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“AT RISK” CARDIOVASCULAR HEALTH PROFILES: METABOLIC DYSREGULATION THROUGH ACCULTURATIVE PROCESSES FOR HISPANIC MEN AND WOMEN IN THE UNITED STATES

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ABSTRACT

This research uses three waves of NHANES data (1999-2004) to investigate the impact of acculturation (using the length of time spent in the U.S., generational designation, citizenship status, and a linguistic acculturation scale) on the metabolic health (using blood sugar levels, waist circumference, systolic blood pressure, diastolic blood pressure, HDL cholesterol, and total serum triglycerides) of adult Hispanics living in the United States. As an "upstream" indicator of potential "downstream" cardiovascular morbidities such as diabetes, biological indicators of metabolic health are an effective way to investigate the origins of health disparities and create early intervention programs for health officials. The paper merges two critical demographic trends, the recent increases in migration of Hispanics to the U.S. and the escalation of cardiovascular diseases to consider four primary foci: to demonstrate the superiority of a metabolic health index rather than a binary "cut off" measure for metabolic wellness, to compare Hispanic metabolic health compared to the aggregate U.S. population, to model relationships between each acculturation metric and the metabolic health index as well as each individual metabolic biomarker, and to demonstrate heterogeneity among Hispanics regarding acculturation metrics and metabolic health. Using OLS, Poisson, and logistic regression models I find that in general, increased acculturation is deleterious to the metabolic health profiles of Hispanics. However sex moderates these relationships, lending credence to divergent metabolic health destinies for acculturating male and female Hispanics. Considerable heterogeneity in the relationships between the four acculturative markers and the six metabolic health indicators exist, yielding a multifarious illustration of the interplay between cardiovascular health and acculturation

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“At Risk” Cardiovascular Health Profiles: Metabolic Dysregulation through Acculturative Processes for Hispanic Men and Women in the United States

I. Introduction

Synchronous cardiovascular morbidities have reshaped the overall health profile of the United States. Obesity rates, incidence of type II diabetes, problematic cholesterol levels, and cardiovascular morbidity in general have all increased dramatically in the U.S. over the past several decades (Flegal et al., 2012; Hubert et al., 1983; Danaei et al., 2011; Isomaa et al. 2001). Increases in these cardiovascular health morbidities have generated public health concerns over an impending “obesity epidemic” (Mokdad et al. 1999), “diabetes epidemic” (Fleming et al. 2001), and an “epidemic of cardiovascular disease” (Gersh et al. 2010). As of 2014, heart disease, stroke, and diabetes were the first, fourth, and sixth leading causes of death in the United States respectively (Centers for Diseases Control and Prevention 2014c). While cardiovascular disease remains a national health concern, the relative burden of these conditions is not equally shared across the population. Indeed, recent reports from the American Heath Association note that Mexican Americans, African Americans, and those reporting their ethnicity as Hispanic in general have rates of diabetes that are “strikingly disproportionate” from whites individuals in the U.S. (Go et al. 2014). Furthermore, ethnic minorities in the U.S. also have higher incidence rates of obesity than whites (Pan et al. 2009). This is particularly troubling considering the most recent wave of U.S. immigrants has been dominated by migrants of Hispanic origins, specifically those from South and Central American and the Caribbean. Between 1990 and 2000 the U.S. Hispanic population grew by nearly 60% (Guzmán and McConnell 2002), and continued to grow by 43% between 2000 and 2010 (Passel et al. 2011). Individuals identifying as Hispanic (of any race) now comprise the largest minority group in the U.S. at more than 16% (Passel et al. 2011). Though occurring completely autonomously of one another, these coexisting trends of increases in the prevalence of cardiovascular diseases in the U.S. population and a growing U.S. Hispanic population signal an impending public health calamity; a situation where rising morbidities are intensified with population compositional change due to deeply entrenched health disparities.

The impetus of this study is to relate two significant population trends in the U.S. over recent decades: the enormous expansion in the Hispanic population in the U.S., and the increases in cardiovascular disease prevalence. While Hispanics have been shown to have higher incidence rates of cardiovascular maladies (Go et al., 2014; Pan et al. 2009), considerable differences in the cardiovascular health within the U.S. Hispanic population have been observed. Incidences of obesity, heart disease, hypertension, and diabetes have been shown to differ by place of birth (born in the U.S. vs outside of the U.S.), language usage, length of time in the United States, and citizenship status (Hunt et al., 2002; DuBard et al., 2006; Pabon-Nau 2010). Though the overall prevalence of cardiovascular disease may be greater in Hispanic populations, there is considerable heterogeneity within this group by immigration status. Thus it is prudent to examine this particular group for potential differences in cardiovascular disease by levels of integration/acculturation into "majority" U.S culture for this population. Using a nationally representative sample of Hispanic adults living in the United States, I will investigate the pathways through which acculturative processes within the Hispanic population affect the metabolic health profiles of Hispanics in the U.S.

II. Background/Literature Review

The Metabolic "Syndrome"

Health officials have tracked current increases in cardiovascular morbidities in the U.S. as they have reached "epidemic" proportions (Mokdad et al. 1999). As public health policies continue to shift from reactive treatment to early "upstream" intervention approaches to combat such diseases, health care researchers and practitioners have identified and targeted a range of certain health "risk factors" which are associated with increases in the risk of developing cardiovascular diseases (McKinley and Marceau 2000). As such, health initiatives aimed at those at risk of developing cardiovascular problems have identified and utilized a "constellation" of biological indicators which can both make individuals more susceptible to the development and/or signal early onset of these morbidities (Zimmet et al. 2005). In the method of using certain indices or "red flags" used by clinical psychologists to identify individuals with mental/psychological health problems, clinicians can identify this condition, collectively designated as the "metabolic syndrome", using a range of physical health indicators which relate to adverse cardiovascular health (Ford et al. 2002). Though there is some variation in its conceptualization, definitions of the metabolic syndrome typically include some indicators for glucose intolerance, obesity, hypertension, and adverse serum lipid levels (Eckel et al. 2005).

