Difference in Cents Between non-produce Standard and Healthy Item Choices in 2 County Rural Sample, 2 Census Tract Urban Sample, and Urban Tracts

Geography	Rural NV	Urban NV	Low-income	High-income
Difference in Cents	15.6	36.5	48.3	49.5

Rural and Urban Nevada NEMS-S Outcome Data Comparison and Hypotheses Testing for H2, H2b, & H2c

The outcome data show evidence to both support an alternative hypothesis and reject null hypotheses derived from Research Question 2. Food access measured through this study of the availability and acceptability of produce between the rural and urban sample geographies were significantly different from each other. The price differences between standard and healthy items were not statistically different between rural and urban Nevada sample geographies.

Rural and Urban Availability and Acceptability Mean Hypotheses Test Results for H2 & H2b

The first Kruskal-Wallis Test (KW) performed on the data show significant differences between rural and urban Nevada and comparison geographies for the availability and acceptability measures. The second KW analysis on the rural and urban Nevada geographies did show a significant difference between means for availability and acceptability. See Table 15: Produce Availability and Acceptability Statistical Results in the 2 County Rural Sample and 2 Census Tract Urban Sample.

Table 15: Produce Availability and Acceptability Statistical Results in the 2 County Rural Sample and 2 Census Tract Urban Sample

Measure	Sample Geography Comparison	Nevada & Utah County	Nevada
Availability	Rural vs. Urban	*p = 0.004	*p = 0.001
Acceptability	Rural vs. Urban	*p = 0.007	*p = 0.001

*** Sig = P<.05, Bonferroni post hoc correction: P<.0167**

Rural and Urban Item Price Difference Mean Hypotheses Test Results for H2c

The first Kruskal-Wallis Test (KW) performed did not show a significant difference between rural and urban Nevada and comparison geography for the item price-difference measure. The second KW analysis on the Nevada geographies also did not show a significant difference between means for hypothesis H2c. See Table 16: Statistical Results of the Price Difference Between Standard and Healthy Item Choices in 2 County Rural Sample and 2 Census Tract Urban Sample.

Table 16: Statistical Results of the Price Difference between Standard and Healthy Item Choices in 2 County Rural Sample and 2 Census Tract Urban Sample

Measure	Geography	p-value
Price	Rural vs. Urban	0.828

*** Sig = P<.05, Bonferroni post hoc correction: P<.0167**

Hypothesis 3

High and Low-income Tract NEMS-S Outcome Data Comparison for H3, H3b & H3c

The outcome data show evidence that the alternative hypotheses cannot be accepted from Research Question 3. The availability and acceptability of produce in the urban high and low-income tract were not significantly different from each other. The price differences between standard and healthy items were also not statistically different between urban high and low-income Nevada sample geographies.

High and Low-income Tract Availability and Acceptability Mean Hypotheses Test Results for H3 & H3b

The first Kruskal-Wallis Test performed on the data show significant differences between the high-income, low-income and comparison geography for the produce availability and acceptability measures. The second KW analysis on the high-income and low-income geographies did not show a significant difference between the means for H3 and H3b. See Table 17: Statistical Results of Availability and Acceptability between a High-income and Low-income Urban Census Tract

Table 17: Statistical Results of Availability and Acceptability between a High-income and Low-income Urban Census Tract

Measure	Urban Nevada Geographies	p-value
Availability	High vs. Low-income tract	0.087
Acceptability	High vs. Low-income tract	0.222

*** Sig = P<.05, Bonferroni post hoc correction: P<.0167**

High and Low-income Tract Item Price-Difference Mean Hypotheses Test Results for H3c

The first Kruskal-Wallis Test (KW) performed did not show a significant difference between urban high-income and low-income Nevada and comparison geography for the item price-difference measure. The second KW analysis on the high-income and low-income urban geographies also did not show a significant difference between means for Hypothesis H3c. See Table 18: Statistical Results of Standard and Healthy Item Choice Comparisons between the High-income and Low-income Urban Nevada Tracts.

Table 18: Statistical Results of Standard and Healthy Item Choice Comparisons between the High-income and Low-income Urban Nevada Tracts

Measure	Geography	p-value
Price	High-income vs. Low-income	0.201

*** Sig = P<.05, Bonferroni post hoc correction: P<.0167**

Additional Statistical Analysis Summary Results

The raw availability and acceptability scores for each venue consist of a summed score of both fruits and vegetables. Analysis within the sample geographies for fruit availability, fruit acceptability, vegetable availability and vegetable acceptability took place through the same statistical methods outlined above. The data for all sample comparison yielded non-significant results. Within the rural and urban Nevada sample geographies, fruit availability ($p=.02$), fruit acceptability ($p=.023$), and vegetable acceptability ($p=.019$) scored near statistically significant.

Chapter 5 Discussion

Per-capita Venue Density Discussion

Per-capita Grocer Density Discussion

The results of the grocer density analysis between geographies were in the unexpected direction based on the hypotheses. The density results of this study show the rural sample had a greater exposure to large grocer venues than the urban sample per 1,000 persons yet differ from national level analysis showing much lower grocer density rates. This study's results demonstrate per 1,000 person grocer density rates approximately twice (.66) that found by Ahern et al. (2011) in their national level grocer analysis of large-grocer venue density (.34), with a similar urban density rate (.21) as the urban sample rate (.34). Ahern et al. (2011) showed a negative association between grocer venue density in rural areas and diabetes rates. With the rural sample maintaining twice the national rate of rural grocer density and three times the national urban density, a reasonable expectation would be diet related disease rates in rural geographies to be closer in alignment with urban areas, as these venues carry foods associated with positive health outcomes such as whole foods. This holds generally true for obesity rates in the rural sample, which show recent fluctuations up to 3.5 percentage points as Clark County but generally maintained a similar trend to Clark County.

The higher grocer density rate in the rural Nevada samples than those rates reported nationally may be influenced by population density rates nationally that are higher than rural Nevada's. Nevada as a state ranked the 42nd least dense state in the Union, maintaining a density rate of 26 people per square mile (U.S. Census., Annual Estimates of the Resident Population, 2016). The rural county sample maintained a density rate of .34 persons per square mile

(American Community Survey 2014, 5-year estimates). With the majority of states maintaining a higher area density rate, the higher rural Nevada grocer density rate may reflect the increased distances to the next population center/town. In rural areas with a higher density of people per area, the distance between population centers/towns where additional grocer venues can be found is likely less than rural geographies with low population densities. The higher grocer venue density in this study's rural samples may reflect that geospatial component of access and may also represent grocers and policy makers attempting to compensate for the increased distances.

The food environment in rural and urban geographies is shaped by different development constraints based the nature of the areas. The process for introducing a grocer venue in a rural geography may involve county level attention due to a low population. Attention by rural county residents may be greater than that of urban residents when it comes to voicing positive or negative attitudes towards a grocer venue. Alternatively, the urban tracts have oversight at a local level, which may facilitate the introduction of grocers with reduced barriers to market entry. Barriers at the Las Vegas valley level may be those such as a lack of attractive area level demographics, which change relatively quickly compared to rural Nevada. The higher grocer density in the rural sample may be a result of the distances between towns. Rural county level approval for grocer venues may have been intended to provide the population a higher exposure within the county due to the extended travel involved. Urban grocers are likely to serve a greater number of shoppers who do not live in the surrounding residences, but may consider a particular venue, or several venues, as their main grocer(s) due to the venue's(') proximity to other activities in the surrounding areas.

