

**INVESTIGATING THE RELATIONSHIP BETWEEN ACCULTURATION AND  
METABOLIC SYNDROME AMONG A BI-NATIONAL SAMPLE OF  
MEXICANS AND MEXICAN-AMERICANS**

A Dissertation

by

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Submitted to the Office of Graduate Studies of  
Texas A&M University  
in partial fulfillment of the requirements for the degree of

**DOCTOR OF PHILOSOPHY**

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December 2012

Major Subject: Health Education

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## **ABSTRACT**

Mexican-Americans are disproportionately burdened by metabolic syndrome, a medical condition characterized by the concurrence of clinical abnormalities that contributes to diabetes, obesity, and cardiovascular disease (CVD). This is alarming since Mexican-Americans constitute two-thirds of the US Latino population, the largest minority and fastest growing group in the US. Investigating acculturative stressors associated with immigration is crucial for eliminating health disparities, but few studies have examined the acculturative impact of Mexican migration to the United States or the relationship between acculturation and metabolic syndrome among Mexican-Americans. The purpose of this dissertation research was to investigate the associations between acculturation and metabolic syndrome among a bi-national sample of Mexicans and Mexican-Americans.

Metabolic syndrome was assessed among a bi-national sample of individuals with diabetes using the definition outlined by the International Diabetes Federation, and acculturation was assessed by proxy measures (years lived in the US and generational status) and responses on the Acculturation Rating Scale for Mexican-Americans, version-II. Chi-square, analysis of variance, and logistic regression were used to determine relationships between country, gender, and acculturation status and metabolic syndrome and its biomarkers.

The overall prevalence of metabolic syndrome was 79.7%, with 85.0% prevalence among Mexican-Americans and 75.7% among Mexicans ( $p=0.069$ ). Mexican-Americans had higher blood pressure and central obesity, while Mexicans had

higher triglycerides levels. The majority (81.2%) of Mexican-Americans was first generation and lived in the US for an average of  $27.65 \pm 16.05$  years. The mean acculturation score was  $-1.83 \pm 1.56$ , which indicated participants in this study were Mexican-oriented, or more closely associated to Mexican cultural influences than Anglo cultural influences. Higher acculturation scores were positively associated with fasting blood glucose and systolic blood pressure and lower acculturation was negatively associated with fasting blood glucose. Logistic regression analysis showed first generation Mexican-Americans were more likely to develop metabolic syndrome than second generation Mexican-Americans (OR 7.399, 95% CI 1.464-37.401,  $p=0.015$ ).

Mexican and Mexican-American individuals with type 2 diabetes have a high prevalence of metabolic syndrome, which increases their risk for heart disease and other cardiovascular complications. Mexican-Americans are especially affected by central obesity and hypertension and Mexican immigrants appear to be impacted by negative lifestyle factors upon entering the United States. Acculturation is a complex process and the unclear relationship between acculturation and metabolic syndrome warrants further investigations.

## DEDICATION

I have completed my journey with passion, knowing some many others will benefit from my accomplishments. I dedicate the completion of my dissertation research...

*To my father:* for his life-long sacrifices to give my siblings and me everything, even when he has had nothing. From my father, I learned how to appreciate everything and never take anything for granted. I learned how to work for what I want and to never expect things to be given to me. And I've learned that my true measure of a person is not about how much I have, but how much I'm willing to give.

*To my mother:* for her constant concern and encouragement. She rarely knows exactly what I am doing or how challenging processes are, but yet she finds a way to build my confidence and assure me that I can do it...whatever *it* is. I also find great comfort knowing she is always by my side and would do anything for me and my family no matter how near are far we are.

*To my sister and brother:* for always being my inspiration. Though we are all first-generation college students, their early struggles and sacrifices humbled me and allowed me to realize that nothing is easy. They provided me with positive examples to follow and cleared the way for me to succeed. From them, I understand the importance of maintaining focus and never taking anything for granted and my responsibility to fulfill my potentials.

*To all Latinos who have dreams:* for inspiring my ambition to succeed, to accept challenges, to overcome adversity, and to rise above. I understand we live in an Anglo-dominated society, but I refuse to believe that we are disadvantaged. I believe we *do*

have the capacity to contribute to society as much as anyone else, but I understand the enormous pressure many of us feel when encountering intimidating or challenging situations. Not all have us have been exposed or trained to overcome adversity, but I have and will do my part to clear paths for future Latinos who have ambitions of their own. We must realize, ¡Podemos tambien! (We can too!).

*To my wife:* for all of her sacrifices and for carrying on with little or no complaint. I always admired her commitment and relentless efforts to maintain our family, even when she often did it alone. Well, no more!!! The time has finally come...we will be a family again!

*To my son:* for not only being a total joy in my life, but for also being an inspiration. I have always known I wanted to provide the best possible life for my family. I may not always be able to provide the most desirable material possessions, but I vow to always exhibit the strongest character and core values. I know my responsibility is to create as many opportunities for him and to expose to as much of the world as I can, but ultimately, the direction he leads will be guided by his own preferences and aspirations. Regardless, I will always be by his side to offer support, encouragement, and advice. "I will not stop until I know you're ready to begin!"

## **ACKNOWLEDGEMENTS**

As I complete the final phase of my academic career, I reflect upon my journey and realize how much I have developed and progressed. I am certainly deserving of my accolades and promising future, but I also realize I could not have completed this journey alone, nor without the help and guidance from others. There are certainly numerous of individuals...and events...that have molded my identity over the years, all are deserving of my appreciation and acknowledgement. But at this point, I acknowledge those who are most relevant to this current process – those who made this possible and those who have been integral to my most recent academic success.

First, I acknowledge my professors, Dr. Lisako McKyer, Dr. Patricia Goodson, Dr. Lizette Ojeda, for increasing my knowledge, and for their unyielding support, expert advice, and words of encouragement. I also acknowledge Dr. Richard Krieder, Dr. Susan Ward, Dr. Danny Ballard, and Dr. Sue Bloomfield for their outstanding leadership and guidance, and Tami Hawkins, Marybeth Henthorne, Mary Hellen Coady, Susan Williams, Donna Dunlap, and Kristy Smith for tons of assistance over the last three years.

Next I acknowledge my supervisor, Frank Thomas, and staff and administration in the Physical Education and Activity Program. I definitely would not have developed as much as I have without the opportunities that were given to me. I also acknowledge the administration and support team of the Center for the Study of Health Disparities, especially Dr. Charles Ridley and fellow colleagues, Ledric Sherman, Charles Rogers,

Brandy Rollins, and Kirsten Salerno. My experiences with the Center increased my awareness of health disparities and the importance of conducting Latino health research.

I next acknowledge my doctoral committee. I thank Dr. Linda Castillo for accepting me as one of her doctoral students and for her offering expert insight on Latino psychology. I thank Dr. Charles Shea for always having an open door and providing me with expert statistical guidance. I thank Dr. Mary Shaw-Ridley for her leadership, advice, guidance, and serving as my mentor and role model. And finally, I thank Dr. Ranjita Misra...actually I can't thank her enough. I've said it for almost three years now, but I can't emphasize this enough - I would not be here without Dr. Misra. She accepted her mentor role, at first, knowing I had limited training and skills, but she pushed me, encouraged me, praised me, guided me, and created and exposed me to opportunities. She has no doubt been the single-most influential person in my professional development, yet she never accepts credit. I will be forever grateful for her and all she has done for me and my family; and for all of my committee members for putting me in position to complete my academic journey and begin my professional career.

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## I. INTRODUCTION

Mexican-Americans are disproportionately burdened by metabolic syndrome<sup>1,2,3,4</sup>, a medical condition characterized by the concurrence of clinical abnormalities that contributes to diabetes, obesity, and cardiovascular disease (CVD)<sup>5,6,7,8</sup>. This is alarming since Mexican-Americans constitute two-thirds of the US Latino population, the largest minority and fastest growing group in the United States<sup>9</sup>. As the United States population undergoes a demographic shift, there is also a continuous influx of Mexican immigrants who account for 32% of all foreign immigrants in the US<sup>10</sup>. Since most of these immigrants are less educated, poor, and uninsured<sup>11</sup>, health care needs of this group can financially threaten the US healthcare system<sup>12,13,14</sup>.

Although the prevalence of metabolic syndrome is also high in Mexico<sup>2,5,15,16,17</sup>, acculturative stressors associated with immigration can increase the risk of chronic diseases<sup>18,19,20</sup> including metabolic syndrome<sup>21</sup>. However, few studies have investigated the relationship between acculturation and metabolic syndrome among Mexican-Americans<sup>21,22,23</sup>. In addition, bi-national studies comparing Mexican natives and Mexican-Americans separated by a vast geographical distance are lacking, since most focus on the US-Mexico border region where common influences are shared<sup>6,24,25,26</sup>. Consequently, gaining a better understanding of changes in risk factors among Mexicans as they migrate to the US is deficient. Therefore, the purpose of this dissertation research was to investigate the associations between acculturation and metabolic

syndrome among a geographically separated, bi-national sample of Mexicans and Mexican-Americans.

### ***1.1 Specific Aims***

The following specific aims will guide this study:

**Specific Aim 1:** *To compare the prevalence of metabolic syndrome between Mexicans and Mexican-Americans.*

**Hypothesis 1:** The prevalence of metabolic syndrome will be higher among Mexican-Americans in the US than Mexicans in Mexico.

**Specific Aim 2:** *To compare differential prevalence of metabolic syndrome among Mexicans and Mexican-American sub-groups (Mexican-oriented and Anglo-oriented; and assimilated, integrated, separated, and marginalized).*

**Hypothesis 2:** The prevalence of metabolic syndrome will be higher among Mexican-Americans with positive acculturation scores than Mexican-Americans with negative acculturation scores and Mexicans.

**Hypothesis 3:** The prevalence of metabolic syndrome will be higher among Mexican-Americans who experience assimilated acculturation than Mexican-Americans who experienced integrated, separated, or marginalized acculturation and Mexicans.

**Specific Aim 3:** *To compare the proxy measures of acculturation (country of birth, number of years lived in the US, and generational status) to the uni-dimensional and bi-dimensional acculturation measures of the Acculturation Rating Scale for Mexican-Americans, version II (ARSMA-II).*

**Hypothesis 4:** Proxy measures will be weakly associated to the uni-dimensional and bi-dimensional measures of the ARSMA-II.

**Specific Aim 4:** *To examine the impact of acculturation on metabolic syndrome after controlling for the demographic characteristics: age, gender, country of birth, education level, physical activity level, and BMI.*

**Hypothesis 5:** Metabolic syndrome will be associated with the acculturation measures: Anglo-orientation subscale score and Mexican-orientation subscale score, acculturation-orientation, and acculturation group.

Examining the associations between acculturation and the prevalence of metabolic syndrome among Mexican-Americans in Texas, a rapidly growing and understudied group with high risk for diabetes and CVD, and Mexicans in central Mexico, a genetically similar group, will contribute to our understanding of the barriers associated with disease management/prevention and immigration.

## ***1.2 Background***

*Metabolic Syndrome* was introduced in 1988 as Syndrome X<sup>27</sup> to strategically recognize the concurrence of several risk factors for type 2 diabetes and cardiovascular disease in a single diagnosis. Since then, the name has changed to insulin resistance syndrome<sup>5,28</sup> and ultimately metabolic syndrome. The specific risk factors associated with metabolic syndrome include abdominal obesity, dyslipidemia, high blood pressure, and elevated blood glucose<sup>29</sup>. Abdominal obesity, also referred to as central obesity, is characterized by excess accumulation of body fat around the mid-section of the body. This disorder is usually caused by the energy imbalance between excessive caloric

consumption (high calorie diet) and minimal caloric expenditure (physical inactivity). Obesity is also associated with type 2 diabetes, hypertension, dyslipidemia, heart attacks, and strokes<sup>30</sup>. Dyslipidemia is characterized by abnormal blood lipid levels, specifically high triglycerides and low high-density lipoproteins (HDL)<sup>31</sup>. Serum triglycerides contribute to the plaque accumulation in arteries, known as atherosclerosis, which restricts blood flow and oxygen delivery to the tissues. This atherosclerotic process may occur throughout the body but is especially alarming in arteries of the heart and brain, leading to a heart attack or stroke. Diets high in saturated fat contribute to increased triglyceride levels in the blood. HDLs, on the other hand, protect against heart attack and stroke by retracting the plaque accumulation in the arteries. High HDL levels are recommended and can be increased with physical activity and consumption of unsaturated fats. Blood pressure<sup>32</sup> is measured by the pressure inside the arteries when the heart contracts (systolic blood pressure) and between heart contractions (diastolic blood pressure). Elevated blood pressure, or hypertension, increases risk for heart attack and stroke by damaging the arteries and contributing to atherosclerosis, and causing chronic kidney disease and vision problems. Blood pressure increases with age, diets high in processed foods and sodium, smoking, and in people with diabetes and/or obesity. Finally, blood glucose<sup>33</sup> is the amount of glucose, or sugar, in the blood after eating. The body responds to elevated blood glucose by releasing insulin into the bloodstream, which eventually allows the glucose to enter the cells. If the cells become resistant to insulin, glucose cannot enter the cells and remain in the blood. Chronic high

blood glucose damages the arteries and contributes to atherosclerosis, heart and kidney disease, blindness, nerve damage, and physical disabilities.

Several organizations have established distinct criteria for defining metabolic syndrome, all with variations of the same abnormalities. The World Health Organization (1998) defined metabolic syndrome by the following criteria: a diagnosis of diabetes mellitus, impaired glucose tolerance, impaired fasting glucose, or insulin resistance; and two of the following: blood pressure  $\geq 140/90$  mmHg, dyslipidemia (triglyceride  $\geq 1.695$  mmol/L, or HDL  $\leq 0.9$  mmol/L in males or  $\leq 1.0$  mmol/L in females), central obesity (waist-hip ratio  $> 0.90$  in males and  $> 0.85$  in females, or body mass index  $> 30$  kg/m<sup>2</sup>), or microalbuminuria<sup>34</sup>. The National Cholesterol Education Program Adult Treatment Panel III [(NCEP/ATP III) (2001)] definition for metabolic syndrome required at least three of the following criteria to be considered having the syndrome: central obesity (waist circumference  $\geq 102$  cm in males or  $\geq 88$  cm in females, dyslipidemia (TG  $\geq 150$  mg/dl or HDL  $< 40$  in males or  $< 50$  in females), blood pressure  $\geq 130/85$  mmHg, and fasting plasma glucose  $\geq 110$  mg/dl<sup>35</sup>. The American Heart Association/National Heart, Lung, and Blood Institute [(AHA/NHLBI) (2004)] decreased the NCEP/ATP III's fasting plasma glucose cutoff to  $\geq 100$  mg/dl<sup>36</sup>. Finally, the International Diabetes Federation [(IDF) (2006)] definition required central obesity (BMI  $> 30$  kg/m<sup>2</sup> or ethnic-specific waist circumference cutoff points for men or women), plus two of the following criteria: TG  $\geq 150$  mg/dl; HDL  $< 40$  in males or  $< 50$  in females; systolic blood pressure  $> 130$  mmHG or diastolic blood pressure  $> 85$  mmHG; or fasting plasma glucose  $> 100$  mg/dl<sup>7</sup>.

