UNIVERSITY OF CALIFORNIA, SAN DIEGO

SAN DIEGO STATE UNIVERSITY

Macro, meso and cultural exchange level of influence on obesity among Mexican immigrants and Mexican-Americans living on the US-Mexico border in Southern California.

A dissertation submitted in partial satisfaction of the requirements for the degree of Doctor of Philosophy

in

Public Health (Health Behavior)

by

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2010

The Dissertation of Barbara Ines Baquero is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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2010

DEDICATION

To my grandparents Manuel, Amalia and Elsa from whom I learned the values of faith, work ethics, respect and perseverance, their love and support has motivated and fueled my desire to achieve this dream.

To Jason for his love, support and encouragement, we shared this achievement together.

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ACKNOWLEDGEMENTS

I would like to first acknowledge my mentor and advisor, Dr. Guadalupe ‘Suchi’ Ayala. She is and will be a role model to me for her passion, commitment and dedication to public health and science. I am thankful to her for opening the doors and windows of the challenging and exciting world of public health.

I want to thank my dissertation committee for their support and guidance through my doctoral training and dissertation work.

I want to thank the San Diego Prevention Research Center for providing the support to obtain the funding and complete this dissertation; their commitment to the Latino Community in South San Diego County is contagious and admirable.

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Baquero, B., Ayala, G.X., Elder, J.P., Arredondo, E.M., Campbell, N.R., Slymen, D.J., Gallo, L. (2009). *Secretos de la Buena Vida*: processes of dietary change via a tailored nutrition communication intervention for Latinas. *Health Education Research*. 24 (5) 855-866. doi:10.1093/her/cyp022. (Advance access published online on April 1, 2009)

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FIELD OF STUDY

Major Field: Public Health/Health Behavior

ABSTRACT OF THE DISSERTATION

Macro, meso and cultural exchange level of influence on obesity among Mexican immigrants and Mexican-Americans living on the US-Mexico border in Southern California.

by

Barbara Ines Baquero

Doctor of Philosophy in Public Health (Health Behavior)

University of California, San Diego, 2010

San Diego State University, 2010

Professor Guadalupe X. Ayala, Chair

The Latino population is now the largest minority group in the United States (US). The higher prevalence of obesity among Mexican immigrants and Mexican-Americans (MI-MA) living in the US compared with Non-Hispanic

Whites has been linked to socio-demographic and behavioral factors. There is emerging evidence that suggests features of the social environment and neighborhood socio-economic characteristics may have an influence on Latinos' obesity rates.

This study was guided by the social-ecological model and used multilevel analytic methods to examine macro, meso and cultural exchange level factors associated with obesity among MI-MA living in the border region of San Diego, CA. Data were collected as part of the San Diego Prevention Research Center Community Survey. Multistage sampling methods were used to recruit participants into the study. Multilevel models were conducted to examine the association of these factors at multiple social-ecological levels on obesity.

Three hundred and ninety seven people completed the survey. The mean age of respondents was 43.4±16.9, 72.6% were females and 77% were born in Mexico. Respondents scored high in the Hispanic domain of acculturation and crossed the border about three times per month mostly to visit family and friends in Mexico. Collective efficacy was an average of 3.5 (range 1 to 5). Respondents reported having 4 (0-5) people in their social network with an average reciprocity of 15 times per month. Neighborhoods where respondents live were on average 68% Latino with 27% of home ownership. Almost forty seven percent of respondents were obese. After controlling for micro-level characteristics, health behaviors and neighborhood clustering, the final model suggested that respondents who were employed, with an income below the poverty threshold were less likely to be obese. Middle-aged respondents with larger social

networks were more likely to be obese. Two cross-level interactions were significantly associated with obesity. Times crossing the border to Mexico in the last month moderated the effect of collective efficacy on obesity. Neighborhood percentage of home ownership moderated the association between Hispanic domain and obesity.

The study provided evidence that the meso, macro and cultural exchange level factors are associated with obesity among MI-MA living in this border region. This study provides the foundation to further investigate the influence of higher social-ecological level determinants of health among MI-MA living in this unique place of influence, the Southern California, US-Mexico border.

I. INTRODUCTION

The Latino population is now the largest racially/ethnically diverse group in the US [1], and their numbers are projected to grow three-fold by 2050. Latinos undergo changes as a result of the immigration process and differences in the social and socio-economic environments between their country of origin and the US [2,3]. Among the challenges faced by Latinos settling in the US are significant disparities in socio-economic status and levels of educational attainment, as well as language barriers [3,4]. Depending on the region in the US in which Latinos settle, additional social and economic challenges might arise [4]. They may find themselves competing with many other Latinos for the same jobs and services, or they may find themselves isolated because Latinos communities are non-existing in their new place of residence [2,5]. However, settling in regions with a high concentration of Latinos and new immigrants may facilitate the expansion of the social network needed to face some of these challenges. In an effort to adapt to the new setting, Latinos may become acculturated, assuming the behaviors and social practices of the dominant culture [4,6,7]. Partially for these reasons, they are at higher risk for developing obesity and chronic diseases due to changes in diet, activity, community support, working conditions, and quality of well being [2,4,8-10]. Indeed, there is evidence that changes in social and behavioral factors are impacting the incidence of obesity and chronic diseases [11-13].

In this context, neighborhoods have been shown to have an influence on residents' health outcomes [14-19]. In recent years, the focus has turned to the social attributes of the environment and more specifically the social

characteristics of neighborhoods and their relationship to health outcomes [20-24]. There is evidence to suggest that neighborhood social processes, such as social capital and collective efficacy are associated with the risk for obesity among racial/ethnic groups [16,25]. The evidence suggests that higher social capital is associated with significantly lower odds of obesity [26]. Collective efficacy has been associated with a lower likelihood of obesity [27].

In addition, recent studies indicate that neighborhood socio-economics may modify the association of social neighborhood characteristics and health outcomes [28,29]. Neighborhood racial/ethnic concentration is one of the variables used to examine macro-level influence on health. Residential concentration has been associated with lower all-cause mortality [30] and higher BMI [31].

For individuals who live in border communities such as San Diego, CA, the contextual influences of their neighborhoods and the proximity to the border may be associated with their health outcomes. The U.S.-Mexico border is one of the busiest and most interdependent borders in the world [32]. Border communities are economically, environmentally, socially and epidemiologically connected. The Pan American Health Organization (PAHO) reported that the health profile of Mexicans living in the border region with the U.S. is more positive than Mexican residents in the rest of the country. But the opposite is true on the U.S side, where health indicators are worse for border city residents than in the rest of the U.S. [32]. Four of the seven poorest cities in the U.S. are located along the border. Obesity and diabetes are serious chronic diseases affecting residents living in border communities [32]. The interactions of neighborhoods and individual

characteristics within the context of a border region merit study to better understand how their synergistic relationships are associated with residents' health.

Research on the influences of health behaviors recognizes that individual behavior is often a function of the larger context of the individual's life. The social-ecological approach proposes that individual health behaviors are, in part, a result of multiple environmental levels, and that these environments can create a health-promoting climate in which people make health-related decisions [33,34]. Only in healthful environments, where individuals are motivated, educated and can apply individual strategies, can behavioral change be expected [35]. The Social-Ecological Model (SEM)[34-36] postulates levels that may influence behaviors and are associated with health outcomes. These levels range from the macro level (cultural, societal), to the meso level (work, neighborhoods) and to the micro level (family, peers, individuals) [34-36]. Using this conceptual and analytic approach, the present study merged theory, evidence and contextual characteristics of the neighborhoods to better understand the obesity epidemic among Mexican Americans and Mexican immigrants living in San Diego, CA. The findings of this study may elucidate modifiable factors for the prevention of obesity and chronic disease among this racial/ethnic group.

AIM OF THE STUDY

This study used multilevel analytic methods to examine the intersection of macro and meso level influences that may be associated with obesity in MI-MA living on the US-Mexico border in Southern California given the hypothesized cultural exchange that occurs in this region.

Objectives

Objective 1: To determine the independent associations between meso and macro levels of influence and cultural exchange factors on obesity.

Objective 2: To examine the extent to which variables measuring the social capital construct and cultural exchange level of influence are associated with each other.

Objective 3: To determine the proportion of variance in obesity that is explained by macro- and meso-level influences and whether these associations are moderated by cultural exchange factors.

II. BACKGROUND AND SIGNIFICANCE

Latino Profile

The latest estimates from the 2008 Census Bureau indicate that there are almost 47 million Latinos in the US [37]. Immigration and high fertility rates account for much of the growth in this population. One third of Latinos living in the US are foreign born, and more than one third of these immigrants are of Mexican origin. Mexican immigrants and Mexican Americans (MI-MA) represent the largest segment of this racial/ethnic group. In California, Latinos represent 36.2% of the population and in San Diego County they make up 25% of the total population, with MI-MA comprising almost 88% of the 882,287 Latinos in the county [2,37]. Socio-economically, Latinos are positioned significantly lower than Whites [2]. Estimates from the American Community Survey (ACS) 2007 indicated that 20.7% of Latinos live below the poverty line compared with 10.2% of Whites. The mean household income for all households in the US in 2007 was $50,740 compared with $40,766 for Latinos. As for occupations, 74% of Latinos held high risk/low–social position occupations compared to 48% of Whites [37].

Compared to other Latino subgroups in the US, MI-MA are mostly young (95.6% under 65 years of age), more than half are married (52.3% compared to 49.8% for all other Latino subgroups), and 42.2% have a household size of 4 or more people, compared to 48% of all other Latino subgroups. Forty four percent worked in service and construction positions compared to 42% of all Latinos. MI-MA have the lowest educational attainment of any Latino subgroup with 43%

compared to 65% for Cubans and 61% for Puerto Ricans [5]. However, when it comes to household income and poverty, MI-MA are faring better than Latinos in the US as a whole. Almost 51% of MI-MA families reported in the ACS 2007, earning an income between $25,000 to $75,000 per year compared to 48.8% of all Latinos [2,37].

The latest release of obesity trends from the National Center of Health Statistics (NCHS)[38] indicate that 67% of the US population is overweight or obese, and almost 50% of Latinos are reported to be overweight or obese [39]. Fifty one percent of Mexican American (MA) women (40-59 years of age) were obese compared with about 39% of Non-Hispanic White women. Latinos in California have the highest rates of obesity in the state; almost 7 of every 10 Latinos in California are overweight or obese [40]. In a study using national data, it was found that BMI has increased by 1.3 units among men and 1.8 units among women in the last decade. NHANES 1999-2004 data demonstrated a linear increase of BMI across time with respect to age. In particular, a shift in BMI in upper percentiles was observed in all races, ethnicities and genders except for Mexican Americans and women of 'other ethnicity'. Among MA men, BMI seemed to shift over time in equal amounts across all percentiles and faster in the 90th percentile. For MA women, BMI percentile >60th appear to decline up to at least the 90th percentile. By 2020, the prevalence of obesity and central obesity (hip-to-waist ratio) is projected to be highest among Non-Hispanic White men and MA men. For women, the prevalence of obesity and central obesity will

be highest in Non-Hispanic Blacks and the rates of increase slowest among MA women [41].

Latinos suffer disproportionately from diabetes, cardiovascular diseases (CVD) and other chronic diseases compared to Non-White Latinos [29,42,43], due in part, to obesity [42,44]. In addition, obesity has been linked to decreased longevity, quality of life and economic productivity [45,46]. The high prevalence rates of obesity in this population pose a serious risk of chronic diseases [2]. In 2006, Latinos were two times more likely than non-Hispanic Whites to be diagnosed by a physician with diabetes [21]. Almost 13% of Latinos over 20 years old have been diagnosed with diabetes compared with 6.4% of Non-Hispanic Whites; 15.6% of MI-MA have diabetes. In a recent literature review, Seeman and colleagues examined the biological risk profile by race, ethnicity and nativity to assess the health outcomes of Latinos in the context of the Latino Health Paradox. Using data from NHANES 1999-2002, foreign-born Latinos were compared to US-born Whites, and risk factor scores were composed using several biological indicators: blood pressure, metabolic risk and inflammatory risk factors. Categories of high and low risk factors were created. After controlling for SES, there were no significant differences in biological risk factors at high-risk levels between foreign-born and US-born Latinos. In addition, Latinos had the lowest SES and displayed higher biological risk factor scores compared to Whites. However, Mexican immigrants (MI) had similar biological risk factor scores compared to Whites [22]. In another study, Cunningham and colleagues, summarized the evidence

comparing immigrants with non-immigrant groups on certain morbidity rates. Studies from 1980 to 2007 were included. Among their results, the study found that Latino immigrants have lower BMI compared with US-born Latinos and similar evidence was found for heart and circulatory disease. Diabetes was different; it was the most prevalent disease among immigrant Latinos. These data suggest the vulnerability of the Latino population in the US, and in particular of MI-MA. Previous evidence indicated that US Latinos are at higher risk for obesity and chronic diseases. The factors related to the prevalence and consequences of obesity are numerous, and connected at multiple levels of influence [47].

Health Behaviors Related to Obesity

Poor diet and physical inactivity are linked to obesity [24]. These two health behaviors combined with smoking accounted for one third of all deaths in the U.S. in 2000 [48,49,11]. Current evidence of obesity related health behaviors such as poor diet and inactivity among Latinos are presented here.

Dietary Patterns

An important dietary behavior strongly related to obesity is fast food consumption [50-53]. The frequency of eating away from home and in particular eating fast food meals has increased dramatically in the last decade. Between 1999 and 2000, 25% of adults in the US reported eating fast food daily. Purchases of fast food continue to increase. In 2007, 37.4% of meals eaten at

home were purchase in a fast food restaurant [54-57]. Diets dependent on away-from-home foods and fast foods are higher in fat, lower in fiber content, higher in energy density and larger portions than meals prepared at home [56-58]. In a study that examined diet quality and fast food consumption, Moore and colleagues determined that those individuals who ate fast food one or more times per week were 2 to 3 times more likely to have an unhealthy diet, measured by the Alternative Healthy Eating Index (AHEI) and after controlling for SES, gender and race/ethnicity [51]. This finding is relevant because it suggests that the frequency of fast food consumption can be a proxy for diet quality, which itself is a correlate of BMI and obesity [51,57,59,60]. Two other studies conducted with Latinos in Southern California examining the influence of eating away from home found that families who ate at fast food outlets one or more times per week were 2 times more likely to be overweight compared to those who ate less than once per week away from home [61,62].

Physical Activity

The Centers for Disease Control and Prevention (CDC) recommends that adults engage in at least 150 minutes of moderate physical activity or 75 minutes of vigorous physical activity every week, and practice muscle strengthening activities two or more days per week to achieve health benefits [63]. Individual physical activity levels are measured in a variety of ways: by whether the CDC's physical activity guidelines are met; average weekly minutes of moderate-to-vigorous physical activity (MVPA); total minutes of physical activity per week; or by physical activity type, i.e. leisure, transportation and work [64]. Estimates from

BRFSS 2005 indicated that 42.5% of Latinos and 42.3% of Latinas reported engaging in regular physical activity, defined by moderate intensity activity for 30 minutes per day 5 or more days per week or 20 minutes of vigorous intensity activity 3 or more days per week. Compared to 52.5% of White men, 42.5% of Latino men engaged in regular physical activity. Fewer Latinas (42.3%) reported engaging in regular physical activity compared to nearly half (49.8%) of white women [63]. The 2007 California BRFSS reported that 50.2% of state residents and 53.3% of San Diego County residents engaged in the recommended amounts of physical activity. According to the California Health Interview Survey, 35.1% of Latinos living in the San Diego South Region reported moderate to vigorous physical activity in the previous week compared with 29.5% of Whites [65]. Pichon and colleagues, using the International Physical Activity Questionnaire (IPAQ) among a sample of mostly MI-MA (77% of 526) women living in the border region of San Diego County, found that 30% reported vigorous levels of physical activity and that only 8.2% of the respondents reported moderate levels of physical activity. In that study, IPAQ defined vigorous physical activity as 3 or more days per week for at least 20 minutes per day, and moderate as 5 days per week for at least 30 minutes per day [66].

Current levels of physical activity and health dietary patterns among Latinos are troublesome. Given these prevalence rates and their association with obesity [60,67] the inclusion of these behaviors is necessary when examining obesity. These two behaviors are represented in the study as meeting physical activity guidelines and weekly of fast food consumption. Including these

behaviors in the study of obesity may elucidate additional modifiable factors for intervention.

US-Mexico Border Region

The US-Mexico border is one of the busiest and most interdependent borders in the world [68]. There are an average of one million legal northbound crossings every day, through this border [69]. Border communities are economically, environmentally, socially and epidemiologically connected [69]. The US-Mexico border is made up of 10 states, 48 US counties, 80 Mexican municipalities and 14 pairs of sister cities. One of those sister cities pairs is San Diego and Tijuana. The Pan American Health Organization (PAHO) reported that the health profile of Mexicans living in the Mexican part of the US-Mexico border region is more positive than Mexican residents in the rest of the country [70]. But the opposite is true on the U.S side, where health indicators are worse for border city residents than the rest of the US [70]. There is an immense cross-border interdependency between the two countries. Mexico is the third largest US trading partner, and the US is Mexico's number one trading partner. The total value of economic trade each day across the border region is $638 million US dollars. Despite the increased trade between the two countries after the North American Free Trade Agreement (NAFTA) was implemented in 1994, economic development in the border cities was uneven. Mexican border cities have low unemployment and higher wages, whereas on the US side the conditions are worse. In fact, four of the seven poorest cities in the US are located along the

US-Mexico border. According to the 2004 US-Mexico Health Initiative, California hosts over 4 million Mexican immigrants along its border. These border communities are mainly urban areas such as San Diego, and most residents (53%) live on the US side. If the population and migration trends continue, by 2020 there will be 20 million immigrants living in border cities. The population spanning both sides of the border not only shares the economic and social advantage of the area, but also shares the burden of the impact of diseases. Infectious diseases, environmental pollutants, air quality, and communicable diseases such as Tuberculosis are among some of the health hazards that residents of these communities are exposed to [68-70]. Obesity and diabetes are serious chronic diseases affecting residents living in the border communities, as well. The US-Mexico Border Diabetes Prevention and Control Project estimated that in 2002, 2.5 million people living in the border region were overweight or obese. It is imperative to study and understand how the influences of the economic and social conditions of these communities may affect residents' obesity rates [70].

Theoretical Foundations and Conceptual Framework

Research on influences of health behaviors recognizes that individual behaviors are often a function of the larger environment of an individual's life. This environment can have both facilitating and constraining influences on a person's own behavior. Most health behavior theories applied by researchers and practitioners recognize the interactional nature of the individual within his/her

environments. The social-ecological approach takes it one step further by proposing that individual health behaviors are, in part, a result of multiple environmental levels, and that these environments create a health climate in which people make health-related decisions [71]. According to this theoretical approach, behavior is not only the result of influences of the environment but also personal attributes, including genetic heritage, psychological processes and behavioral patterns [71]. There are four core principles that guide a social-ecological approach in the context of health behavior: 1) there are multiple levels of influence on health behaviors, represented by macrosystem, mesosystem and microsystem; 2) each of these levels interact to influence behaviors; 3) ecological models should be behavior-specific in order to identify the most relevant and modifiable correlates of influence; and 4) a multilevel framework is the most effective for explaining behavior and health outcomes. Only in healthful environments, where individuals are motivated, educated and can apply individual strategies, can behavior change be expected [35]. Encompassing these principles, several theoretical frameworks have been developed to explain and intervene on behaviors from a multilevel perspective. Bronfenbrenner [72], one of the most influential theorists in the field, proposed the Social-Ecological Model (SEM), which postulates that individual-level behavior is influenced by multiple systems. These systems include macrosystem (cultural, societal) and mesosystem (work, neighborhoods). Macrosystem (macro-level) refer to larger contexts that are not solely geographic and physical but also include characteristics of the social, economical, emotional and ideological contexts.

Macrosystem indicators are the result of the social and ideological policies implemented in the system. For example, population median income and neighborhood ethnic concentration are two indicators of the macrosystem. Mesosystem (meso-level) are those in which groups of people (e.g., co-workers, neighborhood) shape the individual's behavior and where interpersonal relationships happen. Group norms are formed at this level, and while individuals are active participants in this process, they are nonetheless influenced by these norms. Bronfenbrenner postulates that the richer and healthier this level is, the more influential it can be to the individual [35]. Social networks, collective efficacy and trust between members of this level are representative of meso-level characteristics.

Stokols [71], Evans and Stoddard [17,73,74], and recently Mansyur and colleagues [17,73,74] have proposed multilevel and multi-system theories to aid in explaining behaviors and to develop behavioral interventions. Based on an extensive review of the literature on neighborhood influences on obesity, Black and Macinko [17] proposed a general conceptual model using the social-ecological perspective to guide the study of obesity. Black and Macinko's model has been adapted for this study in order to make it specific to obesity and to MI-MA living on the US-Mexico border region in southern California.

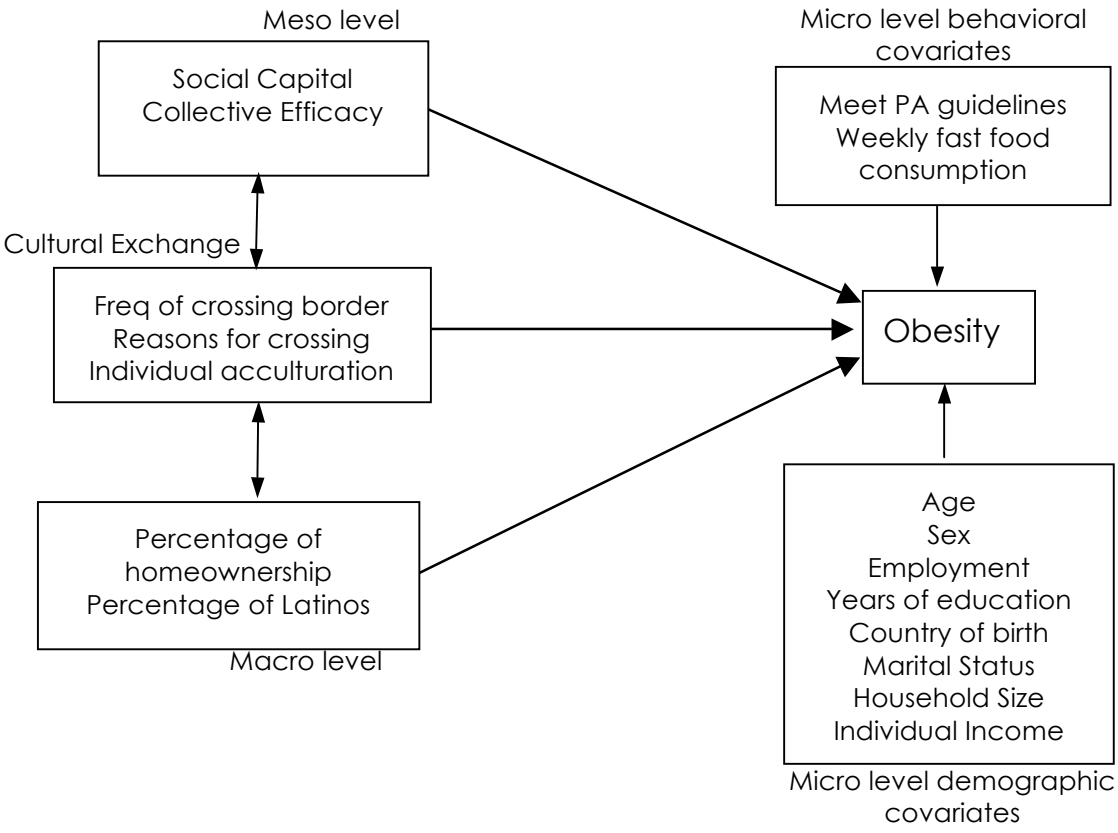

Figure 1.1: Conceptual model: Social-ecological model applied to the study of obesity among Mexican immigrants and Mexican Americans living on the US-Mexico Border region in Southern California.

