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Examining the Association Between US Acculturation in Latinas and Birth Outcomes as Moderated by Obesity: A Study of Mexican Origin Women in California's Central Valley

THESIS

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by

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ABSTRACT OF THE THESIS

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Melissa J. Perez

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Despite low socioeconomic status and lack of resources, Latinas are found to have better-than-expected birth outcomes, which deteriorate with higher US acculturation. In addition, as the incidence of obesity rises amongst Latinas, it is necessary to study this acculturation paradox in the context of obesity. The purpose of this study was to examine the association between US acculturation and poor birth outcomes, particularly examining preterm birth and/or low birth weight (PTLBW), in a sample of Mexican origin women. Furthermore, the differential effect of obesity on the association between acculturation and birth outcomes was examined.

This was a longitudinal observational study using data from the Study for Hispanic Acculturation, Reproduction, and the Environment (SHARE). Participants were 1,062 pregnant women recruited from six Obstetrics and Gynecology Clinics in San Joaquin County, California between 1999 and 2001. The majority of women were of Mexican descent at varying lengths of US residency. Logistic regression analysis was used to examine the associations among acculturation, obesity and poor birth outcomes.

Results demonstrated a significant association between US acculturation and PTLBW such that moderately acculturated women had over three times the odds of experiencing PTLBW, while low and highly acculturated women did not show an increased risk. In moderately acculturated women who were also obese, their chance of PTLBW decreased, indicating that obesity acted as a buffer for PTLBW. This effect was not demonstrated in low or highly acculturated women.

In conclusion, this study re-examines the Latina Acculturation Paradox in the context of obesity. It is unique in that it demonstrates deviation from the paradox, as the most highly acculturated women did not experience the worst birth outcomes. Additionally, this is among the first study to demonstrate a protective effect of obesity in terms of perinatal health.

INTRODUCTION

Latinos are fastest growing population in the United States and make up the largest racial or ethnic minority (US Census Bureau, 2012). In addition, Latinas have the highest fertility rate compared to any other racial or ethnic group in the US (Day, 1996; Passel & Cohn, 2008). Consequently, a large body of research on Latina health focuses on perinatal outcomes. There are two major trends that emerge from this research. One is the "Latina epidemiologic paradox" and the other is the "acculturation paradox". The epidemiologic paradox is based on findings that show despite disproportionately low socioeconomic status and lack of resources, Latinas experience better-than-expected birth outcomes (Brown, Chireau, Jallah, & Howard, 2007; Callister & Birkhead, 2010; Chung, Boscardin, Garite, Lagrew, & Porto, 2003; Fuentes-Afflick, Elena, Lurie, 1997). Specifically, their birth outcomes are comparable to non-Hispanic whites who are more affluent. However, amongst immigrant groups, the more time Latinas remain in the US and become acculturated to American lifestyle, birth outcomes deteriorate (Callister & Birkhead, 2010; Ceballos & Palloni, 2010; Ruiz et al., 2008). This phenomenon has been labeled the acculturation paradox. Explanations for both trends surround protective effects inherent to Latino culture, which are thought to erode after increased time in the US (Belinda Campos et al., 2008; Hammer, 2001; New, Xiao, & Ma, 2013). Additionally, it is thought that the process of acculturation itself leads to adoption of risky health behaviors, increased stress and loss of familial support (Callister & Birkhead, 2010; Farley, Galves, Dickinson, & de Jesus Diaz Perez, 2005; Fox, Entringer, Buss, DeHaene, & Wadhwa, 2015; Mangold, Mintz, Javors, & Marino, 2012; Urquia, O'Campo, & Heaman, 2012). These processes then lead to poor birth outcomes,

particularly seen with increased incidence of preterm birth and low birth weight. This study will re-examine the acculturation effect in a group of Mexican origin women.

Secondly, a major health concern affecting Latinos, both in the US and in Latin America, is the rising rate of obesity. Latinos have some of the highest rates of obesity compared to any other ethnic group in the United States (Clark, Sarah, E., Hawkes, Corinna, Murphy, Sophia M. E., Hansen-Kuhn, Karen A., Wallinga, 2012; Obesity, 2010). There are two possible explanations for this rapidly increasing epidemic: US acculturation and high rates of obesity in country of origin. Many studies have shown a strong association between increasing US acculturation and incidence of obesity (Khan et al., 1997; New et al., 2013; Sundquist & Winkleby, 2000). Furthermore, Mexico has become the most obese nation in the Northern Hemisphere, which may be leading to a more obese immigrant population in the US.

In terms of perinatal health, obesity is known to cause a number of poor birth outcomes including very large infants, birthing complications and higher C-section rates delivery (J H Chung et al., 2006; Hedderson et al., 2006; Rhodes, Schoendorf, & Parker, 2003; Stotland, Hopkins, & Caughey, 2004; Swank et al., 2014). Therefore, as obesity begins to rise amongst Latinas, it becomes more important to study perinatal health in this population. Moreover, the epidemiologic and acculturation trends should be reexamined in the context of obesity to investigate whether obesity may be leading to changes in these trends. Therefore, this study will investigate the differential effect of obesity on the association between US acculturation and poor birth outcomes.

Chapter 1: Background and Significance

Latinos in the United States

According to the US Census Bureau, there are approximately 54 million Latinos living in the United States, which represents roughly 17% of the total population (2013). Results from the 2010 census revealed that racial and ethnic minorities contributed to over 90% of our nation's growth from 2000 to 2010, with the majority of that growth due to Hispanics[1] (U.S. Census Bureau, 2010, Passel, Livingston, Cohn, 2012). It is projected that Latinos will make up one third of the US population by 2050 (Passel & Cohn, 2008). Moreover, Hispanics of Mexican origin comprise the majority of the Latino population (U.S. Census Bureau, 2012), especially in California where 83% of Hispanics are of Mexican descent (Pew Hispanic Center, 2011). Much of the Latino population's growth is attributable to high birth rates. From the year 2000 to 2010 the Latino population grew by 7.2 million due to births and 4.2 million due to new immigrant arrivals (Hoggart, Katherine J., Flores, Marie, Solorio Rosa, Wilhelm, Michelle, Ritz, 2013). The high number of births can be attributed to the fact that Latinas have the highest fertility rate of any racial or ethic group, with a total fertility rate 2.4, compared to 1.8 for non-Hispanic Whites (Passel & Cohn, 2008). Thus, the importance of studying perinatal health outcomes amongst Latinas in the United States remains clear.

It is well established that Hispanics are an ethnic minority in the US that represent a largely under-resourced population (Flaskerud & Winslow, 1998; Fox et al., 2015; James, 1993). Latinos represent a particularly marginalized group due to high rates of

[1] "Hispanic" and/or "Latino" is categorized as an ethnicity by the United States Office of Management and Budget under the Executive Office of the President (OMB, 1997).

undocumented status and the highest poverty rate of any other racial or ethnic group (Census Bureau Supplemental Poverty Measure, 2010). Many studies have demonstrated that low socioeconomic status leads to poor health outcomes, including poor pregnancy and birth outcomes (Chung et al., 2003; Flaskerud & Winslow, 1998; Khan, Sobal, & Martorell, 1997). However, despite experiencing disproportionately high socioeconomic disadvantages and lack of resources, multiple studies reveal that perinatal outcomes of Latinas are comparable to their more affluent European American counterparts and less similar to other disadvantaged groups at similar socioeconomic levels (H. L. Brown, Chireau, Jallah, & Howard, 2007; Callister & Birkhead, 2010; Judith H. Chung, Boscardin, Garite, Lagrew, & Porto, 2003; Fuentes-Afflick & Lurie, 1997). This phenomenon has been named the *Latina Epidemiologic Paradox* and has been demonstrated primarily using low birth weight (LBW) and preterm birth. LBW is significant because it is the single most important indicator of neonatal death in the United States (Callister & Birkhead, 2010, Judith H. Chung et al., 2003; Fuentes-Afflick & Lurie, 1997; James, 1993).

Epidemiologic and Acculturation Paradoxes

The Latina Epidemiologic Paradox demonstrates an unexpected a health advantage amongst Latinas. Despite experiencing a wide range of health disparities, Latinas are found to have lower mortality rates and decreased chance of experiencing adverse birth outcomes including low birth weight, preterm birth, preeclampsia and stillbirth (Brown et al., 2007; Chung et al., 2003; Flores, Simonsen, Manuck, Dyer, & Turok, 2012; Fox et al., 2015; Fuentes-Afflick, Elena, Lurie, 1997). There are many

proposed explanations for this paradox but none have been firmly established. One explanation is that many aspects of Latino and Mexican culture, such as familism or *familismo* (Belinda Campos et al., 2008), strong social support within families and the community as well as good dietary practices (Gress-Smith et al., 2013; McGlade, Saha, & Dahlstrom, 2004), protect against the negative effects of socioeconomic disadvantage. Another proposed explanation for the paradox is a *healthy migrant effect* whereby migration itself, being a difficult physical process especially from Latin America, selects for healthier people (Fuller Thomson, Nuru-Jeter, Richardson, Raza, & Minkler, 2013, Landale, Nancy, S., Oropesa, R. S., Gorman, Bridget, 2000). Lastly, studies have examined behavioral factors among Mexican women compared to other groups and have found that Mexican immigrant women are less likely to use drugs and tobacco during pregnancy than are other groups (Callister & Birkhead, 2010). While these proposed explanations provide insight into the factors driving the paradox, it is an extremely multifaceted process and requires collaboration among researchers to reach more concrete conclusions.

While immigrant Latinas appear to display a health advantage however, studies have simultaneously found that with increased length of residence in the US or increased levels of US acculturation, health declines (Flores, Simonsen, Manuck, Dyer, & Turok, 2012; Hoggart, Katherine J., FLores, Marie, Solorio Rosa, Wilhelm, Michelle, Ritz, 2013; Urquia, O'Campo, & Heaman, 2012). This trend has become known as "acculturation theory" or the "acculturation paradox". Acculturation is a multidimensional process that refers to the movement away from one's culture of origin toward the adoption of a new culture (B. Campos, Schetter, Walsh, & Schenker, 2007).