Individuals with metabolic syndrome tend to have higher waist circumferences, blood glucose, and low-density lipoprotein cholesterol (LDL) levels, along with lower high-density lipoprotein cholesterol (HDL) levels<sup>37,38</sup> that contribute to the increased incidence of cardiovascular disease and heart attack<sup>5,6</sup>. Physical activity and healthy diets have shown to protect against metabolic syndrome, but individuals from urban areas are more affected due to greater access to processed food<sup>16</sup>, a “westernized” dietary pattern<sup>39</sup>, and less physical activity<sup>24</sup>. Since specific complications of several diseases are integrated into a single diagnosis<sup>5</sup>, the prevention of metabolic syndrome alleviates the burdens of several chronic diseases.

*Acculturation*, from a classical perspective, refers to “those phenomena that result when groups of individuals having different cultures come into continuous first-hand contact, with subsequent changes in the original culture patterns of either or both groups,” (defined by Robert Redfield, Ralph Linton, and Melville J. Herskovits, 1936). A more contemporary definition refers to acculturation as the process of psychological and behavioral adjustments by immigrants as they adopt a host culture’s values and attitudes<sup>40,41</sup>. Drastic lifestyle changes upon arriving to the United States often put Mexican immigrants at risk for several health conditions, including chronic diseases<sup>22</sup>, psychological disorders<sup>19</sup>, and violent behavior<sup>20</sup>. This often results from difficulties transitioning into mainstream American society while attempting to maintain their cultural values. However, acculturated individuals have shown to exhibit better disease management<sup>42</sup>, lowered CVD risk<sup>43</sup>, and metabolic syndrome prevalence<sup>22</sup>.

Acculturation has been a universal human experience, which traces back to ancient human history when laws were created to protect host civilizations from foreign influences<sup>44</sup>. More recently, acculturation was first evident in the United States when European settlers made contact with Native Americans. JW Powell was the first to use the word *acculturation* in the English language when he described changes in Native American languages in 1880. Anthropologists, sociologists, and psychologists have since conceptualized theories of acculturation for individual- and group-level transitions to new societies<sup>45</sup>. For most of the 20<sup>th</sup> century, theorists accepted the *unidirectional* model of acculturation, which involved attitudinal and behavioral changes among the minority group toward the dominant culture<sup>44,45</sup>. This one-sided view of acculturation posited that minority groups became fully conformed only when they completely lost their cultural identity<sup>41,44,46</sup>.

During the early 1970s, psychologists began arguing that acculturation could also involve maintenance of ethnic cultural patterns<sup>29</sup>. This led Teske and Nelson to develop the *bidirectional model* of acculturation<sup>44</sup>, which was still a linear model of acculturation with the added possibility that individuals either conform to characteristics of the host culture *or* maintain characteristics of their original culture<sup>46</sup>. However, John Berry further questioned the linear process of acculturation and suggested a bi-dimensional model of acculturation. He proposed that individuals could maintain cultural identity while becoming involved in other cultural groups as well<sup>45</sup>. In 1980, he and his associates developed the *Fourfold Theory of Acculturation*, which suggested that immigrants could possibly acquire the new culture without necessarily losing their old

culture<sup>44</sup>. The possible simultaneous participation in two cultures led to four acculturation strategies: 1) *Assimilation* – when individuals reject their cultural identity and fully adopt the host culture, 2) *Separation* – when individuals fully value their original culture and reject the host culture, 3) *Integration* – when individuals maintain their original culture and adopt the host culture, and 4) *Marginalization* – when individuals have limited access or interest in either culture<sup>44,47</sup>. According to Berry, changes in cultural preference can take place along the two dimensions independently and individuals may adopt different strategies at different times to deal with life issues<sup>44,45</sup>.

The relationship between the acculturation and Latino health outcomes has increasingly become an area of interest. However, findings have provided conflicting results when examining the relationship between acculturation and Latino health. Several studies have indicated that acculturation positively influences immigrant health<sup>43,48</sup> by allowing immigrants to improve English communication skills, becoming more educated, and earning higher incomes. Others have indicated that acculturation has a negative impact on immigrant health<sup>28</sup> by exposing immigrants to discrimination, perceived stress, and unhealthy and violent behaviors.

The conflicting findings provided in the literature may result from inconsistent methods of measuring acculturation. Several studies have measured acculturation unidimensionally as Latinos adjust to American society. For example, “proxy” measures of acculturation, such as country of birth, length of time living in the US, and language preference and usage<sup>49</sup>, are often used. Uni-dimensional scales have also been

developed to measure acculturation. The Short Acculturation Scale for Hispanics (SASH)<sup>50</sup>, for example, is comprised of five questions regarding language preference, to which participants respond with 1) Spanish only, 2) more Spanish than English, 3) both equally, 4) more English than Spanish, or 5) English only. Composite scores are used to assign individuals as having low or high acculturation.

The uni-dimensional measurements of acculturation provide insight as to how immigrants have adjusted to American society according to their English language proficiency, but may fail to take into account how cultural values may influence health. Hence, researchers have utilized multi-dimensional scales to measure acculturation, such as the Acculturation Rating Scale for Mexican Americans – II (ARSMA-II)<sup>51</sup>. The ARSMA-II has two scales: the first one assesses behavioral acculturation and is comprised of the Anglo-orientation and Mexican-orientation subscales. These subscales contain a series of cultural-identifying statements to which participants respond on a Likert scale ranging from 1) not at all to 5) extremely often. Scores from the Anglo-orientation subscale (AOS) are summed and divided by 13 to yield the *mean AOS*. Scores from the Mexican-orientation subscale (MOS) are summed and divided by 17 to yield the *mean MOS*. An acculturation score is produced by subtracting the mean AOS by the mean MOS (*Acculturation score = mean AOS – mean MOS*). Positive acculturation scores indicate participants are Anglo-oriented, or more associated with the Anglo-American culture, while negative acculturation scores indicate participants are Mexican-oriented, or more associated with the Mexican culture. The second scale measures cultural beliefs and emotional values.

### ***1.3 Significance of the Study***

Investigating the determinants of chronic disease among Mexican-Americans is a national health priority, especially due to their disproportionate burdens and population growth in the past couple of decades. Hence, this study provides important comparative information on acculturation characteristics and metabolic syndrome parameters among a bi-national sample of Mexican natives and Mexican-Americans. Results will guide development of strategies to prevent and/or manage chronic diseases in both nations and allow agencies to develop prevention and management programs and policies to reduce health disparities and healthcare expenditures.

## II. REVIEW OF THE LITERATURE

Hispanic populations, especially Mexican-Americans in the US and Mexicans in Mexico, have high prevalence of metabolic syndrome<sup>1,2,3,4,5</sup>. Hence, several studies have focused on metabolic syndrome risk factors among Mexicans and changes in risk factors and prevalence as they immigrate to the United States. For example, Ventura et al. (2009)<sup>37</sup> examined the prevalence of metabolic syndrome among a three-year cohort of Mexican-American children and found that elevated waist circumference and TG and low HDL were the most prevalent criterion for metabolic syndrome. Lorenzo, Hunt, Williams, and Haffner (2006)<sup>38</sup> assessed metabolic syndrome among a five-year cohort of Mexican-American and White adults and found metabolic syndrome was associated with elevated waist circumference and low HDL. In a third cohort study, Otiniano et al. (2005)<sup>6</sup> examined the association between metabolic syndrome and heart attack incidence among Hispanic elderly living along the US-Mexico border. At 7-year follow-up, participants with metabolic syndrome were more likely to be obese and have high blood pressure. Casazza, Dulin-Keita, Gower, and Fernandez (2009)<sup>52</sup> assessed metabolic syndrome among children in Alabama and found higher waist circumference, triglycerides, and blood glucose and lower HDL in participants with metabolic syndrome. Vella, Zubia, Ontiveros, and Cruz (2008)<sup>25</sup> investigated the associations of physical activity and fitness levels with metabolic syndrome among a bi-national sample of Mexican and Mexican-American women and found abdominal obesity, high fasting blood glucose and blood pressure, and low HDL were most associated metabolic syndrome features. Mendez-Hernandez et al. (2009)<sup>53</sup> investigated the relationship

between metabolic syndrome and varying levels of physical activity among employees at a Mexican workplace. Elevated waist circumference and low HDL were the most contributing risk factors for metabolic syndrome.

Several lifestyle factors, including physical inactivity, poor diet, and being older, male, and diabetic, also contribute to the abnormalities associated with metabolic syndrome. Ford, Kohl, Mokdad, and Ajani (2004)<sup>54</sup> examined the association between physical activity and metabolic syndrome among US adults using the NHANES III dataset and found that metabolic syndrome was associated with low physical activity and sedentary lifestyles. Vella, Ontiveros, Zubia, and Dalleck (2011)<sup>25</sup> compared CVD risk factor differences among a bi-national sample of Mexican and Mexican-American women from the Texas-Mexico border region and found higher body fat, cholesterol, and triglyceride levels were associated physical inactivity. Vella's et al. (2008)<sup>24</sup> and Mendez's et al. (2006)<sup>53</sup> found metabolic syndrome was also associated with physical inactivity. Buscemi, Beech, and Relyea (2009)<sup>55</sup> investigated the association between acculturation and food security among Latino families and found that poor diet was associated with childhood obesity and metabolic syndrome. Denova-Guiterrez's (2010)<sup>39</sup> examined the relationship between metabolic syndrome and dietary patterns among participants of the Health Workers Cohort Study in Central Mexico and found that a "Westernized" diet was the strongest predictor of metabolic syndrome. Ramirez-Vargas, Arnaud-Vinas, and Delisle (2006)<sup>16</sup> assessed the prevalence of metabolic syndrome among Mexican adults from different residential areas in Mexico and reported physical inactivity and more access to processed foods were risk factors for

metabolic syndrome in urban areas. Finally, males were more likely to have metabolic syndrome than females (Ventura's et al., 2009<sup>37</sup> and Otiniano's et al., 2005<sup>6</sup>) studies, and males and older and diabetic participants also had higher metabolic syndrome prevalence (Lorenzo's et al., 2006)<sup>38</sup>.

Several studies have investigated health outcomes among Mexicans and Mexican-Americans, but definitive relationships are unclear. Eamranond et al. (2008)<sup>48</sup> investigated the associations between acculturation and CVD risk factors among Hispanics from various US sites and reported Spanish-speakers had worse risk factors than English-speakers. Eamrandond et al. (2009)<sup>43</sup> investigated the relationship between acculturation and chronic disease control among Mexican-Americans and reported Mexican-Americans with low acculturation had higher prevalence of diabetes and hypertension and were more likely to have poor LDL control. Espinosa de los Monteros, Gallo, Elder, and Talavera (2008)<sup>22</sup> examined the relationship between acculturation and metabolic syndrome among Mexican-American women living along the California-Mexico border region and found that higher Anglo-orientation scores were associated with increased health-enhancing behavior. Gonzales, Tarraf, and Haan (2011)<sup>23</sup> investigated the relationship between acculturation and metabolic syndrome among elderly Mexican-Americans in Northern California. Their results showed the prevalence of metabolic syndrome increased with subsequent Mexican-American generations. Stoddard, He, Vijayaraghavan, and Schillinger (2010)<sup>56</sup> investigated the association between acculturation and the prevalence of undiagnosed diabetes among Mexican and Mexican-American adults. Mexicans with diabetes were more likely to be

undiagnosed Mexican-Americans, and US-born Mexican-Americans were less likely to be undiagnosed than Mexican immigrants and Mexican natives.

Some studies have described metabolic syndrome to be associated with higher acculturation and Anglo-orientation. For instance, Vella, Ontiveros, Zubia, and Badar (2009)<sup>21</sup> investigated the relationship between acculturation and metabolic syndrome among Mexican and Mexican-American women living along the US-Mexico border and found that acculturation was associated with metabolic syndrome. Stoddard, He, Vijayaraghavan, and Schillinger (2010)<sup>56</sup> investigated the association between acculturation and the prevalence of undiagnosed diabetes among Mexican and Mexican-American adults and found that Mexicans with diabetes were more likely to be undiagnosed than US-born Mexican-Americans. Ghaddar, Brown, Pagan, and Diaz (2010)<sup>48</sup> investigated the relationship between acculturation and healthy lifestyle habits among Hispanics along the US-Mexico border and found that higher acculturation scores were associated with negative health indicators, such as less physical activity, less fruit and vegetable consumption, and lower scores on the Healthy Habit Scale. Buscemi, Beech, and Relyea (2009)<sup>55</sup> also found higher prevalence of metabolic syndrome among Mexican-Americans with high acculturation scores. Diaz-Apodaca, Ebrahim, McCormack, de Cosio, and Ruiz-Holguin (2010)<sup>26</sup> investigated diabetes risk factors among adults from both sides of the US-Mexico border, and found Mexican-Americans had a higher prevalence of diabetes and higher body mass index, waist circumference, and systolic blood pressure than Mexican participants.

Inconsistent results of health outcomes among Hispanic populations may be attributed to imprecise measurement of acculturation levels. Some researchers have used “proxy” measures of acculturation or uni-dimensional acculturation scales, while others have used bi-dimensional measurements of acculturation. Eamranond et al. (2008)<sup>48</sup> and Buscemi, Beech, and Relyea (2009)<sup>55</sup> measured acculturation by simply asking participants which language they spoke at home (Spanish vs. English speakers). Stoddard, He, Vijayaraghavan, and Schillinger (2010)<sup>56</sup> measured acculturation using the proxy measures - race or ethnicity, birthplace, and country of residence. Finally, Eamrandond et al. (2009)<sup>43</sup>, and Ghaddar, Brown, Pagan, and Diaz (2010)<sup>42</sup>, and Vella, Ontiveros, Zubia, and Badar (2011)<sup>21</sup> measured acculturation using the Spanish Acculturation Scale for Hispanics (SASH). Two studies investigating the association between acculturation and metabolic syndrome have used a bi-dimensional measurement scale to measure acculturation. Espinosa de los Monteros, Gallo, Elder, and Talavera (2008)<sup>22</sup> and Gonzales, Tarraf, and Haan (2011)<sup>23</sup> used the ARSMA-II scale.