This model represents factors at three levels of influence that the evidence suggests are important to the study of obesity. The model adds the cultural exchange level (frequency of crossing the border, reasons for crossing and acculturation), to capture the contextual and dynamic characteristics of individuals living in neighborhoods located in the US-Mexico border region of San Diego, CA. The model incorporates macro-level (percentage of home ownership and percentage of Latinos) and meso level factors (social capital and collective efficacy), controlling for micro level factors (age, gender, country of birth,

employment, years of education, marital status, household size, income) and behaviors (meeting physical activity guidelines and weekly of fast food consumption) as correlates of obesity. This model attempts to explore and describe how and to what extent macro, meso and cultural exchange levels of influence add to the understanding of obesity among MI-MA who live in neighborhoods on the US-Mexico border region in San Diego, CA.

The study captured the characteristics of living in neighborhoods in the US-Mexico, San Diego border region by assessing the macro-level and cultural exchange variables. Macro-level factors were considered at the neighborhood level to describe how larger, broader social and economic policies are expressed as socio-economic characteristics of the neighborhood and how they may affect resident's obesity. Macro-level factors are theoretically located the farthest away from the individual health outcome (obesity), but appear to have an effect on it. For example, neighborhood ethnic concentration (measured by proportion of Hispanics in the neighborhood) has been associated with BMI [75-77]. However, correlates from this level of influence have not been clearly established for MI-MA.

In closer proximity to the individual is the meso level, wherein the individual actively interacts with other members of the neighborhood. Meso-level factors are the result of the social interactions of individuals in the neighborhood. The number of social networks and civic organizations that an individual participates in are some of the social features studied at this level [78]. For example, the amount of trust in people that live in your neighborhood is one of

the variables used at this level of influence. Trust is a quality assigned by an individual to their neighborhood members and is associated with health outcomes [78].

The closest level influencing obesity is the micro-level, which incorporates individual characteristics and behaviors. In this study the micro level of influence (individual socio-demographics) were included in the model because of the established association of these correlates with obesity, and in order to truly assess macro-level and meso-level influences, micro-level (individual) characteristic must be controlled for. Behaviors were added to the model because there are directly related to obesity [60,67,79] and by controlling for them; the study can better estimate the effects of macro, meso and cultural exchange level associations with obesity.

This conceptual model attempted to identify higher socio-ecologic level correlates of obesity. Evidence suggests that place may have an influence on obesity through long-term processes that shape individual and social norms over time [17,28,80]. This study proposed a model applicable to MI-MA in a unique place of influence, the San Diego, CA border region with Mexico.

Review of the Literature

The following is a review of the literature on factors embedded within each system that are correlated with obesity. The review will focus on Latinos, and where available, specifically to MI-MA.

Macro-Level Correlates

In this study macro-level correlates are those describing neighborhood level characteristics. Neighborhood socio-economic indicators related to health outcomes and in particular to obesity are reviewed here. There are a few limitations to this evidence. The definition of what a neighborhood is varied across studies and is most often based on available data [81,82]. Also, a limited number of studies have examined Latinos and in particular MI-MA living in the border region and obesity at this level of influence. Most studies have concentrated on African American and White health disparities [83]. This review presents the limited available evidence on neighborhood (macro level) influence among Latinos and draws from other relevant evidence to discuss potential associations between macro level influences at the neighborhood level and obesity among MI-MA.

In examining neighborhood influence of health, studies must define what they consider a neighborhood. Administrative geographic boundaries, such as the one provided by the US Census Bureau are one of the most widely used methods to define neighborhoods [28,77,80]. This methodology is controversial because it may not adequately capture the true space where people live and interact and may underestimate the effect of neighborhood context [84]. Researchers argue that using these definitions is an artificial choice based on pragmatic reasons. Yet there is a growing body of evidence that supports neighborhoods' relevance to social determinants of health [85]. In the meantime, explicit rationale for the choice of neighborhood definition will help inform future

research [17]. Specific proxies of neighborhood boundaries will allow researchers to test potential conditions by which neighborhoods affect health outcomes [77].

Racial/ethnic neighborhood concentration is one of the correlates used to examine macro level influences on health. Residential concentration of racial/ethnic groups has been associated with higher heart disease mortality among African American women [86] and higher BMI among Mexican Americans [77.] Residential concentration of ethnic/racial neighborhood sorts individuals of comparable socio-economic characteristics into very different neighborhood environments [83]. This macro level process has an effect on health through a concentration of poverty, quality of the neighborhood environment and the individual socio-economic conditions of these ethnic/racial groups [83]. Segregation by ethnicity/race is less pronounced for Latinos compared to African Americans, Most of the literature on the effects of ethnic/racial concentration has focused on African Americans, looking primarily at mortality and physical health [80,81] suggesting that ethnic concentration is harmful to health [81]. Fewer studies however have found benefits of ethnic/racial neighborhood concentration. High concentration of African American in neighborhoods was associated with lower risk of heart disease mortality in Texas [87]; lower mortality in older African American residents in New York [88]; and low likelihood of low birth weight in Chicago [89]. Compared to White neighborhoods, residents in Black segregated neighborhoods were more likely to overweight [31]. Additional evidence suggests that other macro level correlates such as material deprivation, car ownership, and household tenure are associated with higher risk of obesity [90-92]. Robert and

Reither [84] found that community disadvantage, a combined score of the percentage of people receiving public assistance, the percentage of households with income greater than $30,000, and the percentage of adult employment, explained the difference in BMI between Blacks and Whites after controlling for individual-level SES [84]. Data was obtained from The American's Changing Lives study and the 1980 Census. For this study self-reported weight and height were obtained and BMI was calculated. Additional neighborhood level indicators were neighborhood income inequality and neighborhood black concentration. Neighborhood income inequality and black concentration were not associated with BMI. This was the first study that examined ethnic/racial disparities in obesity from a multilevel perspective. The study demonstrated BMI variance between ethnic groups is explained by both within and between neighborhood factors. However, it fell short of demonstrating consistent associations of neighborhood level indicators above and beyond individual level correlates. This study was important because it demonstrated the contribution of neighborhood level influence of obesity.

For US immigrant Latinos, the effect of ethnic/racial concentration may be beneficial. Recent immigrants chose to live in 'ethnic enclaves' to facilitate their adjustment into the new country and maintain their network [81,93,94]. For Latinos, this ethnic/racial concentration may not be a negative indicator of the neighborhood but rather an indicator of the community informal social resources [81]. However, few studies have empirically investigated this hypothesis. In a recent review of the literature that investigated the effect of residential

segregation on health, the authors found 39 articles available by September 2008, of those, only 3 studies included BMI as an outcome of interest and in only 5 studies were Hispanics included in the analysis. Studies that included Hispanics also included other ethnic/racial groups and investigated all-cause mortality, low birth weight and cancer [95]. This finding demonstrates the dearth of published literature that examines obesity among Latinos in the context of neighborhoods characteristics. The following is a review of the available evidence that examines Latinos' health outcomes, finalizing with studies that included Latinos and obesity.

Lee and Ferraro [81] studied neighborhood residential segregation and physical health among Mexican Americans. Residential segregation was measured as residential isolation index, which was defined as 'the extent to which minority members are exposed only to one another rather than the majority members'. Physical health, the outcome of the study, was defined as acute physical symptoms and disability. Data for this study came from the Midlife Development in the United States survey of minority groups. Mexican Americans were interviewed in Chicago. Neighborhood level data were obtained from 1990 Census summary file 3. A multilevel analysis was conducted to accommodate the hierarchical nature of the data. Results indicated a cross level interaction between their measure of ethnic/racial segregation and second generation Mexican Americans. Second generation Mexican Americans who lived in highly segregated neighborhoods were less likely to report acute physical symptoms than first generation Mexican Americans. Similar results were found for disability.

In another study, high neighborhood concentration of Mexican Americans was found to be a protective factor against mortality and morbidity among older Mexican Americans living in Texas, California, Arizona, Colorado and New Mexico. Eschbach and colleagues [96] used data from the Hispanic Established Population for the Epidemiological Study of the Elderly (H-EPESE) and linked to 1990 Census data for 210 census tracts. Percentage of Mexican Americans in the neighborhood was used as measure of ethnic/racial concentration. These results supported the hypothesis that neighborhood characteristics (racial/ethnic concentration) have a beneficial effect on health. The authors proposed a 'barrio advantage' for older Mexican Americans suggesting that the potential negative effects of the neighborhood were counterbalanced by the positive effects of living in a highly concentrated Mexican American neighborhood, where these older residents can find the support and assistance that they need [96].

In a recent study that used data from NHANES III (1988-1994), Phuong Do and colleagues investigated ethnic differences in obesity. The study investigated several macro level neighborhood influences, such as neighborhood disadvantage, neighborhood educational concentration, Black segregation and Latino segregation as explanations for the disproportion rates of obesity among minority ethnic groups. There was a significant association of these neighborhood indicators with BMI after adjusting for individual-level characteristics. Neighborhood characteristics examined in this study appeared to mediate the association of ethnic disparities with BMI, because this association became attenuated after entering neighborhood macro level variables in the

model. MA who lived in disadvantaged neighborhoods had higher BMI compared to Blacks. All neighborhood indicators but one (proportion of Blacks) were associated with higher BMI in MI-MA [77]. This suggests that highly Latino-concentrated neighborhoods may not be beneficial for MI-MA's BMI. Park and colleagues examined the association of neighborhood immigrant concentration and BMI among an ethnically/racially diverse sample of residents living in New York City neighborhoods. Data were collected as part of the New York City government health survey between January 2000 and December 2002. Summary file 3 from the 2000 Census was used in this study. Among the neighborhood level variables were proportion of Hispanic residents, proportion of foreign born and proportion of residents below poverty level. Regardless of neighborhood immigrant composition, foreign-born Hispanics had a lower BMI than US-born Hispanics. Higher BMI was associated with lower immigrant concentration and lower levels of linguistic isolation [97].

It is important to continue investigating how the characteristics of the neighborhood are associated with obesity by examining and identifying correlates of influence. The limited available evidence presented here suggests: 1) the need for more studies that address Latinos' health in the context of the neighborhood characteristics, 2) that the evidence is mixed, and of the few studies available one found a negative effect of Hispanic concentration and BMI [77] while the other study found a beneficial association [97], 3) the definition of what a neighborhood is varies across studies, limiting the ability to compare results between the studies, and 4) combining neighborhood disadvantage

scores does provide an overall assessment of neighborhood characteristics, however, it limits the ability to detangle what neighborhoods indicators are relevant and significant to the outcome.

Meso-Level Correlates

To fully understand obesity rates, disparities among ethnically/racially diverse groups, public health researchers have increased their focus on understanding the influence of the social neighborhood characteristics. In the last decade, studies that explored the influence of neighborhood social environments have proliferated [98]. These studies have increased our understanding of the complex associations between individuals and their neighborhoods, and have generated new research questions and intervention alternatives to be explored. One area of research that has dominated the field includes secondary data analyses based on population-based samples that explore aggregated measures of socio-economic indicators, neighborhood environments and how these measures are associated with morbidity and mortality rates [99-102]. A second line of research that has evolved in the last decade focuses on studies that examine the influence of the built environment (parks, density of grocery stores, walkability, connectivity) on obesity, diet and physical activity [103-105]. In recent years, the focus has turned to the social attributes of the environment and more especially the social characteristics of the neighborhood and its relationship to health outcomes [80,106-109].

The Institute of Medicine (IOM) defines social environments as those that shape norms, enforce patterns of social control, provide or discourage environmental opportunities to engage in particular behaviors, reduce or produce stress and place constraints on individual choices [110]. Social capital [111-113], and collective efficacy [114,115] are some of the constructs identified in the literature to characterize neighborhood social environments and are shown to be associated with obesity and related health outcomes. Researchers argue that these constructs represent dynamic processes between individuals and their environment, the result of which has an influence on health outcomes [25,28,116]. Despite the growing interest in neighborhood influences on health, a limited number of studies have addressed Latinos and obesity. The present study draws from the available evidence to demonstrate why these correlates should be included in a study of obesity among MI-MA living on the US- Mexico border.

Social Capital

In the last decade, social capital has become one of the most studied constructs to explain health outcomes [98]. Nevertheless, defining what social capital means in the context of public health research has been one of the most confusing and difficult aspects of its study [98]. There are two schools of thought regarding social capital; one defines it as 'social cohesion' and the second as 'network'. Social capital as 'social cohesion' encompasses resources available to the individual from her/his community, such as trust, norms, sanctions and assistance. These resources can take different forms depending on the social

group, work, school or neighborhood. This school of thought characterizes social capital as a group attribute; it is part of the community or organization. Social capital as 'network' is defined as social support, information channels and social credentials attributed to individuals in social networks [98]. In this study, social capital is defined as 'social cohesion'. Social capital has been measured and is represented as the combination of social features of the neighborhood, such as civic participation, trust, and social networks [26,28,117]. The social network part of social capital refers to the extent and the intensity of social relations of the individual; sources of social networks are nuclear families, extended family, friends and co-workers. Civic participation is another form of social capital that can capture engagement and investment in neighborhood activities. Examples of civic participation are church, trade unions, and sports or musical groups. Trust is another commonly used correlate to assess social capital.

The evidence establishing social capital's association with health outcomes is strong [98]. However, the evidence is less clear as to how social capital is related to obesity, and few studies have investigated this association among Latinos.

Kim and colleagues examined the contextual effects of social capital at the US, national and state levels on residents' BMI as well as the differential association of social capital by sex and race/ethnicity. Individual-level measures were gathered from BRFSS 2001, the Roper Social and Political Trends Archive, the General Social Survey and the DDB Needham Life Style Archive. In this study, social capital was defined as civic participation and trust. Higher social

capital at the state level was associated with significantly lower odds of obesity. Social capital did not mediate the effect of income inequality on obesity. No differential associations were found between social capital and race/ethnicity or sex. Individual socio-demographic characteristics were associated with social capital [26]. In another study using national level data obtained from the 1999 BRFSS investigated the association of social capital, measured by the Putman's social capital index and obesity. The Putman's social capital index is the combination of community organization life, involvement in community affairs, volunteerism, informal sociability, and social trust. In a multivariate analysis, social capital index was significantly associated with obesity and explained about 10% of the variance on obesity. Social capital, in this study, appeared to be a protective factor for obesity [118]. A more recent study conducted in Canada, Montreal, investigated three measures of social capital: networks, trust and participation. Data came from the Montreal Neighborhood Survey of Lifestyle and Health. In the multilevel model, social capital was associated with normal BMI levels. Similar results were observed for social network and obesity. The study concluded that individuals with higher levels of social capital were less likely to be overweight or obese compared to those with low levels of social capital. Further, the authors reported that regardless of the place where individuals reside, those with more diverse ties and greater access to resources had a lower risk of being overweight and obese [111].

Despite the public health interest in social capital as an explanatory variable to health outcomes, there are not studies that examine social capital,

obesity and Latinos. Below is the available evidence on social capital, Latinos and other health outcomes, to show how social capital is associated to health outcomes.

In 2005, Franzini and colleagues examined the relationship between neighborhood impoverishment index, composed of neighborhood level poverty rate, unemployment rate, vacant housing rate, and proportion of households with children under the age of 5 which were single-headed, and neighborhood social and physical characteristics (e.g. trust, physical disorder) to self-rated health (SRH) in Texas. Fifty nine percent of the sample was Hispanic. In the multivariate model, social capital was positively associated with SRH; however, when neighborhood impoverishment was added to the model, it modified the association of social capital and SRH. This finding supports the evidence that macro level variables may modify the association between neighborhood social factors and health [28].

Social capital has been associated with acculturation and breastfeeding practices among Latinas. Anderson and colleagues studied the influence of acculturation and social capital on breastfeeding. Here, social capital was defined as the existence of community networks, civic engagement, local identity and sense of solidarity, equity, trust and reciprocity. Acculturation was measured by a sum score of items that assessed migration, language preferences and social relationships. Women who exchanged services with friends, relatives or neighbors (reciprocity) were more likely to breastfeed compared with respondents who did not exchange services. Acculturation was not associated

with breastfeeding or social capital [119]. Martin and colleagues examined the association of social capital and food security among white, black and Latino respondents in Hartford, Connecticut. A seven-item scale that assessed social capital through trust, reciprocity and social networks was used. Household food security and hunger were measured using the 18-item US Household Food Security module. The authors set out to explore whether social capital was correlated with food security and hunger independent of household SES. Compared to whites and blacks, Latinos reported significantly lower levels of social capital. Household social capital was associated with significantly lower odds of being hungry after adjusting for SES, and none of the household demographics were significant correlates of hunger when social capital was entered in the model. Furthermore, after controlling for individual-level SES, households in neighborhoods with high social capital were less likely to experience hunger compared to households in low social capital neighborhoods. Interestingly, households with an elderly member were less likely to experience hunger and had higher social capital than households with no elders [120].

This limited evidence suggests that social capital is directly and indirectly associated with obesity. It also implies that social capital may be an important construct to explain health behaviors among Latinos. Social capital appeared to be beneficial for breastfeeding behavior and self-rated health, but less clear is the association with food security.

Despite the advances made in understanding the association of social capital and health outcomes, evidence is lacking as to how this social process

acts on health outcomes among Latinos. Some researchers argue that the social network and social cohesion components of social capital may be largely related to the group-oriented nature of the Latino culture [119,120], suggesting that Latinos may create and activate their social networks in their neighborhood to provide the support and assistance that they need to maintain their health. Social capital has an explanatory role in neighborhood influences on health, and therefore, by drawing from the available evidence, this study attempted to explain the influence of social capital on obesity in MI-MA living in the border region.

Latinos and social capital

Research has been conducted to identify individual and neighborhood level characteristics associated with social capital among ethnic/racial minority groups. The studies reviewed below included Latinos in their analysis.

Subramanian explored the association between SES and demographic attributes that correlated with individual social capital. Data for this study came from the Project on Human Development in Chicago. For this study, social capital was defined as the respondent's perception of whether people in their neighborhood can be trusted. Mistrust was associated with age, gender and race. For example, Latinos were less likely than Blacks to report mistrust. There was a graded relationship between income and mistrust. People in higher brackets of the income ladder were less likely to report mistrust, and differences in trust could not be attributed to individual correlates. There was evidence in this study that differences between neighborhoods contributed to the variance in

individual perceived trust. The distribution of respondents by neighborhood explained almost 22% of the variance in mistrust [16]. In another study, Franzini and colleagues examined predictors of trust among Latinos in Texas. Trust was measured as perceived trust in several groups of people and institutions. Percentage of variance explained by the neighborhood level was significantly associated with trust, indicating that trust varied by neighborhood. Females were less likely to report general trust. More educated and older respondents were more likely to trust US born people. Foreign born were more likely to trust people from Mexico. Speaking Spanish and income were not associated to any type of trust. Trust in people in general was positively associated with collective efficacy and with income inequality [112]. These two studies highlight that trust, a domain of social capital, is an important construct to study among Latinos. These findings provided some evidence to continue generating hypotheses on the associations of social capital variables and health outcomes among Latinos.

Collective efficacy

Collective efficacy is defined as the ability of neighborhood members to activate the informal resources they have in order to achieve a common goal [25,89]. Collective efficacy is the combination of neighborhood informal social control and social cohesion. It represents the willingness and intention to intervene as a neighbor. This is a group-oriented construct that is believed to pull resources from the larger social structures of the neighborhood to reduce unpleasant behavior and to create social order in the neighborhood [25,89].

Sampson and colleagues were first to introduce the concept of collective efficacy in public health. Using data from The Project of Human Development in Chicago neighborhoods, they determined that collective efficacy was a social neighborhood correlate that mediated violent acts at the neighborhood level [89]. Recent studies demonstrated the association of collective efficacy with premature death and mortality [15,114]. However, fewer studies have investigated the association of collective efficacy and obesity among Latinos.

Burdette and colleagues [19] investigated the association of collective efficacy and obesity among women with young children in 20 large cities in the US. Twenty five percent of the sample was Latino mothers. The authors found that low perceived collective efficacy was associated with higher BMI and higher rates of obesity. However, after controlling for covariates (e.g., income, education, race/ethnicity and marital status), the association between collective efficacy and obesity was no longer significant. In two recent studies, Cohen and colleagues examined the associations of neighborhood environment characteristics, obesity and collective efficacy among residents of Los Angeles. Data for these studies came from the Los Angeles Family and Neighborhood Study (LAFANS), a multistage survey that sampled families and their children. Over 65 census tracks were sampled and over half of the sample was Latino. The first study examined the association of collective efficacy and obesity rates among adolescents. Compared with adolescents in neighborhoods with an average collective efficacy, adolescents in neighborhoods with lower collective efficacy were 64% more likely to be at risk of being overweight and 52% more

likely to be obese [25]. In a follow up study, Cohen and colleagues investigated the association of the neighborhood environment with collective efficacy. The study found Latino ethnicity was positively associated with collective efficacy. After controlling for individual-level SES indicators, neighborhood disadvantage, a census composed score of poverty, percent female head of the household, percent of male unemployed and percent of families receiving public assistance, explained the largest proportion of variance in collective efficacy at the neighborhood level [115]. The latter finding is relevant to the present study because it demonstrates the link between neighborhood macro level characteristics and meso level indicators (e.g., collective efficacy). In addition, the largest percentage of respondents of this study was Latinos (57%).

The limited evidence suggests that collective efficacy may be associated with obesity. In addition, these studies suggests that collective efficacy also may be an important construct to further explore among Latinos, since being Latino was associated with higher collective efficacy. These results provide the bases to generate new hypotheses to examine the association of collective efficacy and obesity among Latinos in the context of other neighborhood social characteristics such as social capital.

In sum, the links between meso-level influences (social capital and collective efficacy) and obesity are still largely unexplored, especially among Latinos and in particular among MI-MA [28,77,112,121]. The few available studies provide some cautionary evidence to continue exploring these relationships. The

social-ecological perspective supports investigating these constructs as part of a multilevel, comprehensive approach to examine the complex nature of obesity [98].

Cultural Exchange-Level Correlates

One of the innovative contributions of the present study was represented by the development of the cultural exchange level of influence. Cultural exchange is composed of crossing the border variables and the acculturation domains of the respondents. Guided by the SEM, this level of influence was developed in an attempt to capture some of the social behaviors and acculturative processes that may be occurring among MI-MA residents of neighborhoods along the border region. The process of acculturation and the social behavior of crossing back and forth between the two countries are a unique combination of factors to individuals living in these border communities and may interact with other factors associated with obesity and health. Choosing to live close to the US-Mexico border may be associated with socio-economic factors, but it is associated also with cultural and social factors that attract these individuals to maintain close contact and proximity to their country of origin. Cultural exchange happens between individuals. This exchange may happen between MI-MA US residents and family and friends on the Mexican side of the border. By crossing the border to Mexico, MI-MA US residents exchange services and strengthen social ties in their country of origin. This exchange may modify MI-MA engagement and involvement in their US neighborhoods and civic organizations, potentially slowing down the process of acculturation, or perhaps weakening their ties with residents in their US

neighborhoods. Crossing the border in the last month, reasons for crossing and the acculturation domain scores were chosen because they appeared to assess behaviors related to an individual's exposure to her/his country of origin (e.g., crossing to Tijuana, Mexico) and the motivation to continue doing so (e.g., crossing the border in the last month). Acculturation was added to this level of influence because it measures one aspect of the individual and social processes that influence immigrant Latinos when they immigrate to the US. In addition, acculturation has been shown to be associated with Latinos' behaviors and health outcomes.