Introducing a grocer venue in rural areas may be restricted by zoning laws and regulations that urban areas may not need to consider. Urban venues often share adjoining walls with housing complexes. A new rural venue development proposed in a similar fashion may not move forward due to county level development codes. These regulations may have been codified to preserve the nature or essence of the rural landscape. Through a survey of local residents, Gatzke et al. (2014) found a strong desire for new food venue development in Lincoln County, yet respondents reported an equally strong desire to maintain the county's rural characteristics.

Similar to the findings by Sharkey et al. (2009), at least one venue in all samples maintained a different venue within it. The most common occurrence was fast-food venues within convenience stores in the rural samples. Some fast-food venues within the rural convenience stores were part of national chains and some were individually owned. Two of the urban supermarkets also maintained fast-food venues. The urban supermarket venues that contained fast-food venues were part of national chains and the fast-food venues within them were also national chains.

City and County level councils and commissions have input on land use and development, yet the disproportionate density of unhealthy to healthy venues is a concept not fully grasped by those who would approve or deny a particular venue in Las Vegas urban areas, and may extend to rural Nevada counties. A disconnect between the literature's characterization of unhealthy venues and willingness to define those venues by local legislative bodies exists (Spillman, 2013). While healthy venues such as supermarket, grocers, and farmers' markets are accepted by both parties as being healthy, attempts to define or designate unhealthy venues are conceptualized by some City of Las Vegas commissioners as being related to "overgovernment". The same policy makers claim that working fully towards a healthier food environment is

beyond their role. While willingness to define a healthy venue without a standardized definition, determining what is or what the characteristics of an unhealthy venue are, one member stated that they would be called upon to be "…the wise men and women of dietary consumption." (Spillman, 2013). This disconnect between the literature and application at the policy level may yield positive changes in the food environment related to healthy venues, as it is a generally accepted term, yet the literature and results from this study show a strong disparity of density rates between healthy and unhealthy venues. The increase quantity of healthy venues would need to substantial to equal the density rates of unhealthy venues.

Per-capita Fast-food Density Venue Discussion

The density rate of fast-food venues in the rural sample was less than but not significantly different from the urban geographies. Of concern in both geographies is the high-density rate of fast-food venues. Fast-food venues outnumbered all other venues in the sample geographies. The rural and urban sample contained 3.76 and 4.95 venues, and the high and low-income tracts held 3.57 and 6.13 venues per 1,000 persons respectively. These high-density exposure rates compare poorly to Coughenour et al. (2014) who reported fast-food venue density four times that of supermarket venues in Clark County, NV. This study's data show that the rural sample had a density rate between the two venue types nearly seven times greater, urban sample at over fourteen times, the high-income tract at nearly twenty times, and the low-income tract at nearly fifteen times. The foods in fast-food venues are directly implicated in the obesity and diabetes epidemic and "dominate away-from-home food consumption, tend to be energy-dense or high in calories and fat, and are associated with poorer diet" (Bowman & Vinyard, 2004; Duffey, Gordon-Larsen, Steffen, Jacobs, & Popkin, 2009; Sharkey et al., 2011).

The merging of fast-food venues and sit-down restaurants is likely to have impacted fast-food venue density results. The high-density rate of fast-food venues in the rural samples may be impacted by counties with a tourism-based economy. With few full time residents, the need or desire to build additional (separate physical) venues may not exist. Short term stays and preparation for isolated geographies may negate the need for venues of all types, but may also influence fast-food and restaurant utilization. When vacationing, the desire to cook healthy meals and the ability to do so may be limited. The priority of maintaining a healthy diet may not be a prime concern for vacationers, combined with the possible lack of kitchen facilities may dissuade healthy venue development and offer rationale for the development or maintenance of a higher unhealthy venue density rate.

Esmeralda County maintained a fast-food density rate much higher than any of the samples or geographies within samples, at a rate of 12.5 venues per 1,000 persons. The county also maintained the highest convenience store density rate among all samples or geographies within samples, at a rate of 6.7 venues per 1,000 persons. Since Esmeralda County also did not maintain a single grocer venue, these unhealthy venue density rates may be a result of those venue types providing a food service option where other options may not exist. Further, since Esmeralda County is a thoroughfare for the more populated areas of Northern Nevada and California, these venue types may have been developed to service that transient population.

Additionally, Ahern et al. (2011) points towards a small number of rural counties within a particular study, tourism based counties, and tourism based county residents being healthier as an influencing factor of the rural food environment. The merging of fast-food and sit-down venues, atypical aspects of the rural food environments, such as those geared towards tourism/recreation, and the likelihood of unmeasured features may affect venue density results. As a result, the fast-

food density rates of this study may not align with similar national and local (Clark County, NV) level results that intended to study a singular venue type and may have relied on the categorization of secondary data to do so (Ahern et al., 2011; Coughenour et al., 2014).

The high fast-food venue density rates in the urban environment may reflect influences on the demand side that are related more to the nature of Las Vegas, rather than attributes of its residents such as population, income, or geographical location within the built environment. The Las Vegas economy is based on gaming and tourism, and as a result has daily and weekly population fluctuations. The close proximity of the low-income census tract in relation to the Las Vegas Strip may have influenced fast-food/restaurant venue development during the past 50 years.

Per-capita Convenience Store Density Discussion

Rural and urban Nevada convenience stores mirror the size, format and general content of convenience stores nationwide with the exception of space devoted to gaming machines. The rural sample demonstrated a density approximately four times that of the urban sample. The exposure density of convenience stores was statistically greater in the rural geography compared to the urban sample (2.21 vs. .61). Living or frequenting an area with a high density of unhealthy venues such as convenience stores is important to be aware of for different reasons, for different populations.

Living in the rural Nevada sample may have a detrimental impact of weight related morbidities compared to the urban geography due to high exposure to and exposure prevalence to poor quality foods that these venues sell. Across geographies, Auchincloss, Roux, Brown, Erdmann, & Bertoni, (2008) found an inverse association between the healthfulness of the food

environment and insulin resistance in their multi-site/state study of secondary data. Liese et al. (2007) cite findings that obesity is more common in areas with small corner grocery stores and convenience stores. Their rural sample venues were “heavily weighted towards convenience stores”. They state that within their two rural-county study, obesity was more common in the areas with convenience stores. Distance to convenience stores also show evidence of negative impacts on youth. Jago, Baranowski, Baranowski, Cullen, & Thompson (2007) found that for male Texas youth (10-14), a farther residential distance to a small food venue was associated with higher fruit and vegetable intake.

The density results in all the sample geographies act as a persuading deterrent to healthy eating through exposure displacement of healthy venues by unhealthy venues. The foods that convenience stores sell are consistently associated with poor health outcomes, which largely consist of highly processed, sugar sweetened, high-calorie and low-nutrient dense foods. It may be possible the rural Nevada populations are influenced by this disparate exposure to a greater degree than urban residents and are much more likely to frequent these venues due to a variety of reasons such as a lack of alternatives, conditioning, time, taste, or perceived value.

The high convenience store density rate in the rural Nevada samples may reflect the low population density rates of those counties. With increased distances between populated centers/towns, the need to maintain accessible gas stations is paramount. While not all convenience stores maintain gas stations, it is relatively uncommon to find a gas station without a convenience store. This geospatial disparity between the rural Nevada samples and the urban Las Vegas samples may have influenced the significantly different per-capita density rate of these venues.