Therefore, US acculturation among Mexican or Mexican-American women means movement away from Mexican cultural practices towards adoption of a more mainstream US lifestyle. The acculturation paradox is especially prevalent when examining birth outcomes amongst Latinas. In a study conducted in Texas, Hispanic women were found to have up to four times the risk of preterm birth if they were more acculturated (Ruiz, RJ et al. 2008). Higher levels of acculturation are strongly associated with increased risk of LBW in Latinas (Callister & Birkhead, 2010; Ceballos & Palloni, 2010; Cobas, Balcazar, Benin, Keith, & Chong, 1996). Thus, as levels of US acculturation increase, health is compromised. This effect is especially demonstrated by the deterioration in birth outcomes as Latinas become more acculturated.

Acculturation and Obesity

Additionally, it has been demonstrated that increasing acculturation is associated with higher rates of obesity (Khan et al., 1997; New et al., 2013; Sundquist & Winkleby, 2000). Hispanics represent one of the most obese racial or ethnic groups in the United States (Obesity, 2010). One explanation for this increase is thought to be a change in dietary practices as one begins to eat an American diet of fatty and processed foods. It has been generally thought that the traditional Mexican diet, with a higher vegetable, vitamin and protein content, was healthier than the American diet (Guendelman & Abrams, 1995). However, in the past two decades obesity rates in Mexico and Latin America have rapidly increased. As of 2013, Mexico surpassed the United States as the most obese nation in the northern hemisphere with a 33% obesity rate (FAO, 2013). Due to subsidization of imported maize and other traditional foods, the poor in Mexico can no

longer afford to eat the traditional maize and beans diet and thus turn to heavily processed and fatty foods that are cheaper (Clark, Sarah, E., Hawkes, Corinna, Murphy, Sophia M. E., Hansen-Kuhn, Karen A., Wallinga, 2012). The rising obesity rate in Mexico, combined with a high obesity rates in the US, raises concerns for how obesity is affecting the health of Latinos.

Maternal obesity and excess gestational weight gain have risen steadily in the United States within the past few decades and it is estimated that approximately 1 in 3 women are obese at the time of conception (King, 2006; Wylie, Sundaram, Kus, Ghassabian, & Yeung, 2015). More than 34% of reproductive age Hispanic women were obese between 2009 and 2010, compared with 27% of non-Hispanic Whites (Kominiarek, 2014). It is well known that obesity is associated with many comorbidities such as diabetes and cardiovascular disease (Isasi et al., 2015), however studies also show that maternal obesity and increased gestational weight gain are associated with poor birth outcomes and poor fetal development (Callaway, Prins, Chang, & Mcintyre, 2006; Hedderson et al., 2006; Kliegman, R. M., Gross, 1985; Wylie et al., 2015). Obese mothers are up to four times more likely to give birth to large or macrosomic infants (infants with a birth weight over 4000 grams), which can lead to fetal injury during birth, shoulder dystocia, low Apgar scores and high rates cesarean delivery (J H Chung et al., 2006; Hedderson et al., 2006; Rhodes, Schoendorf, & Parker, 2003; Stotland, Hopkins, & Caughey, 2004; Swank et al., 2014). Rhodes et al. conducted one of the first national studies examining the relationship between excess gestational weight gain, macrosomia and cesarean delivery (2003). Using Nationality Files from 1999 to 2000, which included over 11 million births, they found that excess gestational weight gain was strongly

associated with macrosomia and higher incidence of cesarean section (Rhodes et al., 2003). Maternal obesity has also been shown to increase the risk of gestational diabetes mellitus (GDM) which is itself associated with maternal and neonatal morbidity and up to three times the risk of fetal macrosomia (Cheng et al., 2008; J H Chung et al., 2006). Thus, as obesity among reproductive age Hispanic women continues to rise in both the US and Latin America, studies must reexamine the epidemiological and acculturation paradoxes among Latinas in the context of obesity.

The Acculturation Construct

Lastly, an overview of the acculturation construct and how it is measured will be discussed in order to provide a framework for understanding how acculturation is related to health. As mentioned, acculturation is a multidimensional process that refers to the movement away from one's culture of origin toward the adoption of a new culture (Campos, Schetter, Walsh, & Schenker, 2007). Understanding how acculturation influences health within certain populations can aid researchers in designing appropriate public health and clinical interventions. There are currently eleven published acculturation measures for adult Latinos that have been established since 1980, four of which have been extensively researched and validated among the Hispanic population (Mills, Sarah D., Malcarne, Vanessa L., Fox, Rina S., Robins Sadler, 2014; Wallace, Phyllis, M., Pomery, Elizabeth, A., Latimer, Amy, E., Martinez, Josepha, L., Salovey, 2010). The current measures are based on both unidirectional and bi-dimensional models. Unidirectional models refer to a linear change from a culture of origin to total immersion in the host culture (Lara, Gamboa, Kahramanian, Morales, & Bautista, 2005) as opposed

to bi-dimensional models, which reflect the extent to which people move between each culture (Andrews, Bridges, & Gomez, 2013; Cabassa, 2003; Campos et al., 2007). The most widely used acculturation measure in scientific and clinical research is the Acculturation Scale for Mexican Americans (ARSMA) developed by Cuellar et al. in 1980. The scale is composed of two subscales, one measuring Mexican Orientation (MO) and one measuring Anglo Orientation (AO). The two subscales were found to have good internal reliabilities with Cronbach's alphas of 0.86 and 0.88 for the Anglo Orientation scale and Mexican Orientation scale respectively (Cuellar et al., 1980). The original ARSMA was later revised in 1995 to the ARSMA-II. The revised scale is a multidimensional, multifactorial, orthogonal scale that moves beyond a linear measure to a bidirectional measure by allowing for differentiation between bicultural individuals who possess high and/or low characteristics at either extreme of MOS and AOS, while still retaining the ability to measure acculturation on a linear scale (Cuellar, Israel, Arnold, Bill, Maldonado, 1995). The new ARSMA-II yielded a high Pearson's correlation coefficient ($r = 0.89$) with the original scale. The scale is composed of items that assess four factors: 1) language use and preference 2) ethnic identity and classification 3) cultural heritage and behaviors and 4) ethnic interaction. The measure is bilingual (Spanish and English) and uses a 5-point Likert scale for answer options. Mean scores are generated from each subscale and the MO mean score is subtracted from the AO mean score to obtain an overall score which puts an individual on a continuum from highly Mexican oriented to highly Anglo oriented. Cutoffs are then assigned to obtain an acculturation level which include: Level 1 (very Mexican oriented), Level 2 (Mexican-

oriented to approx. balanced bicultural), Level 3 (slightly Anglo oriented bicultural), Level 4 (strongly Anglo oriented) and Level 5 (very assimilated; Anglicized).

Many studies use nativity and time living in the US as proxy measures for acculturation status. While these proxies have been found to strongly predict acculturation, they have proven inadequate in differentiating low acculturation from moderate and high acculturation (Kasirye et al., 2005). Therefore, the ARSMA-II is the measure that will be used in this study as an accurate assessment of acculturation.

Contribution of this study

To date, few studies examine the effects of US acculturation status on birth outcomes amongst Latinas, in light of obesity. Acculturation reflects underlying beliefs and attitudes about health (Wallace, Phyllis, M., Pomery, Elizabeth, A., Latimer, Amy, E., Martinez, Josepha, L., Salovey, 2010), which can prove useful in developing appropriate strategies for prevention and treatment. Understanding acculturation as it relates to birth outcomes can inform us of the underlying social, economic and health care needs of reproductive age Latinas.

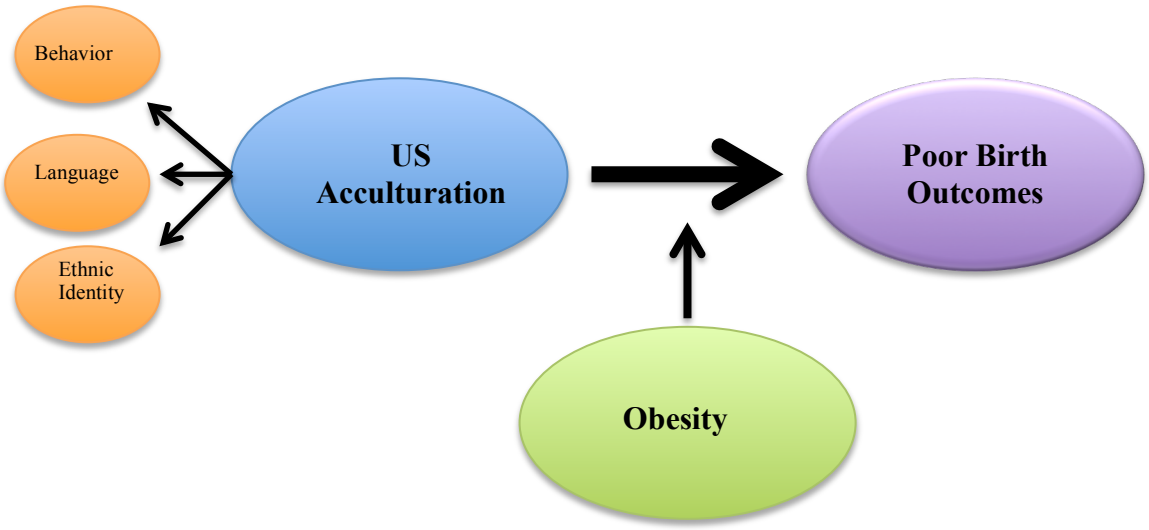
Furthermore, with a rising obesity epidemic we have reason to believe that obesity may moderate the effects of acculturation on pregnancy and birth outcomes. With this newfound knowledge we can tailor clinical approaches to counseling Latina women, and in this case, those of Mexican origin.