Another possible explanation for inconsistent findings between acculturation and metabolic syndrome is the difference in Mexican and MA sampling. Lorenzo et al. (2006)<sup>38</sup> and Casazza et al. (2009)<sup>52</sup> examined multiethnic samples at various US sites and distinguished between Mexican-Americans and other ethnic groups. Ventura et al. (2009)<sup>37</sup>, Eamranond et al. (2008)<sup>48</sup>, Eamranond et al. (2009)<sup>43</sup>, and Buscemi et al. (2009)<sup>55</sup> conducted Mexican American-specific studies at various US sites, while Denova-Guiterrez et al. (2010)<sup>39</sup>, Ramirez-Vargas et al. (2006)<sup>16</sup>, Mendez-Hernandez et al. (2009)<sup>53</sup> examined only Mexicans in Mexico. Others have examined bi-national

samples of Mexicans and Mexican-Americans. Diaz-Apodaca, Ebrahim, McCormack, de Cosio, and Ruiz-Holguin (2010)<sup>26</sup> investigated diabetes risk factors among adults from both sides of the US-Mexico border and reported differences between Mexicans and Mexican-Americans. Otiniano et al. (2005)<sup>6</sup>, Vella et al. (2008)<sup>24</sup> and Vella et al. (2011)<sup>25</sup> also examined a sample of Mexicans and Mexican-Americans along the US-Mexico border without differentiating between them. Espinosa de los Monteros et al. (2008)<sup>22</sup> and Ghaddar et al. (2010)<sup>42</sup> examined acculturation among Hispanics living along the US-Mexico border, but only differentiated between those with high and low acculturation. Stoddard, He, Vijayaraghavan, and Schillinger (2010)<sup>56</sup> reported differences among US-born Mexican-Americans, Mexican immigrants, and Mexicans. Only one study, Lorenzo's et al. (2006)<sup>2</sup> study, compared metabolic syndrome among Mexican-Americans and Mexicans from vastly separated locations.

A final explanation for the inconsistent relationship findings between acculturation and metabolic syndrome is the use of the various definitions of metabolic syndrome. Ventura et al. (2009)<sup>37</sup>, Lorenzo et al. (2006)<sup>38</sup>, Mendez-Hernandez et al. (2009)<sup>53</sup>, Vella et al. (2008)<sup>24</sup>, and Ford et al. (2004)<sup>29</sup>, assessed metabolic syndrome using the NCEP definition; Casazza et al. (2009)<sup>52</sup> used the slightly variant NHLBI metabolic syndrome definition. Otiniano et al. (2005)<sup>6</sup> used the WHO definition to categorize participants into metabolic syndrome and non-metabolic syndrome groups. Ramirez-Vargas, Arnaud-Vinas, and Delisle (2006)<sup>16</sup> assessed the prevalence of Metabolic syndrome using the IDF definition. Lorenzo et al. (2006)<sup>2</sup> compared Metabolic syndrome prevalence using the NCEP and IDF definitions, and Rojas et al.

(2010)<sup>15</sup> assessed the prevalence of metabolic syndrome using the NCEP, IDF, and NHLBI definitions.

### III. METHODOLOGY

This cross-sectional study investigated the relationship between acculturation and metabolic risk factors among a bi-national sample of Mexicans and Mexican-Americans. Data was previously collected from 2007-2009 for a large US-Mexico project exploring self-management behaviors among individuals with type 2 diabetes from central Mexico and Texas. A convenience sample of 151 Mexican and 108 Mexican-American (n=259) individuals with diabetes was recruited from community groups, churches, medical clinics, and hospitals at two locations in the Mexican state of México – El Oro and Toluca; and three Texas locations - McAllen, Laredo, and College Station (see Appendix 1). The sample size and power (set to 80% and  $p=0.05$  alpha level) are based on 5% difference in prevalence of metabolic syndrome, the outcome measure, between Mexicans and Mexican-Americans.

This research combined survey data collected through face-to-face interviews, anthropometric measurements, and blood samples to produce an in-depth understanding of the influence of acculturation on metabolic syndrome. Demographic Information pertaining to participants' age, gender, country of birth, educational level, physical activity level, generational status, and BMI level were collected. Participants indicated their age in years and whether they were born in Mexico or the US. Education status was assessed as an ordinal variable but was regrouped: 1) primary level education and 2) post primary level education. Physical activity levels were assessed as 1) physically inactive and 2) physically active. Participant's generational statuses were: 1<sup>st</sup> generation – Mexican immigrants who were born in Mexico; 2<sup>nd</sup> generation – Mexican-Americans

who US-born to  $\geq 1$  Mexico-born parent; 3<sup>rd</sup> generation – Mexican-Americans were US-born to two US-born parents, but had  $\geq 1$  Mexico-born grandparents; 4<sup>th</sup> generation – Mexican-Americans who were US-born to US-born parents and grandparents, but  $\geq 1$  Mexico-born great-grandparents; and 5<sup>th</sup> generation – Mexican-Americans US-born, to US-born parents, grandparents, and great-grandparents, but  $\geq 1$  Mexico-born great, great grandparents. BMI was calculated by dividing participants' weight in kilograms by their height in square meters ( $BMI = kg/m^2$ ). Acculturation was measured by proxy, uni- and bi-dimensional measures. The proxy measures were country of birth (US or Mexico), number of years lived in the US, and generational status (first-fifth generation).

Mexican-American participants also completed the behavioral section of the Acculturation Rating Scale for Mexican-Americans, version-II (ARSMA-II)<sup>39</sup>. This scale included 13 Anglo- and 17 Mexican-orientated statements with five possible Likert-scale responses: 1–“not at all”, 2–“not very often”, 3–“moderately”, 4–“very often”, and 5)–“extremely often”. Scores from the Anglo-orientation subscale (AOS) were summed to yield a *total AOS score*, which was divided by 13 to yield a *mean AOS*. Similarly, scores from the Mexican-orientation subscale (MOS) were summed to yield a *total MOS score*, which was divided by 17 to yield a *mean MOS*. An acculturation score was produced by subtracting the mean AOS by the mean MOS (*acculturation score = mean AOS – mean MOS*). Positive acculturation scores indicated participants are Anglo-oriented, while negative acculturation scores indicated participants are Mexican-oriented. Finally, participants were categorized into Berry's four acculturation groups by combining their individual mean AOS & MOS scores. Specific cutoff points for high

and low MOS and AOS have not been published, but Rudmin (2003)<sup>44</sup> stated that Four-fold acculturation involves people in acculturation context answering Likert-scale questions. Therefore, median values for the Anglo- and Mexican-orientation subscales were used for this study to decipher between high and low orientation levels. A mean AOS > 3 indicated high Anglo-orientation, or adoption of the Anglo culture, while a mean AOS ≤ 3 indicated low Anglo-orientation, or rejection of the Anglo culture. Similarly for the Mexican-orientation subscale, a mean MOS > 3 indicated high Mexican-orientation, or maintenance of the Mexican culture, while a mean MOS ≤ 3 indicated low Mexican-orientation, or rejection of the Mexican culture. Using the two mean subscale values, participants were categorized into one of the four acculturation groups: 1) Assimilated: high AOS and low MOS; 2) Integrated (bicultural): high AOS and high MOS; 3) Separated: low AOS and high MOS; or 4) Marginalized: low AOS and low MOS. Anthropometric Measurements: height, weight, waist circumference (WC), percent body fat (BF%), systolic blood pressure (SBP), and diastolic blood pressure (DBP) were measured by trained individuals. Height and weight will be used to calculate body mass index (BMI), by dividing weight in kilograms by height in square meters ( $BMI = kg/m^2$ ). BMI values were used to categorize participants into the universally accepted BMI categories: 1) underweight: <18 kg/m<sup>2</sup>, 2) normal weight: 18 – 24.99 kg/m<sup>2</sup>, 3) overweight: 25 - 29.99 kg/m<sup>2</sup>, 4) obese: 30 – 39.99 kg/m<sup>2</sup>, and 5) extremely obese: ≥ 40 kg/m<sup>2</sup>. Blood Samples were collected by trained phlebotomists and examined for fasting blood concentrations of triglycerides (TG), high-density lipoproteins (HDL), glycosylated hemoglobin (HbA1c), and glucose (FBG). Metabolic

*Syndrome* was measured using ethnic-specific criteria established by the International Diabetes Federation<sup>7</sup>. In order for participants to be classified into the metabolic syndrome group, they first had to meet the waist circumference criterion: WC  $\geq$  90cm in males or  $\geq$  80cm in females, then meet two of the additional criteria: 1) TG  $\geq$  150mg/dl, 2) HDL  $<$  40mg/dl in males or  $<$  50mg/dl in females, 3) systolic BP  $\geq$  130mm Hg, diastolic BP  $\geq$  85mm Hg or diagnosed hypertension, 4) FBG  $\geq$  100mg/dl or diagnosed type 2 diabetes. Participants will be dichotomized into metabolic syndrome and non-metabolic syndrome categories.

Statistical analyses were performed using the Statistical Package for Social Sciences, version 20. Means and standard deviations for all continuous-level data (age, number of years lived in the US, BMI, BF%, FBG, SBP, DBP, TG, HDL, and WC) were measured, along with frequency and percentage distributions for all categorical-level data (gender, country of birth, country of residence, education level, physical activity level, BMI level, and metabolic syndrome biomarkers).

### ***3.1 Specific Aims***

Statistical analyses were then performed to address the study's four specific aims:

**Specific Aim 1:** *To compare the prevalence of metabolic syndrome between Mexicans and Mexican-Americans.*

**Hypothesis 1:** The prevalence of metabolic syndrome will be higher among Mexican-Americans in the US than Mexicans in Mexico.

**Analyses:** The prevalence of metabolic syndrome was measured criteria for the total sample and for Mexicans and Mexican-Americans, respectively.

- a) Chi-square ( $\chi^2$ ) analyses tested for associations between country and the prevalence of metabolic syndrome and between country of residence and the prevalence of each metabolic syndrome biomarker.
- b) Analyses of variance (ANOVA) examined mean differences for each metabolic syndrome biomarker between Mexicans and Mexican-Americans.

**Specific Aim 2:** *To compare differential prevalence of metabolic syndrome among Mexicans and Mexican-American acculturation sub-groups (Anglo-oriented vs. Mexican-oriented; and assimilated, integrated, separated, and marginalized group).*

**Hypothesis 2:** The prevalence of metabolic syndrome will be higher among Anglo-oriented Mexican-Americans than Mexican-oriented Mexican-Americans and Mexicans.

**Hypothesis 3:** The prevalence of metabolic syndrome will be higher among the assimilated acculturation group than the integrated, separated, or marginalized groups and Mexicans.

**Analyses:** Acculturation was measured using ARSMA-II only among Mexican-Americans, since this group has had first-hand contact with American society. Each participant's total AOS and MOS scores were summed and averaged. Then mean AOS and mean MOS were calculated to determine participants' Anglo- and Mexican-orientation levels and subsequent placement into the four acculturation groups. Finally, each participant's acculturation score was calculated to distinguish between Anglo-orientation (positive acculturation score) and Mexican-orientation (negative acculturation score) individuals.

- a) Pearson's correlations examined bivariate associations between the metabolic syndrome biomarkers (WC, FBG, TG, HDL, SBP, and DBP) and AOS scores, MOS scores, and acculturation scores.

b) ANOVA examined mean differences in the metabolic syndrome biomarker among Anglo-oriented and Mexican-oriented Mexican-Americans.

ANOVA also tested for significant mean differences in the metabolic syndrome biomarkers among the four acculturation groups and Mexicans.

c) Chi-square ( $\chi^2$ ) analyses tested for associations between metabolic syndrome acculturation-orientations and acculturation groups.  $\chi^2$  analysis also tested for associations between the prevalence of each metabolic syndrome biomarker and acculturation-orientations and acculturation groups.

**Specific Aim 3:** *To compare the proxy measures of acculturation (country of birth, number of years lived in the US, and generational status) to the uni-dimensional and bi-dimensional acculturation measures of the Acculturation Rating Scale for Mexican-Americans, version II (ARSMA-II).*

**Hypothesis 4:** Proxy measures will be weakly associated to the uni-dimensional and bi-dimensional measures of the ARSMA-II.

**Analyses:** Several analyses were performed to measure the relationships between the proxy measures of acculturation and the uni-dimensional and bi-dimensional ARSMA-II measures of acculturation. Since this study examined how behavioral acculturation impacts health outcomes, only the Anglo-orientation and Mexican-orientation subscales of scale 1 were used.

a) Bivariate correlations examined the relationships between 1) number of years lived in the US and AOS scores, 2) the number of years lived in the US and MOS scores, and 3) the number of years lived in the US and acculturation scores.

- b) Bivariate correlations also examined the relationships between 1) generational status (0=first generation, 1=second generation and AOS scores, 2) generational status and MOS scores, and 3) generational status and acculturation scores.
- c) ANOVA tested for significant differences in number of years lived in the US between Anglo-oriented and Mexican-oriented Mexican-Americans. ANOVA also test for significant differences in AOS scores, MOS scores, and acculturation scores first and second generation Mexican-Americans.
- d) ANOVA test for significant differences in the number of years lived in the US among the four acculturation groups.
- e) Chi-square ( $\chi^2$ ) analyses tested for associations between generational status and acculturation-orientation and between generational status and the four acculturation groups.

**Specific Aim 4:** *To examine the impact of acculturation on metabolic syndrome after controlling for the demographic and clinical characteristics: age, gender, country of birth, education level, physical activity level, body fat, and percent glycosylated hemoglobin.*

**Hypothesis 5:** Metabolic syndrome will be associated with the acculturation measures: AOS score and MOS score, acculturation-orientation, and acculturation group.