Per-capita Dollar Store Density Venue Discussion

The absence of dollar store venues within the rural samples was unexpected. Dollar stores originated in rural geographies owing to thrifty low-income populations, but have expanded nationally with international agri-businesses supplying fruit and vegetables year-round (Berry, 2007). The high and low-income tracts in the urban sample maintained a 99 Cents Only venue directly across the street from each tract. These venues are under current examination for their ability to provide healthy foods and healthier alternative items at low(er) prices.

Consumer Level Discussion

Availability and Acceptability Discussion

The rural Nevada produce availability and acceptability outcomes follow the expected direction in the literature (Caspi et al., 2012; Shanks et al., 2015; Sharkey et al., 2009; Walker et al., 2010.) The mean availability of produce in rural Nevada was significantly lower than that of the urban sample (5.83 vs. 9.55). The mean acceptability score of the rural counties was also significantly different from the urban tracts (5.75 vs. 9.45). These results are important due to the low density of produce selling venues in the rural environments.

Rationale for the findings by Gatzke et al. (2014) of low consumption produce rates and higher diet-disease rates by rural Nevada populations may partially be explained by consumer level variables found in this study. Consumption of fruits and vegetables along with physical activity is strongly associated with improving and possibly eliminating diabetes (Bazzano, 2006; Parekh, Petro, Tiller, Feinglos, & Surwit, 1998; Salas-Salvadó, Martinez-González, Bulló, & Ros, 2011). The high density of venues that lack these types of foods in the rural sample may partially contribute to the sample maintaining higher diabetes rates than urban areas of the State.

Between 2006 and 2013 the rural sample maintained between .75 and 1.5 percentage points higher than Clark County for the rate of diagnosed diabetes. These poor indicators may be directly influenced by a 64% lower availability score in the rural geography, and what is available is of statistically poorer quality than the urban environment.

The availability and acceptability of produce may have a substantial impact on Public Health, specifically rural populations. When rural populations are limited to a low-variety and poor quality produce offerings, such as those in these samples, daily consumption may be reduced or may be substituted for fruit and vegetable alternatives that may not have the same health impacts as whole, unprocessed produce. Strong evidence show the consumption of fruits and vegetables directly linked to decreases of all-cause mortality, cardiovascular disease, hypertension, diabetes, obesity and certain cancers (Bazzazno et al., 2002; Bazzano, 2006; Ness & Powles, 1997).

Standard and Healthy Price Comparison between Geographies

The price difference between the rural and urban, and the high and low-income geographies using the NEMS-S non-produce food items was not significant. An additional revelation is the lack of a functional/practical difference. Including the comparison sample of Garfield County, UT, the range between the most and least expensive geography examined in this study is 73 cents.

The price of food and the price of healthy food is a crucial construct of access in fostering a food environment that supports the prevention of obesity, diabetes, cardiovascular disease and some cancers (Cummins et al., 2014; Krukowski et al., 2010; Millen et al., 2015; Sharkey, 2009). Within these samples and within the constructs of the NEMS-S, one could move throughout the

various geographies examined and not be concerned that healthier choices would impact them economically at the register. The health implications of a null price difference between the rural and urban, and high and low-income tracts may be assuring but caution is warranted due to the measurement method between items in the NEMS-S tool and not over-all cost of all of the items within the instrument. See Limitations section below. For all shoppers and specifically low-income shoppers, attempting to choose items while shopping that are a healthier version of the item they intend to purchase, the price difference between those two items is of concern and may influence purchasing behaviors. This is directly relevant through the work by Gatzke et al. (2014) shown above that indicates some shoppers may devote a larger percent of grocer spending towards non-produce items.

This study's findings of similar price differences between items, between high and low-income urban areas are comparable to Andreyeva et al. (2008) in their replicative study of New Haven, CT from 1971. Their second study utilized an augmented NEMS-S (for regional preferences) and found negligible price differences for all items and between items, between high and low-income urban areas. A null price difference was also found by Shanks et al. (2014) using the NEMS-S spanning 12 Montana counties. Using a culturally adapted market basket, Tisone et al. (2014) found eight of ten food items having a non-significant price difference between Texas WIC vendors. The literature show mixed findings on food price across a range of geographies. Generally, rural venues charge more for food and across same sized grocer venues in high-income urban areas, venues charge approximately 4% more than in low-income urban areas, but these differences are not present in all studies and were not evaluated in this study (Dunn et al., 2011; Mantovani et al., 1997; Marcus, 1969; Rogus, 2015; Shanks et al., 2014).

This study's instrument examined the price comparisons between select items within each grocer and not the overall price of all items in the NEMS-S. The influence of price on purchases of healthy or unhealthy foods is critical to improve Public Health morbidity and mortality rates, and has the ability to influence purchasing habits (Epstein, 2010; Glanz & Yaroch, 2004; Goldberger, Wheeler, & Sydenstricker, 1920; Sydenstricker, 1915). Modern researchers cite strong evidence that show when healthier foods are decreased in price, purchases of those items increase, and that the opposite is true for decreased purchasing of unhealthy items as prices increase. Laboratory studies show that an additional price placed upon unhealthy foods may increase healthy food purchases (Epstein, Paluch, Beecher, & Roemmich, 2008). Epstein et al. (2010) demonstrated that an increased price on nutrient poor foods reduced purchasing of those items. While promising, Epstein et al. (2010) show that while healthy food purchases increased, the remainder of the food budget was spent on unhealthy foods by the study participants. Throughout multiple studies, Epstein et al. (2008) Epstein et al. (2010) and Epstein et al. (2015) state strong support for higher prices on unhealthy foods as a way to deter purchasing those items and lower prices/subsidies on healthy foods to encourage purchasing.

Nevada Indicators

Inter-geography Indicators, Rural Focus

Esmeralda County has poor health indicators related to population level economics and educational attainment rates that are associated with increased rates of diet-related disease. Esmeralda County had a high rate of less than high-school graduation, the lowest rate of college among samples, the lowest income in the state and the highest percent of the population in poverty among all samples (23%) (American Community Survey 2014, 5 year estimates). These

characteristics of the population along with the community and consumer food environment data put Esmeralda County residents at a very high risk for diet related diseases such as obesity and diabetes (Cummins et al., 2014; Krukowski et al., 2010; Millen et al., 2015; Sharkey, 2009). Mixed indicators of the Lincoln County population with a higher grocer density may positively influence diet related disease outcomes. When compared with Esmeralda County, Lincoln County had a lower percent of the population without a high school education, seven percentage points higher for college experience, and a higher median household income by $9,000 (American Community Survey 2014, 5 year estimates). These indicators for the Lincoln County sample may put those residents at a relative advantage for diet-related disease risk.

Inter-geography Indicators, Urban Focus

The low-income tract has poor indicators related to population level economics and educational attainment rates. The low-income tract had a high rate of less than high-school graduation, a low rate of some college or higher education, income nearly identical to the lowest county in the state and the highest percent of the population in poverty (17.7%) among all samples except Esmeralda (23%) (American Community Survey 2014, 5 year estimates). When compounded with a food environment characterized by high exposure to unhealthy venues, the low-income population may be at moderate to high risk for diet related disease (Cummins et al., 2014; Krukowski et al., 2010; Millen et al., 2015; Sharkey, 2009).