This study will aim to fill the existing gap in knowledge by examining the association between US acculturation and poor birth outcomes (PTLBW and macrosomia) in a population of Mexican and Mexican-American women at varying

lengths of U.S. residency. It will simultaneously investigate whether obesity is serving to moderate this association. This information will serve to provide insight into whether there may be a shift in the paradox such that birth outcomes in Latinas are changing in the face of rising obesity.

Moreover, this study will test the conceptual model presented in Figure 1 below. The model demonstrates the association between US acculturation and poor birth outcomes, namely PTLBW and macrosomia. The construct of US acculturation or the extent of US acculturation reflects underlying behavior, language, and ethnic identity. These are the factors tested by the ARSMA-II discussed previously. Additionally, the model demonstrates obesity as a likely moderator for the association between acculturation and poor birth outcomes.

Figure 1: Conceptual model for the effects of US acculturation and obesity on birth outcomes.



Research Question and Hypothesis

The primary question that will guide this paper is whether the association between U.S. acculturation and birth outcomes, particularly low birth weight and preterm birth, is moderated by maternal obesity, such that more acculturated women who are more obese experience the most adverse birth outcomes? The primary outcome will be low birth weight (LBW) and/or preterm birth (PTLBW). Additionally, this study will examine the effects of US acculturation and obesity on primary cesarean section rates, gestational diabetes mellitus (GDM) and pregnancy-induced hypertension (PIH).

The primary hypothesis is that the association between US acculturation and PTLBW is moderated by maternal obesity such that women with high levels of acculturation and obesity will experience increased incidence of PTLBW compared to women with low levels of acculturation who are not obese. Hypotheses for secondary outcomes are: the associations between US acculturation and C-section, GDM and PIH are moderated by maternal obesity such that women with high levels of acculturation and obesity will experience increased incidence of these three outcomes compared to women with low levels of acculturation who are not obese.

CHAPTER 2: METHODS

Study Design

This is an observational longitudinal study of pregnant women in the California San Joaquin Valley. Data is from the Study for Hispanic Acculturation, Reproduction, and the Environment (SHARE) conducted between August 1999 and February 2001 by researchers at the University of California, Davis under the principal investigator, Marc Schenker.

Study Participants

Participants were 1,069 women from the Study for Hispanic Acculturation, Reproduction, and the Environment (SHARE). SHARE was funded by the National Institute for Environmental Health Sciences (NIEHS) to investigate factors affecting reproductive outcomes among Latinas in a California urban agricultural community. Participants were recruited from six obstetrics and gynecology (OB/GYN) clinics affiliated with San Joaquin General Hospital, a major regional center in Stockton, California, that serves a large number of Mexican Latinos. The majority of women who received prenatal care through the San Joaquin OB/GYN medical group were Mexican immigrants with varying lengths of US residency. Eligible participants had to be non-white Latina females, reside in San Joaquin County, and receive their prenatal care at one of the clinics affiliated with San Joaquin General Hospital.

Data Collection

The SHARE study was approved by the University of California, Davis, Institutional Review Board. Study participants provided informed consent prior to enrollment in the study. SHARE data were obtained via standardized, computer-assisted

and paper questionnaires administered by bilingual (English and Spanish) interviewers at prenatal clinics. All women underwent a 45-minute interview with a trained bilingual fieldworker in English or Spanish depending on patient preference. All women spoke either English or Spanish (i.e. no indigenous languages). The interview assessed demographic information, acculturation level, reproductive history, nutritional intake, sexual history/behavior, known risk factors associated with poor pregnancy outcomes, such as tobacco use and substance abuse, as well as employment and occupational exposures. Participants were recruited primarily at their first prenatal visit and after delivery participants' and their infants' medical charts were obtained. Data on obstetrical history, maternal physical exam and laboratory test results, pregnancy complications, and method of delivery were obtained for participants. Data on birth weight, gestational age, and maturity ratings at delivery were obtained for infants.

Data Analysis

Outcome variables:

The primary outcome variable was a combined variable of preterm and/or low birth weight (ptlbw). Preterm birth was defined as delivery after 20 weeks but before 37 weeks gestation. Low birth weight was defined as an infant weighing less than 2500 grams at delivery. The second primary outcome variable was macrosomia, defined as a birth weight of greater than or equal to 4000 grams. Only single live births and stillbirths were included in the analysis (N = 1024). The secondary outcome variables were cesarean section (or C-section), defined as a C-section for any indication as oppose to vaginal delivery. The diagnosis of pregnancy-induced hypertension and low Apgar scores

were the final secondary outcomes. The variable "low Apgar" was coded as Apgar scores below 7 for 1-minute and/or 5-minute scores.

Independent variables:

The primary independent variable (IV) was US acculturation level defined as low, moderate and high acculturation. Raw acculturation scores were initially obtained from responses to the ARSMA-II-SV (Acculturation Rating Scale for Mexican Americans-II Short version) questionnaire that was built into the study questionnaire. The ARSMA-II-SV is a 12-item questionnaire developed from the well-established ARSMA-II developed by Cuellar et al. that assesses language use and preference. The ARSMA-II-SV is highly correlated with the ARSMA-II with a concurrent validity of $r = 0.93$ and good reliability with a Cronbach alpha of 0.83 and 0.87 for two of the built-in subscales, describes below. The ARSMA-II-SV uses a five-point Likert scale to score responses to questions about the use of English or Spanish in speaking, reading, writing, and other forms of communication. Response options are: 1 (not at all), 2 (very little/not very often), 3 (moderately), 4 (much or very often), and 5 (extremely often or almost always). The scale was split into two subscales that measure Mexican Orientation and Anglo Orientation. Based on responses, a Mexican-Orientation Score (MOS) and Anglo-Orientation Score (AOS) were calculated. MOS was subtracted from AOS to obtain a raw score for the entire measure. Using preset cutoff points a five-level linear acculturation was established with "1" representing maximum Mexican-Orientation and "5" representing maximum Anglo-Orientation. Because there were relatively low numbers of patients falling into levels 2 – 5, levels 2 and 3 were combined to create a "moderate acculturation" category and levels 4 – 5 were combined to create a "high acculturation category". Patients at

Level 1 represented the “Low Acculturation” category. Thus a final 3-category variable was created which divided patients into “Low”, “Moderate” and “High” acculturation categories. The original scoring table from Cuellar et al. can be found in the appendix. This variable was then dummy coded to create a comparison of low to moderate and low to high acculturation categories. See Table 1 for variable coding. Note: half way through the study the 5-point scale was modified to a 3-point scale by removal of options, 2 (very little/not very often) and 4 (much or very often), in order to keep the interviews under one hour. Post-hoc analysis of this scale change revealed a small but statistically significant difference between the two scales which ultimately required values to be imputed for patients given the 3-option questionnaire. Briefly, imputing was conducted by calculating the proportion of patients who selected each option in the 5-point scale, which were then used to estimate expected proportions for participants receiving the 3-option scale. Values for the scale extremes in individuals given the 3-option scale were replaced by weighted averages. More detailed methods for imputing values can be found in the thesis work conducted by Olivia C. Kasirye and can also be found in her paper published in the Journal of Ethnicity and Disease (Kasirye et al., 2005).

The second independent and moderator variable was obesity, determined by BMI at first prenatal visit and dichotomized to BMI >= 30 as equal to ‘1’ and BMI < 30 equal to ‘0’. Gestational weight gain was also made into a variable, which was calculated by subtracting BMI at last prenatal visit from BMI at first prenatal visit. This variable was then dichotomized into excess weight gain defined as weight gain equal to or greater than 40 lbs, as this is the maximum recommended weight gain defined by the Institute of Medicine (IOM). The IOM set guidelines in 2001 for recommended gestational weight-

gain according to pre-pregnancy BMI. Recommended weight gain ranges from 15 to 40 pounds depending on pre-pregnancy BMI.

Additional variables:

Covariates that required recoding or formation of new variables for demographic data were: *at or below FPL, multigravida, enough to eat, > 2 fruits/veggies per day, work stress during first trimester, fear of baby's health, fear of delivery, ability to rely on family, support from family, ability to deal with problems* i.e. coping. The Federal Poverty Line (FPL) cutoff was determined using the 2001 federal poverty guidelines from the Department of Health and Human Services. In 2001 the federal poverty line (FPL) for a household of four was $17,650 per year (HHS, 2001). The average household size for the entire sample was 4.75 persons with a standard deviation of 2.1 and a median of 4.0. To be conservative, FPL cutoff was set at $10,000 or less per year, which would represent approximately 56% of the FPL for 2001. The variable *multigravida*, meaning more than one gestation, was coded as '1' for participants with greater than or equal to one prior pregnancy and '0' women who were experiencing their first pregnancy. The variable *enough to eat* was coded as '1' for participants who answered "Enough of kinds we want" or "Enough-not always what we want" while '0' was assigned to answering "Sometimes not enough to eat" or "Often not enough to eat". The variable *> 2 fruits/veggies per day* was coded as '1' for participants who answered yes to eating more than 2 fruits and/or veggies per day and '0' for those eating less. *Work stress during first trimester* was coded as 1'' for participants who answered that work was "very stressful" or "extremely stressful" in the first 3 months of pregnancy and '0' for those who answered "moderately stressful", "slightly stressful" and/or "not stressful at all". The

variable *fear of baby's health*, was coded as '1' for patients who answered that they feared their baby's health "all of the time" or "most of the time" and '0' for answering "sometimes" or "never". The same coding was used for *fear of delivery.* The variable *ability to rely on family* was coded as '1' for participants who answered that they felt they could not rely on their family "agree" or "strongly agree" and '0' for answering "disagree" or "strongly disagree". *Support from family* was coded in the same way for answers to whether patients felt their family stood by them. The variable *ability to deal with problems* was coded as '1' for patients who answered that they had success in dealing with problems "most of the time" or "all of the time" and '0' for answering ""sometimes" or "never". Additional note: many variables were coded with values for "not applicable", "don't know", "declined to answer" and "missing". These values were all recoded as "missing" in final analysis.