The evidence available on US-Mexico border health issues mostly addresses health care access[122], infectious diseases[123], tobacco control [124] and environmental health [125]. The interdependence of governance, economic trade and cultural feedback between the two countries affects the public health outcomes of residents on both sides of the border [126]. Cultural differences are sometimes viewed as a barrier for integration between the two countries. However, it is impossible for MI-MA residents of this border region (e.g., San Ysidro) to separate themselves from the cultural and social influences on the other side of the border (e.g., Tijuana) [126]. Some scholars have argued that residents of border regions view themselves as members of the same cultural society, sharing symbols, customs and ethnic identity [127]. Research on the US-Mexico border region suggests that US influences have promoted a new cultural identity among residents of these border communities. For example, they point out that structural characteristics of border cities are designed to promote

tourism, trade and connectivity from the two cities' streets to the port of entry [128]. The design of border cities facilitates the exchange of resources and experiences between residents from both sides of the border. Residents of these border communities described them as 'joint communities', in which they can transit between the two countries, as they need to. In addition, the populations of these communities are diverse in terms of socio-economic class, ethnicity, immigration history, legal status, generation and gender, suggesting that they share a common interest and motivation of these residents to maintain a close tie to Mexico [127].

Crossing the border to Mexico to obtain health care has been well documented [122]. More recently, researchers have focused on examining the association of crossing the border and risk and protective behaviors for HIV and sexually transmitted diseases [129,124,128]. However, there is a limited amount of research examining the effects of crossing back and forth to Mexico and obesity. The available literature does not incorporate in their examinations dimensions of acculturation and immigration, nor include indicators of exposure to Mexico, in terms of time spent or reasons for crossing. In a recent study, Martinez-Donate and colleague explored the influence of US smoking bans on the social norms of residents of Tijuana and Guadalajara, Mexico. They found that after controlling for socio-economic characteristics, the US tobacco control had an effect on the rates of smoking, smoking exposure and smoking bans in Tijuana compared to Guadalajara. This study provided evidence in several ways. First, it provided evidence to support the hypothesis that US social and cultural norms may filter

through the other side of the border to Mexico. Second, this trickling process may have an effect on Mexican's residents, especially among those closer to the border, and third the exchange between the two countries may not only happen at the individual and economical level, but at the meso level of influence, as well.

Acculturation

Acculturation is defined as changes in behaviors and cultural patterns derived from continuous exposure to a dominant culture [130,131]. It is a bi-dimensional social process in which individuals learn or adapt aspects of the dominant culture, but maintain other aspects of their culture of origin [132,133]. This is a long term and flexible process, where the individual moves between the two cultures continuously [134,135]. During this process individuals mix and match aspects of the new culture and their culture of origin to create a new set of norms, rules and categories that they can applied to everyday life activities [134,135]. Acculturation is the combination of cultural and psychosocial changes that penetrate every aspect of life. Mistakenly some researchers have argued for measuring acculturation as a gain/loss process where an individual may have to lose a trait or cultural value from their country of origin to gain a cultural trait from the new culture [134,135]. Efforts have been made in public health research to avoid a gain/loss approach to the measurement of acculturation; currently, its operazionalization in public health research ranges from multidimensional and bidirectional scales (e.g., Marin's Bidimensional Acculturation Scale and Cuellar

ARSMA II), uni-dimensional assessments (e.g., generational status) to single migration history questions (e.g., years in the US or age of arrival to the US) [132].

There is ample evidence that supports that acculturation is associated with obesity. Sobel and Martorell, using Hispanic NHANES data found that acculturation, measured as preference for English, was associated with reduced BMI among Mexican Americans among women. Second and third generation men and women were more likely to have higher BMI[136]. In a later study, Sundquist and Winkleby analyzed data from NHANES (1988-1994) of over 3000 Mexican Americans and found that country of birth and acculturation (primary language spoken) were associated with abdominal obesity. US-born Spanish-speaking women had the highest prevalence of obesity, compared with Mexican-born and US-born English-speaking women [137]. Using data from the National Health Interview Survey (NIHS) 2000, Goel and colleagues examined the association of years in the US and obesity. They found that living in the US for 10 to 15 years was associated with increasing BMI among Latinos in the sample. In another study, birthplace, years in the US and the Bi-dimensional Acculturation Scale for Hispanis (BAS) were used as measures of acculturation to examine obesity rates among Mexican immigrants living in Harris County, Texas. The study found that Mexican-born respondents had a lower risk of obesity compared to US-born respondents. Highly acculturated men, those with a higher BAS acculturation score ≥2.5, were more likely to be obese. Among Mexican immigrant women, increased years in the US was associated with higher BMI, and women living in the US 15 or more years were heavier than recent Mexican

immigrants (< 5 years)[138]. Abraido-Lanza and colleagues studied the Latino Health Paradox in the context of acculturation using data from National Health Interview Survey 1991. Acculturation was measured using place of birth and years in the US. Respondents were categorized into low acculturation (foreign born and less than 15 years in the US) and high acculturation (US born and 15 years or more in the US). Compared to less acculturated Latinos, more acculturated Latinos, those living in the US for 15 years or more and foreign or US born, were 1.5 times more likely to have a BMI greater than 25 after controlling for age and SES [53]. Ayala and colleagues examined BMI scores and several measures of acculturation among MI-MA women in San Diego, CA. Acculturation was measured in three ways, years in the US, country of birth and with the Acculturation Rating Scale for Mexican –Americans II[133]. The study found that BMI was positively and significantly associated with years of residence in the US and overall acculturation, a composed score that reflected both Mexican and Anglo orientation of the Cuellar's scale, and negatively associated with Anglo orientation (e.g., speaks English more frequently, identify with Anglo-American ethnicity) [8]. A study that used data from the 1998 NHIS to examine the relationship between acculturation to the US (measured by length of residence) and obesity among Latinos, found that Latinos who had lived in the US for more than 15 years were four times more likely to be obese than recent Latino immigrants (living in the US for 15 years or less) [139]. In 2005, Hubert and colleagues investigated the association of acculturation and BMI among labor camp residents in Monterey County, California. Acculturation was measured by

the number of years lived in the US, generational status, and primary language spoke at home. Higher BMI was found to be associated with greater acculturation, measured by years in the US and generational status [140]. Regardless of the measure used for acculturation, it appeared that obesity is partially explained by acculturation among Latinos.

Measuring the social (e.g., acculturation) and behavioral (e.g., crossing) exchange that may occur as result of living on the border strengthens what we know about the relationship between place and obesity. By proposing the cultural exchange level of influence, this study added to the body of research on the social epidemiology of obesity.

Micro-Level Correlates

Socio-economic and demographic

Socio-economic status (SES) and demographic variables are strongly associated with obesity among Latinos [141-145]. The influence of education, gender and income are well established in the literature as correlates of health status [2,41,12]. Racial/ethnic minorities, women and low-SES individuals have consistently been shown to have the highest rates of obesity [146]. Evidence also suggests that the SES gradient varies by immigration status [142].

The inverse association between SES and BMI is strong and clear among women, but less clear among men [147]. In a recent study, Barrington and colleagues using data from NHIS 1995-2007 found that US-born Latinos male and female were more likely to be obese, but foreign-born Latinos were less

likely to obese. The findings also provide evidence on the moderation effect of place of birth (e.g., US vs. foreign born) by gender on obesity [148]. Sanchez-Vaznaugh and colleagues found similar results with data from the California Health Interview Survey (2001). Foreign-born males were more likely to be obese that women [143]. Using data from the National Latino and Asian American Survey (2002-2003), Bates and colleagues also found that Latino men of all generational status were more likely to be obese that Latinas [141]. Wang and Beydoun conducted an extensive review of national data sets that included Add Health, BRFSS, and NHANES, and found an upper bound trend of prevalence of obesity among Mexican Americans males and females using the NHANES from 1974 to 2004 [12].

Age is another socio-economic indicator associated with obesity among Latinos [12]. In a study that examined the social disparities in BMI across adulthood by gender, race/ethnicity and socio-economic position, the authors used data from the Monitoring the Future Study (1984-200) and observed that among Hispanics, age was associated with higher BMI after controlling for gender and education [146]. Examining data from NHANES 1999 to 2004, Ogden and colleagues found that older Mexican Americans were more likely to be obese compared with younger Mexican Americans [149]. Obesity was significantly higher in older Mexican American women (over 50 years of age) in the NHANES data [150]. Another finding from the Wang and Beydoun study was the significant and positive association of age and obesity rates across two NHANES datasets

(1999-2002 & 2003-2004), for all age groups. These data support the upper bound increase of obesity rates for Mexican Americans 20 years and older [12].

Marital status is strongly associated with obesity and other health outcomes [151]. In addition, there is evidence from NHANES that the association of marital status and obesity is moderated by sex and age, among Mexican Americans. Younger married and widowed males were more likely to be obese than younger never married males. Middle-aged and older married males had the highest obesity rates compared to all other marital status categories. For females in the sample, being married and middle-aged reduced their risk of obesity, compared to single, widowed and divorced female. There were no significant differences in obesity rates among older females in any of the marital status categories. Overall, never married Mexican American respondents were less likely to be obese [151]. Similar results were found in a recent study conducted with data from the California Health Interview Survey (CHIS) 2001.The authors examined the socio-demographic characteristics of Mexican American respondents and obesity. They reported that among Mexican Americans, marital status was associated with being obese, and married men were more likely to be obese than single men. However, the same associations were not found for women in this sample [152].

Education, income and household size have emerged as significant correlated of obesity among Latinos. Consistently throughout the literature having less educational attainment and being low income, among Latinos, is associated with obesity [11,139,153,142,143]. Greater number of years of education is shown to be

associated with obesity among third generation Latinos [141] and the education gradient effect on overweight and obese was found among Whites and Mexican-origin adults in the Goldman and colleagues study [144].

Parents of elementary school children living in the San Diego County border region, and who had lived longer in San Diego County were more likely to be overweight or obese [62]. Another study conducted in the San Diego County border region that examined correlates of BMI among MI-MA women found that unemployment was significantly correlated with BMI [8]. In a more recent study of the socio-economic gradient and BMI by race/ethnicity and gender, the analysis of CHIS data found that among Latinas, the rates of obesity increased dramatically among those with less than a high school education. For Latinos, there was a negative association between income and education with BMI; the less education and income the higher the mean BMI observed in Latino males in the sample [142]. Despite the evidence, differences in BMI are not fully explained by individual SES. Other reasons such as lifestyle and social and physical neighborhood environments may explain disparities in obesity rates among Latinos and in particular MI-MA groups [48,12].

Summary Statement on Research Gaps

The increasing incidence rate of obesity in MI-MA in the US is the result of complex and dynamic processes that include macro, meso and micro influences. The current scientific knowledge that integrates all of these influences to explain the increasing incidence rates of obesity in the US is limited, and fragmented at

best. A review of the available evidence demonstrated the dearth of research on macro and meso level influences among Latinos and in particular among Mexican immigrants and Mexican Americans. It has been established that individual characteristics, such as race/ethnicity, SES, and acculturation are associated with obesity. New evidence is emerging that associates macro and meso level characteristics of neighborhoods with obesity. Less is known about how these factors act at or between different social-ecological levels to modify neighborhoods and conditions supportive of healthy BMI [77,154]. No one study has examined Latinos' residential concentration and obesity. The research conducted has primarily focused on disparities between African Americans and Whites. In addition these studies used larger national datasets, which limited what kind of research questions and hypothesis can be tested because the available data dictates the study design and research questions.

Drawing from the available evidence, macro level influences in the form of residential segregation and neighborhood disadvantage appear to be associated with higher obesity rates. At the meso level of influence, social capital and collective efficacy emerges as protective factors for certain health outcomes and obesity. The theoretically constructed cultural exchange level of influence is informed by the evidence on acculturative processes and its effect of obesity.

A call for action has been made across the nation to address the obesity epidemic. This epidemic has great implications for public health and the costs of health care [155,156]. The urgency of this issue is highest for racial/ethnic populations. Latinos, and in particular MI-MA, are at greater risk than whites of

mortality and morbidity due to obesity if action is not taken. The evidence is available to demonstrate the health disparities and vulnerability of this Latino group. This systematic disadvantage in health outcomes speaks to what health disparities mean, “Differences which are unnecessary and avoidable, but, in addition, are also considered unfair and unjust” [157]. In order to effectively address this call to action, multilevel and comprehensive approaches to the study of obesity are needed.

Study Rationale

To date no comprehensive study has been conducted that examines the social-ecological levels of influence to better understand obesity rates among MI-MA living on the US-Mexico border. The proposed study investigates multilevel, evidence-based correlates of obesity. A conceptual model was constructed to guide the collection and analysis of the data. This study contributes to the scientific and public health knowledge in multiple ways. First, it focuses on Mexican immigrants and Mexican Americans, the largest minority group in the US and one with the highest rates of obesity. Second, it studies this racial/ethnic group in an important place of influence, the US-Mexico border region in San Diego, California. This is a distinctive community in the US, residents are exposed to the influx resulting from the exchange between both sides of the border. Third the study recruited a sample of MI-MA randomly selected from the population and used evidenced based measures to capture the macro, meso and cultural exchange factors that may be associated with obesity.

Objective and Hypotheses

Using the Social-Ecological Model [55] as a framework, this proposal examined macro-level (percentage of Latinos and percentage of home ownership), and meso-level (social capital and collective efficacy) factors in the context of the cultural exchange that occurs along the border region. This cultural exchange is represented by frequency of crossing the border, reasons for crossing and individual level of acculturation. The study controlled for micro-level (household size, household income, employment, years of education, marital status, age, gender) influences and health behaviors (meeting physical activity guidelines and weekly fast food consumption) given their association with obesity.

Objective 1: To determine the independent associations between meso and macro levels of influence and cultural exchange variables on obesity.

Hypotheses

Controlling for age and sex:

Hypothesis 1.1: Respondents who crossed the border to Mexico with higher frequency in the last month will be less likely to be obese compared with those who do not cross the border.

Hypothesis 1.2: Respondents who crossed the border to visit family and friends in the last month will be less likely to be obese than individuals who do not cross the border in the last month.

Hypothesis 1.3: Respondents who prefer to use the Spanish language will be less likely to be obese than individuals who prefer to use the English language.

Hypothesis 1.4: Respondents with larger social networks will be less likely to be obese compared to respondents with smaller social networks.

Hypothesis 1.5: Respondents with higher levels of reciprocity will be less likely to be obese compared to respondents with lower levels of reciprocity.

Hypothesis 1.6: Respondents who attended meetings of civic organizations in the last month will be less likely to be obese compared to respondents who did not attend civic organization meetings.

Hypothesis 1.7: Respondents with higher levels of trust will be less likely to be obese compared to respondents with lower levels of trust.

Hypothesis 1.8: Respondents with higher collective efficacy will be less likely to be obese compared to respondents with lower levels of collective efficacy.

Hypothesis 1.9: Respondents living in neighborhoods with a higher percentage of homeownership will be less likely to be obese compared to respondents living in neighborhoods with a lower percentage of homeownership.

Hypothesis 1.10: Respondents living in neighborhoods with a higher percentage of Latinos will be less likely to be obese than respondents living in neighborhoods with a lower percentage of Latinos.

Objective 2: To examine the extent to which variables measuring the social capital construct and cultural exchange level of influence are associated with each other.

Hypotheses:

Hypothesis 2.1: Frequency of crossing the border and acculturation will load on the same factor to represent the cultural exchange domain as proposed in the conceptual model.

Hypothesis 2.2: Social networks, civic participation, and trust will load on the same factor to represent the social capital construct at the meso level of influence as proposed in the conceptual model.

Objective 3: To determine the proportion of variance in obesity that is explained by macro- and meso-level influences and whether these levels of influence are moderated by cultural exchange factors.

Hypotheses

Controlling for micro level covariates, health behaviors and neighborhood clustering:

Hypothesis 3.1: There will be a significant interaction between the cultural exchange factor score and the meso-level factor score on obesity. Among respondents with higher levels of cultural exchange, respondents with higher meso level factor scores will be less likely to be obese. Respondents with lower levels of cultural exchange, and lower meso level factor scores will be more likely to be obese.

Hypothesis 3.2: There will be a significant interaction between the cultural exchange factor score and the macro-level factor score on obesity. Among respondents with higher levels of cultural exchange, respondents with

higher macro level scores will be less likely to be obese. Respondents with lower levels of cultural exchange, and lower macro level scores will be more likely to be obese.

Hypothesis 3.3: Adding the meso-level factor score in the multilevel model will increase the total variance explained on obesity by 10%.

Hypothesis 3.4: Adding the macro-level factor score in the multilevel model will increase the total variance explained on obesity by 10

III. METHODS

Study Design

The current study was a multilevel analysis that examined macro-level, meso-level, and cultural exchange influences on obesity among MI-MA living in the border region of Southern CA.

This study used data collected by the San Diego Prevention Research Center (SDPRC) in their biannual community survey. The aim of the SDPRC community survey was to assess the quality of life and physical activity levels of residents of the Southern region of San Diego County. The SDPRC community survey was a cross-sectional study conducted between June and September 2009. Data were collected from the SDPRC participating communities of San Ysidro, Chula Vista and Imperial Beach, and one comparison community, National City. Three hundred and ninety-seven adults completed the survey. The SDPRC community survey used multistage sampling methods to select individuals for the survey. Two hundred census blocks from the participating communities were randomly selected, then households were randomly selected from those blocks and finally one Latino adult was randomly selected from the selected household to complete the survey. Two bilingual, bicultural research assistants conducted a single home visit that included administration of face-to-face survey and measurements of weight and height with the selected adult. Home visits were completed in either English or Spanish depending on the

individual's preference, and the surveys were anonymous and confidential. The SDSU and UCSD Institutional Review Boards approved the study.

Setting

This study was conducted in the South Bay region of San Diego County. The four communities selected for the study are the same ones selected for the SDPRC survey, which are the southernmost communities of San Diego County closest to the U.S.-Mexico border. The San Ysidro-Tijuana border crossing is the busiest in the world [70,] with over 50 million people entering the U.S. through the San Ysidro border in 2005 [37]. National City, Chula Vista and Imperial Beach are cities in the County of San Diego, and San Ysidro is an unincorporated community of the City of San Diego. In Chula Vista, Latinos represented 55.6% of the city's population in 2008; Latinos represented 60.0% of the population in National City, 47.4% in Imperial Beach and 92.0% in San Ysidro [37,158]. The population in these communities is younger, with a mean age of 28 years, compared to national estimates of 36.8 years of age. Between 7.7 and 19.8 percent of the households in these communities lived below the poverty line in 2008, with National City having the highest percentage of households living in poverty. Chula Vista had the highest median household income with $63,095, while San Ysidro had the lowest at $28,230. The median household size across these communities is 3 individuals [37,158]. Despite these differences, these

communities share social and economic characteristics that make them distinct, given their proximity to the U.S.-Mexico border. For example, these communities have a high percentage of Latinos living in their neighborhoods, Spanish is frequently spoken in these communities and they exhibit high neighborhood mobility and low home ownership.

Sampling Methods

The 2009 SDPRC community survey used multistage sampling methods to select and recruit respondents for the survey. Multistage sampling allowed for the selection of a representative sample of individuals from the participating communities [159]. Neighborhoods, households and individuals were randomly selected. Using demographic data and geographic boundaries provided by the U.S Census Bureau, the targeted areas of the study were selected. For this study census blocks, the smallest geographic unit estimated by the U.S. Census, were used to identify and define the neighborhoods.

Figure 2.1 Selected geographic area for study

The U.S. Census collects data from 100% of households in each census block unit, which are geographically delimited by streets or natural features of the area. The population of a census block can vary from zero to several hundred people [160].

The geographic region targeted by this study was bounded by National City in the North, the U.S.-Mexico border in the South, and the Pacific Ocean in the West. See Figure 2.1 for a map of the selected geographic area. All census blocks representative of the selected geographic region were inventoried. Data from U.S. Census Summary File 1 were downloaded to obtain the total number of blocks for the region, the number of households per block, and the number of Latinos per block. In 60 original census tracts, 2,210 blocks were identified. Census blocks east of the I-805 freeway were removed from the list, because these blocks were outside the SDPRC-targeted area. A total of 1,958 census blocks were identified as part of the region representing National City, Chula Vista, San Ysidro and Imperial Beach.

A random sample of 200 census blocks with at least one individual and with at least one household was drawn. One hundred blocks were selected from the community of National City, and an additional 100 blocks were chosen from the three remaining communities of San Ysidro, Imperial Beach and Chula Vista.

A team of four research assistants canvassed the 200 selected census blocks. The research assistants counted the number and recorded the addresses of housing units and other buildings in each of the census blocks selected.

Lists with the total number of houses per census block were produced from the canvassing in order to obtain an accurate count of houses and a record of their addresses. The final account of houses per census block from the canvassing was compared to the original counts provided by the 2000 Census to verify that the counts from the canvassing were reliable and accurate.

After all houses were enumerated, a skip pattern was used to obtain a random sample of 2,400 houses. A skip pattern of every third house for National City and every fifth house for Chula Vista, Imperial Beach and San Ysidro was used. These skip patterns were determined based on the total number of houses per community. The number of houses needed to obtain the study sample was calculated based on individuals' response rates from two previous studies [161-163], which used similar sampling methodology and were conducted with Latinos in the cities of Los Angeles and Boston.

An additional randomly selected sample of 1,723 addresses was created to supplement the original sample of 2,400 households. This additional sample was drawn because research assistants visited all original selected addresses before the end of the study timeline. Households were drawn from previously selected census blocks, which had large concentrations of households with adequate response rates.

Following the selection of households, materials were prepared to conduct recruitment of households, selection of the individuals within the households and recruitment of the individuals. Two documents were created and used to conduct recruitment of households and individuals. The first document was a form called

‘screener’ and the second form was called ‘household roster’. The screener contained the address of the household, which was written on white removable tape, and documented the outcome of each of the household visits. Three visits were programmed for each house. For each visit to the household, five initial outcomes were possible: no one answered the door, no adult (18 years or older) home at the time of the visit, no Latinos, refused to participate, and agreed to participate; a sixth outcome was possible if a survey was conducted and completed.

The second form was the household roster, which listed all of the individuals living in the household. This roster included everyone living in the household for at least 4 days of the week, from the oldest to the youngest individual. Basic demographic information was obtained for each individual, including date of birth.

Recruitment and Data Collection Procedures

Recruitment and data collection procedures for this study were divided into several steps. Two recruitment procedures were conducted, one at the household level and one at the individual level. Similarly, data collection was conducted at the household and individual levels. Research assistants (RA), in teams of two, were trained, certified and deployed to systematically recruit households and individuals, and to conduct surveys. Households were recruited and consented, and then the household roster was completed. After the list of

household members was obtained, an individual was randomly selected from the list to complete the survey.