Additional Diet Related Impacts on Health

In order to prevent an ecological error in interpretation, recognition of differences between the two geographies is needed when reporting of the impact of the food environment on access and health. This study examined the density of venues per-persons, but not venues per

square mile(s). In urban geographies, geographic proximity to supermarkets has frequently shown not to be associated with diet for the general population, as the closest supermarket to one's residence is not the primary venue utilized (Hillier et al., 2011). Alternatively, for low-income urban populations lacking access to a vehicle and shopping nearest to one's residence (less than 1 mile) has been shown to be significantly associated with a greater diabetes rate (Auchincloss et al., 2008). For rural populations, those living more than 10 miles and lacking access to a vehicle is associated with greater diabetes rates (Auchincloss et al., 2008). While urban populations have additional transportation options available and the relative short distance to additional venue options is an inconvenience rather than a geographical impediment, rural areas lack public transportation, private transportation companies and long distances preclude self-propelled methods (Morton et al., 2007). With a higher density of venues per square mile, urban populations have a geospatial advantage over rural residents. This additional distance disparity may act as a neutralizing effect on the positive benefits of a higher grocer density on the rural Nevada population.

Additionally, the significantly lower availability and acceptability scores represent an additional barrier to consuming foods associated with health in the rural areas. The rural grocer venues may be considered 'disfavored' within the mind of the shopper based on the characteristics of the produce (Sharkey et al., 2010). This potential impact on diet through the consumer level produce data, combined with (community level) the long distances between rural Nevada towns maintaining a grocer venue, impose compounding deprivations for low-income residents and a reliance on existing unhealthy venues which are the dominate venues present in all geographies.

Conclusions

This study's results of the food environment within rural and urban Nevada sample geographies show mixed results for expectations based on the literature. Mixed expectations for grocer venue density between the rural and urban areas was based on the literature showing reduced access to grocer venues in rural areas and national level data showing higher rates in rural areas (Ahern et al., 2011; Beaulac et al., 2009; Caspi et al., 2012; Powell et al., 2011). Grocer venue density in the rural sample maintained a higher density than the urban sample. A higher density of convenience stores were found in the rural sample, with high densities of fast-food venues in all geographies, which when taken together produced a dramatic disparity for all populations to unhealthy venue exposure, but impact rural populations to a greater degree due to low-incomes, low educations rates, generally poorer health status (obesity/diabetes) and geographic isolation. The availability and acceptability of produce were found in the expected direction with lower variety and quality scores in the rural geographies. These constructs are vital for the rural sample counties, specifically Esmeralda, which has no grocer venues within its county lines, and may utilize the single closest grocer venue located in Tonopah. The price differences between this study's samples were non-significant and functionally similar between geographies. Of critical importance is the choice of healthy alternatives to item purchases with existing intent, since data show produce consumption and purchasing habits do not align with recommended goals (Gatzke et al., 2014).

Further study of the food environment in Nevada geographies would benefit from a dynamic set of methods that draw from the literature. Capturing multiple levels of the food environment such as those at the community, consumer and personal levels would allow for a dynamic and holistic approach based on a theoretical framework to "truly represent those things

that can enable or hinder healthy consumption patterns" (Caspi et al., 2012). In addition to objective measures related to the venues, these constructs would also consist of urban design features such as walkability, public transportation use and personally defining one's food environment. Study of the geographic relationship between the food environment and one's residence have been shown to have poor correlation since the closest grocer venue is reported not to be the primary grocer utilized (Charreire et al., 2010). Alternatively, low-income urban populations without vehicles and rural populations have shown impacts on diet through proximity based measures to grocer venues (Auchincloss et al., 2008; Sharkey et al., 2010). Urban areas exist in the Las Vegas valley that have historically had disparate access to grocer venues and would benefit from study at the community, consumer and personal level. Additionally, a dynamic analysis would evaluate all food venue formats available, including dollar stores, farmers markets and non-chain strip-mall grocer markets. Dollar Stores and Farmers' Markets are emerging in the literature as prevalent and affordable alternatives for acquiring healthy foods (Berry, 2011). Small grocer venues in Las Vegas mimic supermarket layouts with multiple departments but maintain a size comparable to that of rural grocery venues or smaller.

Limitations

A primary limitation when examining environments for associations between descriptive characteristics and population behavior or health outcomes is that of the ecological fallacy (Greenland, 2001). The rural sample counties are large and the resulting aggregated data may not reflect, nor have the ability to be attributed toward Public Health outcomes at a local level due to additional confounders such as residents possibly not shopping at the venues within their geography (Jillcott et al., 2011). Each county may have unique characteristics that may influence

access, intake and diet-related disease rates above and beyond that of the community and consumer level food environment. Any actions taken towards an individual geography should be tempered by the acknowledgement that the data represent an average for all the populations and assumes a similarity among all samples. Additionally, omission of this fallacy in consideration of zoning influences on the food environment may not include the geographic level they are aimed at, such as for an entire rural county.

The limitation of two rural counties and two urban tracts may have reduced the ability to detect a true difference between venue densities between geographies, specifically large grocer venues. Further study of rural and urban food environments would benefit from a larger rural and urban sample of targeted incomes across tracts. The generalizability between other rural, urban, and rural/urban studies may not be appropriate. Population density in the rural Nevada samples is among the lowest in the country ranging from .29 (Esmeralda County) to .5 (Lincoln County) persons per square mile (American Community Survey 2014, 5 year estimates). Towns are at very far distances from each other with Department of Transportation signage warning of gas availability between convenience store venues. Rural geographies nationally may have town centers in closer proximity to one another therefore allowing a shorter distance to the next town that may have a grocer venue. Among the least population dense states/regions that this study may have a greater applicability towards may be Montana, Utah, Arizona, New Mexico, the desert southwest or others.

Not all grocer venues in Lincoln County were accounted for and in operation during data collection. A single grocer in Pioche, NV (Miner's Market) that was advertised and anticipated to be in operation during data collection was closed and inaccessible. All attempts to contact the operators have proven unsuccessful. The inclusion of this venue would have changed the Lincoln

County grocer density rate from .76 to .95 and changed the rural Nevada density rate from .66 to .77.

This study examined the price differences between types of items within each food category and not a summed price comparison of items between geographies. Using the NEMS-S as a market basket to determine the sum receipt price between geographies would have uncovered different data results that would aid to uncover functional costs between geographies for shoppers. The price difference between standard and healthy items may be less of a concern if the cost of all items is high. Higher prices for all items is likely to be found in rural grocer venues due to factors outlined above such as low sales volume, the inability to take advantage of economies of scale and high cost per item unit sold due to lower shelf space and stocking quantities compared to supermarkets (Mantovani et al., 1995).

Large grocer venues within the low-income tract have changed in quantity over time. A venue site within the low-income tract that previously operated as a supermarket was vacant at the time of data collection. The addition of this supermarket to the density analysis would have increased the density exposure for the low-income tract from .48 to .65, and would have increased the urban density from .34 to .42.

Stronger measures of wealth/income have been shown to have the strongest relationship to obesity and diabetes rates. Utilization of area wealth and education as measures of personal income are more strongly linked to obesity and diabetes rates than median household or median personal income (Drewnowski et al., 2012). The researchers examined two urban samples in Seattle, WA and Paris, France. They found that being low-income, living in a low property value

area and shopping at a low-priced grocer venue were consistently associated with increased obesity risk in both sample geographies.