Table 1: Coding of main variables

Variable Description	**Coding**	**Variable name**
US acculturation level (based on ARSMA-II-SV score)	1: low 2: moderate 3: high	linscale8
Dummy coded acculturation level, low to moderate	0: low 1: moderate 0: high	DUM_linscale8_1
Dummy coded acculturation level, low to high	0: low 0: moderate 1: high	DUM_linscale8_2
Obesity	0: non obese BMI < 30 1: obese BMI ≥ 30	BMI_obese
Excess weight gain	0: wt gain > 40lbs 1: wt gain ≤ 40lbs	D_wtchange_excess
Preterm &/or low birth weight (<2500g) infant	0: no 1: yes	D_ptlbw
Macrosomia	0: < 4000g 1: ≥ 4000g	BW_macro
Cesarean section (C-section)	0: vaginal delivery 1: C-section	D_csect
Pregnancy induced hypertension (PIH)	0: no PIH 1: PIH	pih_preg
Low Apgar	0: scores < 7 at 1-min and 5-min 1: scores ≥ 7 at 1-min and 5-min	lowapgar_1m5m

Inclusion criteria

For the primary outcome, PTLBW, only women with a single live birth or stillbirth were included in the analysis. The total number of patients included in the analysis was 1,024 women.

Primary analyses

Multivariable logistic regression analysis was conducted to determine whether acculturation level was significantly associated with increased risk of preterm birth and/or low birth weight (PTLBW) and macrosomia. Additional analysis examined whether obesity was associated with poor birth outcomes and whether obesity moderated the interaction between acculturation and birth outcomes. Potential confounders were determined by conducting exploratory analyses for associations of multiple covariates with the primary outcomes and the independent variables using Pearson's R correlation for continuous variables and chi square analyses for categorical variables. Potential confounders included in the analysis were: education, FPL, receipt of WIC benefits, fast food consumption, diabetes prior to pregnancy, gestational diabetes and pregnancy induced hypertension. All analyses were done using IBM SPSS Statistics Version 23.

Secondary analyses

Secondary analyses were conducted to examine associations of acculturation and obesity on three secondary outcomes: cesarean section, pregnancy induced hypertension (PIH) and low Apgar scores. Multiple logistic regression was used to examine these associations as described above using the same SPSS software.

CHAPTER 3: RESULTS

Sample Demographics

All patients in the sample were female (N = 1069). The average age of the women was approximately 25 years, with an average age of 20 years upon arrival to the United States. The majority of the sample was born outside the US with only about one quarter (26.3%) born in the US. A little more than half (53%) of the women have been living in the US less than five years. These results are consistent with the majority (64.9%) of women falling within a "low" US acculturation category. The mean education level was approximately nine years of schooling, less than a full high school education. The sample was overweight on average, with a BMI of 27.9, and approximately 28% of the sample was obese – higher than the obesity prevalence in California in 2001, which was at 19.1% (Calif. Dept. Health Services, 2001). On average infant birth weight was within the normal range (mean = 3,349 grams). About three quarters (75.3%) of the women reported being married at the time of survey, with the majority (81.4%) receiving governmental financial assistance through the Women, Infants and Children (WIC) Supplemental Nutrition Program. Of the women who answered smoking, alcohol and drug questions, less than 10% answered "yes" to drinking and drugs during pregnancy while almost 17% answered "yes" to smoking during pregnancy. Note: there was a low response rate for tobacco, alcohol and drug use questions, as less than 10% of the sample answered them. The majority (69.4%) of women had one or more previous pregnancies and approximately 4% had diabetes mellitus before becoming pregnant. Almost 10% of the sample experienced excess weight gain during their current pregnancy and about 3.5% of women developed gestational diabetes. Only 20.6% of women had a cesarean section

delivery, which was slightly below the national average in 2001 at 25% (US National Center for Health Statistics, 2011). Of the 1,024 deliveries, 82 women (8.2%) experienced a preterm birth and/or low birth weight (PTLBW) delivery. Close to 10% of women gave birth to macrosomic infants. Sample demographics can be found in table format in Table 2 below.

Table 2: Patient Demographics (N = 1024)

Variable		**Mean (s.d.)**
Age (yrs)		25.2 (6.3)
Age immigrated to US (yrs)		19.8 (7.1)
Education (yrs)		8.8 (3.2)
BMI		27.9 (6.2)
Infant Birth Wt. (kg)		3.349 (0.566)
		%
Born in US		26.3 (281/1069)
Years living in US	< 5yrs	53.0 (419/791)
	> 5yrs	47.0 (372/791)
US Acculturation level	Low	64.9 (689/1061)
	Moderate	19.8 (210/1061)
	High	15.3 (162/1061)
Married		75.3 (805/1069)
Occupation	Farm work	26.8 (286/1069)
	Non-farm work	42.2 (451/1069)
	No work	31.1 (332/1069)
Receiving WIC benefits		81.4 (726/892)
Smoked during pregnancy		16.9 (33/195)
Drank alcohol during pregnancy		9.8 (44/451)
Used drugs during pregnancy		9.7 (12/124)
Multigravida (G ≥ 1)		69.4 (740/1066)
BMI > 30 (obese)		27.9 (239/858)
Diabetes before pregnancy		3.6 (38/1069)
Excess weight gain during pregnancy		9.2 (92/1003)
Gestational Diabetes		3.4 (36/1069)
Pregnancy Induced Hypertension		4.9 (52/1069)
Cesarean section		20.6 (213/1035)
Preterm &/or LBW		8.2 (84/1024)
Macrosomia (BW > 4000g)		9.5 (99/1027)

* values were calculated using N available for the variable

Sample Demographics by Acculturation Category

To better characterize the sample according to acculturation level, demographics were obtained by acculturation category: low, moderate and high. One-way ANOVA and Chi Square analyses were used to measure whether the differences observed between groups were significant, and these values are reported in Table 3 below. The low acculturation women were a few years older on average than the other two groups with a mean age of 26.4 years. The low acculturation women migrated to the US later, at a mean age of 21.3 years. Less than 3% of the low acculturation group was born in the US on average, and over half (60.3%) had been living in the US for less than 5 years compared to the moderate group with only 11.1% and 0% in the high acculturation group. The low acculturation group also had much less educational experience with an average of 7.6 years of schooling compared to 10.5 years and 11.3 years in the moderate and high acculturation groups respectively. They also had a lower average BMI's overall, and had the least amount of excess weight gain during pregnancy. Average infant birth weight was not significantly different between the groups and the low acculturation group experienced the lowest rate of preterm birth and/or low birth weight infants. The rates of macrosomia did not differ significantly between groups. The average household size was consistent between groups ranging from 4.3 persons in the high acculturation group, to 5.1 people in the moderate acculturation group, while the low acculturation group fell in between with an average household size of 4.8 people. More than half (58.5%) of the low acculturation group's family income fell below the federal poverty line (FPL), whereas slightly less than half of the moderate (48.1%) and high (49%) groups fell below the FPL. A higher proportion of the women in the low acculturation group were employed as

farmworkers (32.9%), compared to less than 10% in the moderate and high groups. A higher proportion of the low acculturation group was married (85.9%), compared with the other groups. The rates of smoking while pregnant did not differ significantly between groups, while gestational alcohol consumption was the lowest for the low acculturation group (5.3%) and highest amongst the moderate acculturation group (14.2%). Similarly, a higher percentage of women in the moderate group reported cocaine use ever (48.7%) than any other group. A higher proportion of women in the low acculturation group were multigravida (73.7%), meaning more than one pregnancy, compared to the other groups. The moderately acculturated group was the most obese, with 35.3% of women meeting the criteria for obesity (BMI $\geq$ 30), and the most highly acculturated group had the most excess weight gain of all the groups (20.7%). The rates of diabetes mellitus, gestational diabetes, pregnancy induced hypertension (PIH) and cesarean section did not differ significantly between the three groups.

Table 3: Participant characteristics by acculturation level

	Low (N=689)	**Moderate** (N=210)	**High** (N=162)	**P-value**
Variable	**Mean (s.d.)**	**Mean (s.d.)**	**Mean (s.d.)**	ANOVA (F)
Age (yrs)	26.4 (6.1)	23.2 (6.2)	22.6 (5.7)	<0.001 (142.6)
Age migrated to US	21.3 (5.8)	11.4 (7.8)	6.1 (5.4)	<0.001 (40.2)
Education (yrs)	7.6 (3.0)	10.5 (2.4)	11.3 (1.6)	<0.001 (177.8)
BMI	27.5 (5.0)	29.0 (7.5)	28.5 (8.8)	0.015 (4.2)
Infant birth wt. (g)	3.372 (0.573)	3.294 (0.568)	3.316 (0.527)	0.169 (1.8)
Household size	4.8 (2.2)	5.1 (2.2)	4.3 (2.0)	0.005 (5.4)
	%	**%**	**%**	Chi Square
Born in US	2.8	49.0	95.7	<0.001
Living in US < 5 yrs	60.3	11.1	0	<0.001
At or below FPL	58.5	48.1	49.0	0.060
Married	85.9	63.3	47.5	<0.001
Farm work	32.9	9.3	5.9	<0.001
Receiving WIC benefits	87.3	73.5	67.8	<0.001
Smoking	10.2	19.3	19.5	0.283
Alcohol	5.3	14.2	13.6	0.011
Cocaine	28.6	48.7	35.5	0.205
Multigravida (G≥1)	73.7	63.2	60.2	<0.001
BMI > 30 (obese)	25	35.3	31.6	0.020
Diabetes prior to pregnancy	4.6	2.5	5.3	0.434
Excess gestational weight gain	5.4	12.4	20.7	<0.001
Gestational Diabetes	3.8	1.9	3.1	0.409
PIH	4.1	6.2	6.8	0.220
C-section	21.0	17.2	24.2	0.255
Preterm birth	5.7	10.2	9.3	0.050
LBW(<2500g)	3.6	7.4	5.9	0.066
Preterm &/or LBW	6.3	11.8	11.3	0.015
Macrosomia	10.4	7.8	7.8	0.380