Though the theoretical definition of the metabolic syndrome has achieved nearly univeral accord, operational definitions given by the major groups studying metabolic health in the international clinical and academic communities are decidedly more tenuous as they are characterized both by divergence and overlap. The history of the usage of a metabolic health index to pre-diagnose cardiovascular dysregulation can be traced to the work of the Swedish physician Eskil Kylin, who identified hypertension (high blood pressure), hyperglycaemia (elevated blood sugar) and hyperuricaemia (high uric acid) as indicative of metabolic disorder (Kylin, 1923; Alberti, 2006). Following in this tradition, Jean Vague studied the relationship between obesity (its merit indicative of the epidemiological shift occurring in the post WWII west) and cardiovascular morbidities (Vague 1947; Alberti, 2006); synthesizing these two , Avogaro and Crepaldi later use the verbiage of a "syndrome" defined by "hypertension, hyperglycemia, and obesity" (Avogaro and Crepaldi 1965; Alberti, 2006). However, it was not until 1988 when Gerald Reaven coined the name "syndrome X" to describe a "clustering of cardiovascular risk factors like hypertension, glucose intolerance, high triglycerides, and low HDL concentrations (Reaven 1988; Isomaa et al. 2001)." Carrying the tradition further, Norman Kaplan referred to the syndrome as "the deadly quartet", and later the "insulin resistance syndrome" (Kaplan, 1989; Alberti, 2006). While an important first step in beginning to create a metric by which to assess metabolic health, critics were quick to point out that Reaven's and Kaplan's conceptualization did not include obesity, a linked disorder which had been identified since the 1960's as highly correlated to cardiovascular disease such as type II diabetes and coronary heart disease (Alberti et al. 2009). Further, their theories were lacking in causal mechanistic explanatory power as their proposed pathway, whereby metabolic markers are linked to diabetes and other cardiovascular disorders, operated through insulin resistance (Alberti et al. 2006).

To overcome these shortfalls and attempt to bring coalescence to the field, a handful of critically recognized definitions from academically and clinically accepted organizations arose around the turn of the millennium, specifically from the World Health Organization (WHO), the National Cholesterol Education Program—Third Adult Treatment Panel (NCEP ATP III), The European Group for the Study of Insulin Resistance (EGIR), and the International Diabetes Federation (IDF). In a highly influential article, Alberti et al. (2006) detail the IDF definition of the metabolic syndrome (developed in 2006) which is based on both an extensive meta-analysis of studies on the subject, and an amalgamation of the three most widely used preexisting definitions of the metabolic syndrome given by the WHO (1999), NCEP ATP III (2001), and the EGIR (1999). Figure 1 illustrates these three initial operational definitions used to define the metabolic syndrome. Though the definitions are rather consistent regarding specific markers (all three definitions all include four specific markers: obesity, blood pressure, and good and bad cholesterol levels), measurement techniques (for example using plasma levels of cholesterol in mmol/l), and gender variation in adverse levels of some of the markers (specifically for obesity and HDL cholesterol), there are more than a few differences across the definitions which merit further discussion. First (and perhaps most importantly for the purposes of this research), both the WHO and EGRIT definitions define the syndrome as having insulin resistance as a prerequisite along with two or more adverse markers, while the NCEP ATP III definition regards insulin resistance as more symptomatic than causal for the metabolic syndrome as it is not included in the definitions, defining the syndrome based on three or more adverse markers (Alberti et al. 2006). Indeed, some studies have indicated that the combination of these biological indicators impact cardiovascular morbidity through the development of insulin resistance or glucose intolerance (Grundy 1999). However, more recent work has indicated that this may not be the only pathway through which the metabolic indicators work, necessitating the need to closely monitor the entire set of metabolic indicators rather than use standard insulin sensitivity tests such as the hyperinsulinemic-euglycemic clamp technique as a proxy test (Alberti et al., 2006; Després et al. 2008). Additionally, the WHO includes adverse albumin levels in the index but not fasting plasma glucose, while the NCEP ATP III and the EGIR do exactly the opposite in their operational definition

(Alberti et al. 2006). Lastly, subtle oscillations in "cut-off thresholds" for adverse levels of the specific biological marker exist among the three offered definitions (though there is not one scale among the three that is more "conservative" than another as they vary in terms of rank order of highest cut-off levels across the different markers) (Alberti et al. 2006).

In an attempt to synthesize these definitions, Alberti and IDF representatives have offered a working definition of the metabolic syndrome which incorporates the strengths of each of the three prior definitions. Shown in figure 2 is the integrated IDF definition for the metabolic syndrome circa 2006 (Alberti et al. 2006). According to this definition, an individual must have elevated central obesity and two of the four other markers to exhibit the metabolic syndrome. Note that for the blood pressure marker, the IDF allows for either elevated systolic *or* diastolic blood pressure to mark hypertension rather than requiring elevated levels of both to mark hypertension (as in the three prior definitions), indeed an important improvement brought about by the IDF definition (Alberti et al. 2006). Also shown in figure 2 is that the IDF sided with the NCEP ATP III and EGIR in including fasting plasma glucose rather than albumin concentrations in the metric (Alberti et al. 2006). Another important difference between the IDF and the previous three definitions of the metabolic syndrome is the notion that central obesity is at least the most identifiable, if not the most prevalent indicator of the metabolic syndrome and should be the focal point of the diagnosis of early signs of cardiovascular dysregulation. The authors report that prothromic and proinflamatory states are also indicative of underlying metabolic problems and acknowledge that the analysis of biomarkers like albumin and the C - reactive protein are also useful gauges for these ends (Alberti et al. 2006). Nonetheless, the six item index offered by the IDF synthesizes the most widely used definitional approaches offered by the three primary expert groups in the field.