Recruitment: Household

The screener captured information about household recruitment. Randomly selected households were visited at most three times to ascertain eligibility and recruit the household to participate in the study. Visits to the households were conducted at different times of the day and during weekday and weekend days. To be eligible for the study, the household should have had at least one member who identified as Latino and who lived in the house for at least 4 or more days per week. At the selected house, the RA team introduced themselves as members of San Diego State University and the SDPRC, explained why they were there, and proceeded to assess household eligibility. If the household was eligible, eligibility and consent to complete the household roster was obtained. Any adult in the household 18 years and older who lived in the house 4 or more days per week could have completed the household roster. The study objectives and procedures were explained to the household member, and verbal consent was obtained.

Data Collection: Household Roster

After a member of the household agreed to participate in the study, a household roster was completed. The RA asked the individual to list all members of the household starting with the oldest and concluding with the youngest.

Household rosters collected data on the demographic characteristics of all household members. For each household member, the date of birth, gender, race/ethnicity, relation to the respondent and highest level of education were obtained. This roster was used to randomly select an adult to participate in the survey. The RA proceeded to identify the household member with the most recent birthday who was identified by the household roster as being Latino and at least 18 years old.

Recruitment: Selected household member

After identifying the selected individual member, the RA asked to speak to her/him or, if not available, an appointment for a later time was made to complete the consent process and the survey. When the RA met with the selected individual, eligibility was confirmed. Then the RA explained the study objectives, as well as the anonymity and confidentially of the survey. If eligible and agreeable, the selected individual completed a verbal or written consent form to participant in the study. Either method of consent was available to the individual because the Institutional Review Board (IRB) requested to have a written consent option. If the selected individual chose to write her/his name, the RA explained that by doing so she/he was going to give away her/his anonymity rights. Two attempts were made to recruit the selected adult to complete the survey. If these attempts were unsuccessful, the screener and household roster was coded as incomplete.

Data Collection: Selected adult survey

Surveys were completed face-to-face in the home in either Spanish or English, depending on the preference of the individual. Research assistants used cards with the response options for each of the Likert scale items of the survey to aid with the selection of their answers, and reduce respondent burden. At the end of the survey, the individual's weight and height were measured following standard protocols as detailed below.

Measures

Obesity

Obesity was the dependent variable of this study. Obesity was derived from body mass index (BMI), one of the most widely used measures of body fat composition and considered a reliable measure for population-based studies [77]. Obesity was used as the dependent variable of this study because it is a significant correlate of risk for diabetes, cardiovascular disease, sleep apnea, and other chronic diseases [39]. Research assistants measured the weight and height of the individual using NHANES protocols. The mean weight in kilograms from the three measurements obtained and the mean height in meters from the three measurements obtained were used to calculate BMI using the formula (kg)/[height (m)]. Quality control procedures were conducted to ensure that the three weight and height measures obtained during data collection were consistent. During data collection, differences between the highest and lowest height of ≥1 centimeter and differences between the highest and lowest weight of

≥ 0.5 kg were reviewed, and in cases where differences was observed, RAs were trained to take a fourth measurement of either weight or height to resolve the discrepancy. Obesity was treated as a dichotomized outcome. Respondents with a BMI equal to or greater than 30 were categorized as obese. Healthy weight and overweight respondents were categorized as not obese and considered the reference category.

Macro-level correlates of influence

Variables were obtained from U.S. Census Bureau Data File Summary 1 available from the 2000 Decennial Census. This file provides data at the census block level. Two variables were identified as important macro-level characteristics of neighborhoods that may influence obesity: percentage of home ownership and percentage of Latinos. Individuals were assigned the macro-level estimates corresponding to the census block (neighborhood) where they live.

Percentage of home-ownership. The total number of units owned by residents divided by the total number of housing units in the census block (neighborhood) was calculated, and this percentage was assigned to each respondent living in the respective neighborhood. This variable represented neighborhood stability. Neighborhood stability was positively associated with collective efficacy and collective efficacy reduced the association between residential stability and violent crime [89].

Percentage of Latinos. The summary file 1 provides a variable that estimates the percentage of Latinos living in the census block, based on the total number of residents in the census block. This variable represented the ethnic density and immigrant concentration of the neighborhood. Evidence suggests that dense racial/ethnic neighborhoods can have a protective [164] or harmful [77] effect on obesity.

Meso-level correlates of influence

Social capital. Social capital is described as the connectivity and engagement of community members [98]. This construct has been extensively researched in multilevel analyses of social determinants of health [98]. Fewer studies have looked at this construct among Latinos, compared to whites. In the present study, the size and reciprocity of the individual's social networks, their participation in civic organizations in the neighborhood, and their level of trust represented the construct of social capital. Spanish and English versions of the social capital and civic organizations scales were obtained from the 2007 Boston Metropolitan Immigrant Health & Legal Status Survey (BM-IHLSS) [163] and modified as described below. Bilingual, native Spanish speakers compared the translation of these scales to confirm language and cultural appropriateness.

Social network. This form of social capital was represented by two variables: 1) the total number of people that the individual listed in her/his immediate network, up to 5 people; and 2) mean reciprocity represented by the

mean number of times that people in the network helped the individual or the respondent helped her/his network in the last year [39,165]. The present study used an egocentric network approach to the study of social networks [166]. Egocentric networks are from the point of view of the respondent. This approach did not include everyone in the network but those who fulfill specific function in relation to the respondent. These functions were of social support, in the form of emotional, financial, and instrumental support [98].

Previous research shows that size and reciprocity of the network are associated with self-rated health [28], mental distress [167], all causes of mortality [168], and obesity [100,111]. The original instrument consisted of 15 questions about the characteristics of the network. This instrument was reduced to 8 questions for the SDPRC survey, and three questions were used in this study yielding the two variables, size of the network and reciprocity, both continuous.

Civic participation. Civic participation was defined as the extent of involvement of individuals in organizations and groups in and around their neighborhoods. The instrument was modified to reflect the organizations and groups in the participating communities. This construct was represented by two variables in this study: 1) the total number of organizations and/or groups that the individual was a member of in the last 12 months, and 2) the total number of meetings they attended in the past month. Civic participation has been linked to mortality and morbidity rates in the US [98]. These questions were collected as continuous variables and were recoded as binary variables. Total number of

organizations/groups the individual was a member in the last 12 months was coded as participated in one or more groups (1) and did not participate (0). The total number of meeting attended in the past month was coded as attended one or more meeting (1) and did not attend any meeting (0).

Trust. Trust assessed the general trust in different social groups and sources of information that the respondent may have been exposed to. General trust has been extensively used in large national studies as an indicator of social capital [98,116]. Some researchers argue that this is a characteristic of the networks and relationships established through civic organizations, and therefore is a predisposing feature of social capital [98]. In this study, this correlate was treated as a characteristic of social capital. Seven items assessed how much the individual trusted a variety of groups that they interact with. Response choices ranged from 4= a lot to 1= not at all. The Social Capital Assessment Tool was originally designed by the World Bank's (WB) and has been adapted by Sampson and colleagues among others [89]. Trust has been associated with self-rated health [28] and food security [169]. The scale used for this SDPRC study was obtained from the Human Development Project in Chicago. Translation of the scale was completed by a professional translator and confirmed by a native Mexican research staff member. A mean score of these items was computed to create a general trust score, with a higher score indicating higher general trust [121,170].

Collective efficacy. This construct assessed the willingness and intention of an individual to act on behalf of the well being of their neighborhood or neighbors [89]. Collective efficacy was originally developed by Sampson and colleagues for the Human Development Project in Chicago (HDPC) [89,171] and it is composed of two scales: social cohesion and informal social control. Sampson and colleagues found a strong correlation ($r=0.80$ $p \leq 0.001$) between the two scales, which indicated that these concepts were covering aspects of collective efficacy as a latent construct. In they study, Sampson and colleagues found that collective efficacy mediated the association of neighborhood disadvantage, residential instability and violence[89]. Higher collective efficacy was negatively associated with SRH and BMI among Latinos [25,28]. The Spanish version of the collective efficacy items was obtained from the Los Angeles Family and Neighborhood Survey [172] and no modifications were made to the items. Adequate psychometric properties of the collective efficacy scale were demonstrated in a sample of Latinos living in Los Angeles County neighborhoods (Cronbach's alpha of 0.77) [25]. Social cohesion is the perceptions of neighborhood unity and trust. It was measured using five items with response options that ranged from 1= strongly disagree to 5= strongly agree. Two items were reverse coded. Informal Social Control was measured with three statements that assessed how likely the individual was to act to provide control and enforce social rules in their neighborhood. The response options ranged from 5= very likely to 1= very unlikely. Collective efficacy was computed by averaging the values of the items in the two scales. A higher collective efficacy score indicated

greater ability of an individual to act on the resources available in her/his neighborhood to intervene for her/his neighborhood well being.

Cultural exchange level of influence

To assess the dynamic features of border region neighborhoods and their relationship to obesity, this study hypothesized that the combination of crossing the border variables and acculturation measures may capture some of the characteristics unique to individuals living in these border region neighborhoods. Because of the proximity to Tijuana, Mexico, Mexican immigrants and Mexican Americans living in neighborhoods on the US side of the border have at their reach the culture and lifestyle of Mexico, which may have an influence on their health outcomes [126]. However, there are no studies that have looked at this influence in relation to obesity.

Crossing the border. Two questions were used for this study. The total number of times respondents crossed the border in the month prior to the survey, and the top reason why they crossed the border. The former question was treated as continuous variable. For the latter question, respondents were asked to rate the most important reason they crossed the border from an exhaustive list created for the question. For this analysis, responses were collapsed into three categories: for business, for friends/family or for medical reasons. A fourth category was added to this question for those individuals who reported no border crossing in the last month. This category was included for statistical and theoretical reasons. By including those individuals who did not cross the border,

the study preserved the sample size; otherwise it would have been cut by almost half. Additionally, including those individuals who did not cross provided a comparison group who did not cross the border. The four categories were treated as dummy variables for statistical purposes; not crossing the border was the reference category.

Acculturation. Developed by Marin and colleagues, the Bidimensional Acculturation Scale for Hispanics (BAS) assesses the bidirectional changes in and adherence to two cultural domains: Hispanic and non-Hispanic. Acculturation has been linked to worse dietary habits [132], BMI [2] and better leisure time physical activity [49]. The BAS consists of 24 items that measure three language-related areas: language use, linguistic proficiency, and electronic media use. This scale has shown good reliability, with Cronbach's scores of 0.94 for the non-Hispanic domain and 0.87 for the Hispanic domain. Validity of the overall scores was obtained through the correlation of the overall scores and several other acculturation measures, such as length of residence in the U.S., age of arrival to the U.S., generational status, ethnic self-identification and an acculturation score from the Short Acculturation Scale for Hispanics (SASH) [134]. The response options range from 4= almost always/ 1= very well to 1= almost never/ 4= very bad. Scores for the Hispanic and non-Hispanic domains were calculated using the mean of items corresponding to each domain. The Hispanic domain represents the extent to which individuals use the Spanish language for communication and consumption of media. The non-Hispanic domain represents

the extent to which individuals use the English language for communication and consumption of media [134]. Hispanic and non-Hispanic domain scores were used for the analysis and treated as continuous variables. Pichon and colleagues found that Anglo orientation (conceptually equivalent to the non-Hispanic domain) was positively associated with moderate and vigorous physical activity and Mexican orientation was negatively associated with vigorous physical activity [66].

Covariates – Micro-level influences

Both demographic and socio-economic status questions were modeled after the 2008 Behavioral Risk Factor Surveillance Survey (BRFSS) and the U.S Census. Demographic and socio-economic variables are consistently associated with health behaviors, health disparities in chronic diseases [2], and morbidity [142]. In addition, studies of neighborhood influences on health suggest that in order to correctly identify neighborhood influences on health, individual socio-economic and demographic correlates should be controlled for [80,173-175]. The Spanish translations of age, sex, marital status, and questions were obtained from the 2006 SDPRC Community Survey, and those for employment, income and years of education were translated by a professional interpreter and verified by a native Spanish speaker. In this study, these individual-level correlates were used as covariates.

Demographics (age, sex, marital status)

Age was calculated from respondents' date of birth found in the household roster and was treated as a continuous variable.

Sex was treated as categorical variable, male was indicated as (0) and female as (1).

Marital status was recoded as married or living as married (1) or single (0). The latter category consisted of respondents who reported being divorced, single, separated, and widowed.

Country of birth was a categorical question with four answer choices. Born in the US, born in Mexico, born in another Centro American or South American country or other country. The question was recoded into born in Mexico or outside the US (1) and born in the US (0).

Socio-economic status (employment, years of education, individual yearly income)

Employment was asked as a categorical variable. The employment status question was modeled after the U.S. Census Bureau [37]. The question asked if the respondent was employed for pay in the last week. Three answer categories available were: yes, no and no, because retired or homemaker. Descriptive statistics were conducted on this question and it was determined to further dichotomized into employed (1) or not employed (0), due to the distribution of the data.

Years of education was asked as the highest level of education the respondent completed. Seventeen categories ranging from none to doctorate were available to the respondent. Frequencies and dispersion statistics were run to determine the distribution of the data and the most adequate categories to represent the sample. Years of education was dichotomized as less than high school education (0) and completed high school or more (1).

Individual income was adapted from the US Census Bureau series of income questions. Respondents were prompted to include all sources of income during the previous year and to report their total individual income for 2008. This question was collected as open ended and later categorized using the poverty threshold guidelines for 2009 for one individual. Individuals with a yearly income of $10,831 or greater were coded as above the poverty line (0) and those who reported $10,830 (threshold) or less were coded as at or below the poverty line (1). Fifty-seven percent of the respondents did not report their individual income in 2008.

Household size was derived from the household roster. This measure included all individuals who lived in the household including the respondent. Larger household size is associated with health behaviors such as higher frequency of away-from-home eating and obesity [62,176].

Covariates – Health Behaviors

To truly assess the association of macro, meso and cultural exchange levels of influence on obesity, obesity-related behaviors should be included and controlled for in the analysis. This study included weekly fast food eating and meeting physical activity guidelines LTPA because these two behaviors are directly associated with obesity.

Weekly fast food consumption was measured with one question. It assessed how often in a normal week the respondent ate breakfast, lunch or dinner from a fast food restaurant, vending machines or street vendors. The answer was collected as number of times a week, ranging from 0 to 10 or more times. This question was taken from the BRFSS 2008. Higher frequency of fast food eating has been linked to adult BMI [75], and unhealthy eating patterns [176]. After inspection of the data, the variable was dichotomized into never eats fast food (0) or eats fast food once a week or more (1).

Meeting physical activity guidelines. Leisure time physical activity minutes were measured with The Global Physical Activity Questionnaire (GPAQ) [177]. The GPAQ measures physical activity participation in three domains and sedentary behaviors, and it consists of 16 questions. The domains are: activity at work, travel to and from places, and recreational activities. The GPAQ was developed by the World Health Organization (WHO) and has been extensively researched and tested among low-education populations around the world [177]. The instrument was originally validated in nine countries using test-retest methods. For concurrent validity it was compared to the International Physical Activity

Questionnaire (IPAQ) [178], which has been validated with Latinos and individuals in San Diego, CA [178]. The GPAQ calculates Metabolic Equivalents (METs) to indicate intensity of physical activity. MET is the ratio of an individual's working metabolic rate relative to their resting metabolic rate. One MET is defined as the energy cost of sitting quietly, which is equivalent to a caloric consumption of 1 kcal/kg/hour.

Moderate and vigorous minutes of recreational activity were converted into MET-minutes by multiplying the number of minutes of vigorous and/or moderate physical activity by their corresponding MET-minute value. Then, moderate and vigorous MET-minutes were added. In the final step, a binary variable that represented meeting physical activity guidelines was generated. Respondents who reported 150 MET-minutes or more of moderate to vigorous LTPA were coded as meeting the physical activity guidelines (1) and respondents who did not meet this cut off point were coded as not meeting the physical activity guidelines (0). This definition of physical activity was used for this study because 1) it is the standard definition used by public health agencies to determine if individuals are sufficiently physically active [63] and 2) for statistical purposes because the data were not normally distributed. It was important to control for diet and physical activity because both behaviors are directly link to obesity and unhealthy weight gain [67,179]. In order to assess the association of the higher levels of the socio-ecological model and obesity proposed in the current study, these behaviors were controlled for.

Statistical Considerations

Definition of Neighborhoods

Census blocks were used to define neighborhoods in this study. Census blocks and other census derived geographic measures have been used in neighborhood contextual studies to define neighborhoods [80,180,181]. A census block is the smallest geographic area assigned by the U.S. Census. They are more homogeneous demographically and economically than larger census areas, and therefore compositional characteristics are also assumed homogeneous [28,182]. Moreover, a census block is a more reliable and closely related measure of neighborhood as defined by residents, thus providing a more accurate assessment of neighborhood effects [28,183].

Power and sample size

This study consisted of 397 households with one respondent per household who completed the survey. Considering the sampling frame, study design and statistical analyses chosen for this study, sampling error was calculated to determine the probability that an effect could be detected on obesity. To ensure that the sample was sufficient to detect an effect when applying a multilevel (hierarchical) logistic regression model, sampling errors were calculated. Tables constructed by Fowler were used to calculate confidence ranges for variability attributable to sampling. Based on parameters of a sample of almost 400 individuals, 40% of whom would be obese, it was estimated with 95% confidence that the sampling error would ranges from ± 5. The true figure of the estimates is

between 40% ± 5 (35% to 45%) [159]. This range indicates that in the true population, the percentage of obesity in the population would be between 35% and 45%. This calculation demonstrates that the study sample sufficient to conduct the proposed analysis. The sampling error was only ±5. Additionally, the number of cases needed to adequately estimate an effect on the outcome using a hierarchical logistic model was projected based on the number of independent variables proposed for the analysis [184]. Ten cases for every independent variable in the model is one of the methods recommended [184]. There were 23 independent variables. If 10 cases were needed for each independent variable, the study would need 230 cases to conduct the analysis. In this case, the study had 397 cases to conduct the analysis, therefore this criteria was met. This sample size appeared to be appropriate to conduct the analyses and test the hypotheses.

Data management

During data management and data cleaning, several procedures were in place to ensure the accuracy of data collected and analyzed. Four sources of data were used for this study: the survey, the weight and height anthropometric form, the household roster and the household screener. Four databases were created to enter each piece of the data collected. Using a unique identifier, all files were linked into one database for these analyses. When possible, one research assistant was assigned and trained to enter one data component (i.e., screeners), to reduce data entry error. Periodic data checks were performed to

ensure correct data entry and maintain a low level of data entry errors. Data coding and decision logs were maintained to track changes and issues with the databases.

Before data analyses were conducted, several steps were taken to clean the data. Frequency tables were run for each variable included in the analysis. An initial data cleaning was conducted on 100% of the data to identify unusual entries. Next, a random sample of 10% of all cases in each of the databases was selected to further inspect and clean. A research assistant conducted the data entry verification of the datasets. After the initial data entry error was determined, and depending on the data entry error rate, additional data entry verification was conducted. An acceptable data entry error rate was set to less than 0.005 for independent variables and 0.001 for the dependent variable. The latter parameter was applied to weight and height. Data records and logs were maintained to count the number and types of errors in the database. The data entry error rate was calculated by dividing the total number of errors identified during the verification over the total number of entries (variables) reviewed in the dataset. The parameters of data cleaning and data entry were met. After an adequate data entry error rate was obtained, a third data-cleaning step was conducted. Frequencies and dispersion descriptive measures were run. During this step, data were checked to examine if they met assumptions of normality, and outliers were identified. Finally, to complete the preparation of the data, skip patterns and logical answer patterns were reviewed. For example, if an individual

responded “no” to doing recreational physical activity in a typical week, the questions that stemmed from it were coded as “888” indicating that they were skipped.

Descriptive Analysis

Before any analyses were conducted, all variables and data used to test the hypotheses of this study were checked. Means, standard deviation and tests of normal distribution were conducted for all continuous variables. Transformations were considered if continuous variables were not approximately normally distributed. Tables of frequencies were run for categorical variables. For categorical variables, frequency tables were examined to assess equal distribution of categories. Bivariate correlations between all continuous variables were conducted to examine the strength and direction of the associations and to inspect for collinearity between them. Variables that appeared to have high correlations (>0.50) were inspected further in the multilevel analysis, using the variance inflation factor (VIF) for collinearity. For categorical and dichotomous variables, chi-square tests were conducted to assess associations.

Data Analysis

To achieve objectives one and three of this study, descriptive and inferential analyses were conducted using STATA IC 11[185]. SPSS 17.0 [186] was used to conduct the factor analysis to achieve objective 2. Significance testing was set at $p \leq 0.05$, and all regression analyses controlled for age, sex, micro-

level correlates of influence, meeting guidelines for physical activity and weekly of fast food consumption. All models were adjusted for the sample methodology and clustering effect of neighborhoods, by using the 'cluster' command in STATA followed by the variable that indicated the unique identifier of the neighborhood.

Scale psychometric properties

Scale properties were examined using Cronbach's alpha coefficients compared to coefficients reported in source studies. Internal consistency reliability checks were conducted on the collective efficacy and acculturation scales.

Factor Analysis

To test the shared communality and underlying relationship within the meso, and cultural exchange level correlates of influence, a series of factor analyses were conducted in SPSS [186]. Correlates included in each of the theoretically constructed levels of influence were tested to empirically determine if these correlates actually reflected these underlying processes in this sample of MI-MA living in the border region of San Diego, CA. Factor analysis techniques were conducted in this study because few studies have examined the underlying association of these variables among MI-MA [28]. It was important for this study to examine if the correlates included at each level of influence were associated with each other and therefore represented a factor or component. This technique was selected over Structure Equation Modeling and confirmatory factor analysis

because the study examined these associations for the first time. The study was not confirming that these latent construct were presented and how they would behave, but rather if the constructs were present in this sample of MI-MA. Factor analysis was considered an adequate procedure to achieve this objective.

Several steps were taken to assess the suitability of the data for factor analysis and to test the hypotheses. Sample size and strength of the associations are two critical issues to consider. In this case, a sample of at least 300 is considered adequate for the factor analysis [184]. Inspecting the strength of the associations between the items is recommended. Correlation coefficients greater than 0.3 are recommended and were assessed in this study. Kaiser's criterion, or the eigenvalue rule, was used. Eigenvalues are one way to extracted factors in a factor analysis. They represent the variance of the factors, the amount of variance relative to the total variance explained. Only factors with an eigenvalue of 1.0 or greater were kept. The scree test was also run to assess the presence of factors. The scree test is the graphic representation in the form of plots to identify how many factors were derived from the data. After the factors were identified and selected, the factor rotation and interpretation was conducted. Orthogonal rotation using the Varimax method was selected for these analyses because it minimizes the number of variables with high loading on each factor and improves the interpretation of the factors. It determines the utility of the resolution and the most parsimonious set of factors to interpret the data [184].

Bivariate Analyses

Each explanatory variable was independently regressed on obesity. Logistic regressions controlling for age, sex and neighborhood clustering were conducted. Odd ratios, robust standard deviations, p values, 95% confident intervals (lower and upper bound) and Pseudo R^2 were obtained. These analyses were conducted to achieve objective 1 of the study.