Note: percentages were calculated from proportions within acculturation category, not within variable - do not add to 100%

Sample Demographics by Obesity Status

Similar to Table 3, in order to better characterize the sample according to obesity status, demographics were obtained by obesity category: obese vs. non-obese. One-way ANOVA and Chi Square analyses were used to measure whether the differences observed between groups were significant. These values are reported in Table 4 below. Significant differences were found within: age, infant birth weight, percentage born in the

US, years living in the US, proportion receiving WIC benefits, proportion of multigravidas, diabetes prior to pregnancy, excess gestational weight gain, gestational diabetes, pregnancy induced hypertension and C-section. Marginal significance was found in the difference between obesity status regarding the proportion of women experiencing significant work stress during the first trimester of pregnancy, with obese women experiencing less work stress. Obese women had an average infant birth weight (BW) of approximately 3500g compared to non-obese women with an average BW of close to 3300g. A higher proportion of obese women were born in the US and have been living in the US longer. A higher percentage of non-obese women received WIC benefits than did obese women. Being obese was associated with a higher chance of being a multigravida, having more than one pregnancy. Obese women had higher proportions of having diabetes prior to pregnancy (9.4% vs. 1.8%), pregnancy induced hypertension (9.6% vs. 3.1%) and having gestational diabetes (5.9% vs. 1.8%) compared to non-obese women.

Table 4. Participant characteristics by obesity status.

	Obese (N=239)	**Non-Obese** (N=619)	**P-value**
Variable	**μ (s.d)**	**μ (s.d)**	ANOVA (F)
Age (yrs)*	27.0 (6.3)	24.5 (6.0)	< 0.001 (28.7)
Age migrated to US	19.7 (7.1)	19.7 (7.0)	0.923 (0.01)
Education (yrs)	8.8 (3.4)	8.7 (3.1)	0.720 (0.1)
Infant birth wt. (g)*	3437 (619)	3330 (200)	0.014 (6.1)
Household size	4.5 (1.9)	4.8 (2.2)	0.068 (3.3)
	%	**%**	Chi Square
Born in US*	31.4	21.8	0.003
Living in US < 5 yrs*	35.5	57.7	<0.001
At or below FPL	49.4	57.2	0.110
Married	80.0	75.8	0.119
Farm work	22.1	29.3	0.224
Receiving WIC benefits*	75.5	83.7	0.010
Tobacco	6.9	16.1	0.100
Alcohol	6.6	7.3	0.820
Multigravida (G≥1)*	81.1	66.2	< 0.001
Diabetes prior to pregnancy*	9.4	1.8	<0.001
Excess gestational weight gain	10.1	10.1	0.989
Gestational Diabetes*	5.9	1.8	0.001
PIH*	9.6	3.1	<0.001
C-section*	30.2	17.1	<0.001
Preterm &/or LBW	10.0	6.8	0.126
Macrosomia (> 4000g)	15.7	8.0	0.001
Enough to eat	91.6	92.2	0.766
Eat fast food > 2x per week	12.6	21.1	0.868
> 2 Fruits/veggies per day	91.8	95.2	0.086
Work stress during 1st trimester (very-extremely)	26.1	39.7	0.059
Fears health of baby (most or all the time)	37.8	39.1	0.730
Fears delivery (most or all the time)	27.8	29.4	0.658
Can't rely on family (agree or strongly agree)	35.7	33.1	0.463
Feels family "stands by me" (agree or strongly agree)	95.4	96.1	0.635
Success dealing with problems (most or all the time)	44.1	42.7	0.707

Note: percentages calculated from proportions within acculturation category, not within variable
* significant difference ($p < 0.05$)

Predicting PTLBW from Acculturation and Obesity Status

Results of multivariable logistic regression analysis can be found below, in Table 5. The unadjusted regression model revealed that the moderately acculturated group had over three times the odds of experiencing preterm birth and/or having a low birth weight

(PTLBW) infant (OR 3.23). There was not a significant association between PTLBW and low or high acculturation. When obesity was added to the nested model, labeled 'Model 2', there was no significant association between BMI ≥ 30 with PTLBW. Once added as an interaction term, in Model 3, women in the moderately acculturated group who were obese experienced a decreased odds of PTLBW (OR 0.23). In this group of women, obesity acted a buffer. Obesity did not affect the association between low and high acculturation with PTLBW. The adjusted model showed the same associations however the odds ratio increased to 4.80 for PTLBW in association with moderate acculturation, and decreased to 0.11 once the obesity interaction term was added as a moderator. The association of PTLBW for low and high acculturation groups remained insignificant in the adjusted model. A significant linear association was not found between acculturation and PTLBW, using both the categorical and continuous variables for acculturation score and birth weight. To examine the actual predicted probabilities for the primary outcome in low, moderate and high acculturation groups, as moderated by obesity, the probabilities were calculated using Equation 1, as generated from the logistic regression model. The values for each permutation (low acculturation with obese/non-obese, moderate acculturation with obese/non-obese and high acculturation with obese/non-obese) can be found in Table 4. The probabilities are demonstrated graphically in Figure 2, which shows that the predicted probability of PTLBW increases with obesity within the low and the high acculturation groups, but decreases with obesity in the moderate acculturation group. In the low group, the probability of PTLBW goes from approximately 5% for non-obese women to approximately 9% for obese women. In the highly acculturated group the probability goes from roughly 6.5% in non-obese women to

about 17% in obese women. The trend is reversed in the moderately acculturated group with a predicted probability of approx.. 14.5% in non-obese women, with a decrease to 6.7% in obese women. The predicted probability for PTLBW in obese women alone is 14.8% as calculated from a separate logistic regression model (see appendix).

Table 5: Unadjusted and adjusted models for primary outcome: Preterm &/or Low birth weight

		Unadjusted		Adjusted	
	Variable	Odds ratio (CI)	P-value	Odds ratio (CI)	P-value
Model 1	**Low Acculturation**	1.0	1.0	1.0	1.0
	Moderate Acculturation	3.23* (1.63-6.53)	0.001	4.80* (1.21-19.00)	0.026
	High Acculturation	1.36 (0.50-3.75)	0.519	2.73 (0.49-15.23)	0.253
Model 2	**Obese (BMI ≥ 30)**	1.89 (0.90-3.97)	0.094	2.97 (0.79-11.15)	0.107
Model 3	**Low Acculturation by Obesity**	1.0	1.0	1.0	1.0
	Moderate Acculturation by Obesity	0.23* (0.06-0.90)	0.034	0.11* (0.01-0.90)	0.040
	High Acculturation by Obesity	1.56 (0.36-6.74)	0.554	0.74 (0.09-6.15)	0.779

* sig association, p-value < 0.05; CI (95%)

Table 6: Calculated predicted probabilities for preterm &/or low birth weight from logistic regression model.

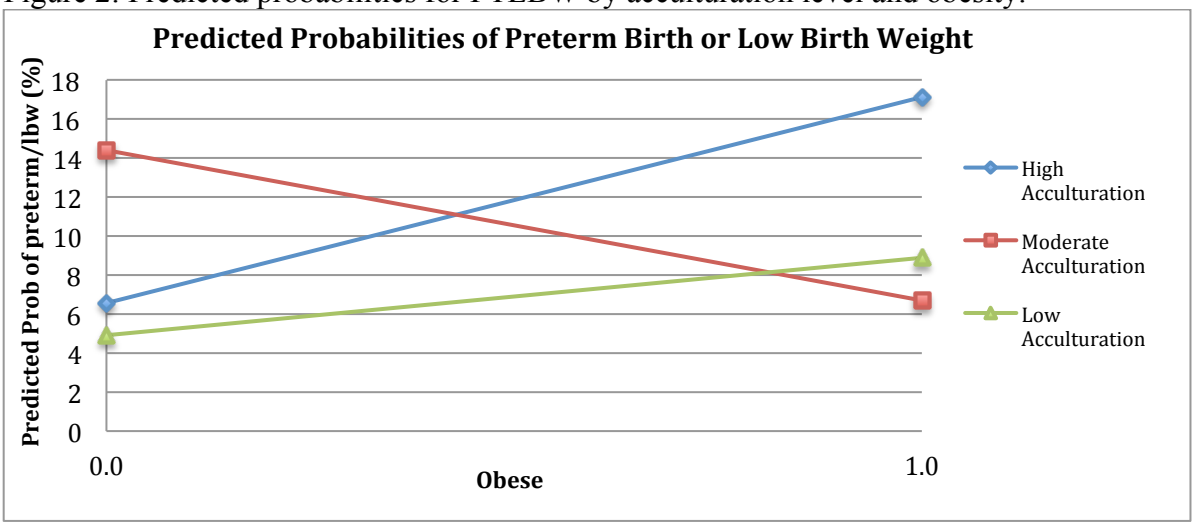
Moderate Acculturation	High Acculturation	Obese	Moderate* Obese	High*Obese	Predicted Odds	Predicted Probability (ptlbw)
1	0	0	0	0	0.1683	0.1441
0	1	0	0	0	0.0704	0.0657
0	0	1	0	0	0.0975	0.0888
1	0	1	1	0	0.0727	0.0677
0	1	1	0	1	0.2066	0.1712
0	0	0	0	0	0.0517	0.0491

Equation 1:

Odds (PTLBW)=e^[-2.963 + 1.181*DUM_linscale8_1 + 0.309*DUM_linscale8_2 + 0.635*BMI_obese + (-1.475)*(DUM_linscale8_1*BMI_obese) + 0.442*(DUM_linscale8_2*BMI_obese)]

Equation 2:
Predicted probability = odds/(1+odds)

Figure 2: Predicted probabilities for PTLBW by acculturation level and obesity.