Though the development of research on the metabolic syndrome has blossomed over the last few decades and a reasonable consensus on particular items used in the metric has been realized, one quickly realizes the relatively weakly developed mechanistic explanation for its causal implications on specific cardiovascular diseases. Though there is some variation in its conceptualization, definitions of the metabolic syndrome typically include some indicators for glucose intolerance, obesity, hypertension, and adverse serum lipid levels (Eckel et al. 2005). Illustrative of the different underlying mechanisms of the three models, the definitional approaches offered by the four main investigative bodies shown in figures 1 and 2 themselves rely on different antecedents (glucose intolerance for the WHO definition, insulin resistance for the EGIR definition, central obesity for the IDF definition, and none at all for the NCEP ATP III definition), and different thresholds for diagnosis of the metabolic syndrome. Indeed Alberti et al. note the lack of research elucidating the causal mechanism of the metabolic syndrome due to collinearity between the individual indicators, an entangling of causality/correlation, and undeveloped theoretical frameworks establishing specific indicators as underlying factors leading to the metabolic syndrome vs. those that are purely symptomatic (in a causal path diagram sense). This disagreement is apparent in the differential approaches to how the indicators are ordered in relative importance as shown in figures 1 and 2 (Alberti et al. 2006). Though outside the scope of this research, it is crucial to note the weakness of the metabolic syndrome's explanatory power, a theme I will return to in later sections. Thus, for purposes of this paper, I will rely on all four definitional approaches, though most heavily on the IDF definition of the metabolic syndrome as it is both the most recent and most integrated. In accord, I specifically focus on six main indicators of the metabolic syndrome: systolic blood pressure, diastolic blood pressure, high density lipoproteins ("good" cholesterol), total plasma triglycerides ("bad" cholesterol), long term plasma glucose (blood sugar), and central obesity.

Figure 1. Definitions of the Metabolic Syndrome Proposed by Three Primary Research Associations

	WHO (1999)	EGIR (1999)	NCEP ATP III (2001)
Criteria	Glucose intolerance, IGT or diabetes and/or insulin resistance together with two or more of the following:	Insulin resistance (defined as hyperinsulinaemia—top 25% of fasting insulin values among the non-diabetic population). Plus two of the following:	Three or more of the following five risk factors:
Fasting plasma glucose		≥ 6.1 mmol/l (110 mg/dl) but non-diabetic	≥ 5.6 mmol/l (100 mg/dl)
Blood pressure	≥ 140/90 mmHg	≥ 140/90 mmHg or treatment	≥ 130/≥ 85 mmHg
Triglycerides	Raised plasma triglycerides: ≥ 1.7 mmol/l (150 mg/dl) *and/or*	> 2.0 mmol/l (178 mg/dl) or treatment *and/or*	≥ 1.7 mmol/l (150 mg/dl)
HDL-cholesterol	Men: < 0.9 mmol/l (35 mg/dl) Women: < 1.0 mmol/l (39 mg/dl)	< 1.0 mmol/l (39 mg/dl) or treatment	Men: < 1.03 mmol/l (40 mg/dl) Women: < 1.29 mmol/l (50 mg/dl)
Obesity	Men: waist–hip ratio > 0.90 Women: waist–hip ratio > 0.85 and/or BMI > 30 kg/m^2	Men: waist circumference ≥ 94 cm Women: waist circumference ≥ 80 cm	Men: waist circumference > 102 cm Women: waist circumference > 88 cm
Microalbuminuria	Urinary albumin excretion rate ≥ 20 µg/min or albumin: creatinine ratio ≥ 30 mg/g		

*Source: Alberti et al. 2006

Apart from unclear mechanistic pathways, the precise operational definition of the metabolic syndrome too has been applied variably. While there is relative agreement regarding the inclusion of certain biomarkers in conceptualizing the metabolic syndrome (recall the “deadly quartet”, and the unanimous agreement on the inclusions of certain *hallmark* indicators of metabolic health), the application of this array of metabolic indicators has been profoundly inconsistent. Clearly the presence of two red flags for impending cardiovascular morbidities are more deleterious than having one (three is worse than having two and so on); however, the operational definition of the presence of the metabolic syndrome itself is quite varied, both in terms of academic research, and clinical application. Most studies have conceived the metabolic syndrome as a sum total of the indicators whereby a “cut-off” for the existence of the metabolic syndrome is established (Ford et al. 2002). Some have argued for the metabolic syndrome to be defined as the presence of two or more of the metabolic indicators along with glucose intolerance (Isomaa et al. 2001; WHO definition; EGIT definition), two or more indicators with central obesity (IDF definition) and other times as simply three or more indicators (Alberti et al., 2009; Cook et al., 2003; NCEP ATP III definition). Thus, while other conceptualizations have deemed certain indicators as more powerful players in the game, others have treated all indicators equally. This incongruity has important effects on both analyses of prevalence of the metabolic syndrome across specific populations, and the individual diagnosis of the metabolic syndrome. Moreover, each of these conceptualizations obscure both the differences in individuals with one or two indicators with those who have none, and the differences between those with two or three indicators with those who have four or more. Fewer studies have analyzed the incidence of the metabolic syndrome as an ordered count indicator rather than a presence/absence “syndrome” (Ridker et al., 2003; Carr et al. 2004). While academic research and clinical applications have typically focused on how many indicators, and their relative importance, define the metabolic syndrome, some research suggests that a count index may be a more accurate measurement technique as it addresses the metabolic syndrome’s definitional imprecision and lack of explanatory mechanistic pathways (Kahn et al. 2005).