Multilevel Regression Analyses

Multilevel regression (MLM) procedures were used because the data was organized at more than one level. MLM is a flexible procedure that does not require the independence of errors within and between levels. This technique allows for adequately analyzing nested data structures, where individuals are nested within households, and households within neighborhoods. Multilevel analyses simultaneously examine the effect of group-level and individual-level correlates; the non-independence of observations within groups is adjusted for [180].

In a multilevel analyses, individual scores must be adjusted for the hierarchical structure of the data, otherwise Type I error is more likely to occur due to the inflated degrees of freedom [184]. MLM addresses this issue by permitting intercepts (means) and slopes (IV-DV relationships) to vary between higher-level units. This type of analysis is adequate to answer the research questions of this study because it allows for testing the regression coefficients across groups (i.e. neighborhoods). Another advantage of MLM is that this

procedure allows the inclusion of correlates at every level of analysis. This type of analysis also allowed for testing cross-level interactions, whether a variable at one level interacts with a variable at another level and its effect on the dependent variable. A theoretical foundation to select independent variables is important in this type of analysis. Correlated predictors (IVs) are problematic in MLM analysis because predictors are adjusted for each other, increasing the likelihood that one of the regression coefficients will not be statistically significant. For this reason, it is important to select a small number of variables that are relatively uncorrelated to each other [184]. MLM are based on multiple linear regression procedures, and distributional assumptions should be considered and followed.

To achieve objective 3, MLM (hierarchical) logistic models were regressed on obesity. The final model was built through a series of steps that tested each of the hypothesized levels of influence. Model 1 was composed of variables in the cultural exchange level regressed on obesity. In Model 2, meso level influences were added and regressed on obesity. Next, Model 3 consisted of cultural exchange, meso and macro levels of influence regressed on obesity. Micro level influences were included in Model 4. In the final main effects model (Model 5), health behaviors (meeting physical activity guidelines and weekly fast food consumption) were entered. The last two models, Models 4 and 5, micro level of influences and health behaviors were treated as controlling variables. These controlling variables were entered last into the final model because the study was interested in observing and examining how the explanatory (cultural exchange, meso and macro) levels of influence would operate independently on obesity.

However, only after controlling for micro level influences and health behaviors can the association of the higher levels of influence be examined on obesity. Odd ratios, 95% confident interval (lower and upper bound) and Pseudo R^2 were presented.

Interactions

Interactions terms were generated between variables in the cultural exchange level, and the meso and macro levels of influence. Three variables were used from the cultural exchange level: number of times crossing the border in the last month, Hispanic domain and non-Hispanic domain. Five variables from the meso level of influence (collective efficacy, size of network, reciprocity, civic organizations meeting attended last month and trust) and two variables from the macro level of influence (percentage of Latinos and percentage of home ownership) were included. Each interaction term was entered into the equation for the final main effect model (Model 5) one at the time. The interaction terms were entered into that model because it contains all the levels and controlling variables regressed on obesity. Significance of the interaction was examined; if the interaction was significant, it was left in the model. If the interaction was not significant, it was dropped from the model.

Statistically significant interactions were graphed to show how the relationship between meso and macro level of influences variables and obesity were moderated by cultural exchange variables.

Model Diagnostics

Several statistical tests were conducted on the multilevel models to determine the statistical appropriateness of the results. These analyses were conducted in Stata [185]. Hosmer-Lemeshow goodness-of-fit test was run to determine if the observed values significantly fit the expected values [187]. A non-significant Chi-square test indicates a good fit of the model. This test was conducted using the 'lfit' command.

Error specification was also tested in each of the model, using the 'linktest' command. This test helped in determining if the explanatory variables entered in the models were relevant and if the linear combination of them was sufficient. A non-significant test of variable _hatsq indicates that the model was correctly specified.

Collinearity was also assessed using the 'collin' command. The variance inflation factor (VIF) was examined among the explanatory variables in the final model. VIF below 10 are considered adequate.

To test the overall fit of the model, the Akaike's Information Criterion (AIC) were estimated for all models developed in objective 3 [187]. AIC scores provide information on the goodness of fit of estimated statistical models; it is a model selection method, which helps to compare models to select the most appropriate (best fit). AIC scores were compared to identify the best model. The command 'fitstat' was used to obtain the scores. Lower AIC scores indicated better model

IV. RESULTS

Survey Response Rates

A total of 4,123 households were randomly selected to complete the survey; of those, 3,948 households were approached during the community survey implementation period. One hundred and seventy five households were not approached because the time allocated for SDPRC community survey data collection was completed, thus their eligibility was not assessed. The 3,948 households were located in 200 neighborhoods in the four participating communities. Using the guidelines recommended by the American Association of Public Opinion Research (AAPOR) [188], disposition codes were assigned to each household and survey outcome rates were calculated. To calculate the survey outcome rates, the disposition code of each household was categorized using the AAPOR coding system [188]. Table 4.1 details the disposition codes for households selected. The final household disposition codes were separated into three major categories: eligible, unknown eligibility and ineligible households. Nearly forty four percent (1,726) of the households were eligible, 28.5% (1,126) were ineligible (no Latinos/MI-MA living in the household) and 30.8% (1,271) were visited but of unknown eligibility. For the latter rate, research assistants were unable to assess the eligibility of 97 (7.6%) of the households due to security gates or managers of properties denying them entry into buildings. Eligible households and those of unknown eligibility were summed and used as the denominator to calculate survey completion rates. Figure 4.1 provides a

visual depiction of households selected to participate in the study. This figure provides percentage rates for eligible households and those of unknown eligibility households.

Table 4.1. Summary of final disposition codes for all households randomly selected

AAPOR code	Disposition categories	Legend	N	Percentage
	Eligible		1,726	**43.7%**
1.1	Completed Interview	I	397	23.0%
2.11	Refused	R	1,168	67.6%
2.112	Known respondent refusal	R	95	5.5%
2.25	Respondent away/unavailable	O	66	3.8%
	Unknown eligibility		1,096	**27.7%**
3.17	Unable to enter building/reach housing unit/unsafe area	UH	31	2.8%
3.18	Unable to locate address	UH	66	6.0%
3.20	No one at the residence/no housing unit	UO	999	91.1%
	Ineligible		1,126	**28.5%**
4.51	Business, government office, other organizations	NE	6	0.5%
4.60	Vacant housing unit	NE	108	9.5%
4.70	Ineligible respondent (no Latino/MI-MA households)	NE	1,012	89.8%
	Total households approached		3,948	**100.0%**
3.11	Not attempted or worked[a]	UH	175	
	Total households selected		**4123**	

Legend: I=complete interviews; R=refusals; UH=unknown household eligibility; UO=unknown other; NE= not eligible

[a] not included in total households approached, but included in the outcome rates calculations

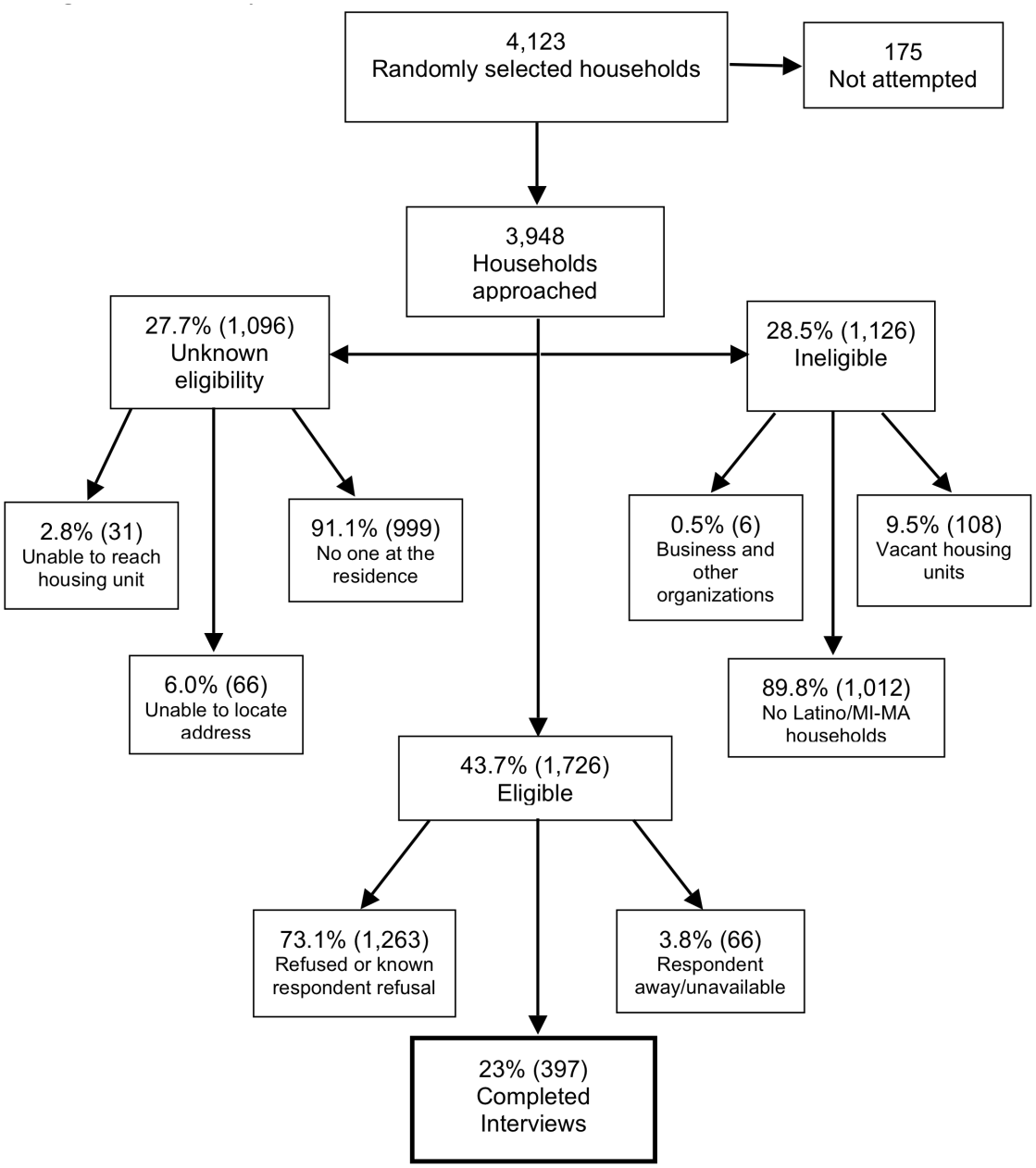

Figure 4.1 Summary of recruitment results

The final outcome rates, the categories included to calculate each of the rates and the equations used to calculate the survey response rates, are presented in Table 4.2. The response rate was estimated at 13.2%. This rate represents the number of completed interviews divided by the number of completed interviews plus the number of refusals plus all cases of unknown eligibility. The cooperation rate was 23.0%, which is the percentage of the number of completed interviews divided by the number of interviews plus the number of non-interviews that were eligible. The contact rate, which assumes that all cases of indeterminate eligibility are actually eligible, was 57.6% and the refusal rate was 42.1%, this is the percentage of refusals divided by the interviews completed plus the refusals plus the unknown eligibility households (AAPOR) [188].

Table 4.2. Outcome Rates[a]

Rates	Equation	Percentage
Response Rate 1	I/I+ (R+O) +(UH+UO)	13.2%
Cooperation Rate 1	I/(I+R+O)	23.0%
Contact Rate 1	I+R+O / I+R+O+(UH + UO)	57.6%
Refusal Rate 1	R/(I+(R+O) + UH + UO)	42.1%
e (estimate of eligibility)	Estimated proportion of cases of unknown eligibility that are eligible	0.60

[a] Outcome rates were calculated according to American Association for Public Opinion Research's Outcome Rate Calculator, Version 2.1, May 2003 (REF).

Legend: I=complete interviews; R=refusals; O= other; UH=unknown household eligibility; UO=unknown other

It was not possible for this study to compare individual-level characteristics of those who completed a survey to those who refused. If the household was not eligible or refused to participate in the study, no further information was obtained

and micro-level data for individuals who refused were unavailable for comparison. However, it was possible to compare households for which a survey was completed to households that refused according to the neighborhood characteristics that were used to randomly select households into the study. Table 4.3 compares households in which a survey was completed to households that refused. Completed interviews were collected in 397 households, and households that refused were those that either the individual approached refused to be screened or agreed to participate but subsequently failed to complete the survey (n=1263). Comparisons were based on three neighborhood characteristics: neighborhood percentage of Latinos, percentage of Latino households and percentage of home ownership. Households in which a survey was completed were in neighborhoods that on average, had a lower percentage of home ownership (27.5%) compared to neighborhoods in which households refused to participate (31.7%; p≤0.005).

Table 4.3. Comparison of respondents to non-respondent households[a]

	Households		
Macro-level variables (neighborhood)	**Completed interviews n= 397 (M±SD)**	**Refused n= 1263 (M±SD)**	**p-value**
Percentage of Latinos	67.7± 16.4	66.1± 18.1	0.091
Percentage of Latino [b] households	60.7± 17.7	59.0± 19.0	0.099
Percentage of Homeownership	27.5± 23.8	31.7± 27.1	0.005

[a] eligibility into the study was assessed

[b] total number of households as Latino in the neighborhood divided by total number of households in the neighborhood.

Data Screening Procedures

Three hundred and ninety-seven self-identified Latinos completed the SDPRC Community Survey in 2009; of those 380 (95%) individuals had BMI data. Of the 17 individuals with missing data, three refused, one was a proxy survey, one respondent was unable to complete the measures due to foot surgery, one respondent was in a wheelchair, three respondents had measurements deemed unreliable and eight were missing.

Micro-level variables (sex, income, marital status, education, employment and country of birth) and health behaviors (met physical activity guidelines and weekly fast food), were dichotomized, as outline in the methods. Age and household size were preserved as continuous variables.

Five explanatory variables, reciprocity, civic organization membership, civic organization meeting attended last month, number of border crossing and reasons to cross the border were further treated to meet normality and address collinearity between variables.

Reciprocity (meso level variables, social network) was not normally distributed. The mean reciprocity was 219.6±361.45, with a range of .50 to 5475.0. To correct the distribution of the data, nine responses 2SD above the mean, (≥ 943) were considered outliers and removed from the variable. The final sample size for analyses involving reciprocity was 379.

Civic organization membership and number of meetings attended last month (meso level variables, civic participation) were recoded to preserve the

sample size of the study. A large proportion of respondents did not participate in any civic organization (56.7%), reducing the sample size of respondents who attended a civic group meeting in the last month to 168. To maximize the sample size, respondents who did not participate in a civic group were coded as having attended 0 meetings in the last month. In addition, when these two questions were included in the analysis, they were highly and significantly correlated r=.579 ($p \leq 0.01$). The two questions, participation in civic groups and attended meetings last month were included in the descriptive, bivariate and factor analyses. These two variables were included in the former analyses because: 1) they provide data to describe the level of involvement of the individual, 2) in the bivariate analysis the variables were independently regressed on obesity, avoiding the problem of collinearity, and 3) to examine the overall shared variance of these two variables in the construct, social capital. However, for the final main effect hierarchical model these two questions were combined into one question as number of civic group meetings attended last month. This variable represented the level of involvement in civic groups including non-involvement.

Crossing the border in the last month was not normally distributed. Almost half of the respondents reported not crossing and 6 respondents reported crossing the border 30 or more times a month; the range of values for this variable was 0 to 52. To address this issue, several procedures were conducted to bring this variable to a normal distribution. Three modifications were conducted on the variable. First, the variable was dichotomized into crossing (1) and not

crossing (0). Second, the variable was categorized into three levels: no crossing (0), crossing one time (1), crossing twice or more (2) and third, the original continuous variable was log10+1 transformed. The original continuous variable was used to conduct the proposed bivariate and hierarchical analyses to demonstrate the associations observed and to ease interpretation. The hierarchical model was then run using the modified variables. The analyses with the modified variables were conducted to explore if by correcting the distribution of the variable, the results observed with the original variable would remain the same or change.

The reasons for crossing the border followed the question on how many times the individual crossed the border into Mexico in the last month. If the individual reported none or '0' times, the reasons for crossing the border item was skipped. However, by doing so almost half of the sample was not asked reasons for crossing the border, thus reducing the sample size. To correct the sample reduction, individuals who did not cross the border were coded as 'not having a reason to cross' and included into the reasons for crossing the border question. The new four categories variable was converted into four dummy variables using the 'xi' command in STATA. These four categories are reported in Table 4.8 for descriptive purposes. For the bivariate and hierarchical analyses, reasons for crossing: friends and family, business and medical were included as independent variables and no border crossing was used as the reference

category. These variables were not included in the factor analysis for cultural exchange because of the binary nature of the variables.

At the macro-level of influence, the study completed surveys from individuals living in 98 different neighborhoods. Forty-four neighborhoods had one survey completed, in the remaining neighborhoods, between 2 and 29 surveys were completed. To adjust for the distribution of surveys completed by neighborhood and the within neighborhood clustering, the 'cluster' command in STATA was added to the bivariate and hierarchical logistic regressions analyses.

Scale Psychometric Properties

The psychometric properties of the two validated scales used in the study were examined to determine if the scales maintained their psychometric integrity in this MI-MA sample. The Cronbach's alpha for collective efficacy in this study was .75 compared to .77 reported by Cohen and colleagues [25] in a sample of Los Angeles residents. This score suggests adequate reliability of the scale in this sample of respondents.

The Cronbach's alpha for the acculturation scales were found adequate and comparable to the scores reported in the validation study [134]. In the validation study, the reliability score for the Hispanic domain was .93 and the non-Hispanic domain was .97. In this study, the Hispanic domain reliability score was .89 and the non-Hispanic domain reliability score was .95, indicating high reliability for these scales. Table 4.4 presents the coefficients.

Table 4.4. Scale psychometric properties

Scale	N items	N	Alpha
Collective efficacy	8	363	.746
Hispanic domain	12	390	.894
Non-Hispanic domain	12	377	.958

Description of the Sample and Obesity Rates

Table 4.5 presents the demographic characteristics of the total sample, and by those categorized as obese and by gender. Table 4.6 shows BMI and health behavior information. The average age of the sample was 43.4 (16.9) years old, with a range of 18 to 89 years. The majority of the respondents were female (72.6%). Fifty-nine percent were married or lived as married, with a median household size of 4, ranging from 1-4 members. Over three quarters of the sample were born in Mexico or another Latin-American country, and the average number of years respondents had lived in the US was 23.9 (15.4), ranging from 6 months to ninety eight years. Fifty-three percent of the sample reported an individual income for 2008 that positioned them below or at the national poverty threshold. Almost half of the respondents completed high school or a higher level of education (46.8%) and were employed at the time of the interview (46.0%). Significant differences were found between men and women on income, employment.

The mean BMI for the total sample was 30.6 (7.3) and the average female BMI was 30.9 (8.0) comparable to the males' 29.8 (5.2). Almost half were categorized as obese (BMI ≥30.0). Meeting physical activity guidelines and weekly consumption of fast food were two factors associated with obesity

controlled for in this study. Among the total sample, 44.5% met the physical activity guidelines of 150 minutes a week of moderate to vigorous physical activity, including 41% obese respondents. Significant differences in health behaviors were observed between men and women. A significantly higher percentage (58.1%) of males met the physical activity guidelines compared to females (39.1%) ($p \leq .01$). Significant gender differences were also found for fast food consumption with a higher percentage of males reporting weekly fast food consumption (72.9%) compared to females (57.4%) ($p \leq .01$). Overall 62% of individuals reported consuming fast food one or more times per week.

Table 4.5. Socio-Demographic characteristics of Mexican immigrants and Mexican-Americans living on the US–Mexico border in Southern California

Participant Characteristics	Total sample % (n)	Obese % (n)	Female % (n)	Male % (n)
	397	46.8 (178)	72.6 (283)	27.4 (107)
Female	72.6 (283)	75.3 (131)		
Age (M±SD)	43.4±16.9	46.1±16.3	43.1±16.8	44.0±17.6
Household size (median; range)	4 (1-10)	3 (1-8)	4 (1-9)	3 (1-8)
Married or living as married	59.7 (236)	66.1 (177)	57.3 (161)	66.4 (71)
Completed ≥ HS	46.8 (182)	41.2 (73)	44.7 (126)	50.5 (54)
Employed	46.0 (182)	41.8 (74)	42.6 (120)	54.2 (58) [b]
Individual income ≤ poverty	53.2 (181)	49.0 (74)	64.6 (153)	26.5 (26) [a]
Born in Mexico	77.0 (305)	72.9 (129)	77.3 (218)	75.7 (81)
Years living in the US	23.9±15.4	25.5±15.4	23.1±15.2	25.6±15.4

[a] significant gender differences $p \leq 0.01$
[b] significant gender differences $p \leq 0.05$

Table 4.6. Body mass index and obesity-related health behaviors of Mexican immigrants and Mexican-Americans living on the US–Mexico border in Southern, CA

Characteristics	Total sample % (n)	Obese	Female	Male
BMI (M±SD)	30.6±7.3	36.0±7.1	30.9 ± 8.0	29.8 ±5.2
Met physical activity guidelines	44.5 (175)	41.1 (72)	39.1 (110)	58.1 (61)[a]
Consumed fast food ≥ once per week	61.6 (244)	61.0 (108)	57.4 (162)	72.9 (78)[a]

[a] significant gender differences at p≤ .01

Of the four participating communities in the study, San Ysidro had the highest percentage of obese respondents, closely followed by National City and Chula Vista with 50.6%, 47.5% and 42.6% respectively. Table 4.7 illustrates the breakdown of obesity rates by community.

Table 4.7. Obesity rates by participating community

Communities	Completed survey n=380	Obese % (n)	Non-obese % (n)
San Ysidro	89	50.6 (45)	49.4 (44)
Chula Vista	101	42.6 (43)	57.4 (58)
Imperial Beach	7	42.9 (3)	57.1 (4)
National City	183	47.5 (87)	52.5 (96)

In summary, the Mexican immigrants and Mexican Americans in this sample were middle aged, mostly female and living below the poverty line. Almost half of the sample was obese. The highest concentration of obese individuals was in the City of San Ysidro.

Description Statistics on Cultural Exchange and Meso and Macro Level Variables

Table 4.8 presents descriptive statistics of the correlates of obesity selected for this study. They are presented by level of influence, starting with cultural exchange, followed by meso level of influence and finally macro level of influence. Forty nine percent of the respondents reported not crossing the border to Mexico in the last month. For those who crossed, they crossed the border an average of 2.4 (5.1) times in the month previous to the interview. The most frequent reason why respondents crossed the border was to visit family and friends (84.1%). Respondents scored higher in the Hispanic domain of acculturation 3.5 (.53) and lower in the non-Hispanic domain scale 2.4 (.88), indicating that respondents predominantly used Spanish language most often in their communication, were more proficient in Spanish and utilized electronic media in Spanish. Significant differences were found between females and males on both Hispanic domain and non-Hispanic domain scores, indicating that females compared to males preferred to communicate and use media in Spanish. Males scored higher in the non-Hispanic domain compared to females suggesting that males were slightly more proficient and comfortable communicating and consuming media in English.