Implications

The availability of healthy foods is crucial to facilitate any potential impact on obesity and diabetes rates. In rural environments, populations are more likely to participate in the practice of reciprocity (Morton et al., 2007). Since home gardening is more prevalent in rural areas, reciprocity is a method of preserved food allocation between households that allows rural populations to maintain nutrient intake throughout the year. These existing efforts have the potential to be strengthened through educational efforts, such as those sought in Lincoln County (Gatzke et al., 2014).

Additional avenues of healthy venue support as well as increasing the variety and quality of produce could come through Government supported efforts such as the Healthy Food Financing Initiative. This program offers both financial and technical assistance grants geared towards infrastructure and human capital support. They have been used in the past to improve small venue capacity through equipment purchases and educational and technical intervention. Further support to increase the availability and acceptability has been demonstrated through efforts in New York City. A collaborative effort between stakeholders, entrepreneurs and New York City permitting officials facilitated the introduction of approximately 1,500 produce vendor carts into the city in 2010. The weekly farmers' market count in Las Vegas prior to 2010 stood at two, with recent counts around one dozen. Certain metropolitan and residential areas within the Las Vegas valley may be ideal areas to attempt similar actions to address access to a variety of quality fruits and vegetables.

Maintaining measurement of the food environment using standardized methods and instruments is critical not only to compare sample geographies across studies, but also to facilitate results to policy makers (Eyler et al., 2015; Glanz et al., 2016; Lytle, 2009). When data that represent the food environment are collected, analyzed and presented in various inconsistent ways, researchers inadvertently sabotage efforts to guide future policy actions (Rogus et al., 2015). The authors point towards reliable measure of price to take place that would facilitate local examination. Valid repetitive studies could then be used to inform policy intervention at the local level. Legislation to facilitate this potentiality initiated under the 2017 House Budget would consolidate several Federal programs, including SNAP, and shift distribution responsibilities to the States. The Nevada State Division of Welfare and Supportive Services could then examine the growing body of Public Health literature on healthy food price constructs at increasingly granular levels such as rural/urban/frontier, county, census tract or census block. In Las Vegas, study of the food environment at the Ward level may be ideal. This data could then be used to adjust benefit rates based on local conditions rather than national price indices that may reduce purchasing power at healthy venues for low-income populations. This is critical for rural populations, as they have been shown to redeem 59% of their SNAP benefits in rural supermarkets, with low-income rural populations only spending slightly over half of their allotment in supermarkets (Kaufman et al., 2007).

Formal and informal education is strongly linked to diet and have the ability to ameliorate diet related disease through increased incomes and kitchen based knowledge and skills (Carnahan et al., 2016; Drewnowski et al., 2014). Policymakers must balance limited resources when attempting direct and indirect influence on chronic disease. Education efforts within the state of Nevada have been challenging at the primary and secondary level in part due to per-pupil

spending lower than the national average and high teacher to student ratios (Milliard, 2014). Southern Nevada has shown lower rates in higher education when compared nationally and regionally within the Mountain West area (Pharr, Coughenour, Gerstenberger., 2014). Filling in where public education efforts may have faltered are community health districts, Co-operative extensions, multi-disciplinary academic departments and non-profits such as those called for in The Southern Nevada Food Council White Paper and in Goal 2 of The Southern Nevada Regional Plan for Sustainable Development. These entities focus efforts on supporting healthy food environments through efforts such as public and private planning and policy development, community, school and personal gardening, and farmers' markets.

Active engagement by the above community organizations to help reshape the food environment is critical and impactful in the development of a healthy food environment. The literature and grey literature show non-profits and faith based organizations acting as healthy venue development facilitators. These actors represent their communities and are often cited as cultural ambassadors, health/wellness ambassadors, and community development corporations (Ahern et al., 2011; Pothukuchi, 2005). These groups also facilitate the process through ground-level evaluation of the food environment in order to characterize barriers and facilitators to a healthy community. Pothukuchi (2005) point to 32 U.S. cities that participated in citywide grocer development programs with community agencies facilitating the process through communication with city planners.

Active engagement by stakeholders has directly influenced efforts to reshape the environment. These actions have the potential to advance the issue of healthy food environments through Federal level representation such as an Office of Environmental Food Justice. Mustafa Ali, resigned Chief of the Environmental Protection Agency's Office of Environmental Justice, stated that precisely through recommendations made by stakeholders, (academics, grassroots, faith based organizations, et al.) was how his office formed (Goodman, 2017). Environmental Justice reflected in the food environment may influence long-term health through the 'equitable distribution of the burdens and benefits' of healthy and unhealthy venue density, produce diversity and quality, and/or access to healthier foods through economic means. Since strong evidence show rural, low-income and low-income minorities having reduced access to foods that are associated with the prevention of diet-related disease, decreased morbidity and mortality through an unhealthy food environment, an environmental justice approach may be ideal.

Nutrition Environment Measures Survey (NEMS)
Food Outlet Cover Page

Rater ID: ☐☐

Store ID: ☐☐☐☐

- O Grocery Store
- O Convenience Store
- O Other: _____

Secondary Store Type (if applicable):

- O Not Applicable
- O Drugstore or pharmacy
- O Ethnic food store
- O Corner store
- O General merchandise store (Target, WalMart, etc)
- O Big box store (Sam's Club, CostCo, etc)

Date ☐☐/☐☐/☐☐ (Month Day Year)

Start Time: ☐☐:☐☐ O AM O PM

End Time: ☐☐:☐☐ O AM O PM

Number of cash registers: ☐☐

Restaurant ID: ☐☐☐☐

- O Fast Food
- O Fast Casual
- O Sit Down
- O Specialty: _____
- O Other: _____

Site Visit Date ☐☐/☐☐/☐☐ (Month Day Year)

Start Time: ☐☐:☐☐ O AM O PM

End Time: ☐☐:☐☐ O AM O PM

Menu/Internet Review Date ☐☐/☐☐/☐☐ (Month Day Year)

Start Time: ☐☐:☐☐ O AM O PM

End Time: ☐☐:☐☐ O AM O PM

Other Visit/Interview Date ☐☐/☐☐/☐☐ (Month Day Year)

Start Time: ☐☐:☐☐ O AM O PM

End Time: ☐☐:☐☐ O AM O PM

Comments: _____

Nutrition Environment Measures Survey (NEMS)
Cover Page

5426

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
Measure #2: FRUIT

Store ID: ☐☐☐☐☐☐☐☐☐☐ Rater ID: ☐☐

Does this store sell any fresh fruit? Yes O No O Comments: _____

If yes, continue. If no, move on to the next measure.