**Analyses:** Logistic regression analyses were performed to predict metabolic syndrome. The impact of acculturation and the acculturation subgroups on metabolic syndrome will be assessed by odds ratios (OR) and 95% Confidence Intervals (CI), controlling for the following independent variables:

- a) Anglo-orientation subscale (AOS) score
- b) Mexican-orientation subscale (MOS) score
- c) Generational status
- d) Age
- e) Gender

- f) Residential region
- g) Education level
- h) Physical activity level
- i) Glycosylated hemoglobin (HbA1c)

#### IV. RESULTS

Table 1 describes the demographic characteristics for the total sample. Two hundred fifty-nine participants with type 2 diabetes mellitus completed the study. The mean age was  $54.0 \pm 11.9$  years, and the majority of the participants were Mexican (57.9%), female (77.6%), primary school educated (67.2%), and self-reported physically active (64.9%). The participant's mean body mass index ( $31.5 \pm 7.3 \text{ kg/m}^2$ ), percent body fat (males:  $31.2 \pm 7.15\%$  & females:  $39.7 \pm 7.15\%$ ), and waist circumference (males:  $38.9 \pm 5.08$  in, females:  $38.6 \pm 5.21$  in) were all indicative of an obese sample (51.4%) since these values characterized obese levels of the respective measurements ( $\text{BMI} \geq 30 \text{ kg/m}^2$ ; body fat: males  $\geq 25\%$ , females  $\geq 32\%$ ; waist circumference: males  $\geq 35.4$  inches, females  $\geq 31.5$  inches). However, obesity was significantly higher among Mexican-Americans (67.9%) than Mexicans (40.0%). The low-density lipoprotein [(LDL) ( $112 \pm 34.9 \text{ mg/dl}$ )], total cholesterol [(TC) ( $192.3 \pm 47.2 \text{ mg/dl}$ )], and male high-density lipoprotein [(HDL) ( $41.8 \pm 16.4 \text{ mg/dl}$ )] values were all within recommended levels ( $\text{LDL} \leq 130 \text{ mg/dl}$ ;  $\text{TC} \leq 200 \text{ mg/dl}$ ; HDL: males  $\geq 40$ ). However, the sample's triglyceride [TG ( $209.9 \pm 134.32 \text{ mg/dl}$ )] and female HDL ( $43.2 \pm 11.3 \text{ mg/dl}$ ) levels were not within recommended levels ( $\text{TG} < 150 \text{ mg/dl}$ ; HDL: females  $\geq 50 \text{ mg/dl}$ ), increasing the risk of cardiovascular complications. The average fasting blood glucose [(FBG) ( $173.3 \pm 82.9 \text{ mg/dl}$ )] and glycosylated hemoglobin levels [(HbA1c) (7.98%)] were both higher than recommended levels ( $\text{FBG} < 100 \text{ mg/dl}$ ,  $\text{HbA1c} < 7.0\%$ ), which indicated poor glucose control among participants. Finally, the sample's systolic [(SBP), ( $129.9 \pm 19.7 \text{ mmHG}$ )] and diastolic blood pressures [(DBP), ( $78.71 \pm 11.8 \text{ mmHG}$ )]

approached the maximal recommended values for individuals with Type 2 Diabetes (SBP < 130 mmHg, DBP < 80 mmHg). However, Mexican-Americans had higher blood pressure (SBP: 136.65±21.46 mmHg, DBP: 83.51 mmHg) values the Mexicans (SBP:

*Table 1. Demographic Characteristics of the Total Sample*

		Texas Border		Central Texas		Urban Mexico		Rural Mexico		Total Sample	
Categorical Variables				Frequency (%)							
N		88	(34.0)	21	(8.1)	74	(28.6)	76	(29.3)	259	(100)
Sex	Male	12	(13.6)	10	(47.6)	21	(28.4)	15	(19.7)	58	(22.4)
	Female	76	(86.4)	11	(52.4)	53	(71.6)	61	(80.3)	201	(77.6)
BMI	Obese	66	(75.0)	7	(33.3)	26	(35.1)	34	(44.7)	133	(51.4)
	Non-obese	22	(25.0)	14	(67.7)	48	(64.9)	42	(55.3)	126	(48.6)
Edu	Primary	60	(68.2)	17	(89.5)	42	(57.5)	44	(59.5)	163	(64.2)
	Secondary	28	(31.8)	2	(10.5)	31	(42.5)	30	(40.5)	91	(35.5)
PA	Inactive	9	(10.7)	9	(47.4)	36	(50.0)	33	(45.2)	87	(35.1)
	Active	75	(89.3)	10	(52.6)	36	(50.0)	40	(54.8)	161	(64.9)
Interval Variables				Mean ± SD							
Age (years)		49.8	± 11.0	49.4	± 9.6	57.1	± 11.1	56.8	± 12.6	54.0	± 11.91
BMI (kg/m²)		36.3	± 8.62	28.2	± 4.83	28.3	± 4.24	29.9	± 5.42	31.5	± 7.37
Body Fat %		43.1	± 6.91	35.4	± 6.92	34.3	± 7.03	35.6	± 7.22	37.8	± 8.03
HbA1c (%)		7.5	± 1.72	7.59	± 1.73	7.87	± 2.21	9.24	± 2.70	7.98	± 2.20
LDL (mg/dl)		102.9	± 29.6	118.1	± 36.0	123.8	± 36.5	110.9	± 36.3	112.1	± 34.91
TC (mg/dl)		178.4	± 39.9	200.0	± 49.1	203.4	± 49.0	195.5	± 49.8	192.3	± 47.21
WC (in)		41.89	± 4.81	36.42	± 3.85	36.35	± 4.70	37.77	± 4.47	38.65	± 5.17
SBP (mmHg)		136.0	± 21.3	139.6	± 22.7	127.1	± 17.6	123.2	± 15.8	129.9	± 19.78
DBP (mmHG)		83.90	± 12.0	81.89	± 10.3	74.70	± 9.05	75.9	± 11.9	78.71	± 11.85
HDL (mg/dl)		43.15	± 9.89	40.33	± 7.67	41.23	± 11.5	44.47	± 12.2	42.76	± 10.94
FBG (mg/dl)		157.9	± 62.4	166.2	± 48.8	165.4	± 99.9	199.9	± 85.5	173.3	± 82.96
TG(mg/dl)		180.4	± 83.4	260.7	± 231	235.8	± 157	205.1	± 114	209.9	± 134.1

Texas Border = McAllen & Laredo, TX; Central Texas = Bryan & College Station, TX; Urban Mexico = Toluca, Mexico; Rural Mexico = El Oro, Mexico; BMI = body mass index (obese = BMI ≥ 30 kg/m<sup>2</sup>, non-obese = BMI < 30 kg/m<sup>2</sup>); Edu = highest education level (primary = illiterate or completed ≤ 8th grade, secondary = completed ≥ 9<sup>th</sup> grade); PA = physical activity level (active = meets guideline of ≥ 3 days of ≥ 30 minutes of moderate physical activity or ≥ 2 days of ≥ 20 minutes of vigorous physical activity per week; inactive = does not meet guideline); body fat % = percent body fat composition fat (male obesity ≥ 25%, female obesity ≥ 32%); HbA1c = glycosylated hemoglobin (optimal range: ≤ 7%); LDL = low-density lipoproteins (optimal level < 130 mg/dl); TC = total cholesterol (optimal level < 200 mg/dl); WC = waist circumference (male obesity ≥ 35.4 in, female obesity ≥ 31.4 in); BP = blood pressure (optimal range: BP = blood pressure (optimal range: systolic blood pressure (SBP) < 130 mmHg, and/or diastolic blood pressure (DBP) < 85 mmHg); FBG = fasting blood sugar (optimal range < 100 mg/dl); TG = triglycerides (optimal range < 150 mg/dl).

125.33±16.78 mmHg, DBP: 75.30±10.62 mmHg) and above the recommended levels by

the American Diabetes Association (130/80 mmHg). This is suggestive of risk for

cardiovascular and renal complication for immigrant Mexican-Americans in the United States.

#### ***4.1 Bi-national Comparisons***

Table 2 provides prevalence of metabolic syndrome by country of residence and gender and percentages of individuals who met criteria for each biomarker. The overall prevalence of metabolic syndrome was 79.7%, with 85.0% prevalence among Mexican-Americans (MAs) and 75.7% among Mexicans (Mex). Country of residence was significantly associated with blood pressure [(BP), ( $\chi^2_{(1)}=13.548$ ,  $p=0.001$ )] and waist circumference [(WC), ( $\chi^2_{(1)}=6.42$ ,  $p=0.011$ )], and a higher percentage of Mexican-Americans had high blood pressure and central obesity. However, country of residence had no significant impact on participants' HDL ( $\chi^2_{(1)}=0.950$ ,  $p=0.333$ ), TG ( $\chi^2_{(1)}=3.381$ ,  $p=0.066$ ), or MetS ( $\chi^2_{(1)}=3.316$ ,  $p=0.069$ ).

One-way analyses of variance (ANOVA) revealed Mexican-Americans had significantly higher mean WC [(MA:  $40.9\pm5.10$  inches, Mex:  $37.1\pm4.63$  inches);  $F(1,256)=38.66$ ,  $p=0.001$ ], SBP [(MA:  $136.65\pm21.5$  mmHg, Mex:  $125.13\pm94.6$  mmHg);  $F(1,256)=23.29$ ,  $p=0.001$ ], and DBP [(MA:  $83.51\pm11.7$  mmHg, DBP:  $75.3\pm10.6$  mmHg);  $F(1,256)=34.31$ ,  $p=0.001$ ] than Mexicans, further suggesting higher cardiovascular risks among Mexican-Americans due to their higher blood pressure and central obesity. Mexicans ( $182.87\pm94.6$  mg/dl), on the other hand, had a significantly higher fasting blood glucose [ $F(1,252)=4.94$ ,  $p=0.027$ ] than Mexican-Americans ( $159.48\pm59.9$  mg/dl), possibly indicating greater insulin-resistance and/or poorer glucose control. Both groups, however, had higher than-recommended-glucose levels and were

at high risk for diabetes-related complications. Table 3 provides mean values for the metabolic syndrome biomarkers.

#### 4.2 Gender Comparisons

The prevalence of metabolic syndrome was associated with gender ( $\chi^2_{(1)}=6.25$ ,  $p=0.013$ ), with higher prevalence among females (83.1%) than males (67.9%) (Table 2).

Gender was also associated with HDL ( $\chi^2_{(1)}=19.674$ ,  $p=0.001$ ) and

*Table 2. Prevalence Metabolic Syndrome and Biomarker Values by Country & Gender*

		Mexicans (n=150)		MAs (n=109)		Total	
MetSBiomarkers				Frequency (%)			
MetS <sup>b,c</sup>	Males (n=58)	22	(64.7)	16	(72.7)	38	(67.9)
	Females (n=201)	87	(79.1)	75	(88.2)	162	(83.1)
	Total	109	(75.7)	91	(85.0)	200	(79.7)
WC <sup>a,b,c</sup>	Males	26	(72.2)	16	(72.7)	42	(72.4)
	Females	96	(84.2)	83	(97.6)	179	(89.9)
	Total	122	(81.3)	99	(92.5)	221	(86.0)
BP <sup>a,c</sup>	Males	17	(47.2)	16	(72.7)	33	(56.9)
	Females	42	(36.8)	51	(60.0)	93	(46.7)
	Total	59	(39.3)	67	(62.6)	126	(49.0)
HDL <sup>b,c</sup>	Males	11	(31.4)	14	(63.6)	25	(43.9)
	Females	84	(76.4)	63	(73.3)	147	(75.0)
	Total	95	(65.5)	77	(71.3)	172	(68.0)
FBG	Males	36	(100)	22	(100)	58	(100)
	Females	114	(100)	87	(100)	201	(100)
	Total	150	(100)	109	(100)	259	(100)
TG	Males	22	(64.7)	15	(68.2)	37	(66.1)
	Females	75	(67.6)	45	(52.3)	120	(60.9)
	Total	97	(66.9)	60	(55.6)	157	(62.1)

$\alpha = 0.05$ ; a = Significant associations by country, b = Significant associations by gender; c = Significant associations by country-gender; MAs = Mexican-Americans; MetS = metabolic syndrome (International Diabetes Federation definition (patients must meet criteria for WC, then criteria for two of the remaining conditions: BP, HDL, FBG, or TG); WC = waist circumference (male obesity  $\geq 35.4$  in, female obesity  $\geq 31.4$  in); BP = blood pressure (optimal range: systolic blood pressure (SBP)  $< 130$  mmHg, and/or diastolic blood pressure (DBP)  $< 85$  mmHg); HDL = high-density lipoproteins (optimal range: male  $\geq 40$  mg/dl, females  $\geq 50$  mg/dl); FBG = fasting blood sugar (optimal range  $< 100$  mg/dl); TG = triglycerides (optimal range  $< 150$  mg/dl).

WC ( $\chi^2_{(1)}=11.465$ ,  $p=0.001$ ), indicating a higher percentage of females with central

obesity and lower-than-recommended HDL levels than males. However, males and

females did not differ in their BP ( $\chi^2_{(1)}=1.856$ ,  $p=0.173$ ) and TG ( $\chi^2_{(1)}=0.493$ ,  $p=0.483$ ) were not significant. Males had significantly higher systolic [SBP (males:  $135.05 \pm 21.53$  mmHg, females:  $128.44 \pm 18.92$  mmHg);  $F(1,256)=5.161$ ,  $p=0.024$ ] and diastolic blood pressure [(males:  $82.60 \pm 12.12$  mmHg, females:  $77.59 \pm 11.48$  mmHg);  $F(1,256)=8.374$ ,  $p=0.04$ ] values than females as shown in Table 3. This provides additional support that males have higher risk for developing hypertension and related complications.

*Table 3. Mean Metabolic Syndrome Biomarker Values by Country & Gender*

		Mexicans (n=150)			MAs (n=109)			Total		
MetS Biomarkers		Mean $\pm$ SD								
WC <sup>a,d</sup> (inches)	Males (n=58)	37.94	$\pm$	4.90	40.53	$\pm$	5.94	38.92	$\pm$	5.08
	Females (n=201)	36.79	$\pm$	4.72	40.96	$\pm$	4.90	38.57	$\pm$	5.21
	Total	37.07	$\pm$	4.63	40.87	$\pm$	5.10	38.65	$\pm$	5.17
SBP <sup>a,b,d</sup> (mmHg)	Males	129.53	$\pm$	19.85	144.09	$\pm$	21.34	135.05	$\pm$	21.46
	Females	123.75	$\pm$	15.53	134.73	$\pm$	21.20	128.44	$\pm$	18.91
	Total	125.33	$\pm$	16.78	136.65	$\pm$	21.46	129.93	$\pm$	19.67
DBP <sup>a,b,d</sup> (mmHg)	Males	78.94	$\pm$	11.15	88.59	$\pm$	11.30	82.60	$\pm$	12.07
	Females	74.15	$\pm$	10.23	82.20	$\pm$	11.50	77.59	$\pm$	11.48
	Total	75.30	$\pm$	10.62	83.51	$\pm$	11.70	78.72	$\pm$	11.78
HDL <sup>c,d</sup> (mg/dl)	Males	44.09	$\pm$	10.07	36.55	$\pm$	6.84	41.18	$\pm$	9.64
	Females	42.50	$\pm$	12.53	44.15	$\pm$	9.54	43.22	$\pm$	11.32
	Total	42.88	$\pm$	11.97	42.60	$\pm$	9.54	42.76	$\pm$	10.98
FBG <sup>a</sup> (mg/dl)	Males	172.92	$\pm$	83.12	175.45	$\pm$	57.71	173.88	$\pm$	73.97
	Females	186.02	$\pm$	98.09	155.14	$\pm$	60.04	173.19	$\pm$	85.58
	Total	182.87	$\pm$	94.61	159.50	$\pm$	59.85	173.35	$\pm$	82.92
TG (mg/dl)	Males	225.83	$\pm$	133.34	248.59	$\pm$	193.77	234.77	$\pm$	158.53
	Females	218.70	$\pm$	139.54	182.62	$\pm$	103.77	202.95	$\pm$	126.18
	Total	220.37	$\pm$	137.69	196.06	$\pm$	128.98	209.99	$\pm$	134.32

$\alpha = 0.05$ ; a = Significant differences by country; b = Significant differences by gender; c = Significant country x gender interaction; d = Significant differences by country-gender; MAs = Mexican-Americans; WC = waist circumference (male obesity  $\geq 35.4$  in, female obesity  $\geq 31.4$  in); BP = blood pressure (optimal range: systolic blood pressure (SBP)  $< 130$  mmHg, and/or diastolic blood pressure (DBP)  $< 85$  mmHg); HDL = high-density lipoproteins (optimal range: male  $\geq 40$  mg/dl, females  $\geq 50$  mg/dl); FBG = fasting blood sugar (optimal range  $< 100$  mg/dl); TG = triglycerides (optimal range  $< 150$  mg/dl).