Figure 2. International Diabetes Federation Amalgamated Definition of the Metabolic Syndrome

Indicator	Criteria for Inclusion in Metabolic Risk Index
Central obesity	Waist circumference ≥ 90 cm in males Waist circumference ≥ 80 cm in females[1]
Raised triglycerides	≥ 1.7 mmol/l (150 mg/dl)
	or specific treatment for this lipid abnormality
Reduced HDL-cholesterol	< 1.03 mmol/l (40 mg/dl) in males
	< 1.29 mmol/l (50 mg/dl) in females
	or specific treatment for this lipid abnormality
Raised blood pressure	Systolic: ≥ 130 mmHg
	or
	Diastolic: ≥ 85 mmHg
	or treatment of previously diagnosed hypertension
Raised fasting plasma glucose	Fasting plasma glucose ≥ 5.6 mmol/l (100 mg/dl)
	or previously diagnosed Type 2 diabetes
	If > 5.6 mmol/l or 100 mg/dl, oral glucose tolerance test is strongly recommended but is not necessary to define presence of the syndrome

*Source: Alberti et. al, 2006

Despite this variation in how the metabolic syndrome is identified and how it operates to increase the risk of cardiovascular disease, the importance of using simple health metrics (blood pressure, waist circumference, etc.) to identify those at risk of metabolic morbidities should not be diminished as it is both humanitarianly beneficial and cost effective. Most empirical estimates demonstrate that around one in five Americans suffer from the metabolic syndrome (Park et al., 2003; Alberti et al., 1998; Cook et al. 2003); indeed, the most recent estimates using NHANES data estimates that 22.9% of Americans have the metabolic syndrome (Beltran-Sanchez et. al , 2013). As an effective clinical strategy, the monitoring of these “upstream” metabolic red flags allows healthcare workers to develop preventative intervention strategies to reverse or retard future “downstream” cardiovascular health morbidities including heart disease, stroke, type II diabetes, and other cardiovascular maladies (Isomaa et al., 2001; Lakka et al. 2002).

[1] Note that Alberti et al. include separate waist circumference by race and sex. Those presented in the table are the prescribed cut off points for “ethnic south and central Americans” (the population used in the analysis) (Alberti et al. 2006).

Hispanic Acculturation

Increased academic attention to Hispanic migration has paralleled the large increases in the U.S. Hispanic population over the past several decades (Passel et al. 2011); though theories of immigrant assimilation based on invasion/succession patterns have existed in the since Chicago School academics first studied earlier waves of immigration to the U.S. (Park and Burgess 1925). While these human ecology models were used primarily to describe residential change and spatial assimilation processes, modern theories apropos of cultural and social changes from initial entry across the life course spent in the receiving county have added to our understanding of these dynamic immigration processes. Changes in linguistic usage, generational status, citizenship status, and time spent in the receiving nation have all been related to a range of differences within immigrant populations including (but not limited to) health status (Wiking, 2004; Goedecke et al. 2009). Specific analysis of these processes has been elucidated using a handful of theoretical frameworks.

Most similar to the early ecological theories are socio-cultural assimilation theories or acculturation theories. While decidedly more dynamic and bi-directional than the early functionalist models posed by Chicago School adherents, social acculturation theories are predicated on the view that members of immigrant groups gradually adopt the "cultural patterns" of the "core culture" in the receiving/host country including language use, SES, attitudes, and an array of hegemonic cultural norms associated with the host nation (Gordon 1964). Cabassa provides a good working definition of the process: "…acculturation [is] defined as those psychological and social changes that groups and individuals experience when they enter a new and different cultural context (2003)." A major criticism of this early "straight line-assimilation" is its inability to explain vacillating processes across "assimilating immigrants" and their influence on the majority group. Further, it fails to explain differences in the experiences of some immigrant groups compared to others in terms of status attainment and other social outcomes. To address these concerns, Herbert Gans instead proposes a "bumpy-line theory of ethnicity" where the immigrant group heads gradually towards socio-cultural assimilation to the majority culture across generations, but with tangents (Gans, 1992; Alba and Nee 1997). According to this theory, directionality of assimilation processes is conceptualized using three standard models: "the single continuum model", "the two culture matrix model", and the "multidimensional model" (Keefe and Padilla 1987). First, the single continuum model is characterized by fixed linear movement from the non-acculturated (with reference to the host society), to biculturated, to a defined "end point" of completely acculturated to the host society. In support, Bean and Stevens noted a robust positive association between a foreign born individual's time in the U.S. and their ability English proficiency, giving some credence to acculturative processes operating across the life course after entry to the host country in a general linear fashion (2003).

More importantly however (addressing prior theoretical limitations), the cultural matrix model allows for differential outcomes based on four potential pathways: *integration*, where immigrants become further tied to the host society while retaining aspects of their own unique culture, *assimilation* where immigrants become more entrenched in the host culture while shedding their former cultural identities, *marginalization*, when immigrants do not connect to the new culture while simultaneously loosing ties with their past culture, and *separation* where immigrants retain their own cultural norms while resisting those of the receiving country (Keefe and Padilla, 1987). Indeed, existing research has demonstrated that not only do "orthogonal" acculturation models exist, but more integrative "bicultural" strategies may indeed be the healthiest trajectory for Hispanics entering the U.S. (Oetting and Beauvais 1991) as "dual cultural and linguistic contexts" for Mexican Americans were associated with lower levels of stress (Romero and Roberts 2003) and are most effective when targeting obesity within the U.S. Mexican population (Agne et al. 2012).