Availability and Price

Produce Item		Available Yes	Available No	Price	#	Unit pc	Unit lb	Quality A	Quality UA	Comments
1. **Bananas**		O	O	$☐.☐☐	☐	O	O	O	O	_____
2. **Apples**	O Red delicious O _____	O	O	$☐.☐☐	☐	O	O	O	O	_____
3. **Oranges**	O Navel O _____	O	O	$☐.☐☐	☐	O	O	O	O	_____
4. **Grapes**	O Red seedless O _____	O	O	$☐.☐☐	☐	O	O	O	O	_____
5. **Cantaloupe**		O	O	$☐.☐☐	☐	O	O	O	O	_____
6. **Peaches**		O	O	$☐.☐☐	☐	O	O	O	O	_____
7. **Strawberries**		O	O	$☐.☐☐	☐	O	O	O	O	_____
8. **Honeydew Melon**		O	O	$☐.☐☐	☐	O	O	O	O	_____
9. **Watermelon**	O Seedless O _____	O	O	$☐.☐☐	☐	O	O	O	O	_____
10. **Pears**	O Anjou O _____	O	O	$☐.☐☐	☐	O	O	O	O	_____

11. **Total Types:** (Count # of yes responses) ☐☐

32528

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
Measure #3: VEGETABLES

Store ID: ☐☐☐☐☐☐☐☐☐☐ Rater ID: ☐☐

Does this store sell any fresh vegetables? Yes O No O Comments: _____

If yes, continue. If no, move on to the next measure.

Availability and Price

Produce Item		Available Yes	Available No	Price	#	Unit pc	Unit lb	Quality A	Quality UA	Comments
1. **Carrots**	O 1 lb bag O _____	O	O	$☐.☐☐	☐	O	O	O	O	_____
2. **Tomatoes**	O Loose O _____	O	O	$☐.☐☐	☐	O	O	O	O	_____
3. **Sweet Peppers**	O Green bell peppers O _____	O	O	$☐.☐☐	☐	O	O	O	O	_____
4. **Broccoli**	O Bunch O _____	O	O	$☐.☐☐	☐	O	O	O	O	_____
5. **Lettuce**	O Green leaf O _____	O	O	$☐.☐☐	☐	O	O	O	O	_____
6. **Corn**		O	O	$☐.☐☐	☐	O	O	O	O	_____
7. **Celery**		O	O	$☐.☐☐	☐	O	O	O	O	_____
8. **Cucumbers**	O Regular O _____	O	O	$☐.☐☐	☐	O	O	O	O	_____
9. **Cabbage**	O Head - Green O _____	O	O	$☐.☐☐	☐	O	O	O	O	_____
10. **Cauliflower**		O	O	$☐.☐☐	☐	O	O	O	O	_____

11. **Total Types:** (Count # of yes responses) ☐☐

38744

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #4: GROUND BEEF

Store ID: ☐☐☐☐☐☐☐☐☐☐

Rater ID: ☐☐

Does this store sell any beef? Yes ○ No ○ Comments: _____

If yes, continue. If no, move on to the next measure.

Availability and Price

Item	Available Yes	No	N/A	Price/lb.	Comments
Healthier option:					
1. Lean ground beef, **90% lean, 10% fat** (Ground Sirloin)	○	○		$☐.☐☐	
Alternate Items:					
2. Lean ground beef, (<10% fat) ☐☐ **% fat**	○	○	○	$☐.☐☐	
3. Ground Turkey, (≤10% fat) ☐☐ **% fat**	○	○	○	$☐.☐☐	

4. # of varieties of lean ground beef (≤10% fat) ○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6+

Regular option:					
5. Standard ground beef, **80% lean, 20% fat** (Ground Chuck)	○	○		$☐.☐☐	
Alternate Item:					**Comments**
6. Standard alternate ground beef, if above is not available ☐☐ **% fat**	○	○	○	$☐.☐☐	

26746

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #5: HOT DOG

Store ID: ☐☐☐☐☐☐☐☐☐☐ Rater ID: ☐☐

Does this store sell any hot dogs? Yes ○ No ○ Comments: _____

If yes, continue. If no, move on to the next measure.

Availability and Price

Item	Available Yes	No	N/A	Price/pkg.	Comments
Healthier option:					
1. Oscar Mayer 98% Fat-free Wieners (turkey/beef) ≤1g fat	○	○		$☐.☐☐	
Alternate Item: (≤ 9g fat)					
2. Other:Brand name and type *e.g., Ball Park Fat Free Beef Franks*	○	○	○	$☐.☐☐	☐☐ oz pkg ☐☐ Hot dogs/pkg ☐☐ g fat ☐☐☐ kcal/svg
Regular option:					
7. Oscar Mayer Wieners (turkey/pork/chicken)-regular 12g fat	○	○		$☐.☐☐	
Alternate Item: (> 9g fat)					
9. Other: Brand name and type *e.g., Ball Park Beef Franks*	○	○	○	$☐.☐☐	☐☐ oz pkg ☐☐ Hot dogs/pkg ☐☐ g fat ☐☐☐ kcal/svg

17407

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #6: FROZEN DINNERS

Store ID: ______ Rater ID: ☐☐

Does this store sell any frozen dinners? Yes O No O Comments: ______

If yes, continue. If no, move on to the next measure.

A. Reference Brand

1. Stouffer's brand (preferred) O Yes O No

2. Alternate brand (with reduced-fat dinners available) Brand Name: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Comments: ______

B. Availability

1. Are reduced-fat frozen dinners available? (≤9g fat/8-11 oz.) O Yes O No ______

Shelf space:(measure only if reduced-fat frozen dinners are available)

2. Reduced-fat dinners/regular dinners: Proportion O < = 10% O 11-33% O 34-50% O 51%+

C. Pricing (All items must be same brand)

Reduced-Fat Dinner	Price/ Pkg	Regular Dinner	Price/ Pkg	Comments
1. Lean Cuisine **Lasagna** ☐☐ oz.	$☐☐.☐☐	Stouffer's **Lasagna** ☐☐ oz.	$☐☐.☐☐	______
2. Lean Cuisine **Roasted Turkey Breast** ☐☐ oz.	$☐☐.☐☐	Stouffer's **Roasted Turkey Breast** ☐☐ oz.	$☐☐.☐☐	______
3. Lean Cuisine **Meatloaf** ☐☐ oz.	$☐☐.☐☐	Stouffer's **Meatloaf** ☐☐ oz.	$☐☐.☐☐	______

Reduced-Fat Alternate (≤ 9g fat)	Price/ Pkg	Regular Alternate (≥ 10g fat)	Price/ Pkg	Comments
4. Other ______ ☐☐ oz. ☐☐☐Kcal. ☐☐ g fat	$☐☐.☐☐	Other ______ ☐☐ oz. ☐☐☐Kcal. ☐☐ g fat	$☐☐.☐☐	______
5. Other ______ ☐☐ oz. ☐☐☐Kcal. ☐☐ g fat	$☐☐.☐☐	Other ______ ☐☐ oz. ☐☐☐Kcal. ☐☐ g fat	$☐☐.☐☐	______
6. Other ______ ☐☐ oz. ☐☐☐Kcal. ☐☐ g fat	$☐☐.☐☐	Other ______ ☐☐ oz. ☐☐☐Kcal. ☐☐ g fat	$☐☐.☐☐	______

29844

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #7: BAKED GOODS

Rater ID: ☐☐

Date: ☐☐ / ☐☐ / ☐☐
Month Day Year

Store ID: ☐☐☐☐

Does this store sell baked goods? Yes ○ No ○ Comments: _____

If yes, continue. If no, move on to the next measure.