On the collective efficacy scale, respondents scored an average of 3.5 (.73), indicating moderate to high willingness and intention to act on behalf of their neighbors' well being. The median size of the respondent's social networks was 4 (1-5), with an average reciprocity of 14.9 (12.7) times a month. This

suggests that respondents maintained constant contact with their network, as high as 4 times a week. There was a significant difference between females and males in reciprocity. Females were significantly more likely than males to ask for help or to provide help to her social network ($p \leq .05$). Forty-three percent of the respondents belonged to a civic organization in their neighborhood, and 42.3% had attended one or more civic organization meetings in the last month. Respondents scored 2.8 (.56) on the trust scale, indicating that they somewhat trusted organizations and sources of information in their neighborhood.

At the macro level of influence, the percentage of Latinos and the percentage of home ownership were examined. The neighborhoods randomly selected into the study were on average 68.1% Latinos, but had a lower percentage of home ownership at 27.0%. These results indicate high ethnic Latino concentration and lower residential stability in the randomly selected neighborhoods.

In summary, half of the respondents crossed the border to Mexico in the last month to visit family and friends. Respondents scored higher in the Hispanic domain scale, indicating a preference for the Spanish language. Their social ties and reciprocity were high. Low civic participation and moderate collective efficacy and trust were observed. Neighborhoods in which respondents lived appeared to have high proportions of Latinos and low homeownership.

Bivariate Analysis of Socio-Ecological Correlates on Obesity

To achieve objective one of this study, univariate logistic regressions were run on obesity, controlling for age and sex on each of the correlates of interest. Age was significantly associated with obesity, indicating older individuals were 1.02 times more likely to be obese than younger individuals ($p \leq .004$). Controlling for age and sex, respondents who were unemployed and born in the US were more likely to be obese. Unemployed individuals were 1.44 times more likely than employed individuals to be obese ($p \leq .05$). Similarly, respondents born in the US were 2.3 times more likely to be obese than their counterparts born in Mexico ($p \leq .003$). No other micro-level variables or health behaviors were significantly associated with obesity.

At the cultural exchange level of influence, only the Hispanic domain score was significantly associated with risk of obesity. Individuals who scored lower on the Hispanic domain scale (less comfortable speaking in Spanish) were twice as likely to be obese than those who scored higher in the Hispanic domain scale (prefer to communicate in Spanish) ($p \leq .05$).

Among the meso-level variables only reciprocity appeared to have a trend. After controlling for age and sex; individuals with higher reciprocity were more likely to be obese than those who reported lower levels of reciprocity ($p \leq .05$).

Variables at the macro level of influence were not significantly associated with obesity. Table 4.9 presents these bivariate associations.

Table 4.8. Correlates of obesity among Mexican immigrants and Mexican-Americans living on the US–Mexico border in Southern, CA

Characteristic	Total Sample (M±SD) %(n)	Obese	Female	Male
Cultural Exchange				
Number of times crossed the border in the last month	2.4±5.1	2.7±5.2	2.3±4.93	2.6 ±5.5
Did not cross the border	49.1(194)	45.2(80)	49.1(138)	47.7(51)[a]
Top reason to cross				
Family and friends	84.1 (169)	83.5 (81)	85.3(122)	80.4 (45)[b]
Medical	12.4 (25)	14.4 (14)	13.3 (19)	10.7 (6)[b]
Business	3.5 (7)	2.1(2)	1.4 (2)	8.9 (5)[b]
Hispanic Domain	3.5±.53	3.5 ± .56	3.6 ±.49	3.4 ±.57[b]
Non-Hispanic Domain	2.4±.88	2.3 ± .91	2.3 ±.88	2.6 ±.86[b]
Meso level of influence				
Collective Efficacy[c]	3.5±.73	3.5 ±.72	3.4 ±.74	3.5 ±.71
Size of network	4 (1-5)	4 (1-5)	3.5 ± 1.3	3.5 ± 1.2
Reciprocity	179.5±153.4	196.8±164.2	191.7 ±154.3	151.7 ±149.7[b]
Trust[c]	2.8±.56	2.8 ± .57	2.8 ±.54	2.8 ±.60
Participate ≥1 civic organizations	43.3 (172)	42.7 (76)	42.4 (120)	43.9 (47)
Attended ≥1 meetings last month	42.3 (168)	29.3 (22)	41.0 (116)	43.9 (47)
Macro level of influence				
Percentage of Latinos	68.1±16.1	69.8 ±16.3	67.8 ±16.7	68.2 ±14.6
Percentage home ownership	27.0±23.8	25.2±22.1	25.9 ±23.9	30.0 ±25.7

[a] trends in gender differences at $p \leq 0.10$

[b] trends in gender differences at $p \leq 0.05$

[c] higher score indicates higher collective efficacy or trust

Table 4.9. Correlates of obesity among Mexican immigrants and Mexican-Americans living on the US–Mexico border in Southern, CA

Variable	Odds	Robust SE[b]	p value	95% CI	Pseudo R^2
Micro-level predictors – socio-demographics					
Age[a]	1.02	.007	**0.004**	1.01-1.03	0.024
Female[a]	1.25	.280	0.313	.80-1.94	0.001
Married	1.42	.323	0.118	.91-2.22	0.034
Completed HS or greater	.84	.192	0.452	.53-1.31	0.030
Employed	.69	.126	**0.048**	.48-.99	0.030
Income below poverty level	.67	.160	0.094	.41-1.07	0.029
Born in Mexico	.43	.120	**0.003**	.25-.75	0.048
Household size	1.08	.080	0.294	.93-1.25	0.030
Health Behaviors					
Met LTPA guidelines	.81	.146	0.252	.57-1.15	0.030
Ate fast food ≥1 time per week	1.37	.335	0.190	.85-2.21	0.032
Cultural Exchange					
Frequency of crossing the border	1.01	.024	0.497	.09-1.06	0.029
Business reason	.79	.768	0.810	.11-5.29	0.028
Leisure family & friends reason	1.03	.223	0.866	.67-1.58	0.028
Medical reason	1.64	.644	0.205	.76-3.54	0.031
Non-Hispanic domain	1.10	.189	0.557	.79-1.54	0.030
Hispanic domain	.54	.136	**0.016**	.33-.89	0.045
Meso-level predictors					
Collective efficacy	.94	.171	0.752	.66-1.34	0.027
Size of social network	1.12	.091	0.145	.95-1.32	0.033
Reciprocity	1.00	.000	**0.020**	1.00-1.00	0.041
Participate in civic organizations	.93	.190	0.759	.63-1.39	0.028
Attended meetings last month	.95	.191	0.831	.64-1.41	0.028
Trust	.73	.165	0.176	.47-1.14	0.033
Macro-level predictors					
Percentage of Latinos	2.68	1.91	0.164	.66-10.83	0.032
Percentage of homeowners	0.43	0.218	0.097	0.16-1.16	0.034

[a] Bivariate analysis regressions were not controlled for any other covariate

[b] Controlled for neighborhood clustering: using robust standard errors to control for within neighborhood clustering

Factor Analysis, Reliability and Scale Properties

Two factor analyses were conducted to examine the extent to which the variables theoretically selected to represent the concept of cultural exchange level of influence and the construct of social capital were present in this sample of MI-MA. This was an objective of the study because the concept of cultural exchange was developed for this study and social capital has not been established or explored among MI-MA. Examining the presence of these concepts among the individuals surveyed was important to guide further multilevel analyses. Furthermore, the factor analyses would help determine if a factor score could be created to represent the cultural exchange concept and social capital construct in the final hierarchical model.

Factor Analysis for Cultural Exchange

A factor analysis was conducted to examine the shared linear association of the variables included in the cultural exchange level of influence. Variables included at this level were: number of times in the last month the respondent crossed the border, and the Hispanic and Non-Hispanic domains of acculturation. Table 4.10 presents the bivariate correlations between the variables representing cultural exchange. The Hispanic and non-Hispanic domains were negatively and highly correlated as expected, since these two scales are part of the same construct, i.e. acculturation. Number of crossings to Mexico in the last month did not load with the Hispanic and non-Hispanic domain scores.

Table 4.11 presents the results of the factor analysis. Of the three variables included in the cultural exchange level of influence, one factor appeared, explaining 53.06% of the variance. As expected, the acculturation domains highly loaded into one factor, with a factor loading of -0.849 for the Hispanic domain and -.877 for the non-Hispanic domain. The number of crossings in the last month appeared with an eigenvalue of 0.969, marginally below the expected 1.000 eigenvalue and the factor loading was below the 0.60 threshold at 0.319. However, this crossing the border explained 32.29 of the cultural exchange level variance. This factor structure was not as expected, as the study hypothesized that one factor structure would emerge from these variables. This result did not confirm the hypothesis that these variables share significant common variance to represent the cultural exchange latent level. However the significant bivariate correlation indicates that there is a significant and positive association between the Hispanic domain acculturation score and crossing to Mexico in the last month (Table 4.10). No further analyses were conducted using the suggested factor. Variables included in the cultural exchange level were treated as separate variables. This decision allowed observing the independent association of each of the variables with obesity.

Table 4.10. Bivariate correlations of variables included in the cultural exchange level of influence

	Number of crossings last month	Hispanic domain	Non-Hispanic domain
Number of crossings last month	1.000		
Hispanic domain	.158[a]	1.000	
Non-Hispanic domain	-.059	-.552[a]	1.000

[a] Correlation significant at the p ≤0.01
[b] Correlation significant at the p ≤0.05

Table 4.11. Varimax rotation factor pattern for the cultural exchange level of influence (loading ≥ 0.60) in 395 MI-MA respondents

Factors Variables	Factor loading	Eigenvalues	% Variance explained[a]
Acculturation		1.592	53.06
Non-Hispanic domain	0.877		
Hispanic domain	-0.849		
Crossing the border[b]		0.969	32.29
Number of crossing in the last month	0.319		

[a] Total variance explained 85.35%
[b] Results from this variable were included for descriptive purposes

Factor Analysis for Social Capital

A factor analysis was conducted to assess whether there was a linear association of variables theoretically indicated as social capital. Five variables were included in the analysis to determine if these variables represented the latent construct of social capital among the MI-MA study sample and could compose one factor score that could be used in the final hierarchical main effects model. The variables examined were size of the network, reciprocity, number of

civic organizations the respondent belonged to, number of meetings attended in the last month and trust. Table 4.12 shows the bivariate association of these variables. The correlation coefficients indicated a weak association between the variables. Only the number of meetings attended in the last month and the total number of civic groups the respondent belonged to were highly associated at r=.746 ($p \leq 0.01$). The observed associations between the variables were in the expected direction, except number of meeting attended last month and reciprocity, which were negatively associated. This indicates that the more meetings a respondent attended in the last month, the lower the reciprocity the respondent reported.

The factor analysis yielded two factors, explaining 59.5% of the total variance of social capital. Total number of meetings attended in the last month and number of civic organizations the respondent belonged to loaded into the first factor. This factor represents the civic involvement component of social capital. The second factor was composed of the respondents' size of network and reciprocity. Factor loadings for size of network and reciprocity were above the >.60 threshold. This factor may reflect the individual's social support in the forms of their network and reciprocity. However the factor loading for trust was below the threshold (>.60) and therefore could not be considered as part of the second factor. Table 4.13 presents the factor loadings for social capital.

The observed variance explained, factor loadings and factor structure suggest that four of the five variables may represent the latent construct of social capital in this MI-MA sample, partially confirming the study's hypothesis that

these variables (including trust) would form on factor to represent the social capital. Based on the observed factor structure it was decided to examine the influence of social capital variables as independent correlates in further analyses. This approach is consistent with previous studies, which have examined the association of social capital and health outcomes, using these variables as independent correlates [98].

Table 4.12. Bivariate correlations of variables included in the social capital construct part of the meso-level of influence

	Size of network	**Reciprocity**	**Number of civic org. groups**	**Mtg attended last month**	**Mean trust**
Size of network	1.000				
Reciprocity	.141[a]	1.000			
Number of civic org. groups	.183[a]	.027	1.000		
Mtg attended last month	.113[b]	-.035	.746[a]	1.000	
Mean trust	.109	.018	.131[b]	.112[b]	1.000

[a] Correlation significant at the p ≤0.01
[b] Correlation significant at the p ≤0.05

Table 4.13. Varimax rotation factor pattern for social capital construct (loading ≥ 0.60) in 379 MI-MA respondents

Variables[a]	Factor Loading	Eigenvalues	% Variance explained[b]
Civic organizations		1.847	36.94
Meetings attended last month	.924		
Number of civic organizations belonged to	.912		
Social networks		1.129	22.58
Size of social network	.709		
Reciprocity	.743		
Trust[a]	.347		

[a] Trust did not meet the threshold of inclusion in the social network factor, it was included in the table for descriptive purposes.
[b] Total variance explained 59.52%

Macro Level of Influence Associations

Table 4.14 presents the bivariate correlation of the two selected macro-level variables. No factor analysis was conducted at this level, because these two variables represent independent and distinct constructs at this level of influence. As observed in the bivariate association, percentage of Latinos in the neighborhood and percentage of home ownership were significantly and negatively associated with each other ($p \leq 0.01$). This association suggested that the higher the Latino ethnic concentration, the lower the percentage of home ownership.

Table 4.15 Bivariate correlation of macro-level variables

	Percentage Latinos	**Percentage homeownership**
Percentage Latinos	1.000	
Percentage homeownership	-0.166[a]	1.000

[a] Correlation significant at the p ≤0.01

Hierarchical Logistic Regression Model

Obesity (binary outcome) was regressed on 3 levels of influence, controlling for micro-level influences, health behaviors and clustering within neighborhood. Table 4.16 shows the steps taken to build the final main effects model. The final model explained 68.01% (Percent concordant pairs) of the total variance in obesity. Model 1, cultural exchange explained 60.05% of the variance. Model 2, meso level of influence, consisting of social capital variables and collective efficacy explained an additional 1.34% of the variance. The macro-level variables contributed just over one percent of the explained variance in obesity (62.78%). The micro level of influence and obesity-related health behaviors explained most of the variance at 67.68%.

All variables theoretically selected for this study were included in the final model. Of the correlates of interest for this study, the Hispanic domain score and the non-Hispanic domain score, at the cultural exchange level, were significantly related to obesity across the model building process. At the meso level of influence, size of the network and reciprocity were significantly associated with obesity across the model building process. In addition, in the final model (Model 5) income, employment, size of the network and age were the only variables that

remained significantly associated with obesity. Respondents who had an annual income above the poverty threshold (OR= 2.04, CI= 1,23, 3,70) and who were unemployed (OR=1.01, CI= 1,49, 2,85) were significantly more likely to be obese, compared to respondents who were employed and had an income below the poverty threshold. Respondents with larger social networks were 1.20 times more likely to be obese than those respondents with smaller social networks. Older adults were 1.03 times more likely to be obese than younger respondents. No other correlate was significantly associated with obesity in the hierarchical model.

Table 4.18 presents the results from the alternative models built with the modified crossing the border variables. The results observed using the original distribution of the data were not observed in the replication of the analyses conducted with the modified variables. Because the crossing the border variable was part of a developmental concept in this study, the results from the original analyses were kept and presented in the results.

Model Diagnostics and Goodness-of-Fit

Hosmer-Lemeshow goodness-of-fit

The non-significance test of goodness-of-fit indicated that the observed frequency of the data and the predicted frequency of the data matched closely and therefore the model had an adequate fit. The chi-square statistic was 4.41 (df=8); p= 0.818.

Variance inflation factor (VIF)

Collinearity was tested among all variables in the final main effects model. The VIF was calculated for each of the variables. The VIF is calculated as $VIF_j = 1/1-R^2_j$ [189]. A VIF score of ≥10 suggests further examination of the collinearity of the variables. The command 'collin' was used in STATA to run the collinearity diagnostics. The VIF values for the hierarchical model ranged from 1.06 to 1.63. The VIF values of the variables in the final main effects model were below the threshold, indicating that collinearity of the variables was not a problem.

Model specification error

Each model built in the hierarchical logistic regression was tested for error specification. In all models, the error specification was estimated by creating two variables, the '_hat' and the '_hatsq'. The former variable _hat was estimated as the variable of prediction and '_hatsq' as the variable of squared prediction. Then the models are refitted to assess the specification error. For an adequate model specification error '_hat' should significant and '_hatsq' should not be significant. In the final main effects model, both the '_hat' variable was significant and the '_hatsq' was not significant, indicating that the model was specified correctly.

Interactions

Several interaction terms were examined between selected cultural exchange variables and meso- and macro-level correlates. Table 4.17 shows all

interaction terms generated and included in the final model. Two interaction terms were significantly associated with obesity when entered in the final model (Model 5), the number of times the respondent crossed the border in the last month and collective efficacy. This interaction term is between a cultural exchange level of influence and a meso-level variable. A second interaction term between the Hispanic domain score and the percentage of home ownership was significant. This was a cross-level interaction between cultural exchange level of influence and macro-level variable. The model (Model 6) that included both interactions explained less than 1% of variance for a total variance explained of 68.01%. No other interaction terms were significant.

Table 4.18 describes the interaction tested with the modified border crossing variables. The interaction effect observed between crossing the border and collective efficacy using the original variable was not observed in any of the alternative models in which crossing the border variable was modified to correct for its distribution. No significant interactions were observed between the modified crossing the border variables and collective efficacy.

Table 4.16 Hierarchical Logistic Regression model for obesity

Correlates	Variance	Model 1		Model 2		Model 3		Model 4		Model 5	
	Percent concordant pairs	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI
Model 1: Cultural Exchange	60.05%										
Frequency of cross the border		1.02	0.96, 1.07	1.02	0.96, 1.08	1.02	0.95, 1.08	1.09	0.99, 1.19	1.08	0.99, 1.18[a]
Business reason[e]		0.57	0.09, 3.46	0.62	0.08, 4.34	0.64	0.08, 5.06	0.27	0.02, 3.20	0.29	0.02, 3.44
Leisure family & friends reason[e]		1.25	0.77, 2.03	1.19	0.70, 2.00	1.19	0.71, 2.01	0.77	0.43, 1.39	0.81	0.44, 1.48
Medical reason[e]		2.03	0.91, 4.49	1.86	0.81, 4.25	1.91	0.83, 4.40	1.24	0.47, 3.26	1.39	0.50, 3.81
Hispanic domain		0.46	0.26, 0.80[c]	0.43	0.24, 0.74[c]	.042	0.24, 0.74[c]	0.41	0.20, 0.84[c]	0.41	0.20, 0.86[b]
Non- Hispanic domain		0.69	0.50, 0.96[b]	0.65	0.47, 0.91[b]	0.66	0.48, 0.92[b]	0.73	0.46, 1.15	0.75	0.47, 1.18
Model 2: Meso level	61.39%										
Collective efficacy				0.96	0.67,1.38	0.98	0.69, 1.41	0.99	0.65, 1.52	0.99	0.64, 1.55
Size of social network				1.18	0.99,1.40	1.16	0.98, 1.37	1.19	1.01,1.40[b]	1.20	1.02, 1.41[b]
Reciprocity				1.00	1.00, 1.00[b]	1.00	1.00,1.00[c]	1.00	0.99,1.00	1.00	0.99, 1.00[a]
Civic org. meetings				0.92	0.63, 1.35	0.87	0.59, 1.29	0.91	0.57, 1.45	0.86	0.53,1.40
Trust				0.86	0.56,1.31	0.87	0.57, 1.34	1.02	0.61, 1.70	0.99	0.59, 1.67
Model 3: Macro level	62.78%										
Perc. Latinos						2.29	0.41,12.58	2.56	0.33, 19.34	2.81	0.35, 22.44
Perc. homeownership						0.64	0.21, 1.97	0.32	0.07,1.36	0.31	0.07, 1.34

[a] p≤.10; [b] p≤.05; [c] p≤.01; [d] p≤.001. [e] reference category: no reason to cross the border

Table 4.16 Hierarchical Logistic Regression model for obesity (continue)

Correlates	Variance	Model 1		Model 2		Model 3		Model 4		Model 5	
	Percent concordant pairs	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI
Model 4: Micro level	68.67%										
Age								1.03	1.01, 1.05[c]	1.03	1.01, 1.05[c]
Female								1.43	0.74, 2.77	1.42	0.72, 2.83
Completed HS or more								0.76	0.42, 1.36	0.74	0.40, 1.34
Born in Mexico								0.40	0.16, 1.02[a]	0.41	0.16, 1.03[a]
Total household size								1.11	0.92, 1.34	1.10	0.91,1.34
Married								1.31	0.70, 2.44	1.39	0.73, 2.67
Income below poverty								0.46	0.25, 0.82[b]	0.49	0.27, 0.89[b]
Employed								0.56	0.35, 0.88[b]	0.55	0.35, 0.87[b]
Model 5: Health Behaviors	67.68%										
Met physical activity guidelines										0.94	0.58, 1.52
Weekly fast food										1.19	0.63,2.24

[a] p≤.10; [b] p≤.05; [c]p≤.01; [d]p≤.001.

[e] reference category: no reason to cross the border

Table 4.17. Interactions terms examined[c]

Interaction terms	**Obese**	
	OR	CI
Cross the border x collective efficacy	1.10	1.04, 1.16[b]
Cross the border x size of networks	0.97	0.91, 1.02
Cross the border x reciprocity	0.99	0.99, 1.00
Cross the border x meeting attended	0.97	0.85,1.11
Cross the border x trust	1.03	0.92, 1.14
Cross the border x perc. Latinos	0.92	0.69, 1.41
Cross the border x perc. homeownership	1.06	0.89, 1.26
Hispanic domain x collective efficacy	0.98	0.52, 1.86
Hispanic domain x size of network	1.10	0.72, 1.66
Hispanic domain x reciprocity	0.99	0.99, 1.00
Hispanic domain x meeting attended	0.98	0.38, 2.64
Hispanic domain x trust	0.58	0.21, 1.55
Hispanic domain x perc. Latinos	40.68	0.38, 4352.26
Hispanic domain x perc. homeownership	0.08	0.01, 0.70[a]
Non-Hispanic domain x collective efficacy	1.16	0.83, 1.16
Non-Hispanic domain x size of network	0.86	0.65, 1.13
Non-Hispanic domain x reciprocity	1.00	0.99, 1.00
Non-Hispanic domain x meeting attended	0.75	0.44, 1.30
Non-Hispanic domain x trust	1.41	0.82, 2.41
Non-Hispanic domain x perc. Latinos	0.32	0.07, 1.30
Non-Hispanic domain x perc. homeownership	2.19	0.72, 6.62

[a] $p \leq .05$; [b] $p \leq .01$

[c] Introduced interaction terms one at the time in the final Model 5, which controlled for neighborhood clustering, micro-level influences and health behaviors.

Table 4.18. Alternatives hierarchical logistic regression models for obesity with binary variable, three categories and the log transformed and centered crossing the border variable.