If the cultural matrix model allows for heterogeneity of process, the multidimensional model accounts for heterogeneity in outcomes. Specifically, the multidimensional model suggests that each element of culture should be considered independently regarding the degree to which immigrants acculturate as some processes occur completely, some not at all, and some are decidedly mixed; they also can occur at different rates (Keefe and Padilla 1987). Theories focusing on acculturation patterns for immigrants across the life course typically focus on SES changes, residential patterning/mobility, intermarriage, and (relevant to the study at hand) language use (Keefe and Padilla 1987). A great deal of scholarship on acculturation has illustrated that stronger and more numerous ties to the host country culture results in positive consequences for immigrants, whereas greater links to the sending/"home" country is associated with maladjustment and negative outcomes in terms of SES attainment (Cheung-Blunden and Juang 2008). For Hispanics, increased levels of linguistic acculturation and older generational status have been associated with higher levels of income (Negy and Woods 1992), better educational outcomes (Hurtado-Ortiz and Gauvain 2007), and upward residential attainment (Alba et al. 1999). However, increased attention to different pathways and outcomes of acculturation have drawn more mixed results than more static acculturation frameworks have allowed for (Kimberlin 2009). The relative health benefit/impairment in particular has been much more anomalous with regards to acculturation processes for Hispanics in the U.S. Research has documented negative outcomes of the acculturation process for Hispanics residing in the United States, particularly those associated with health. Higher levels of acculturation for Hispanics have been linked to a wide range of "risky behaviors" including participation in unprotected sex (Marks et al. 1998), smoking (Unger et al. 2000), violence (Samaniego and Gonzales 1999), the development of eating disorders (Gowen et al. 1999), low birth weight (Scribner and Dwyer 1989) and drug use (Epstein et al. 2001).

These mixed results and unique theoretical models are similar to Zhou's "segmented assimilation theory", a dynamic acculturation theory that allows for a range of pathways, or "divergent destinies" for successive generations of immigrants (Portes and Zhou 1993). This theory, also rooted in SES changes, allows for three potential pathways for immigrants across generational attainment. In the first, immigrants follow a linear pathway across generations towards the American middle class (the classic view of acculturation), while in the second immigrants rapidly move towards persistent deprivation. The final pathway is characterized by rapid economic advancement, due in part to group solidarity and the maintenance of particular advantageous attributes (Portes and Zhou, 1993; Zhou 1997). Indeed, the most current models of Hispanic immigrant acculturation allow for a range of potential pathways reflecting the inherent heterogeneity of this social process.

While a tempest of proposed mechanisms, conceptual definitions, theoretical models, and measurement techniques rages within the acculturation framework, other theorists have posed much more simplistic processes in the investigation of Hispanic acculturation processes. Specifically, theoretical approaches accounting for selection biases note initial baseline differences between those who migrate and those who do not, especially when it comes to health. The "healthy migrant effect" accounts for potential selection biases inherent in the decision to immigrate to a country, noting that those who migrate are fundamentally different than those who do not (Kennedy et al. 2006). In this theoretical cannon, the differences due to selection account for the relatively healthy status for those who migrate, as people of poorer health are typically inhibited from migration both by their own limitations and health screening processes by the receiving nation (Kennedy et al. 2006). This "healthy migrant theory" or "salmon bias hypothesis" has received a great deal of empirical support as those who migrate from Hispanic sending nations are typically of better health than the aggregate average in the sending nation (Wingate and Alexander, 2006; Gordon-Larsen et al. 2003). Basing their theory deeply within the counterfactual logic, the investigation of the effects of acculturation on one's health profile is virtually impossible as those who immigrate are inherently dissimilar than those who do not, hence making the comparison incongruent. However, others have argued that while there certainly are selection effects for migration, the idea that selection effects completely account for observed differences across levels of acculturation may be overstated (Jasso et al. 2004).

The proposed "Hispanic Paradox" where Hispanics, which as a group have lower levels of socioeconomic status than whites, on average exhibit better health, morbidity, and mortality outcomes than the aggregate population further complicates these processes (Franzini et al. 2001). While some have posed the healthy migrant theory as one rationale for this apparent health advantage for Hispanics despite their otherwise disadvantaged status (Gordon-Larsen et al. 2003), others have argued that it completely accounts for this paradox (Crimmins et al. 2007). Contradictory findings have also been posed asserting that this paradox persists even when accounting for selection bias and individual wellness behaviors (Franzini et al. 2001). This view of acculturation could also be linked to certain variants of assimilation as posed in the "segmented assimilation theory", highlighting the non-linear nature and divergence in process/outcome of integration strategies for Hispanic immigrants in the U.S. Indeed the contradictory findings regarding the Hispanic Paradox, coupled with the aforementioned array of potential integration/assimilation strategies and outcomes make the pathways through which acculturative processes elicit particular outcomes for immigrants exceedingly thorny. Thus, the extant literature on acculturation, mirroring some of the inherent issues in the literature on the metabolic syndrome, is afflicted with a great deal of heterogeneity both in terms of causal mechanisms and theoretical approaches.

The Metabolic "Syndrome" within Acculturative Contexts for Hispanics in the United States

Though both Hispanic acculturation and population metabolic health have received due attention over recent decades, the marriage of these two fields has been beset by a range of issues. Apart from the aforementioned conceptual and operational issues inherent in both academic fields, approaches to studying these two social phenomena together have been inconsistent, prompting a range of substantive results. Nonetheless, some significant findings and conclusions have emerged from the nascent research in this field.

Prior scholarship has focused on the association between acculturation and both health outcomes (myocardial disease, diabetes etc.), and health markers (such as the metabolic syndrome and its constituent indicators). Overall, there is evidence for an increased prevalence of the metabolic syndrome in Hispanics when compared to whites across the entire U.S. adult population, as Mexican Americans had a prevalence rate of about 30% compared to 23% for whites in the U.S. (Ford et al. 2002). In terms of incidence rates within the Hispanic population, some studies regarding the relationship between acculturative processes for Hispanics and their metabolic health profiles have shown a "protective" effect of acculturation in Hispanics in lowering the odds of the metabolic syndrome (de Heer et al. 2011), while others have shown that there is no influence (Kollannoor-Samuel et al. 2011). However, most literature has demonstrated that higher levels of acculturation increase the risk of metabolic problems in general for Hispanic immigrants (Ford et al., 2002, de Heer et al. 2011).