Availability & Price

Low-fat baked goods ≤3g fat/serving

Item	Available Yes	Available No	Amt. per package	g fat/ per item	kcal/ per item	Price	Comments
Healthier option:							
1. Bagel Single	○	○		☐☐	☐☐☐	$☐.☐☐	
	Yes	**No**	**N/A**				
Package	○	○	○	☐☐	☐☐	☐☐☐	$☐.☐☐
Alternate Items:	**Yes**	**No**	**N/A**				
2. English muffin	○	○	○	☐☐	☐☐	☐☐☐	$☐.☐☐
3 a. Low-fat muffin ☐☐☐☐☐☐☐☐☐☐	○	○	○	☐☐	☐☐	☐☐☐	$☐.☐☐
b. # varieties of low fat muffins ○ 0 ○ 1 ○ 2 ○ 3+							
Regular option (≥ 4g fat/serving or 400 Kcal/serving):							
4. Regular muffin	○	○		☐☐	☐☐	☐☐☐	$☐.☐☐
Alternate Items:	**Yes**	**No**	**N/A**				
5. Regular Danish	○	○	○	☐☐	☐☐	☐☐☐	$☐.☐☐
6. Other	○	○	○	☐☐	☐☐	☐☐☐	$☐.☐☐

54166

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #8-GS: BEVERAGE

Store ID: ☐☐☐☐☐☐☐☐☐☐

Rater ID: ☐☐

Does this store sell any beverages? Yes O No O Comments: _____

If yes, continue. If no, move on to the next measure.

Availability & Price

Healthier option:	Available size	Available Yes	No	Price	Comments
1. Diet Coke	12 pack 12 oz.	O	O	$☐.☐☐	_____
Alternate Item: _____	O 12 pack 12 oz. O 6 pack 12 oz.	Yes O	No O N/A O	$☐.☐☐	_____

Regular option:		Yes	No		
3. Coke	12 pack 12 oz.	O	O	$☐.☐☐	_____
Alternate Item: _____	O 12 pack 12 oz. O 6 pack 12 oz.	Yes O	No O N/A O	$☐.☐☐	_____

Healthier option:	Yes	No		
5. Minute Maid 100% juice, (64 oz., half gallon)	O	O	$☐.☐☐	_____

Alternate Items:	Yes	No	N/A		
6. Tropicana 100% juice, (64 oz., half gallon)	O	O	O	$☐.☐☐	_____
7. Other: _____	O	O	O	$☐.☐☐	_____

Regular option:	Yes	No		
8. Minute Maid juice drink, (64 oz., half gallon)	O	O	$☐.☐☐	_____

Alternate Items:	Yes	No	N/A		
9. Tropicana juice drink, (64 oz., half gallon)	O	O	O	$☐.☐☐	_____
10. Other: _____	O	O	O	$☐.☐☐	_____

362

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #9: BREAD

Store ID: _____ Rater ID: ☐☐

Does this store sell any bread? Yes ○ No ○ Comments: _____

If yes, continue. If no, move on to the next measure.

Availability & Price

Item	Available Yes	No	N/A	Loaf size (ounces)	Price/loaf	Comments
Healthier Option: Whole grain bread (100% whole wheat bread and whole grain bread)						
1. Nature's Own 100% Whole Wheat Bread	○	○		☐☐	$☐.☐☐	
Alternate Items:						
2. Sara Lee Classic 100% Whole Wheat Bread	○	○	○	☐☐	$☐.☐☐	
3. Other: _____	○	○	○	☐☐	$☐.☐☐	

4. # of varieties of 100% whole wheat bread and whole grain (all brands) ○0 ○1 ○2 ○3 ○4 ○5 ○6+

Regular Option: White bread (Bread made with refined flour)						
5. Nature's Own Butter Bread	○	○		☐☐	$☐.☐☐	
Alternate Items:						
6. Sara Lee Classic White Bread	○	○	○	☐☐	$☐.☐☐	
7. Other: _____	○	○	○	☐☐	$☐.☐☐	

54990

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #10: CHIPS

Store ID: ____________ Rater ID: ☐☐

Does this store sell chips? Yes O No O Comments: ____________

If yes, continue. If no, move on to the next measure.

Availability & Price

Low-fat chips ≤3g fat/1 oz. serving

Item	Size	Available	Price	Comments
Healthier Option :		Yes No		
1. Baked Lays Potato Chips	☐☐ oz.	O O	$☐.☐☐	____________
Alternate Item:		Yes No N/A		
2. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐	☐☐ oz.	O O O	$☐.☐☐	____________

3. # of varieties of low-fat chips (any brand) O 0 O 1 O 2 O 3 O 4 O 5 O 6+

Regular Option (select most comparable size to healthier option available):

Item	Size	Available	Price	Comments
		Yes No		
4. Lays Potato Chips Classic	☐☐ oz.	O O	$☐.☐☐	____________
Alternate Item:		Yes No N/A		
5. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐	☐☐ oz.	O O O	$☐.☐☐	____________

51552

Measure Complete ☐

Nutrition Environment Measures Survey (NEMS)
MEASURE #11: CEREAL

Store ID: ☐☐☐☐☐☐☐☐☐☐ Rater ID: ☐☐

Does this store sell any cereal? Yes ○ No ○ Comments: _____

If yes, continue. If no, move on to the next measure.

Availability & Price

Healthier cereals < 7 g sugar per serving

Item	Available Yes	No	N/A	Size (ounces)	Price	Comments
Healthier Option :						
1. Cheerios (Plain)	○	○		☐☐	$☐.☐☐	_____
Alternate Item:	**Yes**	**No**	**N/A**			
2. Other _____	○	○	○	☐☐	$☐.☐☐	_____
3. # of varieties of healthier cereals	○ 0	○ 1	○ 2	○ 3+		
Regular Option (>7g of sugar per serving):						
4. Cheerios (Flavored) _____	○	○		☐☐	$☐.☐☐	_____
Alternate Item:	**Yes**	**No**	**N/A**			
5. Other _____	○	○	○	☐☐	$☐.☐☐	_____

33595

Appendix B: Rationale for Store Measures Criteria

NEMS
Rationale for Store Measures Criteria

Listed below is an explanation as to the rationale for each of the measures on the stores survey.

Topic	Basis for Criteria
Milk	FDA criterion of ≤ 3 gm fat/serving was used in distinguishing the healthier option (non-fat or 1% milk) *Source: US Food and Drug Administration, A Food Labeling Guide, Appendix A, http://vm.cfsan.fda.gov/~dms/flg-6a.html, accessed November 2004.*
Fruits and Vegetables	In order to determine the top selling types of fruits and vegetables in the US, we consulted: *Sources:* • *Produce for Better Health Foundation, "Top 20" list, based on results from 2000 A.C. Nielson Survey* • *FoodReview, Vol. 25, Issue 3, published by Economic Research Service, USDA* We eliminated potatoes from the vegetable list to be consistent with the 5-A-Day guidelines and most nutrition epidemiological research and because of their caloric density relative to other vegetables.
Ground Beef	Standard ground beef available in supermarkets today, although slightly leaner than 20 years ago, is typically 80% lean/20% fat by weight. Pan-broiled, a 3-oz. patty contains 209 calories, 14 g fat (60% of calories from fat), 5 g saturated fat. USDA reported that in 2001, ground beef comprised 43% of total beef intake and placed per capita consumption at 29 lbs. per year per person. This would translate to 2000 calories and 134 g fat per week, on average, for those who choose standard ground beef. Health experts recommend that people choose lean beef. While leaner varieties of ground beef are becoming more popular, they are more costly than those with higher fat content and may not be readily available to some consumers. *Sources:* • *Ground Beef Nutrient Comparisons, USDA, Agricultural Research Service, 2002. USDA Nutrient Database for Standard Reference, Release 15. Available at http://www.beef.org/documents/Grd%20Beef%20Comps_18-211%20for%20bn.pdf, accessed December 2004.* • *Average Annual Per Capita Consumption of Beef Parts and Ground Beef, 1980-2001, www.beef.org/documents/NCBA_STATS_May2004.XLS* • *Using the Dietary Guidelines for Americans, USDA Center for Nutrition Policy and Promotion.*