Correlates	Alternative Model binary crossing the border (A)[f]		Alternative Model three categories crossing the border (B)[f]		Alternative Model Log and centered crossing the border (C)[g]	
	OR	CI	OR	CI	OR	CI
Model 1: Cultural Exchange						
Frequency of cross the border	0.84	0.04, 15.22	1.02	0.22, 4.71	0.24	0.00, 7.39
Business reason[e]	0.69	0.54, 8.78	0.36	0.19, 6.75	0.28	0.02, 2.96
Family & friends reason[e]	0.63	0.22, 1.75	0.30	0.06,1.44	0.46	0.19, 1.12
Medical reason[e]	-	-	0.50	0.09, 2.70	0.83	0.26, 2.63
Hispanic domain	0.45	0.21, 0.92[b]	0.43	0.21, 0.89[b]	0.41	0.20, 0.85[b]
Non- Hispanic domain	0.73	0.46, 1.15	0.74	0.47, 1.16	0.75	0.48, 1.18
Model 2: Meso level						
Collective efficacy	0.88	0.49, 1.58	0.82	0.45, 1.47	0.98	0.66, 1.46
Size of social network	1.21	1.04, 1.42[b]	1.23	1.05, 1.43[b]	1.24	1.05, 1.45[c]
Reciprocity	1.00	0.99, 1.00	1.00	0.99, 1.00	1.00	0.99, 1.00
Civic org. meetings	0.85	0.53, 1.35	0.85	0.53, 1.36	0.84	0.53, 1.35
Trust	1.04	0.60, 1.77	1.02	0.61, 1.73	1.02	0.59, 1.75
Model 3: Macro level						
Perc. Latinos	3.09	0.41, 23.2	3.30	0.45, 23.8	3.39	0.44, 25.7
Perc. homeownership	0.29	0.06, 1.25	0.28	0.06, 1.25	0.30	0.06, 1.32
Model 4: Micro level						
Age	1.03	1.01, 1.05[c]	1.03	1.01, 1.05[c]	1.03	1.01, 1.05[c]
Female	1.40	0.70, 2.80	1.28	0.62, 2.63	1.31	0.64, 2.70
Completed HS or more	0.76	0.42, 1.38	0.74	0.40, 1.36	0.72	0.38, 1.33
Born in Mexico	0.40	0.16, 0.99	0.40	0.16, 0.97	0.41	0.16, 1.03
Total household size	1.10	0.91, 1.33	1.08	0.90, 1.31	1.08	0.90, 1.31
Married	1.35	0.70, 2.59	1.36	0.71, 2.60	1.40	0.73, 2.67
Income below poverty	0.49	0.27, 0.87[b]	0.52	0.29, 0.91[b]	0.48	0.26, 0.88[b]
Employed	0.53	0.33, 0.83[a]	0.53	0.34, 0.84[c]	0.50	0.32, 0.79[c]
Model 5: Health Behaviors						
Met physical activity guidelines	0.96	0.59, 1.54	0.91	0.57, 1.47	0.93	0.58,1.48
Weekly fast food	1.27	0.68, 2.39	1.13	0.57, 2.24	1.13	0.59, 2.15
Interaction						
Crossing X Collective efficacy	1.23	0.58, 2.63	1.22	0.80, 1.85	2.24	0.86, 5.79

[a] p≤.10; [b] p≤.05; [c]p≤.01; [d]p≤.001. [e] reference category: no reason to cross the border. [f] model that includes crossing the border as log inverse transformed/ results are similar that centered Log inverse transformation no interaction term

Interpretation of Interaction Terms

To examine the effect of the interaction terms on obesity, the predicted values for these interactions were calculated and plotted. Figures 4.2 and 4.3 show the interactions terms.

Figure 4.2 shows the stratification of percentage of home ownership 1SD below the mean (low), at the mean (moderate) and 1SD above the mean (high). There seemed to be a gradient effect of neighborhood percentage of home ownership on acculturation. Living in neighborhoods with a higher percentage of homeowners strengthened the association of preferring to speak Spanish (less acculturation) and obesity, compared to respondents who lived in neighborhood with moderate and low home ownership. Individuals who preferred to speak Spanish (higher on the Hispanic domain) were less likely to be obese if they lived in neighborhoods with a higher percentage of home ownership.

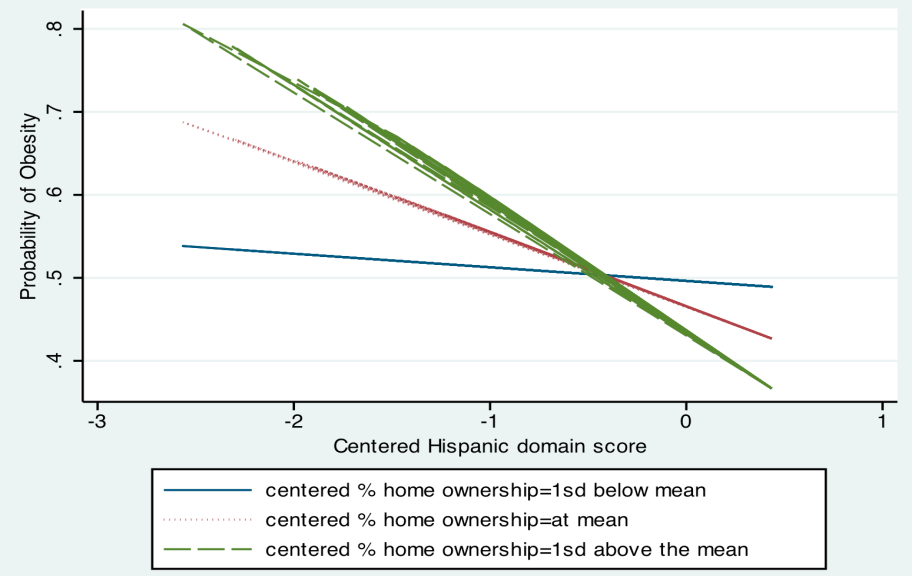

Figure 4.2. Interaction between percentage of home ownership and Hispanic domain score

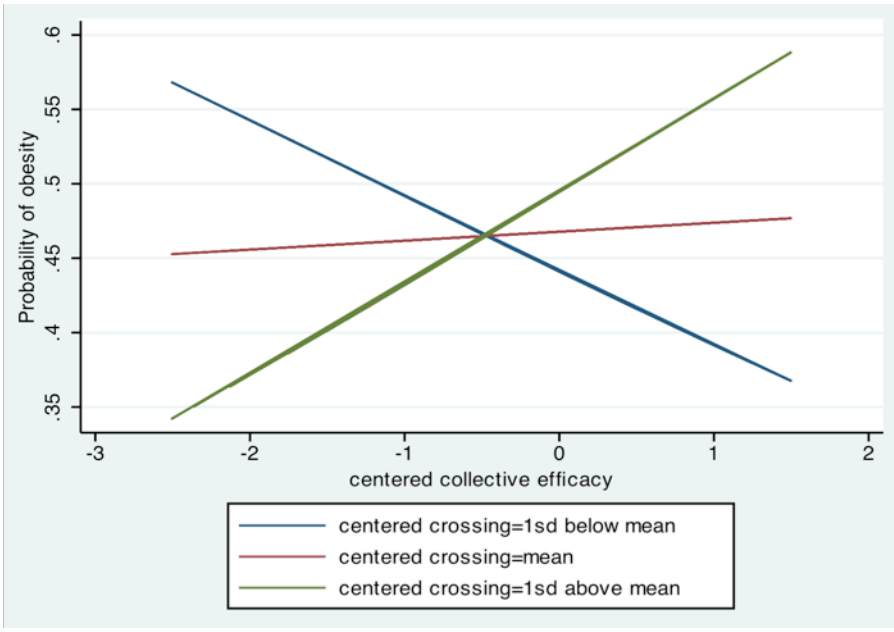

Figure 4.3. Interaction between the number of times crossing the border in the last month and collective efficacy

Figure 4.3 displays the interaction effect of the number of times crossing the border and collective efficacy on obesity. The association of collective efficacy and obesity was moderated by how often a respondent crossed the border to Mexico in the last month. A strong and positive association between collective efficacy and obesity was observed among those individuals who crossed the border more often, compared with respondents who crossed on average and less often. There was a strong and negative association between collective efficacy and obesity among those who crossed the border less often, compared to those respondents who crossed on average and more often.

Evaluation of models within the Social-Ecological Framework

To examine the importance of variables included in each level of influence and the models constructed, the Akaike's Information Criterion (AIC) was used to identify the best model. Table 4.19 presents the results of the AIC scores and ranks the models from best (1) to worst (6). Scores were ranked based on the lowest score. Model 6, which included the two significant interaction terms, had the lowest AIC score and therefore can be considered statistically the best model. The second best model was 4, which examines the combination of cultural exchange, meso and macro levels of influence, controlling for micro-level correlates.

Table 4.19 Summary of AIC scores for variables in the models

Model	**AIC**	**Ranking**
Model 6: Main effect and interaction terms	1.334	1
Model 5: Main final effect model only	1.352	3
Model 4: Cultural exchange, meso, macro and micro levels of influence	1.343	2
Model 3: Cultural exchange, meso and macro levels of influence	1.390	6
Model 2: Cultural exchange and meso level of influence	1.385	4
Model 1: Cultural exchange level of influence	1.381	5

V. DISCUSSION

This study tested a multi-level model of obesity among Mexican immigrants and Mexican-Americans living along the US-Mexico border in Southern California. The aim of the study was to explore the association of macro- and meso-level factors and obesity in the context of the cultural exchange that occurs in this unique region, the Southern California US-Mexico border. The study provided an excellent opportunity to examine social-ecological-level factors characteristic of a border community and their association with obesity.

Summary of Findings

The first objective of the study was to test the independent association of explanatory variables and covariates on obesity. People who were older, unemployed, less comfortable speaking Spanish (Hispanic domain), and born in the US were more likely to be obese. Further, higher reciprocity was marginally associated with obesity. The second objective of the study was to examine the shared variance between variables selected for the cultural exchange level and for the construct of social capital. Assessing whether the measured variables represented these latent constructs was important to determine, because the cultural exchange level was theoretically developed for this study, and social capital has not been studied extensively among MI-MA living along the Southern California-Mexico border. The variables included in the cultural exchange level of influence appeared to explain 53.06% of the variance of this

latent level of influence. As for social capital, the variables network size, reciprocity, civic groups membership, and civic meeting attendance explained 59.2% of variance of this construct. The factor structure observed for both constructs did not support using these constructs as factor scores, thus variables in the cultural exchange level of influence and social capital construct were treated and entered in the multilevel model as independent variables. The third and final objective tested a multilevel model on obesity. This model explained approximately 16% of the variance in obesity. After controlling for micro-level correlates and health behaviors, reciprocity and network size were associated with obesity. As expected, older respondents were more likely to be obese. Being unemployed, born in US, and living above the poverty threshold, were positively associated with obesity. Meeting physical activity guidelines and consuming fast foods weekly were not associated with obesity. Two statistically significant cross-level interactions were found between the cultural exchange and meso- and macro-level correlates. Times crossing the border modified the relationship between collective efficacy and obesity. Neighborhood percentage of home ownership modified the relationship between the Hispanic domain of acculturation and obesity.

Obesity Rates

Forty-seven percent of the sample was obese. The mean BMI was 30.6±7.3. This rate of obesity is higher than national rates for Latinos from the Behavioral Risk Factor Surveillance System (BRFSS 2008), at 29% (CI = 27.7, 30.0), and the rates observed in California, at 29.2% (27.6, 30.9) [39]. Rates of obesity among females in this sample were higher than the latest rates reported for Latinos by the BRFSS (2006-2008). Twenty nine percent of Latinas were obese in that survey compared to 75.3% in this sample. For males, the difference was in the opposite direction; in the BRFSS 27.8% of Latino males were obese compared to 24.7% in this sample.

The obesity rates of this study are comparable to those of other studies conducted in this same region. In a study conducted by Duerksen and colleagues, the mean BMI of the caregivers of elementary school children was 28.8±6.0; 37% were obese [62]. In another study, conducted by Ayala and colleagues among a sample of MI-MA female heads of household, 41% were obese with a mean BMI of 29.7±5.56 [8]. However, in the SDPRC 2006 Community Survey using self-reported data, 29.5% of the respondents were obese with a mean BMI of 28.2±5.8. The similar obesity rates observed between previous studies using measured data and the current study suggest the representative of the current results among residents of the Southern California US-Mexico border region.

Correlates of Obesity

One of the objectives of this study was to examine the independent association of each of the explanatory variables on obesity. This analytical step was important in this study because no other study has reported the strength and direction of these associations with obesity among MI-MA. Micro-level influences and health behaviors conceptualized as covariates in this study were also independently regressed on obesity.

Of the explanatory variables regressed independently, only the Hispanic domain of the acculturation scale and reciprocity were associated with obesity. Individuals who felt less comfortable communicating and consuming media in Spanish were more likely to be obese. This finding is supported by some of the current literature [138,141,190]. For example, Barcenas and colleagues found that less acculturated women, those who were immigrants and had lived in the US for less than 5 years, had a lower mean BMI than women who were immigrants and had lived in the US for 15 years or more [138]. Bates and colleagues found that second and third generation Latinos had a higher mean BMI (BMI ≥30) than first generation Latinos [141]. Contrary to the findings in this study, Ayala and colleagues found an association of more years in the US and less integration with the Anglo culture with a larger BMI, among Mexican women living in the San Diego, CA region [8]. Acculturation is a complex process that has been associated with obesity. Depending on how acculturation is measured, the

association between acculturation and obesity may change [145]. In the present study, a validated bidirectional acculturation measure with a high reliability among Mexican Americans, was used. At the meso level of influence, only reciprocity appeared to be marginally associated with obesity. Greater reciprocity was associated with being obese. These results need to be taken with caution since the associations were adjusted only for age and sex. The findings from reciprocity and network size are discussed together later in this chapter.

Age, employment and country of birth were associated with obesity. Among Latino immigrants, country of birth is consistently associated with obesity and obesity related behaviors [2,48]. In this case, being born in US was associated with an increased risk of obesity, thus suggesting that being born in Mexico may work as a protective factor or being born in the U.S is a risk factor. This result is similar to other studies in which foreign-born Latinos appeared to have a better health profiles compared to Latinos born in the US [8,131,142,191]. For MI-MA residents of neighborhoods along the border, the proximity of Mexico may help to maintain their healthier behavior patterns and the cultural practices associated with their country of birth, which may translate into healthier weight. Being unemployed was associated with a higher likelihood of obesity. A similar association was found in a study conducted in the South Bay region of San Diego County that examined BMI and acculturation measures [8]. In that study, Ayala and colleagues observed that being unemployed was associated with a

higher BMI. Furthermore, age was observed to increase the risk of obesity. This finding is consistent with the literature [12], and its supported by the evidence that suggests that age is positively association with BMI. As Latinos in the US age, their risk for obesity appears to increase [145,12,150,13]. Older individuals may be more sedentary [192] and may suffer from chronic diseases (i.e., arthritis) that limit their ability to maintain a healthy weight. Developing opportunities to mitigate the effects of age on obesity risk becomes even more critical as the population gets older.

Neither meeting physical activity guidelines for LTPA nor consuming fast food at least once a week were significantly related to obesity in this study. The measurement instruments selected to assess these behaviors are consistently used in population studies [177], and the percentage of people meeting physical activity guidelines in this sample of MI-MA was similar to national rates. In the 2007 BRFSS, 45.5% of Latinos met the recommended physical activity guidelines compared with 44.5% in this sample [63]. There are several possible reasons why these two health behaviors were not associated with obesity in this sample. Assessing leisure time physical activity may not have captured the types of physical activity that respondents participate in. Physical activity for work or transportation may have been a better indicator of activity [49,193]. Slattery and colleagues investigated physical activity and obesity among Latinas and found that Latinas reported higher levels of housework, caregiver activity, dancing and work activity [190]. In the present study, meeting leisure time physical

activity guidelines was included in the model as a control variable. Future research with this sample should study the association with other dimensions of physical activity. Despite the lack of significant association in this study, other studies have found an association between leisure time physical activity and obesity [194]. Physical activity levels are also associated with acculturation [49,66,131]; low levels of acculturation having been linked to low rates of leisure time physical activity [66,131]. If this evidence is true, there may be an association of low acculturation and physical activity, which may modify the association of physical activity and obesity in this sample. These associations merit further investigation in future analyses.

Equally important is the observed lack of a significant association between weekly fast food consumption and obesity in this study. In contrast to this finding, Ayala and colleagues observed an association between visiting fast food, buffet or sit down restaurants at least once a week or more and higher adult BMI among Mexican-Americans in South San Diego [61]. Evidence repeatedly supports the association of fast food consumption and obesity [57,60,195,194], and the question used in this study to assess fast food consumption has been used in national survey samples. Percentage of weekly fast food consumption reported by this sample was lower than the 2007 California Health Interview Survey (CHIS), which reported that 74.3% of Latinos in South San Diego reported eating fast food one or more times in the previous week [65]. The lack of significant association between fast food consumption and obesity may

be due to the complexity of measuring eating patterns. Fast food may not capture the variance associated with eating and obesity in this sample of MI-MA. In addition, social desirability or under reporting may have played a role in the number of times respondents reported eating fast food. Acculturation may have also played a role. In a recent review of the literature on diet and acculturation, Ayala and colleagues observed that independent of the acculturation measure used, less acculturated Latinos maintained a more traditional diet compared to more acculturated individuals [132]. Perhaps, individuals in this sample have maintained a traditional Latino diet, which may be associated with a healthy BMI.

A Social-Ecological Model to Explain Obesity among Mexican immigrants and Mexican-Americans

The study tested a multilevel model, guided by the social-ecological perspective, to examine obesity rates among MI-MA living in the Southern California border region. Only when all three levels of influence are examined concurrently can one comprehensively assess their association with obesity. It was evident from the process of building the final model that the theoretically selected levels of influence were related to obesity. The addition of every level of influence further increased the amount of variance explained on obesity. Nevertheless, the final model explained a modest amount of variance. Despite

the variance explained, this multilevel analysis provided evidence of the cross-level relationships and their associations with obesity.

This study hypothesized that each of the meso and macro levels of influence would add 10% to the variance explained in the final model. These hypotheses were not supported. Between the two levels, less than 5% of variance was explained. This is contradictory to other studies that have explained at least 10% of the variance with these levels of influence [25,77,170]. It is possible that the small amount of variance explained was due to the limited number of explanatory variables included in the analysis. Other studies that have conducted similar multilevel analyses have used larger samples, affording the opportunity to include more explanatory variables in their analysis. For example, Franzini and colleagues had a sample of over 3,000 individuals and 26 explanatory variables, mostly at the macro and meso levels of influence. In that study, up to 60% of the variance on self-rated health was explained by neighborhood differences. Cohen and colleagues investigated the association between collective efficacy and the built environment and found that about 20% of the variance in collective efficacy was due to differences between neighborhoods; this study had a sample size of over 2,000 respondents [28,115]. Second, differences in the amount of variance explained in this study compared with previous study may be due to the outcome examined and the sample size. In the studies previously mentioned, the outcomes were collective efficacy and self-rated health, and their samples were in the thousands.

The network size variable, as part of social capital, was significantly related to obesity in this study. In the univariate analysis, reciprocity was observed as a trend. There is evidence that supports the observed trend of reciprocity associated with obesity. In this study, reciprocity was represented by the number of times that a mutual exchange of financial, emotional, social and instrumental support occurred and network size was represented as the number of people up to five closest to the respondent. In a qualitative study conducted with Latina mothers to investigate the social context of their preschool children's eating and physical activity behaviors, researchers found that the social support and social networks available to the mother affected their ability to provide healthy meals and leisure time for their children [196]. Latina immigrants relied on other Latino families and mothers for help in parenting their children, particularly by assisting with the diets of their children [196]. Two other studies that measured social networks as a form of social capital among Latinos found that Latinas who exchanged more services with friends, relatives and neighborhoods were more likely to breastfeed compared to those who did not exchange services with their network [119]. Latinos households with higher social capital, defined as community networks, civic engagement, trust and reciprocity, were less likely to report hunger compared to those with lower social capital [169]. These studies are relevant to interpreting the results of the present study because they demonstrate the importance of social networks among Latinos, and suggest positive associations between social capital and Latino health. Unlike the

previous studies, in the present study, respondents with larger social networks, and higher reciprocity were more likely to be obese. This is similar to recent research findings suggesting that an individual's social network increases the risk for obesity. Christakis and Fowler investigated the association of social networks over time among participants in the Framingham Heart Study, observing an increase in weight gain from person to person in their social networks. They found that a respondent was more likely to become obese if a member of her/his network became obese. The researchers asserted that social ties seem to be more important than the geographic distance between the respondent and her/his network. Friends, siblings and spouses seemed to have the most impact on the respondent risk for obesity [197]. A follow up study by Bahr and colleagues, using network-based simulations, showed how obesity may spread along social networks. They postulated that people with similar BMI may cluster together and therefore 'support' their weight status or weight increase [198]. The social network exchange may support behaviors that promote weight gain and may include cultural norms where weight gain is acceptable [135]. On the other hand, there is research that suggests that social capital in the form of reciprocity may be protective for obesity. Moore and colleagues found that individuals with higher social capital in the form of social networks were less likely to be overweight or obese [111]. Holtgrave and Crosby reported similar findings, i.e. that social capital as measured by Putnam's social capital index was a protective factor for obesity and diabetes [118]. In this study, network size

and reciprocity were two of variables used to measure social capital. The fact that network size emerged as a correlate of obesity is supported by the evidence which suggests that Latinos are a group oriented culture, where family and friends are a important part of their social activities and community interaction [77]. In this sample MI-MA may demonstrate their support by exchanging foods and sharing activities that may put them at risk for obesity.

Interactions

Two significant interactions with obesity were observed. Cross-level interactions emerged between the number of times the respondent crossed the border in the last month and collective efficacy and the percentage of home ownership and the Hispanic domain score (acculturation). These interactions partially confirmed the hypothesis proposed in the study, indicating that the cultural exchange level moderated the relationship between meso -and macro-level correlates on obesity.

Collective efficacy, the perceived neighborhood social cohesion and intention to act on behalf of a neighbor for the well being of the neighborhood, had a significant gradual effect on obesity risk, depending on how often a respondent crossed the border to Mexico. For those respondents who crossed the border often, higher collective efficacy was associated with a higher probability of obesity. But the opposite was true for respondents who rarely or never crossed the border. Among those respondents, low levels of collective

efficacy were associated with a higher probability of obesity. However, after the border crossing variable was transformed, the association became non-significant. Despite this latter finding, these associations provoke many questions and hypotheses. Frequent crossers may feel comfortable and proficient on both sides of the border, which may increase their risk for obesity [25]. Individuals who do not cross the border may not be able to cross to Mexico due to being undocumented and as such, also may be fearful and mistrusting of their neighbors in the US. Cohen and colleagues further proposed a biological path to explain why individuals with low collective efficacy may be at higher risk for obesity. These researchers argue that individuals with low collective efficacy may be exposed to greater life stressors (such as being undocumented or not speaking the dominant language) due to the lack of social cohesion and control of their environment. These daily stressors may translate into high levels of cortisol excretion, which over time can tax the body and increase the risk for obesity.

This observed cross-level interaction adds to the available evidence because it provides information on the association of collective efficacy with obesity among Mexican immigrants and Mexican-Americans living along the US-Mexico border. Previous studies have found that collective efficacy appears to modify the relationships between neighborhood macro-level characteristics and health outcomes. Cohen and colleagues found that lower neighborhood collective efficacy was associated with higher risk of being overweight among

adolescents [25]. Collective efficacy mediated the association of social disorder and sex worker use among Latinos living in Durham, North Carolina [199], and Sampson and colleagues found that collective efficacy mediated the association of disadvantage concentration and residential instability and violence among residents of neighborhoods in Chicago [89]. In this study, crossing the border moderated the association of collective efficacy and obesity, suggesting that collective efficacy is an important meso-level correlate of obesity, and that as a social characteristic of the neighborhood, it is also susceptible to the neighborhood context.