Across a range of studies, the strongest and most commonly linked metabolic indicator to Hispanic acculturation is obesity. Studies have shown that that the time spent in the U.S., nativity status, and English language usage are all associated with increased obesity incidence for Hispanics living in the U.S. (Gordon-Larson et al. 2003). However, the association between Hispanic linguistic acculturation and type two diabetes is extremely mixed with evidence for a protective effect of linguistic acculturation in decreasing the odds of type two diabetes (Mainous et al. 2007), a negative effect whereby English language use is associated with increases in type two diabetes (Sundquist and Winkleby 1999) and divergent relationships (positive and negative) based on different Hispanic sending nations (Kieffer et al.1999). Hypertension too has been associated with immigrant acculturation in the U.S.; Steffen et al. used random effects modeling in a meta-analysis using 125 articles and found that on average, “more acculturated” immigrants had 3 mm Hg higher diastolic blood pressure readings and 4 mm Hg higher systolic blood pressure levels than “less acculturated” immigrants (with acculturation defined variably across the 125 studies) (2006). Like many health issues, cardiovascular problems seem to, in general, develop for immigrants as they gradually adopt the cultural traits of the receiving nation, incorporating both its socio-cultural norms, and health profiles (Bean and Stevens 2003). However, as discussed, different trajectories of for newly arriving immigrants could account for these nuances in outcomes as immigrants have a range of procedural and outcome options within the orthogonal cultural matrix (Romero and Roberts 2003).

Though acculturation theories are informative for understanding immigrant health profiles across the life-course, as with other patterns change over time for Hispanic immigrants, both the descriptive “Hispanic paradox”, and the explanatory “Healthy Migrant Theory” are germane to this sort of analysis (Gordon-Larsen et al. 2003). While the former argues that despite lower overall socioeconomic status, recently emigrated Hispanic immigrants experience a morbidity and mortality advantage more congruent with those of higher socioeconomic standing and less marginalized groups in the U.S. (Markides and

Eschbach, 2005; Wang et al. 2011), the latter is based on the notion that those who emigrate have superior health profiles (those who are in poorer health are less able to cross transnational boundaries), confounding changes due to acculturation with selection biases (Abrafdo-Lanza et al.1999). From this perspective, Hispanic immigrants may enter the U.S. with better cardiovascular profiles. Nonetheless, selection problems cannot completely account for processes which manifest once immigrants arrive in the U.S.; acculturation models are more practical for framing how the metabolic health profiles of Hispanic immigrants change over acculturative processes once already in the United States. Thus, limiting my analysis to only those Hispanics living in the U.S. helps address this problem, though it cannot completely account for the potential for a selection bias effect to taint results. Nonetheless, combining these three theoretical perspectives is the most effective way to investigate health outcomes for Hispanic immigrants across varying levels of acculturation.

Though scholarship on immigration and health status has grown exponentially with the increasing relevancy of the subject matter, significant gaps in the literature exist in the relationship between acculturative process for Hispanic immigrants in the United States and biomarkers indicating cardiovascular dysregulation. Most studies have focused on only one or two indicators of acculturation, ignoring how these indicators are differentially linked to cardiovascular morbidities as they represent different processes or contexts through which personal acculturation decisions are made and the self is negotiated. Further, most studies have relied on non-representative samples or imprecise measurements of acculturation processes. Inconsistent results from research using self-report health metrics could stem from reporting differences; studies using self-report measures for health have been shown to be mediated by levels of acculturation where higher levels of acculturation are associated with better self-reported health (Wiking 2004). Research in the field has also relied on binary measures of the metabolic syndrome with "cut off" thresholds for presence of the syndrome vs. non-presence, typically where two or more (with a potential "precursor"), or three or more problematic indicators is indicative of the metabolic syndrome. I am not aware of any nationally representative studies that look at the relationship between acculturation processes and cardiovascular health using a complete "constellation" of six cardiovascular biomarkers as a count indicator as opposed to a binary outcome. Scholarship has also pointed to sex differentials in indicators of cardiovascular disease risk, with men typically being more disposed to higher metabolic risk (Goedecke et al. 2009). Regarding this relationship with acculturation, I am not aware of any nationally representative studies which account for sex differences in the Hispanic population when looking at the metabolic syndrome.

To these ends I pose an investigation of how acculturative processes for Hispanics living in the U.S. relate to the sum of the principal biological indicators of cardiovascular disease risk. In this analysis, the metabolic syndrome is not applied as a binary measure (indeed at this point I put to rest the notion of a "syndrome" per say, opting instead for a "cardiovascular/metabolic risk index" as an additive measure) but as a count measure.[2] Therefore I am able to investigate levels of risk and the influence of particular indicators individually. For Hispanic acculturation, I include four unique acculturation measures to analyze heterogeneity within the U.S. Hispanic population in terms of the amount of acculturation and cardiovascular disease risk. Further, I will relate these acculturation measures to the entire count of metabolic indicators, and each indicator independently. Finally, I will test for variation between men and women within the relationship. I test the following hypotheses:

H_1: *Adult Hispanics in the U.S., on average, have a higher count of metabolic indicators for cardiovascular disease than the U.S. average*

H_2: *Higher levels of acculturation for adult Hispanics living in the U.S. are associated with higher counts of metabolic indicators.*

Part a: *Higher levels of reported English usage and lower levels of Spanish language usage are associated with higher counts of metabolic indicators.*

Part b: *Hispanic Citizens (vs non-Citizens) have higher counts of metabolic indicators.*

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[2] Logistic regression models were run using the standard binary indicator of the metabolic syndrome with both two or more indicators signaling the presence of the syndrome (coded as a 1), and with three or more indicators defining the metabolic syndrome. Results using the three or more conception were somewhat similar to the subsequent findings using the count outcome variable, while results using the two or more conception revealed no findings. As an important tenet of this research, I use the count measure as a more nuanced measure to indicate metabolic heterogeneity when investigating the Hispanic heterogeneity as such. The results for the binary regression for both the two and three indicator thresholds are shown in appendix 1.