Although males and females did not differ in HDL levels [ $F(1,252)=1.543$ ,  $p=0.215$ ], males had optimal HDL levels (male HDL  $\geq 40$  mg/dl) while female HDL fell below

recommended levels for females ( $HDL \geq 50$  mg/dl). Similarly, waist circumference [ $F(1,256)=0.204$ ,  $p=0.652$ ] blood triglycerides, [ $F(1,252)=2.461$ ,  $p=.0118$ ] and glucose levels [ $F(1,252)=0.003$ ,  $p=0.956$ ] did not differ between males and females, but were higher than recommended for both groups (WC: male obesity  $\geq 35.4$  inches, female obesity  $\geq 31.4$  inches; fasting blood sugar: optimal range  $< 100$  mg/dl; triglycerides: optimal range  $< 150$  mg/dl).

Participants were then examined by country-gender groups to determine which group had the highest risk for metabolic syndrome and cardiovascular disease. The association between the country-gender and metabolic syndrome was significant ( $\chi^2_{(3)}=9.232$ ,  $p=0.023$ ) with higher prevalence among the females (MA females: 88.2%, Mex females: 79.1%) than the males (MA males: 72.7%, Mex males: 64.7%) (Table 2). This indicates that Females, particularly Mexican-American females, were at greatest risk for cardiovascular disease than males. Significant associations were also noted between country-gender and HDL ( $\chi^2_{(3)}=26.326$ ,  $p=0.001$ ), WC ( $\chi^2_{(3)}=18.766$ ,  $p=0.001$ ), and BP ( $\chi^2_{(3)}=15.860$ ,  $p=0.001$ ). Mexican males had the lowest prevalence of low HDL (31.4%); almost all US females (97.6%) had central obesity; and Mexican-American males and females had higher blood pressure than Mexicans.

One-way (country and gender) ANOVA revealed significant mean differences in four of the six MetS biomarkers: WC [ $F(3,256)=13.429$ ,  $p=0.001$ ], HDL [ $F(3,252)=3.07$ ,  $p=0.028$ ], SBP [ $F(3,256)=10.252$ ,  $p=0.001$ ], and DBP [ $F(3,256)=15.633$ ,  $p=0.001$ ] (Table 3). No differences were noted for blood triglyceride [ $F(3,252)=2.138$ ,  $p=0.096$ ] or glucose [ $F(3,252)=2.227$ ,  $p=0.086$ ]. Fisher's least square difference (LSD) post-hoc

analyses indicated that Mexican-Americans (females:  $40.96 \pm 4.90$  inches, males:  $40.53 \pm 5.94$  inches) had significantly higher central obesity than Mexicans (males  $37.94 \pm 4.26$  inches, females:  $36.79 \pm 4.72$  inches), but waist circumference means for all four groups exceeded recommended levels (male  $< 35.4$  inches, female  $< 31.5$  inches). Mexican males ( $44.09 \pm 10.07$  mg/dl) and females ( $42.50 \pm 12.53$  mg/dl) and Mexican-American females ( $44.15 \pm 9.54$  mg/dl) all had significantly higher mean HDL values than Mexican-American males ( $36.55 \pm 6.87$  mg/dl), but only Mexican males met recommended HDL levels (males  $\geq 40$  mg/dl, females  $\geq 50$  mg/dl). Mexican-American males (SBP:  $144.09 \pm 21.33$  mmHg, DBP:  $88.59 \pm 11.30$  mmHg) had a significantly higher mean SBP and DBP than all other groups: Mexican-American females (SBP:  $134.73 \pm 21.20$  mmHg, DBP:  $82.20 \pm 11.50$  mmHg), Mexican males (SBP:  $129.53 \pm 19.85$  mmHg, DBP:  $78.94 \pm 11.15$  mmHg), and Mexican females (SBP:  $123.75 \pm 15.52$  mmHg, DBP:  $74.15 \pm 10.23$  mmHg). SBP for Mexican-American females was significantly higher than Mexican females.

ANOVA revealed one country x gender interaction for HDL [ $F(1,243)=7.593$ ,  $p=0.006$ ]. HDL was higher for males than females among Mexican-Americans, but was higher for females than males among Mexicans.

### ***4.3 Regional Comparisons***

The total sample was also examined according to residential region to determine location specific prevalence of metabolic syndrome and the related biomarkers. Table 4 presents metabolic syndrome characteristics by residential region. The majority of participants resided at the Texas Border [(34%) (McAllen and Laredo)], Rural Mexico

[(28.6%) (El Oro, Mexico)], and Urban Mexico [(29.3%) (Toluca, Mexico)]. The Texas Border region had the highest regional prevalence of metabolic syndrome (89.7%), which was attributed to significant associations between residential region and blood pressure ( $\chi^2_{(3)}=13.734$ ,  $p=0.001$ ) and waist circumference ( $\chi^2_{(3)}=20.732$ ,  $p=0.001$ ).

*Table 4. Metabolic Syndrome Characteristics by Residential Region*

	Texas Border		Central Texas		Urban Mexico		Rural Mexico	
	Frequency (%)							
MetS <sup>a</sup>	78	(89.7)	13	(65.0)	48	(67.6)	61	(83.6)
WC <sup>a</sup>	85	(97.7)	14	(70.0)	56	(75.7)	66	(86.8)
BP <sup>a</sup>	54	(62.1)	13	(65.0)	28	(37.8)	31	(40.8)
HDL	62	(71.3)	15	(71.4)	49	(69.0)	46	(62.2)
FBG	88	(100)	21	(100)	74	(100)	76	(100)
TG	49	(56.3)	11	(52.4)	48	(66.7)	49	(67.1)
	Mean ± SD							
WC (in) <sup>b</sup>	41.89 ± 4.81		36.42 ± 3.85		36.35 ± 4.70		37.77 ± 4.47	
SBP (mmHg) <sup>b</sup>	135.98 ± 21.25		139.60 ± 22.68		127.14 ± 17.56		123.18 ± 15.85	
DBP (mmHg) <sup>b</sup>	83.90 ± 12.02		81.85 ± 10.27		74.70 ± 9.05		75.88 ± 11.99	
HDL (mg/dl)	43.15 ± 9.90		40.33 ± 7.67		41.23 ± 11.52		44.47 ± 12.25	
FBG (mg/dl) <sup>b</sup>	157.87 ± 62.38		166.15 ± 48.78		165.38 ± 100.74		199.91 ± 85.50	
TG(mg/dl) <sup>b</sup>	180.45 ± 83.41		260.71 ± 231.60		235.83 ± 157.50		205.12 ± 113.94	
$\alpha = 0.05$ ; a = significant associations by region; b = significant mean differences by region; Texas Border = McAllen & Laredo, TX; Central Texas = Bryan & College Station, TX; Urban Mexico = Toluca, Mexico; Rural Mexico = El Oro, Mexico; MetS = metabolic syndrome (individual must meet criteria for WC plus criteria for two of the remaining four risk factors: BP, HDL, FBG, and TG); WC = waist circumference (male central obesity $\geq 35.4$ in, female central obesity $\geq 31.4$ in); BP = blood pressure (optimal range: systolic blood pressure (SBP) < 130 mmHG, and/or diastolic blood pressure (DBP) < 85 mmHg); HDL = high-density lipoproteins (optimal range: male $\geq 40$ mg/dl, females $\geq 50$ mg/dl); FBG = fasting blood sugar (optimal range < 100 mg/dl); TG = triglycerides (optimal range < 150 mg/dl).								

One-way (region) ANOVA revealed participants differed in mean waist circumference [F(3,256)=22.93,  $p=0.001$ ], triglycerides [F(3,252)=3.417,  $p=0.018$ ], glucose [F(3,252)=3.978,  $p=0.009$ ], and blood pressure values [SBP: F(3,256)=8.520,  $p=0.001$ , [DBP: F(3,256)=11.715,  $p=0.001$ ]. Fisher's LSD post-hoc analyses indicated several significant regional differences among participants. Central obesity was significantly higher among participants from the Texas Border region as compared to

participants from the Central Texas, Urban Mexico, and Rural Mexico regions. Blood triglyceride levels were significantly higher among participants from Central Texas, Urban Mexico, and Rural Mexico than participants from the Texas Border region. The high triglyceride levels is attributed to high fatty diets. Participants in the Rural Mexico region had significantly higher mean blood glucose than participants from the Urban Mexico region, thus contributing to the higher FBG for Mexicans than Mexican-Americans. Finally, both Texas regions had significantly more hypertensive than the Mexican regions, further indicating Mexican-Americans have higher blood pressures than Mexican-Americans.

#### ***4.4 Acculturation Comparisons***

Table 5 provides acculturation information for the Mexican-American participants (n=108). Acculturation was only assessed among Mexican-Americans (MAs), since they had more first-hand exposure to the American culture and its influences than Mexicans living in Mexico. Acculturation was measured by proxy measures (generational status and years lived in the US) and by the bi-dimensional subscales [(Anglo-orientation subscale (AOS) and Mexican-orientation subscales (MOS)] of the Acculturation Rating Scale for Mexican-Americans, version II (ARSMA-II). The majority (81.2%) of MAs was first generation Mexican-American (i.e. born in Mexico and migrated to the United States) and lived in the US for an average of  $27.65 \pm 16.05$  years. Since all Mexican-American participants were either born in Mexico (1<sup>st</sup> generation immigrant) or were born in the US to Mexican-born parents (2<sup>nd</sup>

generation Mexican-American), generational status was examined in lieu of country of birth.

*Table 5. Acculturation Characteristics among Mexican-Americans*

Acculturation Values		Mean	SD
AOS score		2.36	± 1.03
MOS score		4.22	± 0.82
Acculturation Score		-1.87	± 1.53
Number of Years Lived in the United States		27.65	± 16.05
Acculturation Categories		Frequency	%
Acculturation-Orientation	Anglo-Oriented	17	17.2
	Mexican-Oriented	82	82.8
Acculturation Group	Assimilated	8	8.1
	Bicultural	18	18.2
	Marginalized	3	3.0
	Separated	70	70.7
Generational Status	First Generation	65	81.3
	Second Generation	20	18.7

AOS = Anglo-orientation subscale of the Acculturation Rating Scale for Mexican-Americans, version II (ARSMA-II). Measures engagement of Anglo cultural practices on a Likert scale from 1=not at all, to 5=extremely often; MOS= Mexican-orientation subscale of the ARSMA-II. Measures engagement of Mexican cultural practices on a Likert scale from 1 = not at all, to 5 = extremely often; Acculturation score = mean AOS – mean MOS. Positive score=Anglo-orientation (respondents are more closely associated to the Anglo culture than the Mexican culture), negative score=Mexican-Orientation (respondents are more closely associated to the Mexican culture than the Anglo culture); Acculturation groups were assigned according to high (> 3) or low (≤ 3) AOS and MOS scores: 1) Assimilated: respondents scored a high AOS and low MOS, indicating they were engaged in the Anglo culture but not in the Mexican culture, 2) Bicultural: respondents scored a high AOS and high MOS, indicating they were equally engaged in both the Anglo and Mexican cultures, 3) Separated: respondents scored a low AOS and high MOS, indicating they were very engaged in the Mexican culture but not in the Anglo culture, 4) Marginalized: respondents scored a low AOS and low MOS, indicating they were not engaged in neither the Anglo culture nor the Mexican culture; Generational status: first generation MAs were born in Mexican and migrated to the US. second generation MAs were born in the US, but had ≥ 1 parent who was born in Mexico.

The mean Anglo-orientation subscale (AOS) score was  $2.36 \pm 1.03$ , and the mean Mexican-orientation subscale (MOS) score was  $4.22 \pm 0.82$ . These scores yielded a mean acculturation score of  $-1.83 \pm 1.56$ , indicating that participants in this study were Mexican-oriented, or more closely associated with the Mexican culture than the Anglo culture. The AOS and MOS scores also placed the majority (70.7%) of participants into the separated acculturation group, which provided additional indication that the study's participants maintained close associations to the Mexican culture.

#### ***4.4.1 Relationships between Acculturation and Metabolic Syndrome***

Table 6 provides results from the bivariate correlation analyses between acculturation and metabolic syndrome. Pearson's correlation coefficient was used to examine the relationships, between the acculturation measures: AOS, MOS, acculturation score, years lived in the US, and generational status, and the metabolic biomarkers: waist circumference, systolic and diastolic blood pressures, and blood triglyceride, glucose, and HDL levels.

Only one significant relationship was noted between the proxy measures of acculturation and the metabolic biomarkers. Generation status (0=first generation, 1=second generation) was significantly and inversely related to metabolic syndrome (0= no MetS, 1= MetS), indicating that Mexican-Americans born in the United States (second generation) were less likely to develop metabolic syndrome ( $r = -0.218, p=0.026$ ). Duration of residence in the US was weakly associated with metabolic syndrome and the associated risk factors. Relationships were also noted between the ARSMA-II acculturation values and the metabolic biomarkers. Fasting blood glucose (FBG) was significantly and directly associated with AOS ( $r = 0.312, p=0.001$ ) and acculturation score ( $r = 0.362, p=0.001$ ), and inversely related to MOS ( $r = -0.299, p=0.002$ ). Mexican Americans who were more Anglo-oriented (higher AOS and acculturation scores) had higher average blood glucose levels than Mexican-oriented Mexican-Americans. AOS was also significantly and directly related to systolic blood pressure [ $r = 0.204, p=0.035$ ], indicating that MAs who are more influenced by American society (e.g. poor diet,

stressful lifestyle) have higher blood pressure than MAs who maintain Mexican cultural patterns.