Predicting Macrosomia from Acculturation and Obesity Status

Results of the same multivariate logistic regression analysis as was conducted for PTLBW, can be found for macrosomia in Table 5. In the unadjusted model there was a marginal association (p = 0.057) between the incidence of macrosomia and being moderately acculturated (OR 0.360). Moderately acculturated women had approximately one-third the odds of having a macrosomic infant. Macrosomia was not found to be significantly associated with low or high acculturation. In this model, obesity was associated with over two times the odds of having a macrosomic infant (OR 2.066). However, obesity was not found to moderate this association as it did for PTLBW, nor did it moderate the associations between low and/or high acculturation with macrosomia. Significant associations with macrosomia were not found for any of the covariates in the adjusted model. The predicted probabilities were calculated from this model and shown

graphically in Figure 3. The raw values for each combination can be found in Table 6. The predicted probabilities of macrosomia increased as from non-obese to obese women in all three acculturation groups. The greatest increase was seen in the low acculturation group with a probability 3.4% for macrosomia in non-obese women and 17.7% in obese women, which represents little over a 14% increase. The smallest slope was found amongst the high acculturation group with only a 5% increase in predicted probability of macrosomia from non-obese to obese.

Table 7: Unadjusted and adjusted models for Macrosomia (BW > 4000g)

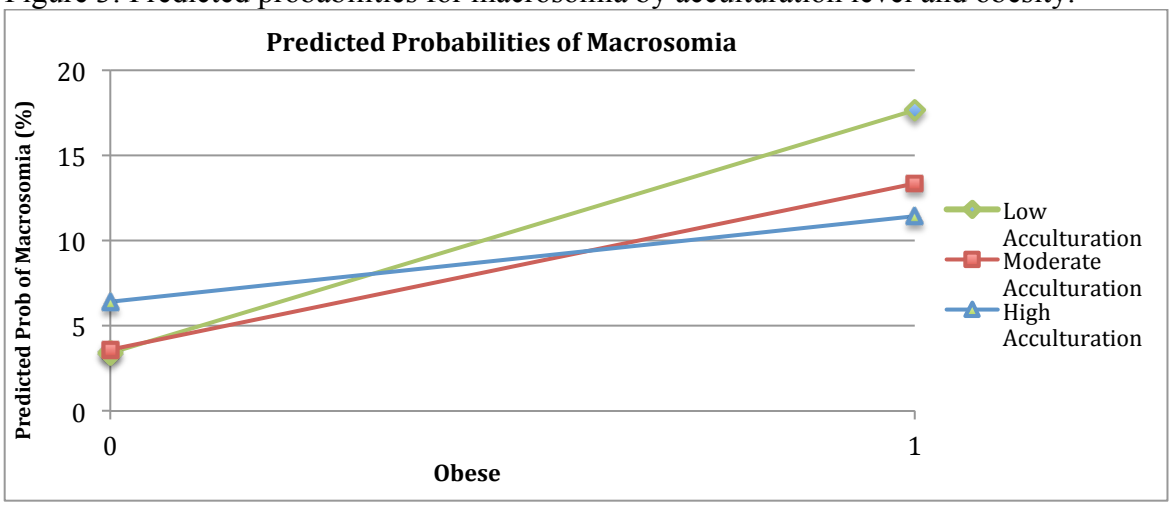
		Unadjusted		**Adjusted**	
	Variable	Odds ratio (CI)	P-value	Odds ratio (CI)	P-value
Model 1	Low Acculturation	1.0	1.0	1.0	1.0
	Moderate Acculturation	0.360^{+} (0.126-1.031)	0.057	0.512 (0.158-1.654)	0.263
	High Acculturation	0.660 (0.252-1.732)	0.399	0.554 (0.141-2.174)	0.397
Model 2	Obese (BMI ≥ 30)	2.066* (1.191-3.583)	0.010	1.752 (0.784-3.919)	0.172
Model 3	Low Acculturation by Obesity	1.0	1.0	1.0	1.0
	Moderate Acculturation by Obesity	1.992 (0.511-7.772)	0.321	1.393 (0.284-6.837)	0.683
	High Acculturation by Obesity	0.912 (0.206-4.030)	0.903	1.171 (0.192-7.153)	0.865

* sig association, p-value < 0.05
+ marginal association

Table 8: Calculated predicted probabilities for macrosomia from regression model.

Moderate Acculturation	High Acculturation	Obese	Moderate* Obese	High*Obese	Predicted Odds	Predicted Probability (Macrosomia)
1	0	0	0	0	0.0374	0.03608
0	1	0	0	0	0.0685	0.0641
0	0	1	0	0	0.2144	0.1765
1	0	1	1	0	0.1538	0.1333
0	1	1	0	1	0.1291	0.1144
0	0	0	0	0	0.1037	0.0940

Figure 3: Predicted probabilities for macrosomia by acculturation level and obesity.



Additional Participant Characteristics by Acculturation Category

Further analysis of demographics within each acculturation group revealed significant differences between groups for many behavioral and social characteristics. When diet habits were examined for all three groups, results showed that the low acculturation group answered 'yes' to having "enough (food) to eat" during the week with the least frequency (90%) compared to the other groups. The moderate group answered 'yes' with the highest frequency (98.1%). The high acculturation group ate fast food more than twice a week about 30% of the time, which was more than the other groups. The low acculturation group ate the least fast food (5.5%). Additionally, highly acculturated women had the lowest frequency of eating more than 2 fruits or veggies per day (88.1%), while low and moderate groups ate more than 2 fruits or veggies per day between 96% and 94% of the time.

When stress was examined within each group, analysis revealed that the groups did not differ significantly with regard to work stress. The least acculturated women reported fearing the health of their baby 'most or all of the time' with a frequency of

38.3%, which was similar to the moderate group (38.1%). The moderately acculturated group was found to fear delivery most or all of the time with a greater frequency (27.6%) compared to the other two groups. In terms of family support, the lowest acculturated group felt they could not rely on their family with the greatest frequency (40.0%) compared to the other two groups. However, the low acculturation group felt their family stands by them more than the other groups (96.8%). Lastly, in terms of coping skills, the most highly acculturated group felt they had success in dealing with problems most or all of the time (51.9%) with the highest frequency, while the moderate group had the next highest frequency (43.8%), while the low acculturation group felt they had the least success dealing with problems (39.8%).

Table 9: Characterization of social and behavioral characteristics by acculturation group

		Low	**Moderate**	**High**	
Category	Variable	%	%	%	P-value
Diet	Enough to eat*	90.0	98.1	93.8	<0.001
	Eat fast food > 2x per week*	5.5	25.2	30.2	<0.001
	> 2 Fruits/veggies per day*	95.7	94.3	88.1	0.004
Stress	Work stress during 1st trimester (very-extremely)	33.0	31.3	27.8	0.149
	Fears health of baby (most or all the time)	38.3	38.1	37.9	0.052
	Fears delivery (most or all the time)*	24.0	27.6	19.4	<0.001
Family support	Can't rely on family (agree or strongly agree)*	40.0	26.2	26.9	<0.001
	Feels family "stands by me" (agree or strongly agree)*	96.8	95.7	93.8	<0.001
Coping	Success dealing with problems (most or all the time)*	39.8	43.8	51.9	<0.001

- all variables coded as (1,0)
- p-values obtained from chi square analysis
* proportions are significantly different between groups

Comparing Mexican and Anglo Orientation Scores

Lastly, an independent samples t-test was performed to compare the moderate acculturation group's Mexican Orientation Scores (MOS) and Anglo Orientation Scores (AOS) to the scores of both the low and high acculturation groups. The mean MOS and AOS were significantly different between moderate and low as well as moderate and high groups, as seen in Table 6. However, the mean difference was greater for AOS between moderate and low acculturation groups compared to the difference between moderate and high groups. Conversely, the mean difference for MOS was greater between moderate and high groups than it was for moderate versus low groups.

Table 10: Independent samples t-test for comparison of MOS and AOS in moderate vs. low and high acculturation groups

Score	**Moderate Acculturation**		**Low Acculturation**		**Mean Diff**
	Mean	St. Dev.	Mean	St. Dev.	
Mexican Orientation	3.87	0.59	4.31	0.45	-0.44**
Anglo Orientation	3.90	0.77	1.57	0.50	2.33**
	Moderate Acculturation		**High Acculturation**		**Mean Diff**
	Mean	SD	Mean	SD	
Mexican Orientation	3.87	0.59	1.96	0.81	1.91**
Anglo Orientation	3.90	0.77	4.64	0.38	-0.73**

** $p < 0.01$

Results of Secondary Analyses

Secondary analysis examined three additional outcomes: cesarean section, pregnancy induced hypertension (PIH) and low Apgar scores. Results of multivariate logistic regression analysis for these outcomes revealed significant associations between obesity and the incidence C-section (OR 2.041) and low Apgar scores (OR 2.052). Obese women had over two times the odds of having a C-section, however there was no association between C-section and acculturation. Obese women were also slightly more than twice as likely to have infants with low Apgar scores. There was no association

between acculturation and low Apgar scores however. Additionally, analysis did not reveal any association between acculturation and/or obesity and PIH.

Table 11: Secondary logistic regression analyses.