Part c*: Generational status is associated with higher counts of metabolic indicators. First generation Hispanics living in the U.S. will have lower counts than second generation Hispanics, second generation Hispanics will have lower counts than third generation (or longer) Hispanics*

Part d: *Increased time in the U.S. is associated with higher counts of metabolic indicators.*

H_3: *Each of the metabolic indicators will contribute differently to the overall relationship between the number of metabolic indicators present and Hispanic acculturation processes*. *Likewise, the acculturation markers will show variation in their relationships to both the overall count of the metabolic biomarkers, and the individual indicators themselves.*

H_4: *Gender variation exists in these associations.*

III. Data and Methods

1. Analytic Sample

For this analysis I use the National Health and Nutrition Examination Survey (NHANES), a complex nationally representative multi-stage continuous survey administered by the National Center for Health Statistics (NCHS), part of the Center for Disease Control and Prevention (CDC). Specifically, I pooled three waves (1999-2000, 2001-2002, and 2003-2004) of the National Health and Nutrition Examination Survey; NHANES was conducted in three waves prior to 1999, at which point it was administered bi-yearly (for example 1999-2000, 2001-2002 etc.). As a nationally representative multi-stage continuous survey of approximately 5,000 persons, the survey strategy is decidedly complex. Essentially the survey design divides the United States into primary sampling units (PSU's) which are then randomly selected. Next, these selected PSU's are divided into distinct strata and separated into a sequence of neighborhoods which are again randomly selected. Once the strata are selected, households within the chosen strata are then randomly selected from these neighborhoods and the eligibility of the occupants is determined via an interview sequence. In this manner participants are selected. Further, African-Americans, Hispanics, and people over the age of 60 and between the ages of 12-19 are oversampled to enhance reliability. This is generally accomplished by increasing the chance of selection for strata with higher levels of these demographic groups using selection weights. Theoretically, each individual sampled in the NHANES survey represents roughly 50,000 persons living in the United States. The survey instrument is divided into three distinct components: an electronically administered interview (one focusing on health, another on demographics, and additional one on diet) which is conducted in the individual's home, a physical examination, and a specimen collection for laboratory analysis. The lab and examination components are conducted in "mobile examination centers" (MEC) which are essentially RV trailers containing all necessary diagnostic equipment that can travel to each of the neighborhoods sampled.[3] This socio-epidemiological survey identifies important health movements in the U.S., socio-demographic health trends, and specific disease risk factors. The NHANES survey is aimed at disease prevention, sound health policy and programs, and the cultivation of improved health knowledge of the citizenry (Center for Disease Control, 2014a). Response rates for NHANES have remained rather high across all waves. In my analysis I use 1999-2000, 2001-2002, and 2003-2004 data which have response rates of 82% (interview) and 76% (examination/lab), 84% (interview) and 80% (examination/lab), and 79% (interview) and 77% (examination/lab) respectively (Center for Disease Control 2014a).

Because I use three waves of the continuous NHANES spanning six years (1999-2004), and I am using four specific modules, the construction of my data set for the individual level measures demands multiple sequential data management steps. I first appended all three waves of each of the four modules based on the unique respondent identification number (coded "SEQN" in the NHANES data set): demographics, examination, laboratory, and questionnaire, keeping only the necessary variables (as described anon). This effectively transfers twelve files into four. Subsequently, I then merged the four modules (with six years of data) into one file again based on both the respondent identification number and the survey year (coded "sddsvyyr"), as respondent codes are year specific. Finally, I pooled all three

[3] For a complex discussion of the survey methodology please see CDC Survey description: http://www.cdc.gov/nchs/nhanes/about_nhanes.htm

sample years of the NHANES data (1999-2000, 2001-2002, and 2003-2004) to complete the sample dataset.

Because of the aforementioned complex design, NHANES has created a weighting scheme to adjust for oversampling and non-response bias (which was most prevalent in the laboratory and examination portion of the instrument) and make the data representative of the U.S. population. Weights were created for each sampled individual and are to be combined depending on the module being used (specific weights are created for both the examination and the interview portion of the survey). For my analysis in particular, because I am using both the interview and examination modules, I used the mobile examination center weights (using the "svy:" command in STATA 13) as prescribed in the NHANES methodology handbook (Center for Disease Control 2014b). Furthermore, because I am using six years of data and the weighting scheme is different for the 1999-2000 wave, each individual was be given a six-year MEC weight with the following formula (Center for Disease Control 2014b):

```
if sddsrvyr=1 or  sddsrvyr=2 then
   MEC6YR  = 2/3*  WTMEC4YR ; /* for 1999-2002 */

if sddsrvyr=3  then
   MEC6YR = 1/3 * WTMEC2YR ; /* for 2003-2004 */
```

*Source: (Center for Disease Control 2014)

For my analysis, I begin by comparing the aggregate counts of metabolic indicators for U.S. Hispanics and the entire U.S. population to compare Hispanics' relative metabolic risk index to the U.S. average. Because my primary ends are not *inter*-population comparisons, but rather *intra*-population heterogeneity, I limit the remainder of my analysis to only Hispanics living in the U.S. The sample is then specified as those who report their ethnicity on the demographic questionnaire as either "Mexican American" or "Other Hispanic". Regardless of race designation, only respondents who reported their ethnicity as "Hispanic" were included in the sample population to avoid any contamination of the specifically Hispanic sample. Further, because only participants ages twenty and above are included in the laboratory and examination portion of the NHANES instrument, this analysis is limited to *adult* U.S. Hispanics ages twenty and above. My analytic sample includes all adult Hispanics living in the U.S. who completed all four modules and have available (non-missing) data on all variables described anon. After adjustments using probability weights, I arrive at an analytic sample of 1,938 Hispanics residing in the United States; this subset comprises the sample population for this analysis.