*Table 6. Bivariate Correlations between Acculturation and Metabolic Syndrome*

MetSBiomarkers		AOS	MOS	Accult Score	Years US	Generation
MetS	r	-0.032	0.095	-0.069	0.075	<b>-0.218</b>
	p-value	0.746	0.332	0.478	0.500	<b>0.026</b>
WC (inches)	r	0.115	-0.034	0.094	0.203	0.108
	p-value	0.236	0.728	0.334	0.065	0.271
HDL (mg/dl)	r	0.004	0.057	-0.027	0.074	0.133
	p-value	0.971	0.561	0.786	0.501	0.175
TG(mg/dl)	r	-0.008	0.053	-0.032	-0.078	0.016
	p-value	0.934	0.588	0.741	0.480	0.868
FBG (mg/dl)	r	<b>0.312</b>	<b>-0.299</b>	<b>0.362</b>	0.046	0.120
	p-value	<b>0.001</b>	<b>0.002</b>	<b>0.001</b>	0.686	0.231
SBP (mmHg)	r	<b>0.204</b>	-0.024	0.148	0.031	0.015
	p-value	<b>0.035</b>	0.804	0.128	0.782	0.878
DBP (mmHg)	r	0.154	-0.072	0.139	0.032	0.130
	p-value	0.114	0.461	0.153	0.770	0.188

$\alpha = 0.05$ ; significant correlations between acculturation and MetSBiomarkers are bolded; AOS= Anglo -orientation subscale scores; MOS = Mexican -orientation subscale scores; Accult Score = acculturation score (= mean AOS – mean MOS); Years US= duration of years lived in the United States; Generation = generational status (0=1<sup>st</sup> generation: born in Mexico and migrated to the United States, 1=2<sup>nd</sup> generation: born in the US, but  $\geq 1$  parent was born in Mexico); MetS= metabolic syndrome: 0=no MetS, 1=MetS (individual must meet criteria for WC plus criteria for two of the remaining four risk factors: BP, HDL, FBG, and TG); WC = waist circumference (male central obesity  $\geq 35.4$  in, female central obesity  $\geq 31.4$  in); BP = blood pressure (optimal range: systolic blood pressure (SBP) < 130 mmHG, and/or diastolic blood pressure (DBP) < 85 mmHg); HDL = high-density lipoproteins (optimal range: male  $\geq 40$  mg/dl, females  $\geq 50$  mg/dl); FBG= fasting blood sugar (optimal range < 100 mg/dl); TG= triglycerides (optimal range < 150 mg/dl).

#### 4.4.2 Generational Comparisons

Table 7 shows metabolic syndrome characteristics between first and second generation Mexican-Americans. The prevalence of metabolic syndrome was higher among first generation Mexican-Americans (89.4%) than second generation Mexican-Americans (70.0%) [ $\chi^2_{(1)}=4.982$ ,  $p=0.026$ ], but the two generations did not differ in average blood pressure, central obesity, or blood levels of triglycerides, HDL, or glucose. When the two generational groups were compared to the Mexican sample,  $\chi^2$

analyses revealed associations between generation and blood pressure ( $\chi^2_{(2)}=14.181$ ,  $p=0.001$ ), waist circumference ( $\chi^2_{(2)}=6.333$ ,  $p=0.042$ ), and metabolic syndrome ( $\chi^2_{(2)}=7.600$ ,  $p=0.022$ ). The higher percentage of first generation Mexican-Americans with high blood pressure and central obesity (BP: 61.2%, WC: 92.9%) contributed to the higher prevalence of metabolic syndrome (MetS: 89.4%) than the Mexican sample (MetS: 75.7%). According to the findings, first-generation Mexican immigrants, who were Mexican-born and closely linked to the Mexican culture, were adversely affected by the transition into the American society and initial exposure to negative lifestyle factors, such as poor diet or low access to healthcare. However, the second-generation Mexican-Americans, who were born and raised in the United States, were protected against poor health outcomes.

The mean values for each of the metabolic syndrome biomarkers did not differ between first and second generation Mexican-Americans. However, significant differences in waist circumference [ $F(2,252)=20.256$ ,  $p=0.001$ ] and blood pressure values [SBP:  $F(2,252)=11.271$ ,  $p=0.001$ ], DBP:  $F(2,252)=11.271$ ,  $p=0.001$ ] were revealed when the two groups were compared to the Mexican participants. Fisher's LSD indicated that both first and second generation Mexican-Americans (first generation: WC  $40.65\pm 5.20$  inches, SBP  $136.38\pm 21.73$  mmHg, DBP  $82.65\pm 11.27$  mmHg, second: WC  $42.05\pm 4.70$  inches, SBP  $137.20\pm 20.85$  mmHg, DBP  $86.45\pm 12.65$  mmHg) had significantly higher average obesity and blood pressure values than the Mexicans (WC:  $37.07\pm 4.63$  inches, SBP:  $125.33\pm 16.78$  mmHg, DBP:  $75.3\pm 10.62$  mmHg).

#### ***4.4.3 Orientation Comparisons***

Table 7 also shows metabolic syndrome characteristics between the two acculturation-orientation groups. The Mexican-American sample was dichotomized into Anglo-oriented and Mexican-oriented acculturation groups, which were determined by positive (Anglo-oriented) and negative (Mexican-oriented) acculturation scores. No significant associations were noted between acculturation-orientation and metabolic syndrome ( $\chi^2_{(1)}=0.313$ ,  $p=0.576$ ) and the metabolic biomarkers (BP:  $\chi^2_{(1)}=1.612$ ,  $p=0.383$ , HDL:  $\chi^2_{(1)}=0.014$ ,  $p=0.906$ , WC:  $\chi^2_{(1)}=0.143$ ,  $p=0.706$ , TG:  $\chi^2_{(1)}=0.011$ ,  $p=0.917$ ). However, when compared to the Mexican participants,  $\chi^2$  analyses revealed a significant association between acculturation-orientation and BP ( $\chi^2_{(2)}=12.103$ ,  $p=0.002$ ), with higher blood pressure among the Mexican-Americans. This indicated that although Mexican-oriented Mexican-American participants follow similar cultural patterns as Mexicans in Mexico, exposure to negative lifestyle factors in the United States contributes to similar blood pressure values to Anglo-oriented Mexican-Americans. This further indicates that poor health is attributed to society rather than ethnic culture.

Analyses of mean differences of metabolic syndrome biomarkers revealed that the Anglo-oriented participants (SBP:  $146.94 \pm 26.04$  mmHg, DBP:  $89.35 \pm 13.33$  mmHg) had significantly higher blood pressure than Mexican-oriented MAs (SBP:  $135.04 \pm 20.69$  mmHg, DBP:  $82.06 \pm 11.31$  mmHg) [SBP [ $F(1,97)=4.231$ ,  $p=0.042$ ]; DBP:  $F(1,97)=5.520$ ,  $p=0.021$ ]. Blood pressure values for both groups, however, were above the recommend range for individuals with diabetes (BP < 130/85 mmHg). Anglo-

*Table 7. Metabolic Syndrome Characteristics for Generational Status and Acculturation-Orientation*

Generational Status				Acculturation-Orientation			Mexicans	
MetSBiomarkers	Frequency (%)							
MetS <sup>a,c</sup>	First	76	(89.4)	Anglo	15	(88.2)	109	(75.7)
	Second	14	(70.0)	Mexican	67	(82.7)		
WC <sup>c,g</sup>	First	79	(92.9)	Anglo	16	(94.1)	122	(81.3)
	Second	18	(90.0)	Mexican	74	(91.4)		
BP <sup>c</sup>	First	52	(61.2)	Anglo	12	(70.6)	59	(39.3)
	Second	14	(70.0)	Mexican	48	(59.3)		
HDL	First	64	(75.3)	Anglo	12	(70.6)	95	(65.5)
	Second	12	(57.1)	Mexican	56	(69.1)		
FBG	First	86	(100)	Anglo	17	(100)	150	(100)
	Second	21	(100)	Mexican	82	(100)		
TG	First	48	(56.5)	Anglo	9	(52.9)	97	(66.9)
	Second	11	(52.4)	Mexican	44	(54.3)		
Mean ± SD								
WC (inches) <sup>d,h</sup>	First	40.65 ± 5.20		Anglo	40.78 ± 5.21		37.07 ± 4.63	
	Second	42.05 ± 4.70		Mexican	40.57 ± 4.53			
SBP (mmHg) <sup>d,f,h</sup>	First	136.38 ± 21.73		Anglo	136.99 ± 22.17		125.33 ± 16.78	
	Second	137.20 ± 20.85		Mexican	137.09 ± 19.68			
DBP(mmHg) <sup>d,f,h</sup>	First	82.65 ± 11.27		Anglo	83.19 ± 11.79		75.3 ± 10.62	
	Second	86.45 ± 12.65		Mexican	85.82 ± 12.57			
HDL (mg/dl)	First	41.87 ± 8.31		Anglo	42.75 ± 9.77		42.88 ± 11.97	
	Second	44.95 ± 12.46		Mexican	40.27 ± 8.63			
FBG (mg/dl) <sup>f,h</sup>	First	155.64 ± 58.20		Anglo	152.98 ± 56.06		182.87 ± 94.61	
	Second	173.75 ± 68.13		Mexican	206.64 ± 54.89			
TG(mg/dl)	First	195.61 ± 124.96		Anglo	199.08 ± 134.75		220.37 ± 137.69	
	Second	200.90 ± 151.32		Mexican	178.27 ± 113.34			
$\alpha = 0.05$ ; a= significant associations between generational statues and the MetSbiomarkers; b=significant mean differences by generational status; c= significant associations between generational statues and the MetSbiomarkers when compared to the Mexican sample; d= significant mean differences by generational status when compared to the Mexican sample; e= significant associat ions between acculturation-orientation and the MetSbiomarkers; f=significant mean differences by acculturation-orientation; g= significant associations between acculturation-orientation and the MetSbiomarkers when compared to the Mexican sample; h= significant mean differences by acculturation-orientation when compared to the Mexican sample; Generation = generational status (0=1 <sup>st</sup> generation: born in Mexico and migrated to the United States, 1=2 <sup>nd</sup> generation: born in the US, but ≥ 1 parent was born in Mexico); Acculturation-Orientation (based on acculturation score = mean AOS – mean MOS. Anglo-orientation: positive acculturation score, Mexican-orientation: negative acculturation score); MetS= metabolic syndrome (individual must meet criteria for WC plus criteria for two of the remaining four risk factors: BP, HDL, FBG, and TG); WC= waist circumference (male central obesity ≥ 35.4 in, female central obesity ≥ 31.4 in); BP = blood pressure (optimal range: systolic blood pressure (SBP) < 130 mmHG, and/or diastolic blood pressure (DBP) < 85 mmHg); HDL = high-density lipoproteins (optimal range: male ≥ 40 mg/dl, females ≥ 50 mg. dl); FBG= fasting blood sugar (optimal range < 100 mg/dl); TG = triglycerides (optimal range <150 mg/dl).								

oriented MAs ( $191.47 \pm 69.99$  mg/dl) also had significantly higher average blood glucose than Mexican-oriented MAs ( $152.71 \pm 53.91$  mg/dl) [FBG:  $F(1,93)=6.430$ ,  $p=0.013$ ]. Comparisons to the Mexican participants revealed significant mean differences in SBP [ $F(2,247)=14.771$ ,  $p=0.001$ ] and DBP [ $F(2,247)=18.767$ ,  $p=0.001$ ], with the Mexican sample having lower blood pressure values (SBP:  $125.13 \pm 16.78$  mmHg, DBP:  $75.30 \pm 10.62$  mmHg) than both the Anglo-oriented and Mexican-oriented groups. Also, Mexican blood pressure values were within the recommended ranges (SBP < 130 mmHg, DBP < 85 mmHg). The Mexican sample had significant higher mean blood glucose ( $182.87 \pm 94.61$  mg/dl) than the Mexican-orientation group [ $F(2,243)=3.829$ ,  $p=0.023$ ], but the FBG of all three groups greatly exceed the recommended range (FBG < 100 mg/dl). Central obesity among the Mexican-American groups (Anglo-oriented:  $42.59 \pm 4.77$  inches, Mexican-oriented:  $40.28 \pm 5.15$  inches) were significantly higher than Mexican sample ( $37.07 \pm 4.63$  inches) [ $F(2,247)=18.279$ ,  $p=0.001$ ].

#### ***4.4.4 Acculturation Group Comparisons***

Metabolic syndrome was examined by Berry's Four-Group Acculturation model<sup>44</sup>, as shown in Table 8. The prevalence of metabolic syndrome did not vary among the acculturation groups ( $\chi^2_{(3)}=1.319$ ,  $p=0.725$ ), nor did the percentage of participants who met criteria for the metabolic biomarkers: BP ( $\chi^2_{(3)}=0.174$ ,  $p=0.982$ ), HDL ( $\chi^2_{(3)}=1.690$ ,  $p=0.639$ ), WC ( $\chi^2_{(3)}=2.293$ ,  $p=0.514$ ), TG ( $\chi^2_{(3)}=0.729$ ,  $p=0.866$ ). However, comparisons to the Mexican sample revealed an association between acculturation groups and BP ( $\chi^2_{(4)}=11.546$ ,  $p=0.021$ ), with all four acculturation groups - assimilated (62.5%), bicultural (64.7%), separated (60.0%), marginalized (66.7%) -

having higher proportion of individuals with high blood pressure than the Mexican sample (39.9%).

*Table 8. Metabolic Syndrome Characteristics among Acculturation Groups*

	Assimilated		Bicultural		Separated		Marginalized		Mexicans	
MetS Biomarkers	Frequency (%)									
MetS	6	(75.0)	15	(88.2)	58	(82.9)	3	(100)	109	(75.7)
WC	7	(87.5)	17	(100)	63	(90.0)	3	(100)	122	(81.3)
BP <sup>b</sup>	5	(62.5)	11	(64.7)	42	(60.0)	2	(66.7)	59	(39.9)
HDL	5	(62.5)	11	(64.7)	49	(70.0)	3	(100)	95	(65.5)
FBG	8	(100)	18	(100)	70	(100)	3	(100)	150	(100)
TG	4	(50.0)	10	(58.8)	38	(54.3)	1	(33.3)	97	(66.9)
Mean ± SD										
WC (in) <sup>d</sup>	41.94 ± 4.42		43.22 ± 5.49		40.08 ± 5.02		36.93 ± 2.76		37.07 ± 4.63	
SBP (mmHg) <sup>d</sup>	142.13 ± 19.43		146.47 ± 26.84		134.84 ± 20.79		123.67 ± 15.63		125.13 ± 16.78	
DBP (mmHg) <sup>d</sup>	87.5 ± 13.79		87.12 ± 13.76		82.01 ± 11.23		81.33 ± 9.07		75.30 ± 10.62	
HDL (mg/dl)	39.88 ± 9.43		44.06 ± 13.28		42.53 ± 8.93		41.33 ± 7.64		42.88 ± 11.97	
FBG(mg/dl) <sup>c,d</sup>	201.13 ± 47.72		174.56 ± 89.9		148.48 ± 44.83		221.33 ± 81.57		182.87 ± 94.61	
TG(mg/dl)	174.13 ± 70.14		204.47 ± 157.3		195.77 ± 130.67		189.33 ± 216.25		220.37 ± 137.69	
$\alpha = 0.05$ ; a = Significant associations by acculturation group; b = Significant associations with Mexican sample; c significant mean differences by acculturation group; d = Significant mean differences by comparison with the Mexican sample; Acculturation groups were assigned according to high (> 3) or low ( $\leq 3$ ) AOS and MOS scores: 1) Assimilated: respondents scored a high AOS and low MOS, indicating they were engaged in the Anglo culture but not in the Mexican culture, 2) Bicultural: respondents scored a high AOS and high MOS, indicating they were equally engaged in both the Anglo and Mexican cultures, 3) Separated: respondents scored a low AOS and high MOS, indicating they were very engaged in the Mexican culture but not in the Anglo culture, 4) Marginalized: respondents scored a low AOS and low MOS, indicating they were not engaged in neither the Anglo culture nor the Mexican culture; MetS = metabolic syndrome (individual must meet criteria for WC plus criteria for two of the remaining four risk factors: BP, HDL, FBG, and TG); WC = waist circumference (male central obesity $\geq 35.4$ in, female central obesity $\geq 31.4$ in); BP = blood pressure (optimal range: systolic blood pressure (SBP) < 130 mmHG, and/or diastolic blood pressure (DBP) < 85 mmHg); HDL = high-density lipoproteins (optimal range: male $\geq 40$ mg/dl, females $\geq 50$ mg/dl); FBG = fasting blood sugar (optimal range < 100 mg/dl); TG = triglycerides (optimal range < 150 mg/dl).										