	Secondary outcomes					
	C-section		**PIH**		**Low Apgar**	
Variable	OR	CI (95%)	OR	CI (95%)	OR	CI (95%)
Moderate vs. Low Acculturation	0.600	0.319-1.127	0.938	0.260-3.383	1.433	0.693-2.961
High vs. Low Acculturation	1.273	0.703-2.304	1.794	0.564-5.710	0.865	0.325-2.304
Obese (BMI ≥ 30)	2.041*	1.311-3.176	2.342	0.965-5.681	2.052*	1.114-3.779
Moderate Acculturation by Obesity	1.357	0.538-3.425	2.342	0.459-11.943	0.860	0.284-2.598
High Acculturation by Obesity	0.917	0.342-2.458	1.570	0.317-7.780	0.667	0.133-3.340

* significant association $p \leq 0.05$

CHAPTER 4: DISCUSSION

This study investigated the association between US acculturation and PTLBW in a sample of Mexican-American women. It simultaneously examined the differential effect of obesity on the association between acculturation and birth outcomes. Results revealed a significant association between acculturation and PTLBW delivery, with moderately acculturated women experiencing the highest risk of having a PTLBW infant compared with both low and highly acculturated women. It was hypothesized that the association between US acculturation and PTLBW would be affected by maternal obesity such that women with high levels of acculturation and obesity would experience increased incidence of PTLBW, compared to women with low levels of acculturation who are not obese. Thus, findings partially supported the hypothesis. Results revealed that women with higher levels of acculturation had increased incidence of PTLBW, however only on the spectrum from low to moderate acculturation. Once high acculturation was reached, the hypothesis was no longer supported, in that the most highly acculturated women had better outcomes than moderately acculturated women. Similarly, the findings are partially consistent with the "acculturation paradox" which demonstrates that the incidence poor birth outcomes increases as Hispanic women become more acculturated to the US environment (Flores et al., 2012; Fox et al., 2015; Hoggart, Katherine J., FLores, Marie, Solorio Rosa, Wilhelm, Michelle, Ritz, 2013; Urquia et al., 2012). Also, consistent with previous studies, our findings demonstrate that low acculturation was not significantly associated with poor birth outcomes.

As stated, this study is unique in that the acculturation effect was not observed among the most highly acculturated women, suggesting that the traditional linear

relationship between acculturation and poor birth outcomes is not true for Latinas in this sample. Adoption of unhealthy behaviors, loss of social support and increased stress responses are thought to account for the association of poor health outcomes and acculturation (Callister & Birkhead, 2010; Farley et al., 2005; Fox et al., 2015; Mangold et al., 2012; Urquia et al., 2012). However, many of these theories remain rooted in the demonstration of a linear relationship between acculturation and birth outcomes. The curvilinear relationship between US acculturation and poor birth outcomes observed in this study may be related to a unique situation for moderately acculturated women. Perhaps once the transition from low to moderate acculturation takes place, women have adopted risky health behaviors and increased stress, but endure a simultaneous delay in acquisition of resources and ability to improve quality of life, which may no longer remain true for women once they reach high acculturation. It may be that barriers, such as language, education and economics, remain for moderately acculturated women, but have been overcome by highly acculturated women. Perhaps the underlying factors that lead to adoption of unhealthy behaviors, such as loss of social support and increased acculturative stress, are more prominent amongst moderately acculturated Latinas. It has been shown that high levels of stress and pregnancy related anxiety, which are risk factors for low birth weight and preterm birth (Wadhwa, Pathik D. Sandman, Curt A., Porto, Manuel, Dunkel-Schetter, Christine, Garite, 1993), have been demonstrated particularly in Mexican Americans (Farley et al., 2005; Mangold et al., 2012). However, it must be noted that studies also illustrate Mexican women to have some of the most protective coping strategies, a characteristic that has been suggested as one explanation for the epidemiologic paradox (Farley et al., 2005).

Furthermore, perhaps the negative health factors associated with increased acculturation are truer for moderately acculturated individuals. Moderately acculturated women may be most susceptible to the loss of protective effects offered by traditional Mexican culture, as well as the negative effects of acculturating. This explanation is supported by this study's findings that moderately acculturated women have less education than highly acculturated women. Less education may prevent women who are moderately acculturated from obtaining opportunities that come with more education, such as higher paying jobs. Moderately acculturated women were also found to have the largest household size suggesting difficult living arrangements. It has been demonstrated that challenges associated with finding suitable living arrangements, as well as low occupational attainment leads to high acculturative stress (Cervantes et. al, 2013, Concha, Maritza, Sanchez, Mariana, De la Rosa, Mario and Villar, 2013). This study also revealed that the a higher proportion of moderately acculturated women received WIC benefits compared to women who were most highly acculturated, suggesting increased financial struggles and thus more stress. Additionally, women who were moderately acculturated represented the highest proportion of those fearing delivery of their baby, in addition to less success in dealing with problems. These findings suggest increased psychological stress amongst these women. Research demonstrates that an increased stress response leads to higher incidence of poor birth outcomes, specifically preterm birth and low birth weight (Fox et al., 2015; Wadhwa et al., 2004; Wadhwa, Pathik D. Sandman, Curt A., Porto, Manuel, Dunkel-Schetter, Christine, Garite, 1993).

Moreover, results of this study supported the idea that moderately acculturated women partake in risky health behaviors. For example, the highest rates of alcohol

consumption were found amongst moderately acculturated women. Similarly, moderately acculturated individuals were the most obese and largely reported having enough food to eat. These results suggest unhealthy eating habits amongst these women and possibly, inadequate physical activity, as a higher proportion of moderate individuals did not work compared to highly acculturated individuals.

In terms of familial support, results were mixed amongst the moderately acculturated women. These women reported feeling they could rely on their family more than the low acculturated women group but reliance was similar to the highly acculturated women, which does not suggest comparable loss of familial or social support. However, moderately acculturated women felt their family stood by them less than the low acculturated women but more than the highly acculturated women. This result is more consistent with prior findings of decreasing social support as US acculturation increases. Perhaps this discrepancy is an artifact of how the questions were interpreted or it could be that this population may have less family in living in the US, who are still able to offer some support transnationally. Importantly, studies have demonstrated that increased social support is associated with lower incidence of low birth weight (Feldman, Dunkel-Schetter, Sandman, & Wadhwa, 2000). Thus, if social support is lacking for moderately acculturated women, their birth outcomes may be suffering as a result. In light of these results, it appears that unhealthy behaviors and increased stress are the primary explanations for the disproportionately poor birth outcomes amongst moderately acculturated women.

Another unexpected finding demonstrated that obesity acted as buffer for PTLBW in moderately acculturated women. Women who were moderately acculturated and obese

had a decreased risk of giving birth to PTLBW infants. This differential effect however was not found amongst the least and most highly acculturated women. Thus, obesity was only protective of poor birth outcomes for moderately acculturated women. Possible explanations for this finding must be explored further. Again, the initial hypothesis was also partially supported with this finding, in that obesity was found to act as a significant moderator. However the direction of moderation was different than expected. It was hypothesized that obesity would make birth outcomes worse as women became more highly acculturated. This effect was true for the lowest and most highly acculturated women, but the reverse was found with moderately acculturated women.

One likely explanation for this finding is that obese women have heavier infants, which may tip birth weight in the direction of macrosomia. Interestingly, and consistent with the literature, results of this study indicated that birth weight was significantly higher amongst obese women. This result suggests that once a moderately acculturated woman becomes obese, she has a higher chance of giving birth to a heavier baby, which decreases her chance of having a low birth weight infant. However, the fact that obesity did not affect the probability of having a low birth weight infant for the least and most highly acculturated women, conflicts with the explanation. Moreover, moderately acculturated women were less likely to have macrosomic infants compared to low and high acculturation women. These results suggest additional explanations, as the association between birth weight and obesity does fully explain the differential effect of obesity in moderately acculturated women only.

Another possibility is that obese, moderately acculturated women do less farmwork and are thus removed from the risks inherent to farmwork, such as pesticide

exposure, intense physical work, increased heat exposure and other reproductive hazards. However, in a study conducted by the principal investigator of SHARE, farmwork was not found to be associated with PTLBW. Additionally, results within this paper do indicate a significant difference in farmwork between obese and non-obese women. Thus, the using association of farmwork and obesity does not explain the finding.

There is limited data to support the notion that obesity alone can be protective of health. However, a few studies have explored what has come to be known as the "obesity paradox". The obesity paradox posits that obesity can actually be protective of health in come cases. However, this paradox has only been shown in patients with chronic diseases, mainly demonstrating that once a patient acquires a chronic disease obesity is protective (Kalantar-Zadeh, Rhee, & Amin, 2014). There is strong evidence to support that once diseases such as cardiovascular disease, type II diabetes and myocardial infarction are acquired, obesity confers a survival advantage (Costanzo et al., 2015; Morse, Gulati, & Reisin, 2010; Sharma et al., 2014). Importantly, these studies do not support that obesity itself confers a health advantage. It is well known that obesity leads to poor health in an otherwise healthy person. However, the obesity paradox reveals that once poor health is acquired, obesity can allow for better outcomes. Explanations for the obesity paradox continue to remain unclear and although demonstrated in adults, this effect has never been explored or found in maternal populations. In relation to this study, perhaps moderate acculturation increases a woman's risk for chronic diseases or poor health, thus allowing obesity to be protective of poor birth outcomes. Many health risks associated with diseases like cardiovascular disease and type II diabetes may be disproportionately prevalent amongst moderately acculturated women. Studies have

shown that acculturation is associated with increased risk of chronic diseases such as high incidence abdominal obesity and diabetes mellitus (Khan et al., 1997; Pérez-Escamilla & Putnik, 2007; Wylie, Sundaram, Kus, Ghassabian, & Yeung, 2015). Furthermore, studies show that more US acculturation leads to diets high in sugar and fats (Guendelman & Abrams, 1995). This study provides evidence to support these processes by demonstrating that increased rates of fast food consumption and obesity are most prevalent among moderately acculturated individuals. Additionally, as mentioned previously, the literature has found acculturation to be been associated with high stress and pregnancy anxiety (Belinda Campos et al., 2008; Farley et al., 2005; Fox et al., 2015). All of these factors may combine through the process of acculturation to form a type of chronic illness. Poor birth outcomes, as a product of this chronic illness composite, may stand to benefit from obesity in this particular population.