	We chose the healthier option as 90% lean/10% fat, because it contains half the fat of regular ground beef 80% lean/20% fat. Leaner options (<10% fat) are not readily available, even in supermarkets (although we agree they would be healthier choices); therefore, comparing the availability of these two options (10% vs. 20% fat) should distinguish one food outlet from another. *Sources:* • *Ground Beef Nutrient Comparisons, USDA, Agricultural Research Service, 2002. USDA Nutrient Database for Standard Reference, Release 15* • *Georgia Beef Board*
Frozen Dinners	We chose Stouffer's as the reference food, because the company sells both regular and low-fat dinners. We chose very common varieties, e.g., roasted turkey breast, that had regular and low-fat options. *Sources:* • *Robert Earl, Senior Director, Nutrition Policy, National Food Processors Association, Washington DC, 20005* • *Stouffer's, www.stouffers.com and www.leancuisine.com*

Beverages	We are comparing the availability and relative cost of diet vs. sugared soft drinks, and 100% juice vs. juice drinks. *Source: Dietary Guidelines for Americans, USDA Center for Nutrition Policy and Promotion (Limit your intake of beverages… high in added sugars.)*
Whole Grain Bread	Although there may be other breads that could be considered "whole grain", we limited our recording to "100% whole wheat bread" for ease and accuracy of data collection. *Source: Dietary Guidelines for Americans, USDA Center for Nutrition Policy and Promotion (Include several servings of whole grain foods daily—such as whole wheat...)*

Appendix C: Community Level Food-Venue Notation

Venues		Name		Address/coordinates					Category			
#									Grocery Store		General Merthandiser	
									Fast-Food		Convenience	
									Health Food/Nutrition		Food Stand/Cart	
									Butcher		Food Truck	
									Bakery		Farmers Market	
	Notes:								Sit-down Restaurant		Bar	
									Discount Retailer		Casino/Hotel	
									Dollar Store		Brothel	
									Mass Merchandiser		Other/Misc	
									Mass Merchandiser (club)			
#									Grocery Store		General Merthandiser	
									Fast-Food		Convenience	
									Health Food/Nutrition		Food Stand/Cart	
									Butcher		Food Truck	
									Bakery		Farmers Market	
	Notes:								Sit-down Restaurant		Bar	
									Discount Retailer		Casino/Hotel	
									Dollar Store		Brothel	
									Mass Merchandiser		Other/Misc	
									Mass Merchandiser (club)			
#									Grocery Store		General Merthandiser	
									Fast-Food		Convenience	
									Health Food/Nutrition		Food Stand/Cart	
									Butcher		Food Truck	
									Bakery		Farmers Market	
	Notes:								Sit-down Restaurant		Bar	
									Discount Retailer		Casino/Hotel	
									Dollar Store		Brothel	
									Mass Merchandiser		Other/Misc	
									Mass Merchandiser (club)			

Appendix D: NEMS-Scoring Sheet

NEMS Scoring Sheet for Stores

Store:

Item	Availability of Healthier Item	Avail Total Points	Price	Price Total Points	Quality	Quality Total Points
Milk	YES low-fat/skim = 2 pts Proportion (lowest-fat to whole) ≥ 50% = 1 pt		Lower for lowest-fat = 2 pts Same for both = 1 pt Higher for low-fat = -1 pt			
Fruits	0 varieties = 0 pts < 5 varieties = 1 pt 5-9 varieties = 2 pts 10 varieties = 3 pts				25-49% acceptable = 1 pt 50-74% acceptable = 2 pts 75%+ acceptable = 3 pts	
Vegetables	0 varieties = 0 pts < 5 varieties = 1 pt 5-9 varieties = 2 pts 10 varieties = 3 pts				25-49% acceptable = 1 pt 50-74% acceptable = 2 pts 75%+ acceptable = 3 pts	
Ground Beef	YES lean meat = 2 pts 2-3 varieties ≤ 10% fat = 1 pt > 3 varieties ≤ 10% fat = 2 pts		Lower for lean meat = 2 pts Higher for lean meat = -1 pt			
Hot dogs	YES fat-free = 2 pts Light, not fat-free = 1pt		Lower for fat-free or light = 2 pts Higher for fat-free or light = -1 pt			
Frozen dinners	YES all 3 reduced-fat types = 3 pts YES 1 or 2 reduced-fat types = 2 pts		*Lower for reduced-fat = 2 pts Higher for reduced-fat = -1 pt			
Baked goods	YES low-fat items = 2 pts		Lower for low-fat (per piece) = 2 pts Higher for low-fat (per piece) = -1 pt			
Beverages	YES diet soda = 1 pt YES 100% juice = 1 pt		Lower for diet soda = 2 pts Higher for 100% juice = -1 pt			
Bread	YES whole grain bread = 2 pts >2 varieties whole wheat bread = 1 pt		Lower for whole wheat = 2 pts Higher for whole wheat = -1 pt			
Baked chips	YES baked chips = 2 pts > 2 varieties baked chips = 1 pt		**Lower for baked chips = 2 pts Higher for baked chips = -1 pt			
Cereal	YES healthier cereal = 2 pts		**Lower for healthier cereal = 2 pts Higher for healthier cereal=-1 pt			
	Availability Subtotal=		**Price Subtotal=**		**Quality Subtotal=**	
				Total NEMS Store Score =		

Ranges- Availability Subtotal: 0 to 30 **Price Subtotal**: -9 to 18 **Quality Subtotal**: 0 to 6
TOTAL NEMS SCORE RANGE: -9 to 54

* Based on majority of frozen food items
**Per box or bag, not price per ounce

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Curriculum Vitae

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Education

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Masters of Health Education 2005-2007	School of Public Health, University of Nevada Las Vegas
Baccalaureate of Science 2002-2005	Department of Sports Education Leadership, Physical Education, University of Nevada Las Vegas.
Associate of General Education 1998-2000	Community College of Southern Nevada, Las Vegas, NV

RESEARCH EXPERIENCE

Master's Thesis

Nickelson, J.R. Food access in Las Vegas, NV: Distance to Supermarkets Based on Census Tract Median Household Income, an Analysis. Las Vegas, NV, 2007.

Research Assistant, Assistant Journal Editor. 06/06 to 07/07

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Data collection and entry on scholarly projects, author correspondence, data entry, maintained author database, lead investigator on an environmental analysis of Las Vegas fast-food and grocery prevalence.

MEMBERSHIP IN SOCIETIES

- North American Association for the Study of Obesity
- American School Health Association
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MEETINGS/CONFERENCES ATTENDED

- North American Association for the Study of Obesity, 2004, 2005, 2010
- American School Health Association, Burbank, CA 2005
- Society for Public Health Education, Las Vegas, NV 2006
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