One-way (acculturation group) ANOVA revealed that the assimilated group (210.13 $\pm$ 47.70 mg/dl) had significantly higher blood glucose than the separated group (148.48 $\pm$ 44.83 mg/dl) [F(3,93)=3.931, p=0.011], indicating a possible difference in health outcomes between groups. However, the Mexican participants also had a significantly higher FBG [F(4,243)=2.515, p=0.042] than the separated group, indicating that people living in Mexico have poorer glucose control or greater insulin-resistance.

Addition comparisons to the Mexican sample revealed significant mean differences in WC [ $F(4,247)=10.504$ ,  $p=0.001$ ], SBP [ $F(4,247)=7.802$ ,  $p=0.001$ ], and DBP [ $F(4,247)=8.769$ ,  $p=0.001$ ], with Fisher's LSD indicating that the bicultural (WC:  $43.22 \pm 5.49$  inches, SBP:  $146.47 \pm 26.84$  mmHg, DBP:  $87.12 \pm 13.76$  mmHg), separated (WC:  $40.08 \pm 5.02$  inches, SBP:  $134.85 \pm 20.79$  mmHg, DBP:  $82.01 \pm 11.23$  mmHg), and assimilated (WC:  $41.94 \pm 4.40$  inches, SBP:  $142.13 \pm 19.43$  mmHg, DBP:  $87.50 \pm 13.79$  mmHg,) groups all had significantly higher central obesity and blood pressure values than the Mexican sample (WC:  $37.07 \pm 4.63$  inches, SBP:  $125.13 \pm 16.78$  mmHg, DBP:  $75.30 \pm 10.62$  mmHg). The higher blood pressure and central obesity values among the acculturation groups decreases the value of culture as a protective factor against poor health outcomes, such as hypertension and obesity.

#### ***4.4.5 Proxy Measures of Acculturation vs. Bi-dimensional ARSMA Values***

Table 9 presents comparisons between the proxy and ARSMA acculturation measures. One of the specific aims of the study was to determine the relationships between proxy measures of acculturation (generational status and years lived in the US) with the bi-dimensional acculturation measures of the ARSMA (Anglo-orientation subscale (AOS) scores, Mexican-orientation subscale (MOS) scores, acculturation-orientation, and acculturation group). The majority of first and second generation Mexican-Americans was Mexican-oriented, with a higher percentage among first generation individuals (87.2%) than second generation individuals (70.0%). Though the relationship between generational status and acculturation-orientation only approached significance ( $\chi^2_{(1)}=3.569$ ,  $p=0.059$ ), it indicated that second generation Mexican-

Americans were less connected to the Mexican culture than first generation Mexican-Americans.

*Table 9. Comparisons between Proxy and Bi-dimensional Measures of Acculturation*

	Generational Status				Acculturation-Orientation				Mexican Americans	
	1 <sup>st</sup> Generation		2 <sup>nd</sup> Generation		Anglo-Oriented		Mexican-Oriented			
Frequency (%)										
Acculturation-Orientation										
Anglo-Oriented	11	(12.8)	6	(30.0)	17	(15.7)	-	-	17	(15.7)
Mexican-Oriented	75	(87.2)	14	(70.0)	-	-	91	(84.3)	91	(84.3)
Berry's Groups										
Assimilated	5	(5.8)	3	(15.0)	8	(47.1)	0	(0.0)	8	(7.40)
Bicultural	12	(14.0)	5	(25.0)	7	(41.2)	11	(12.1)	18	(16.7)
Separated	66	(76.7)	12	(60.0)	0	(0.0)	79	(86.8)	79	(73.1)
Marginalized	3	(3.5)	0	(0.0)	2	(11.8)	1	(1.10)	3	(2.78)
Mean ± SD										
AOS <sup>b</sup>	2.21	± 0.97	2.86	± 1.16	4.02	± 0.68	2.03	± 0.75	2.33	± 1.04
MOS	4.32	± 0.77	3.99	± 0.80	3.12	± 1.11	4.46	± 0.48	4.26	± 0.79
Accult Score <sup>b</sup>	-2.11	± 1.46	-1.13	± 1.72	0.90	± 0.91	-2.43	± 0.95	-1.93	± 1.55
Years in the US <sup>b</sup>	21.98	± 12.51	46.05	± 12.04	31.17	± 19.67	27.07	± 15.45	27.65	± 16.05

α=0.05; a= significant association between generational status and acculturation-orientation; b=significant mean difference by generation; MA=Mexican-American; AOS= Anglo-orientation subscale of the Acculturation Rating Scale for Mexican-Americans, version II (ARSMa-II). Measures engagement of Anglo cultural practices on a Likert scale from 1=not at all, to 5=extremely often; MOS= Mexican-orientation subscale of the ARSMa-II. Measures engagement of Mexican cultural practices on a Likert scale from 1 = not at all, to 5 = extremely often; Acculturation score = mean AOS – mean MOS. Positive score=Anglo-orientation (respondents are more closely associated to the Anglo culture than the Mexican culture), negative score=Mexican-Orientation (respondents are more closely associated to the Mexican culture than the Anglo culture); Generational status = 1<sup>st</sup> generation: a Mexican immigrant who was born in Mexico, 2<sup>nd</sup> generation: a Mexican-American who was American-bom but had ≥ 1 Mexican-born parents; Years in the US= duration Mexican-American participant lived in the US.

One-way ANOVA revealed second generation Mexican-Americans score significantly higher AOS (2.86 $\pm$ 1.16) and acculturation (-1.13 $\pm$ 1.72) scores than first generation Mexican-Americans (AOS score: 2.21 $\pm$ 0.97, acculturation score: -2.11 $\pm$ 1.46) [AOS: F(1.104)=6.689, p=0.011; acculturation score: F(1.83)=10.758, p=0.010]. These results also indicated that second generation Mexican-Americans responded more favorably toward Anglo-orientation, and thus, have lower ethnic identity as compared to first generation Mexican-Americans. The mean MOS for both first and second

generation MAs was not significantly different [ $F(1,104)=2.929$ ,  $p=0.090$ ]. One-way ANOVA also compared the number of years lived in the United States by generational status and acculturation-orientation. The number of years ( $46.05 \pm 12.04$  years) second generation Mexican-Americans had lived in the US was significantly higher the number of years first generation Mexican-Americans ( $21.94 \pm 12.602$  years) had lived in the US [ $F(1,83)=56.941$ ,  $p=0.001$ ]. Differences in the mean number of years among acculturation-orientations [ $F(1,83)=0.670$ ,  $p=0.416$ ] and acculturation groups [ $F(3,81)=1.026$ ,  $p=0.386$ ] were not significant.

*Table 10. Bivariate Correlations between Proxy and Bi-dimensional Measures of Acculturation*

Acculturation Measures			1	2	3	4
1	AOS	R				
		p-value				
2	MOS	R	<b>-0.424</b>			
		p-value	<b>0.001</b>			
3	Accult Score	R	<b>0.887</b>	<b>-0.794</b>		
		p-value	<b>0.001</b>	<b>0.001</b>		
4	Generation	R	<b>0.246</b>	-0.165	<b>0.249</b>	
		p-value	<b>0.011</b>	0.090	<b>0.010</b>	
5	Years US	r	0.166	-0.079	0.146	<b>0.640</b>
		p-value	0.130	0.474	0.182	<b>0.001</b>

$\alpha = 0.05$ ; significant correlations between acculturation measures are bolded; AOS = Anglo-orientation subscale of the Acculturation Rating Scale for Mexican-Americans, version II (ARSMA-II). Measures engagement of Anglo cultural practices on a Likert scale from 1 = not at all, to 5 = extremely often; MOS = Mexican-orientation subscale of the ARSMA-II. Measures engagement of Mexican cultural practices on a Likert scale from 1 = not at all, to 5 = extremely often; Acculturation score = mean AOS – mean MOS. Positive score = Anglo-orientation (respondents are more closely associated to the Anglo culture than the Mexican culture), negative score = Mexican-Orientation (respondents are more closely associated to the Mexican culture than the Anglo culture); Generational status = 1<sup>st</sup> generation: a Mexican immigrant who was born in Mexico, 2<sup>nd</sup> generation: a Mexican-American who was American-born but had  $\geq 1$  Mexican- born parents; Years in the US = duration Mexican-American participant lived in the US.

Finally, bivariate correlations were performed to determine relationships between the proxy measures and ARSMA scores (results in Table 10). Pearson's correlation showed significant positive association between generational status (0 = first generation, 1 = second generation) and participants' Anglo-orientation ( $r=0.246$ ,  $p=0.011$ ) and acculturation ( $r=0.249$ ,  $p=0.010$ ) scores. This provides additional support that second

generation Mexican-Americans are more Anglo-oriented than first generation Mexican-Americans. Bivariate correlation analyses revealed weak associations between generational status and Mexican-orientation scores ( $r = -0.165, p = 0.090$ ); and between number of years lived in the US with Anglo-orientation score ( $p = 0.130$ ), Mexican-orientation score ( $p = 0.474$ ), and acculturation score ( $p = 0.182$ ).

#### ***4.5 Predictors of Metabolic Syndrome***

Table 11 shows the predictors of metabolic syndrome. Two logistic regression models were examined to determine the impact of the primary independent variable, acculturation, on metabolic syndrome. The first model excluded Mexican participants since acculturation only applied to Mexican-Americans living in the United States. Step 1 of the model only included the acculturation measures [Anglo-orientation subscale (AOS) scores, Mexican-orientation subscales (MOS) scores, and generational status ( $0 = 1^{\text{st}}$  generation,  $1 = 2^{\text{nd}}$  generation)]. Multicollinearity was avoided by excluding acculturation scores and years lived in the US since acculturation score was significantly correlated to AOS ( $r = 0.887, p = 0.001$ ) and MOS ( $r = -0.794, p = 0.001$ ), and years lived in the US was significantly correlated to generational status ( $r = 0.640, p = 0.001$ ), as shown in Table 10. Regression analysis revealed generational status (odds ratio [OR]=3.688, 95% CI 1.066-12.764,  $p = 0.039$ ) was the only predictor of metabolic syndrome, indicating that first generation Mexican immigrants were 3.688 times more likely to develop metabolic syndrome than second generation Mexican-Americans. This may result from difficulties maintaining healthy lifestyles as they transition to American society.

Step 2 of the model included the acculturation measures, but controlled for demographic (age, gender, residential region, education level, and physical activity level) and glycosylated hemoglobin. Regression analysis revealed that generational status (OR 7.399, 95% CI 1.464-37.401,  $p=0.015$ ) was still a significant predictor of metabolic syndrome with first generation Mexicans-Americans 7.399 times more likely to develop metabolic syndrome than second generation Mexican-Americans. Residential region (OR 19.194, 95% CI 2.301-160.099,  $p=0.006$ ) was also a significant predictor of metabolic syndrome in this model with residents of the Texas Border region being 19.194 times more likely to have metabolic syndrome than residents of the Central Texas region. According to the first model, first generation Mexican immigrants residing at the Texas Border region had an increased risk of developing metabolic syndrome and experiencing poor health outcomes. Finally, age also appeared to impact metabolic syndrome, with a 1.059 times increased likelihood of developing metabolic syndrome with every year of life. However, this relationship only approached significance (OR=1.059, 95% CI 0.991-1.132,  $p=0.090$ ).

The second regression model included all participants to assess predictability of metabolic syndrome between Mexicans and Mexican-Americans. Residential region was used in Step 1, since it not only captured participants' country of residence, but also allowed examination of region-specific predictability. The analysis revealed that participants from Urban Mexico (OR=0.411, 95% CI 0.186-0.908,  $p=0.028$ ) had a lower risk for metabolic syndrome than Rural Mexicans. Step 2 included residential regions, but controlled for demographic (age, gender, and education and physical activity levels)

*Table 11. Regression Analyses of Acculturation Measures on Metabolic Syndrome*

<b>Model 1</b>			<b>Model 2</b>		
Independent Variables	Metabolic Syndrome		Independent Variables	Metabolic Syndrome	
	p-value	OR <sup>a</sup> (95% CI)		p-value	OR <sup>a</sup> (95% CI)
<b>Step 1</b>			<b>Step 1</b>		
AOS score	NS	-	Residential Region		
MOS score	NS	-	Texas Border	NS	-
Generational Status			Central Texas	NS	-
1st Generation	0.039	3.688 (1.066, 12.764)	Urban Mexico	0.028	0.411 (0.186, 0.908)
2nd Generation		Ref	Rural Mexico		Ref
<b>Step 2</b>			<b>Step 2</b>		
AOS score	NS	-	Residential Region		
MOS score	NS	-	Texas Border	NS	-
Generational Status			Central Texas	NS	-
1st Generation	0.015	7.399 (1.464, 37.401)	Urban Mexico	0.041	0.318 (0.106, 0.952)
2nd Generation		Ref	Rural Mexico		Ref
Residential Region			Gender		
Texas Border	0.006	19.194 (2.301, 160.099)	Male	0.086*	0.482 (0.209, 1.109)
Central Texas		Ref	Female		Ref
Gender			Highest Education		
Male	NS	-	≤ Primary	NS	-
Female		Ref	> Primary		Ref
Highest Education			PA Level		
≤ Primary	NS	-	Inactive	NS	-
> Primary		Ref	Active		Ref
PA Level			Age	NS	-
Inactive	NS	-	HbA1c	NS	-
Active		Ref			
Age	0.090				
	*	1.059 (0.991, 1.132)			
HbA1c	NS	-			

$\alpha=0.05$ ; \* $\alpha=0.10$ ; Model 1 excluded Mexican participants since acculturation only applied to the Mexican-Americans living in the United States; Model 2 included all participants; Metabolic syndrome = individual must meet criteria for WC plus criteria for two of the remaining four risk factors: BP, HDL, FBG, and TG; WC = waist circumference (male central obesity  $\geq 35.4$  in, female central obesity  $\geq 31.4$  in); BP = blood pressure (optimal range: systolic blood pressure (SBP)  $< 130$  mmHG, and/or diastolic blood pressure (DBP)  $< 85$  mmHG); HDL = high-density lipoproteins (optimal range: male  $\geq 40$  mg/dl, females  $\geq 50$  mg/dl); FBG = fasting blood sugar (optimal range  $< 100$  mg/dl); TG = triglycerides (optimal range  $< 150$  mg/dl); AOS = Anglo-orientation subscale of the Acculturation Rating Scale for Mexican-Americans, version II (ARSMA-II). Measures engagement of Anglo cultural practices on a Likert scale from 1 = not at all, to 5 = extremely often; MOS = Mexican-orientation subscale of the ARSMA-II. Measures engagement of Mexican cultural practices on a Likert scale from 1 = not at all, to 5 = extremely often; Generational status = 1<sup>st</sup> generation: a Mexican immigrant who was born in Mexico, 2<sup>nd</sup> generation: a Mexican-American who was American-born but had  $\geq 1$  Mexican-born parents; Texas Border = McAllen & Laredo, TX; Central Texas = Bryan & College Station, TX; Urban Mexico = Toluca, Mexico; Rural Mexico = El Oro, Mexico; BMI = body mass index (obese = BMI  $\geq 30$  kg/m<sup>2</sup>, non-obese = BMI  $< 30$  kg/m<sup>2</sup>); Edu = highest education level (primary = illiterate or completed  $\leq 8$ th grade, secondary = completed  $\geq 9$ th grade); PA = physical activity level (active = meets guideline of  $\geq 3$  days of  $\geq 30$  minutes of moderate physical activity or  $\geq 2$  days of  $\geq 20$  minutes of vigorous physical activity per week; inactive = does not meet guideline); body fat % = percent body fat composition fat (male obesity  $\geq 25\%$ , female obesity  $\geq 32\%$ ); HbA1c = glycosylated hemoglobin (optimal range:  $\leq 7\%$ ).

and glycosylated hemoglobin variables. Participants from the Urban Mexico region

were still protected against metabolic syndrome (OR=0.318, 95% CI 0.106-0.952,

p=0.041). Gender also appeared to impact metabolic syndrome, with male participants

having lower risk for metabolic syndrome than female participants. However, this relationship only approached significance (OR=0.482, 95% CI 0.209-1.109).