A second cross-level interaction was observed between percentage of home ownership, Hispanic domain acculturation score, and obesity. Percentage of home ownership moderated the association between the Hispanic domain score and obesity. Individuals who reported feeling less comfortable using the Spanish language (lower Hispanic domain score) were at greater risk of being obese if they lived in neighborhoods where more residents own their homes. For those respondents who lived in neighborhoods with lower home ownership, the association of the Hispanic domain score and risk of obesity was also negative, but less strong. There appeared to be a gradient effect of percentage of home ownership on the association of Hispanic domain score with obesity risk. Percentage of home ownership in this study was conceptualized as a proxy for neighborhood stability and socio-economic status. It is possible that respondents who lived in neighborhoods with low socio-economic resources

and instability (low homeownership), may be exposed to stressors associated with neighborhood environment, thus having an effect on obesity. However, these effects may be mitigated by respondents levels of comfort speaking Spanish. In the univariate analysis feeling less comfortable with Spanish was associated with a higher risk for obesity. What this interaction demonstrates is that those associations do not happen in a vacuum, but they occur in the context where individuals live. This gradient relationship between acculturation and obesity risk is partially supported by a previous study on neighborhood context. In a study that examined the association between neighborhood social-ecological influences on self-rated health, the association between social capital and self-rated health was mediated by neighborhood poverty. The higher levels of social capital on self-rated health were reduced by increased neighborhood impoverishment [28]. Although Franzini's study did not examine the same macro-level variables explored in the current study, some similarities can be drawn. The study investigated neighborhood macro and meso level characteristics on health outcomes and found that macro (neighborhood) level correlates mediated the association between social processes of the neighborhood (meso-level) and health outcomes.

Generalizability of the Sample

The average age of this sample was slightly older (43.4±16.9) than the mean age reported in other studies conducted in this region with MI-

MA. Martinez reported a mean of 39 years from the SDPRC Community Survey sample in 2006 [200]. Pichon and colleagues reported a mean age of 34 years among MI-MA caregivers from the South Bay region of San Diego [66]. It is possible that the higher mean age in this sample was due to the fact that the study did not have an upper age limit. However, this study sample was similar to other regional samples of MI-MA [66,200] on other micro-level characteristics, such as percentage of employment, marital status and education. Income was assessed at the individual level and calculated as the percentage of those respondents who lived below the poverty level for 2009. A higher proportion of individuals (53.2%) were categorized with an income below the poverty level compared to the national Latino rate of 23.2% reported by the Census Bureau in 2008 [201]. However, in this study most of the respondents were female and among them 57.2% reported not working. These factors that may have inflated this rate. Additionally, the higher rates of poverty observed in this sample may be an expression of the economic conditions of the region and the country. For example, the unemployment rate in San Diego County in August 2009 when the survey was being implemented was 10.4%, one of the highest in the country [202]. The combination of these factors may have exaggerated the higher poverty levels observed in the sample.

Finally, the additional households selected from previously randomly selected neighborhoods, should not have affected the representativeness of

this final sample because the additional households were also randomly selected and individuals in the households were also randomly selected.

Response Rates

Overall the response rate of the 2009 SDPRC community survey was lower than the response rate of the 2006 SDPRC community survey (13.2% vs. 38%), which was conducted over the phone using random digit dial methodology.

Of the almost 4,000 households randomly selected and approached to participate in the study, only 13.2% completed a survey. The cooperation rate was slightly higher at 23.0%. The contact rate was the highest at 57.6% and the refusal rate was 42.1% compared to 20% in the 2006 SDPRC community survey. These rates suggest several points. First, this population is hard to reach, even by a well-established partnership between the universities and community organizations such as the SDPRC. Both the refusal rate and the contact rate support this interpretation. Although 57.2% of the households were contacted, 42% refused to participate. Also, the short period of implementation (5 months, from May to September, 2009) may have hindered the study's ability to pursue the recruitment of eligible households or to add more randomly selected households to be approached for recruitment. For example, in the 2006 SDPRC Community Survey over 13,000 telephones numbers were attempted, of those 7% were eligible, 39% were unknown eligibility and 54%

were not eligible. These rates also support the interpretation that Latinos households are hard to reach and that adding more households and extending the recruitment period may have increased the response rate for this survey. Despite the high rate of Latino ethnic concentration in the randomly selected neighborhoods (68.1%), over one thousand households were not eligible to participate. The criteria used to randomly select the neighborhoods, (i.e. at least 1≥ households and 1≥ residents) may not have been specific enough to capture neighborhoods with a high concentration of Latino households. The neighborhoods were not selected based on the percentage of Latinos, but rather were selected based on a more ample criteria that may have included neighborhoods with a lower percentage of Latinos, potentially increasing the not eligible households. Lastly, Census 2000 data were used to select neighborhoods. These data may no longer accurately describe the residents of these neighborhoods. For example, the percentage of Latinos may have shifted in some neighborhoods, reducing the number of households with Latinos.

The study did not collect data on the characteristics of those who refused to participate. The only information available to compare households is macro-level data of the neighborhoods from which households were selected. Significant differences between respondents and non-respondents by percentage of home ownership were found. Neighborhoods where respondents lived had a lower percentage of home ownership compared to the neighborhoods of non-respondent households. This result should be taken with

caution since they are based on data that is almost 10 years old. Recent homeownership rates reported by the American Community Survey indicate that in the Metropolitan Statistical Area (MSA) of San Diego, Carlsbad and San Marcos, the 2006 homeownership rate was 61.2%. This rate may have changed in the last few years due to the housing crisis that the country is experiencing. The Census reported that in California, for the last quarter of 2009, the overall homeownership rate was 56%. At the census block level for all the neighborhoods selected into the study, the 2000 Census data are the most accurate and detailed data available. These data suggests that individuals in neighborhoods with more renters were more willing to complete the survey than individuals in neighborhoods with more homeowners. Percentage of home ownership was included in this study as an indicator of neighborhood stability. If this interpretation is applied to this finding, one can say that individuals in more stable neighborhoods were less responsive to this type of survey methodology than individuals in less stable neighborhoods. These findings also indicate that Latinos are hard to reach as a community, regardless of their concentration in these neighborhoods. Despite that fact and the low response rate, we are confident that the study design produced reliable and trustworthy data. Nevertheless, findings from this study may not generalize to other Latinos groups or even other Latinos living in US-Mexico border communities.

Factor Analysis

Another objective of this study was to assess the shared variance of variables included at the cultural exchange level of influence and the social capital construct. It was hypothesized that variables in the cultural exchange level would share sufficient linear variance to represent one latent factor score. Similarly, the study explored how the variables included in the social capital construct as part of the meso level of influence were related to each other.

It was hypothesized that variables included in the cultural exchange level would load into one factor to represent this level of influence. This hypothesis was not confirmed; items in the cultural exchange level did not load together to form one factor. The loadings between the Hispanic and non-Hispanic scores were high, indicating a strong linear association between the variables, this association was expected since these scores represent the acculturation construct. However, the crossing the border variable did not load with the acculturation scores, suggesting that this variable is an independent concept from acculturation. There was a significant and positive bivariate association between crossing the border and the Hispanic domain score, which suggests that higher Spanish language preference an individual reported the more crossing the border she/he reported. Thus the Hispanic domain score and crossing the border are related, but not enough to merge into one construct. Future research could investigate socio-economic characteristics by reasons individuals reported crossing the border, and how these characteristics are

associated with health behaviors and health outcomes. In addition, the interaction of crossing the border and the acculturation scores should be investigated. This information can add to the understanding of living in a border neighborhood and how it is associated with the health of residents. Since, this level of influence was developed for this study, there was no other study to compare these results to.

The factor structure observed for social capital partially confirmed the hypothesis. Social capital was represented by two factors instead of one, as proposed in the hypothesis. The factor analysis was conducted with these variables because it was important for this investigation to determine if these variables represented the construct of social capital among this sample of MI-MA. Despite the fact that social capital has been studied extensively as an explanatory construct of health outcomes [98], to our knowledge no studies have examined how this construct operates among MI-MA living in the US-Mexico border region. The factor structure that emerged from the analysis suggests that civic participation distinctly represented one factor and the social network variables represented the second factor. Trust did not load adequately on any of the factors. The factor structure that emerged in this study suggests that the social capital construct was represented by the social network and civic participation variables and not by trust among this sample of MI-MA. However, given that they did not load on one factor, in the final hierarchical model these variables were entered as independent correlates, as previous studies using

these variables have, allowing us to examine their independent association consistent with the exploratory nature of this study. In addition, much of the body of evidence on social capital suggests treating these variables as independent correlates. For example, trust and norms of reciprocity as social capital indicators and self-rated health were studied in a sample of Mexican-Americans in Texas [28]. In another study, Martin and colleagues studied the association of social capital using community networks, trust and civic participation and food security among a sample of Latinas in Connecticut, [120]. These studies did not use social capital scores or indices, but rather independent variables to represent social capital in their analysis. This approach has the advantage of exploring the association of each of these correlates and obesity, especially when so little research has been conducted with MI-MA.

Unexpectedly, trust did not share an adequate amount of variance with the other social capital variables. Some scholars argue that trust is not a component of social capital but a precursor of social capital [16,170]. Researchers studying social capital and health argue that individuals may have to trust people in their neighborhood first before engaging in building its capital [98,112,170]. Perhaps the moderate levels of trust observed in the sample are the reasons why this variable did not load with the other variables in the social capital construct. Possibly, individuals living in this region are less trusting of sources of information, neighbors and organizations in their community, because they

cannot easily communicate with them (i.e., higher Hispanic domain). Or they may be undocumented immigrants fearful of police, as Parrado and colleagues reported was the case for Latino immigrants in North Carolina [199]. Lastly, MI-MA in this region may also be less trusting because of reported low perceived safety of their neighborhoods [200]. Future research should investigate correlates of trust among these residents to better understand the reasons for a lower level of trust and its relationship to health outcomes.

Macro Level of Influence Variables

Two variables at the neighborhood level were used to represent the macro level of influence. No factor analysis was conducted with these variables, because they represented distinct characteristics of the macro level of influence. Among the selected neighborhoods in the study, percentage of Latinos (ethnic concentration) and percentage of home ownership (neighborhood stability) were negatively associated, indicating that the higher the presence of Latinos in a neighborhood, the lower the neighborhood stability. This association suggests that MI-MA in low homeownership neighborhoods may move from home to home in search of cheaper rent and better living spaces. In addition, the low neighborhood stability may indicate that residents are less engaged in and committed to their neighborhood because they move often, and thus we see the low reported rates of trust and civic organization. These macro-level characteristics are distal influences on the individual

behavior. An example of a direct effect was observed in a study that Franzini and colleagues conducted, where neighborhood poverty weakened the positive association observed between social capital and self-rated health [28]. Do and colleagues found that women rely more on neighborhood resources than men do, and that heavier reliance on neighborhood resources increased the racial/ethnic disparities in BMI for women, but reduced it for men [77]. Sampson argues that just as individual-level socio-economic factors might have an impact on the individual's behaviors, so do macro-level factors (i.e., neighborhood socio-economic) status have an effect on neighborhood collective efficacy and social capital. He goes further to suggest that even if individuals have moderate to strong efficacy (i.e. perceived social cohesion) but live in neighborhoods affected by macro-level disadvantage (i.e. low home ownership), the collective capacity of the individuals in the neighborhood can be weakened [171]. If this interpretation is applied to the results of this study, one can suggest that low homeownership may threaten the ability of neighbors to connect, establish relationships and collaborate to address their communities' problems for better health, resulting in low social capital and moderate collective efficacy as observed in this study.

Strengths and Limitations

Strengths

This theoretically-based study was designed to test several hypotheses about the association of higher levels of influence from the socio-ecological model on obesity. This perspective informed the development of the cultural exchange level of influence, providing the opportunity to contextualize this higher levels of influence in this unique place of influence, the Southern California US-Mexico border. This study is informed by the available science, which suggests that to understand the obesity epidemic in the US, studies should include macro-level factors and social determinants of health. Adding macro- and social-level factors is necessary to disentangle the complex associations of the neighborhood macro and social factors with health. Supporters of this approach argue for the use of comprehensive, multilevel models that may identify variables that are potentially more likely to change. This approach should include the cross-level interactions of individual-level factors along with macro and social factors if it is to be consistent with its theoretical framework.

The study benefitted from the sampling design and recruitment methodology implemented by the San Diego Prevention Research Center Community Survey. By obtaining a randomly selected sample of neighborhoods, households and respondents from the participating communities, this study recruited a cross-section of the targeted population. In addition, face-to-face interviews potentially reduced the respondent burden and increased the validity of the information obtained during the interviews. Weight

and height were measured to calculate BMI using nationally validated protocols at the respondents' home, yielding reliable measurements for this study.

Scales and questions used in the study to measure the observed variables have been validated and/or have been used extensively in previous studies. For example, measures used to assess social capital constructs were based on theoretical approaches and conceptualizations of social capital. In this study, the three main domains that defined social capital were captured as social networks, civic participation and trust. Few studies have reported using this triangulation of measures to capture this construct [89,98,134,163,177].

Limitations

The study was not conducted without some limitations. The cross-sectional design of the study limits the ability to establish any causal relationship. Power and effect size calculations were conducted to estimate whether the sample was adequate to conduct the multilevel analysis on obesity. However the modest sample size may have hindered the ability to detect other significant associations. Having recruited from randomly selected neighborhoods, intra-neighborhood clustering was a concern. This issue was addressed by controlling within neighborhood variance using the robust cluster standard deviation command in all regression analyses. In addition, the definition of neighborhood was driven by the design of the SDPRC Community

Survey and variables included for this study at the macro-level of influence were informed by the evidence and available data.

The census block, the smallest geographic boundary available from the Census Bureau, was used for this study. Neighborhoods were defined based on the geographic boundaries provided by the Census. This approach is controversial because it may not reflect the context and composition of the place where the individual interacts, and by which the individual is influenced [203,180]. On the other hand, most neighborhood-based studies in public health use these boundaries and data are available from the Census to conduct their analysis [80,174]. Furthermore, there is evidence that demonstrates that these definitions of a neighborhood can provide a proxy for its contextual influence on health outcomes [25,28,89]. The sampling methodology allowed for the calculation of population weights and for the estimations of current percentages of Latinos in the participating communities. However, due to time restrictions, this study was not able to include these estimates in the analyses. Thus the findings are only applicable to the respondents in this sample and generalizability is limited to respondents in the neighborhoods selected. However, these findings can be compared to other studies findings were residents of the region have participated [8,66,200]. Socio-demographic and obesity rates are comparable between previous studies and the current study.

The response rate of the SDPRC Community Survey was less than optimal. There is not a consensus on how to calculate survey response rates,

which makes it more difficult to compare rates between surveys. In the present study, guidelines from the American Association for Public Opinion Research were used. These guidelines were also used to calculate response rates for the 2006 SDPRC Community Survey. The response rate may indicate that certain response biases, may have affected the validity of the study. For example, seasonality may have played a role in the low response rates. Implementation of the survey was conducted during the summer months of 2009 and almost a third of the households selected were never screened because no one was home. During this time of the year, household members take time off for vacation or move to Tijuana, Mexico to save money. Evidence of this seasonal migration has been observed in previous studies conducted in the region (no published data). The length of the survey may have turned away some eligible respondents. The interview and body measurements lasted approximately one to one and half hours. Eligible individuals may have refused to participate when research assistants mentioned the length of the survey during the verbal consent process. From anecdotal information from research assistants, one of the most common excuses for not participating in the interview was lack of time. Also, the observed moderate to low trust levels among respondents may suggest that residents of these neighborhoods were less receptive to research assistants soliciting for information at their door. Despite the fact that interviewers (research assistants) were members of the participating communities, residents approached may have not trusted them and refused to

participate. The low response rate speaks to the difficulty of reaching Latinos even in highly concentrated Latino immigrant neighborhoods in this region. Parrado and colleagues used participatory methods to recruit Latinos in North Carolina and implemented recruitment and data collection for two years to obtain an adequate sample for the study [199]. More, gender imbalances may have biased the study, since the majority of the respondents were females. Despite the fact that gender was not associated with obesity in the final main effect and no gender differences were found in the explanatory variables, females may perceive and be influenced by the macro and social factors differently than males in the study, as Do and colleagues reported [77].

All the explanatory and controlling variables were self-reported information, which may be biased by respondent burden and social desirable answers. Also in the present study, only meeting leisure time physical activity guidelines were included. Other domains of physical activity, such as work or transportation related physical activity may better represent levels of physical activity among MI-MA [49]. Fast food consumption was measured with only one question. Dietary measures are weakened with recall biases [204,205]. It is possible that respondents may have underestimated the frequency with which they ate fast food in a week.

Some of the explanatory variables lacked a normal distribution. Several variables were dichotomized or modified in other ways, by log transformation, as in the case of the crossing the border variable, to bring the variable to a

normal distribution. However, these modifications were not successful in replicating the results observed using the original data.

Another potential limitation of the study may come from the limited number of variables available at the neighborhood level from the Census and the lag between macro level variables and variables collected during this study. The available Census data are almost 10 years old and the percentages associated with the neighborhood level variables may have changed. The current study was designed to define a neighborhood as the smallest geographic unit available to study. Because of this, the number of indicators available from the Census is limited. Collapsing the census blocks into census tracks, a larger geographic area would have violated the original design of the study and would have hindered the variance at the neighborhood level.

Future Research & Practice

The findings of this study generate new research questions and areas for investigation. The next research question to be explored should be the association of macro- and meso-level influence on obesity-related health behaviors. Studying more proximal health behaviors, in a more comprehensive manner possible, such as dietary intake and physical activity and macro- and meso-level factors, can assist with developing more effective interventions that incorporate the macro and social context of the neighborhoods in which our targeted residents live.

Second, studies that address racial/ethnic inequalities in health should include macro- and meso-level variables, because adding the contextual and compositional characteristics of neighborhoods (place) to the understanding of inequalities in health can inform how these higher level factors are associated with such health disparities. One study by itself may not be able to determine whether a causal path exists between, for example, neighborhood poverty and high obesity rates, but several studies that include these measures can help to inform what we know about these processes. These data can also fuel advocacy efforts by providing evidence that associate neighborhood macro characteristics with health outcomes. One randomized controlled trial in South Africa demonstrated that the intervention had an effect on the levels of social capital of residents and that these changes were associated with a lower risk of HIV infection [206]. Community-based interventions may already be changing the levels of collective efficacy or social capital among their participants, but we are not capturing these processes because we are not looking beyond the individual level to explain health outcomes.

Third, further exploration should be conducted using the concept of cultural exchange, specifically for studies working along the US-Mexico border regions. Crossing the border and reasons for crossing may add an additional social behavioral dimension to the study of the acculturation process among residents of border communities such as the Southern California US-Mexico border. Most measures of acculturation are language based or unidimensional

(i.e., years in the US), limiting their utility. Adding questions on the social behaviors (i.e., crossing to Mexico) associated with acculturation could increase our understanding of how acculturation among border community residents affects their health. Adding questions such as the frequency with which a US resident crosses the border to Mexico, whether they live in a border neighborhood or their reasons for crossing, includes the wider context in which acculturation or the lack of acculturation occurs. This measure will be especially helpful in a city like San Diego, CA where Latinos may access services and resources in Spanish relatively easily. Learning English is not an absolute necessity, even less so if one can cross the border to Mexico and have services and resources in Spanish at one's disposal. Compared to Latinos who live in regions of the US where few people speak Spanish and contact with their country of origin is limited, differences in health outcomes may appear. For instance, developing measures that assess the advantages or disadvantages of living in a border community or the advantages or disadvantages of crossing the border or total amount of time an individual spends in Mexico in the last year, or a question on why the respondent chose to live in that neighborhood may improve the validity of this construct and broaden our understanding of the characteristics of individuals that reside in border communities.

Fourth, another area of future research necessary to better understand the influence of neighborhoods on health is the definition of neighborhood. Though most studies have used census data, which is economical, convenient

and proven informative, the extent to which these predetermined definitions of neighborhoods truly capture this 'place' of influence remains understudied. Future studies should include other measures of what the respondent considers her/his neighborhood. For example, triangulation methodology may assist with this assessment. Asking a respondent to circle the boundaries of her/his neighborhood on a map of her/his city could be one approach. Another approach could be asking the respondent how far her/his neighborhood extends (i.e., "when you think of your neighborhood, is it the block around your house?") and using open-ended questions where the respondent can describe the geographic and social characteristics of their neighborhood. On one hand these approaches can yield a more salient and perhaps valid measures of the neighborhood from the respondents perspective. On the other hand, Census (i.e. macro-level) data may have to be adjusted using Geographic Information Systems (GIS) technology and combining data from different geographic parameters to obtain the desire macro level indicators. What combination of these methodologies would provide valid and reliable measurements of the subjective and objective socio-economic neighborhood environment is an area of high priority.

Future Policy Implications

This area of research is still evolving and much more work needs to be conducted before there is a clear picture of the influence of place on health

among ethnic/racial groups. Therefore policy recommendations are limited at this time. Perhaps, one policy within the public health funding system would be to sponsor more research that is based on comprehensive socio-ecological models including macro- and meso-level correlates.

Local policy initiatives to address disadvantaged communities are emerging as way to improve the public health of the community. Indeed, studies such as this can inform local policy makers (e.g., school boards, church leaders) on the opinions and evaluations of their fellow neighbors. Data collected through the SDPRC Community Survey and results from this study can be used by the SDPRC Community Engagement Committee (CEC) to advocate for neighborhood changes. For example, empirical data showing high obesity rates and lower rates of physical activity among their residents can reinforce advocacy directed at city council members. Finding that among the residents trust is low may explain the lack of participation in community and neighborhood organizations and activities. The information detailing low civic organization participation rates can serve to develop local awareness campaigns to promote community engagement. Most importantly, the findings from this study represent tools that the CEC and SDPRC can use to inform future efforts to address obesity in the participating communities. Members of the CEC can take this information to their local agencies so they can inform their constituencies and motivate them to participate in the SDPRC efforts to combat obesity in the community. Promotora trainings can include a component

on the importance of the social neighborhood environment. They can learn of the links between social capital and health and can translate this information to their program's participants, thus building their awareness and perhaps their social capital and collective efficacy. This study has added to the understanding of neighborhood macro and social factors related to the health of the residents of these border communities, informing the development of successful interventions that can potentially translate to improvements of the community and local policy initiatives.

Conclusions

Findings from this study contribute to the understanding of macro and meso levels of influence on obesity among Mexican immigrants and Mexican-Americans in the context of the Southern California US-Mexico border region. The strong design of the study, which was guided by theory and informed by evidence, also contributes to the existing knowledge on neighborhood influences on obesity among ethnic/racial groups, presenting evidence that supports cross-level interaction and its association with obesity. This suggests that the Southern California border region has particular macro and meso characteristics that may have an indirect effect on the obesity of its residents. There is more to be investigated about how these correlates are associated with health outcomes, especially among those subgroups most affected. MI-MA in the US represents a distinctive social, economic, and behavioral and cultural

ethnic group. Extending the public health paradigms to include higher levels of explanatory correlates can only contribute to the understanding of health behavior and to the success of public health interventions. This study accomplished this goal and enhanced the prospects for future research by originating a valuable new construct in the form of cultural exchange. This construct provides a method to capture the wider context of neighborhood influences, through the combination of the social behavior of crossing the border and acculturation, which are unique to border communities. A public health professional cannot deny the distal forces that affect individual behaviors. Identifying and understanding these influences is one step closer to developing public health strategies and interventions that are salient and successful in the targeted communities.

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