It must also be mentioned that when comparing Mexican orientation (MO) and Anglo (AO) orientation scores between moderately and low or highly acculturated women, there were mixed results. Moderately acculturated women were more Anglo-oriented than low acculturated women but were more Mexican-oriented than the highly acculturated women. These results suggest that moderately acculturated women are more bicultural compared to women at the extremes of the acculturation spectrum. Studies on acculturation have reported two products of biculturalism: integration and marginalization (Cabassa, 2003; Cuellar, Israel, Arnold, Bill, Maldonado, 1995; Ryder, Alden, & Paulhus, 2000). Perhaps, in this sample the bicultural individuals remain more marginalized than do the low and highly acculturated women. Furthermore, perhaps

bicultural women do not display the traditional patterns that have been observed in the formation the epidemiologic and acculturation paradoxes.

Study Strengths

Major strengths of this study were the large sample size (N = 1069), longitudinal design and combination of patient-reported and medical chart data. The large sample size provided enough power to allow statistical significance. In addition, the fact that acculturation data was collected before birth data, it is plausible to infer directionality of associations. Lastly, the large variety of data allowed the ability to answer interesting questions about social and behavioral factors, which could then be combined with data from the medical chart for more objective information.

Study Limitations

Notable limitations of this study must be taken into account when interpreting the results. One limitation was the method for recruiting patients. The study used a convenience sample, in that only women who utilized clinic services were included in the study. Therefore, a large proportion of the population, made up of those who do not have access to or do not choose to utilize prenatal services, was excluded. Women at low acculturation levels, many of whom are likely undocumented, may not know about their rights to prenatal care in the United States. Leaving out this significant group, limits the study's ability to fully represent California's Mexican immigrant population.

Secondly, the majority of women in this sample were of relatively low acculturation. It is plausible to assume that when compared to the statewide population of Mexican immigrant and Mexican-American women these women, living on a predominately farm working area in the central valley, have greater ties to Mexican

culture than do women in other parts of the state. Considering this observation, the imputation procedure must addressed here. Acculturation (ARSMA-II) scores were imputed for approximately two thirds of the sample due to a change in questionnaire format half way through the study, as described in chapter three. Despite a very common and sound imputation method being used, scores could have been pushed away from the extremes (i.e. low or high acculturation) and more towards the center. It is possible that the "moderate acculturation" category was made larger by imputing scores, especially because this sample was of relatively low acculturation. However, slightly over 370 participants received the 5-option questionnaire, which was a large sample size from which to calculate the proportion of patients selecting each of the five options and use that distribution for imputation.

Lastly, not all known risk factors for PTLBW were controlled for in the logistic regression model, as they did not show associations between either the outcome variables (PTLBW and macrosomia) or the independent variables. For example, smoking, drinking and doing drugs, like cocaine, while pregnant have been shown to increase chances of preterm birth and low birth weight (). However, it is likely that because very few of these women smoke, drank alcohol or did drugs, there was not enough statistical power to find significant associations between dependent and independent variables. However, moderately acculturated women had the highest rates of alcohol and cocaine use, thus we can assume alcohol and drug use were partially controlled for through acculturation.

Implications

Despite these limitations, results of this study have clinical and public health implications. First, acculturation should be taken into account when assessing the risk of poor birth outcomes in Mexican immigrant women living in the US. Likewise, extent of US acculturation must be considered when providing prenatal care to Mexican immigrants and/or Mexican Americans. In light of these results, particular attention must be given to women who are transitioning from low to moderate acculturation or who already fall within the moderate range of the US acculturation spectrum. As postulated, these women may acquire poor health behaviors and experience increased levels of stress while facing insurmountable social and economic barriers. Moreover, as the obesity epidemic continues to rise in both the US and Mexico, health care providers will assume a larger burden in counseling women about weight loss during the prenatal period. Importantly, while these results do not legitimize obesity in moderately acculturated women, perhaps the strong emphasis placed on weight loss can be reexamined in the context of acculturation. However, it remains that maternal counseling should be conducted on a individual basis using sound clinical judgment.

With these implications in mind, further studies are required to examine the underlying factors that may explain why moderate acculturation in Latina women is associated with the worst birth outcomes – a significant deviation from the acculturation paradox. A prospective study could help to investigate causality between acculturation and poor birth outcomes. Furthermore, birth outcomes as they relate to the acculturation paradox, must be studied in diverse groups of Latinas (i.e. comparing outcomes of Mexican, Cuban, Puerto-Rican, Central American and various South American

immigrants). Much of the data used for examining the epidemiologic and acculturation paradoxes is gathered from Mexican origin women. Lastly, the "obesity paradox" must be examined in relation to perinatal health. To date there are no studies that examine the obesity paradox in pregnant women. Similarly, the obesity paradox has not been studied in the context of acculturation, much less in Latinas specifically.

Brief Conclusion

This study provides a unique perspective from which to view the Latina epidemiologic paradox and acculturation theory. The relationship between US acculturation and poor birth outcomes was explored in the context of obesity, which led to distinctive findings. Results of this study provide additional data points in the areas of Latina health, acculturation theory and obesity. With this information, this study helps to inform research in these areas as well as guide directions for future research.

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APPENDIX

SPSS Output for logistic regression model demonstrating association between acculturation and obesity.

Classification Table[a]

Observed			Predicted		
			Dich 1stpnv BMI to >30		Percentage Correct
			.00	1.00	
Step 1	Dich 1stpnv BMI to >30	.00	613	0	100.0
		1.00	238	0	.0
	Overall Percentage				72.0

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	DUM_linscale8_1	.493	.187	6.986	1	.008	1.638	1.136	2.361
	DUM_linscale8_2	.330	.221	2.219	1	.136	1.391	.901	2.147
	Constant	-1.101	.098	127.355	1	.000	.333		

a. Variable(s) entered on step 1: DUM_linscale8_1, DUM_linscale8_2.

SPSS Output for logistic regression model demonstrating association between acculturation and excess gestational weight gain.

Classification Table[a]

Observed			Predicted		
			IOM Excess wt chg >40lbs		Percentage Correct
			.00	1.00	
Step 1	IOM Excess wt chg >40lbs	.00	904	0	100.0
		1.00	91	0	.0
	Overall Percentage				90.9

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	linscale8	.756	.133	32.228	1	.000	2.129	1.640	2.764
	DUM_linscale8_1	.149	.252	.351	1	.553	1.161	.709	1.902
	Constant	-3.612	.280	166.964	1	.000	.027		

a. Variable(s) entered on step 1: DUM_linscale8_1.

SPSS Output for logistic regression model demonstrating association between acculturation and time in the US.

Classification Table[a]

Observed			Predicted		
			Time in US, <5yrs=0, >5yrs=1		Percentage Correct
			.00	1.00	
Step 1	Time in US, <5yrs=0, >5yrs=1	.00	405	12	97.1
		1.00	267	103	27.8
	Overall Percentage				64.5

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	linscale8	2.510	.314	64.031	1	.000	12.300	6.652	22.744
	Constant	-2.927	.342	73.309	1	.000	.054		

a. Variable(s) entered on step 1: linscale8.

- increasing acculturation is associated with 12x odds of being in US for over 5 yrs

Acculturation levels by score cutoffs from Cuellar et al., 1995.

Table 1. Cutting Scores for Determining Acculturation Level Using ARSMA-II

Acculturation Levels	Description	ARSMA-II Acculturation Score*
Level I	Very Mexican oriented	< −1.33
Level II	Mexican oriented to approximately balanced bicultural	≥ −1.33 and ≤ −.07
Level III	Slightly Anglo oriented bicultural	> −.07 and < 1.19
Level IV	Strongly Anglo oriented	≥ 1.19 and < 2.45
Level V	Very assimilated; Anglicized	> 2.45

*Raw score means were used tocalculate the Acculturation Score. The choices selected for each item are added and divided by the number of items on the MOS and AOS scales separately to obtain the raw score mean for each scale. These means were used in the formula: Acculturation Score = AOS (Mean) - MOS (Mean).

SPSS output of adjusted model with covariates:

Classification Table[a]

Observed			Predicted		
			Preterm &/or LBW recoded dich 1-yes		Percentage Correct
			.00	1.00	
Step 1	Preterm &/or LBW recoded dich 1-yes	.00	336	4	98.8
		1.00	25	5	16.7
	Overall Percentage				92.2

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	DUM_linscale8_1	1.568	.702	4.985	1	.026	4.796	1.211	18.995
	DUM_linscale8_2	1.004	.878	1.308	1	.253	2.728	.489	15.232
	BMI_obese	1.088	.675	2.601	1	.107	2.969	.791	11.145
	BMI_obese by DUM_linscale8_1	-2.230	1.085	4.222	1	.040	.108	.013	.902
	BMI_obese by DUM_linscale8_2	-.304	1.082	.079	1	.779	.738	.088	6.153
	wic_paid	-.463	.508	.831	1	.362	.629	.232	1.704
	educ	-.031	.087	.124	1	.725	.970	.818	1.150
	gdm_preg	.835	.896	.867	1	.352	2.304	.398	13.354
	pih_preg	2.824	.603	21.891	1	.000	16.837	5.159	54.949
	FPL_f_income	.270	.446	.367	1	.544	1.310	.547	3.137
	D_fastfood	.585	.566	1.067	1	.302	1.795	.592	5.447
	dbts_preg	-.003	.064	.003	1	.957	.997	.880	
	D_foodq_ok	-.214	.883	.059	1	.809	.808	.143	
	Constant	-3.097	1.312	5.570	1	.018	.045		

a. Variable(s) entered on step 1: wic_paid, educ, gdm_preg, pih_preg, FPL_f_income, D_fastfood, dbts_preg, D_foodq_ok.

Double-click to activate