## V. DISCUSSION AND CONCLUSION

The prevalence of metabolic syndrome in this study was high, with an overall prevalence of 79.9%, and respective 75.5% and 85.0% prevalence among Mexicans and Mexican-Americans. These are among the highest reported prevalence of metabolic syndrome among Mexican or Mexican-American groups<sup>1,2,3,4,5,15,16,17</sup>, indicating that this sample is at high risk for developing cardiovascular complications. The high rate of metabolic syndrome, however, was expected since all participants had been previously diagnosed with type 2 diabetes mellitus, one of the criteria for metabolic syndrome that also increased their likelihood of meeting the additional criteria for metabolic syndrome. Only Blaum, West, and Haan (2007)<sup>57</sup> examined metabolic syndrome among individuals with diabetes as they compared diabetic and non-diabetic Mexican-Americans. However, the authors only reported the prevalence of the individual criteria for metabolic syndrome, which were high among individuals with metabolic syndrome, regardless of their diabetic status<sup>57</sup>. The results of this study concurs with theirs, except for the low percentage of individuals in this study with high blood pressure.

All five criteria of metabolic syndrome contributed to the overall prevalence of metabolic syndrome, with the exception of lower blood pressure percentages among Mexicans and a low percentage of Mexican males who met the HDL criterion. The high rates of central obesity, the necessary component of the IDF definition, especially accounted for the high prevalence metabolic syndrome on both sides of the border. Many studies have examined metabolic syndrome among Mexicans or Mexican-Americans using the NCEP/ATP III definition for metabolic syndrome<sup>2,3,4,15</sup>. However,

use of the NCEP/ATP III criteria has less inclusive cut-off points for waist circumference and perhaps captured less individuals at risk for metabolic syndrome than using the IDF definition. Lorenzo et al. (2006)<sup>2</sup>, Rojas et al. (2009)<sup>15</sup>, and Ford (2005)<sup>3</sup> compared metabolic syndrome using both the NCEP/ATP III and IDF definitions, and all reported higher prevalence using the IDF definition. Therefore, using the IDF definition likely captured a higher prevalence of metabolic syndrome than if the NCEP/ATP III definition or any other less inclusive definition was used.

This was the second study to assess the prevalence of metabolic syndrome among a bi-national sample of Mexicans and Mexican-Americans. The only other study was conducted by Lorenzo et al. (2006)<sup>2</sup>, who only compared Mexicans in Mexico City and Mexican-Americans in San Antonio. Espinosa de los Monteros, Gallo, Elder, and Talavera (2008)<sup>22</sup>; Vella, Zubia, Ontiveros, and Cruz (2008)<sup>24</sup>; Vella, Ontiveros, Zubia, and Dalleck (2010)<sup>25</sup>; and Vella, Ontiveros, Zubia, and Badar (2009)<sup>21</sup> also examined metabolic syndrome among bi-national samples of Mexican and Mexican-Americans, but these studies were conducted along the US-Mexico border and results were not differentiated between Mexicans and Mexican-Americans. The vast geographic separation between residential regions (rural and urban Mexico and border and central regions of Texas) in this study allowed metabolic syndrome to be analyzed among more representative bi-national sample of Mexicans and Mexican-Americans. The results confirm that Mexican-American participants living at the Texas border region had the greatest risk for metabolic syndrome; these are most likely to be immigrants without health care access. Gender-specific risk assessments revealed that central obesity and

lower-than-recommended HDL levels contributed to the highest prevalence of metabolic syndrome among Mexican-American females, and higher blood pressure values contributed to the high prevalence of among Mexican-American males. Mexican males had the lowest prevalence of metabolic syndrome due to normal blood pressure and optimal HDL levels.

The design of this study also allowed for the assessment of various measurements of acculturation while comparing results to a referent Mexican group. Anglo-oriented Mexican-Americans had significantly higher blood pressure and glucose values than Mexican-oriented Mexican-Americans, indicating that acculturation was possibly associated with poor health measures. However, both sub-groups had significantly higher blood pressure and abdominal obesity than the Mexican participants. This is an important finding because it suggests that health risks are higher among the Mexican-oriented group in the United States than culturally-similar Mexican natives in Mexico. Therefore, high blood pressure and central obesity appear to be attributed to psychosocial factors (e.g. perceived stress<sup>58</sup>, low social support<sup>59</sup>) or environmental factors (e.g. low access to healthy food or low access to health care<sup>21,23</sup>), rather than cultural influences. However, these factors were not examined.

Examination of metabolic syndrome by Berry's acculturation groups<sup>44</sup> did not provide useful results since the majority of Mexican-Americans were either integrated (bicultural) or separated, the two groups most culturally-similar to Mexican natives. Comparisons to the Mexican participants revealed that these groups were more affected

by high blood pressure than the Mexicans, further suggesting a psychosocial or environmental impact on Mexican-American health.

First generation Mexican-Americans had a higher prevalence of metabolic syndrome and were more likely to develop metabolic syndrome than second generation Mexican-Americans. This is an important finding since Mexican immigrants, who were Mexican-born and closely linked to the Mexican culture, may be adversely affected by initial exposure to negative lifestyle factors in the US, while second-generation Mexican-Americans, who have developed English-language skills and have a better opportunity to understand US health recommendations, appear to have better health outcomes. However, comparisons to the Mexican participants revealed that the two generational groups had higher prevalence of hypertension, central obesity and metabolic syndrome, which further suggested that negative health, may be attributed to lifestyle factors rather than cultural influences. Carter-Pokras et al. (2008)<sup>60</sup> and Gorman, Read, and Krueger (2010)<sup>61</sup> similarly reported health improvements among subsequent generations. However, Gonzales, Tarraf, and Haan (2011)<sup>23</sup> reported that there was no difference in the prevalence of metabolic syndrome between Mexican immigrants and US-born Mexican-Americans, but that the prevalence increased with subsequent Mexican-American generations. Ahmed et al. (2009)<sup>62</sup> similarly reported increase in diabetes prevalence with subsequent generational status.

Finally, this study analyzed associations between proxy measures of acculturation and bi-dimensional acculturation measurements of the ARSMA scale. US-born Mexican-Americans had higher Anglo-orientation subscale scores and a lower

prevalence of metabolic syndrome than first generation immigrants. This indicated that the Anglo-culture acquisition allows second generation Mexican-Americans to may develop better language skills that possibly improve health literacy and communication with health care providers, better understanding of health practices, or increased access to health care<sup>23</sup>. Years lived in the US was also positively associated generational status, which is attributed to the fact that second generation Mexican-Americans have lived in the US for more than twice as long as Mexican immigrants. Therefore, generational status and years lived in the US appeared to be appropriate proxy measures of acculturation. However, Anglo-orientation subscale and acculturation scores were positively associated with fasting glucose and blood pressure and Mexican orientation subscale scores were inversely related to fasting glucose. These findings indicated that acculturation is also related to poor health measures, while affiliation with the Mexican culture protects against health complications. These findings were consistent with Vella, Ontiveros, Zubia, and Bader (2009)<sup>21</sup>, who reported that acculturation was associated with metabolic syndrome. Since acculturation was associated with both positive and negative health measures, further investigations are required to determine the relationship between proxy measures of acculturation and bi-dimensional acculturation measurements with certainty.

To summarize the acculturative impact on metabolic syndrome, the only notable differential prevalence between acculturation groups was between first and second generation Mexican-Americans, with first generation Mexican immigrants having a significantly higher prevalence of metabolic syndrome. However, all analyses of the

acculturation measurements indicated that the groups most culturally similar to the Mexican natives had higher prevalence of metabolic syndrome than the referent Mexican group. These results opposed the hypothesis that the prevalence of metabolic syndrome would not differ between the Mexican-oriented acculturation groups and the Mexican sample. In addition, these results further indicated that Mexican-Americans are apparently impacted by psychosocial or environmental factors in the US, rather than cultural differences.

### ***5.1 Implications***

The disproportionate burden of chronic diseases among Mexican-Americans has been well established<sup>63</sup> and needs to continue to be addressed if the Healthy People 2020<sup>64</sup> goal of eliminating health disparities in the US is to be met. Despite a surge of recent investigations on Mexican-American health, this research adds to the literature that Mexican-Americans are at high risk for chronic diseases and at greater risk than their Mexican counterparts. It also provides support for continued efforts to improve health issues among these populations, especially as the Mexican immigrant population continues to rise.

Since Mexican immigrants are ethnically and culturally similar to Mexicans in Mexico, the transition to the US, rather than cultural influences, appears to impact their health status. However, they appear to gain awareness of US health practices the longer they live in the live in the US. Therefore, efforts to improve health behaviors should focus on overcoming psychosocial and environmental barriers<sup>58,59</sup>. Health professionals must be adequately trained to identify these high risk groups and devise early treatment

and management plans. They must also deliver services to alleviate the comprehensive dangers of metabolic syndrome, perhaps through culturally sensitive initiatives that increase health care access, improve navigation through the health care system, and improve health habits (e.g. improved medical compliance, increased physical activity, improved diet)<sup>48,56</sup>. Finally, culturally competent health educators and social workers<sup>65,66,67</sup> must be positioned to provide appropriate patient counseling focused on developing self-management skills, building self-efficacy<sup>2,4,54</sup>, and improving health literacy<sup>68</sup>.

## ***5.2 Limitations***

Several limitations from this study are recognized. First, assessment of metabolic syndrome among individuals with diabetes automatically fulfilled one of the five IDF criteria for metabolic syndrome. Also, since diabetes is associated with other comorbidities<sup>15,33</sup>, the likelihood of meeting the other IDF criteria increased. In addition, the skewed distribution of participants with poor health may have prevented more accurate analyses of the impact of acculturation on metabolic syndrome since poor health outcomes may have been reported among individuals with low acculturation. Second, Mexican-Americans were defined as individuals of Mexican descent who lived in the United States at the time of the study. Therefore, a Mexican resident who was temporary living in or visiting the United States may have been recorded as a Mexican-American. This was especially possible at the two Texas border sites of McAllen and Laredo, since participants could have easily commuted across the border. Third, there was skewed distribution of participants that restricted certain analyses, especially

through comparisons by gender, region, acculturation-orientation, acculturation group, and generation. Fourth, generational status did not capture the entire range of descent of Mexican immigrants since all of the Mexican-Americans in the study were either first generation immigrants or second generation Mexican-American. Samples of subsequent generations would have allowed for more accurate indications of how acculturation impacts metabolic syndrome. Fifth, the accuracy of self-reported physical activity was doubtful since the majority of the participants indicated they were physically active. Accurate assessment of physical activity could have given a deeper understanding of why the Mexican-Americans in this study were so affected by high blood pressure and obesity. Finally, education status between English and Spanish questionnaires limited the measurement of education status to 1)  $\leq$  primary education level and 2)  $>$  primary education level. Consistent measurement could have allowed more accurate analyses of the educational impact on metabolic syndrome and perhaps a better understanding of why the prevalence of metabolic syndrome increases among Mexican immigrants. Despite these limitations, the results contribute to a better understanding of risk factors for diabetes and cardiovascular disease among Mexicans and Mexican Americans.

### ***5.3 Recommendations for Future Research***

Several recommendations are suggested for future research. First, future studies on metabolic syndrome among Mexican-Americans should include participants with and without diabetes. Comparisons between individuals with diabetes and non-diabetic individuals will allow for more population-based prevalence and provide deeper

understanding of how acculturation impacts health behaviors. Second, future studies should include more male participants to allow for more reliable detections of gender-specific risk factors associated with metabolic syndrome. Third, future studies should strive for equal representation between Anglo-oriented and Mexican-oriented participants to allow researchers to determine associations between acculturation measures and health outcomes more accurately. Fourth, future studies should strive for a greater number of participants from non-border areas. Mexican-Americans who live along the US-Mexico border are more influenced by the Mexican culture more than Mexican-Americans living in non-border areas. Equal representation between residents will allow for more accurate examination of how acculturation affects health. Finally, socioeconomic status should be examined as it may restrict access to certain health care services and serve a significant predictor of metabolic syndrome.

#### ***5.4 Conclusions***

In summary, this study demonstrated that Mexican and Mexican-American individuals with type 2 diabetes have a high prevalence of metabolic syndrome, which increases their risk for heart disease and other cardiovascular complications. Mexican-Americans are especially affected by central obesity and hypertension and Mexican immigrants appear to be impacted by negative lifestyle factors upon entering the United States. Acculturation is a complex process and the unclear relationship between acculturation and metabolic syndrome warrants further investigations. Finally, comprehensive strategies addressing Mexican-American and immigrant health issues must utilize a culturally-competent, multidisciplinary team of health professionals and

focus on developing self-management skills, improving health literacy, and alleviating psychosocial barriers to health.

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