2. Measures

2a. Dependent Variable

To investigate these hypotheses, I use both a count measure of the six individual indicators used to classify the metabolic syndrome and the indicators independently as rationalized in the descriptive and measurement section anon. Though the cut off levels for having a problematic indicator on the metabolic health index vary slightly across the four operational definitions, a consensus was reached using the most "conservative" definitions for each indicator. For reasons previously discussed, I rely most heavily on the IDF cut offs, though an extensive review of the literature afforded me the opportunity to investigate results using the different criteria and cut-off levels to make an informed metric of six unique indicators, and their cut off levels marking them as unfavorable. The following six indicators describe an *overall* representation of one's overall metabolic health: **increased central adiposity**, measured by *waist circumference* where circumference over 88 cm. for women and over 102 cm. for males indicates the "obesity threshold" (Méthot 2010; Sierra-Johnson et al., 2006; NCEP ATP III definition), **hyperglycemia**, measured by *glycosylated hemoglobin* where 5.7% concentration marks the "high blood sugar threshold" (Osei et al., 2003; NCEP ATP III definition; IDF definition), **hypertension**, measured with both *systolic pressure* and *diastolic pressure* levels with thresholds above 130 mm HG and 85 mm Hg respectively to denote high levels (Ford et al., 2002; Sierra-Johnson et al., 2006; IDF definition), **high density lipoprotein (HDL) cholesterol**, measured by *depressed levels of HDL* with a threshold of less than 40 mg/dL for men and 50 mg/dL for women (Ford et al., 2002; Sierra-Johnson et al., 2006; NCEP ATP III definition; IDF definition), and **total plasma cholesterol**, measured by *high levels of* *triglycerides* using a threshold of 150 mg/dL (Ford et al., 2002; Sierra-Johnson et al., 2006; WHO definition; IDF definition). Thus, the "constellation" of these six indicators classifies the (additive) metabolic risk index and shall indicate the relative level of metabolic health across individuals within the sample population.[4]

2b. Independent Variables of Interest

I measure acculturation through four indicators: linguistic usage, citizenship status, generational status/designation, and length of time spent in the U.S. To assess Linguistic Acculturation, I created a five-item scale based on individuals' reported language(s) read and spoken, languages(s) used as a child, language(s) usually spoken at home, language(s) usually used to think, and language(s) usually used with friends. Each component is scored "0" for Spanish only, "1" for more Spanish than English, "2" for both equally, "3" for more English than Spanish, and "4" for English only. The composite scale gives scores ranging from "0" (only speaking Spanish), to "20" (only speaking English).[5] To justify the use of a single measure drawn from five individual items, I performed a principle component analysis on the linguistic acculturation scale and eigenvalues loaded on one component, justifying the composite measure of linguistic usage. As shown in Table 1, component one has an eigenvalue of 4.15 while component two drops drastically to 0.38 as a single component accounts for 83% of the variance in the five scores. Hence, a unidemensional scale assessing linguistic acculturation for Hispanic immigrants is both warranted and preferred as a tool to investigate different contextual uses of English relative to Spanish for Hispanics in the U.S.

[4] Note that I looked at different thresholds to define each of the indicators and found very little variation in results when using different prescribed levels. I find these levels to be on the conservative end for defining whether the metabolic indicators were problematic or not. Further, I combined blood pressure into a single metric of high and low blood pressure (instead of including systolic and diastolic separately). Again, overall relationships were not changed though the fit of the Poisson distribution was significantly worse with the five count outcome as opposed to a six count outcome. For a detailed description of the analyses using different indicator, see the subsequent section on descriptive statistics/measurement

[5] I also tested inter-item reliability for the linguistic acculturation scale through the computation of Cronbach's alpha. Four of the five items in the linguistic acculturation scale show excellent internal consistency (language(s) read/spoken, used at home, used to think and used with friends), while the other (language used as a child)shows very good internal consistency. Because the coefficients are all well over the anticipated .75 point, I can be certain that my linguistic acculturation scale shows a high degree of inter-item reliability. Results for the analysis using Cronbach's alpha is shown in appendix 2.

Table 1. Principal Component Analysis for the Five Item Linguistic Acculturation Scale

Component	Eigenvalue	Difference	Proportion
Component 1	4.15	3.77	0.83
Component 2	0.38	0.18	0.08
Component 3	0.20	0.03	0.04
Component 4	0.17	0.04	0.03
Component 5	0.13		0.02

I also assess the role of naturalizing to the U.S. by comparing Hispanic (officially documented) citizens and non-citizens. Citizenship status is included as a dummy variable with "1" indicating official citizenship and "0" indicating otherwise. I also investigate generational differences (a categorical measure as well) using three dummy variables indicating if a person is a first generation U.S. American (both the individual and at least one parent was born outside of the U.S.), a second generation U.S. American (the individual was born in the U.S. but at least one parent was born out of the U.S.), or native born (the individual and both parents were born in the U.S., hence in the third generation or greater). Analytical results are reported using "native born" as the reference category, thereby comparing more recent Hispanic arrivals to those who have been in the U.S. for longer. Because NHANES only includes length of time in the U.S. as an ordered measure of intervals ("less than one year", "more than one year, but less than ten" etc.). I use dummy variables for the length of time in the U.S. indicating "less than 10 years in the U.S.", "more than 10 but less than 20 years in the U.S.", and "20 or more years in the U.S."; the latter is included as the reference category to compare more recent arrivals to those who have been in the U.S. for a longer period of time, mirroring the comparisons for nativity status.[6] Because of high multicollinearity between the temporal acculturation metrics, the years spent in the in the U.S. and nativity status, I include separate analyses for these two measures. Specifically, I use linguistics, citizenship and nativity in the first set of models, and linguistics, time, time spent in the U.S., and citizenship status in the second set of models. Models were run using the same sample population of and quantitative techniques to allow for uniformity of analysis.

[6] As in the determination of the metabolic indicator thresholds, I conducted sensitivity tests for different conceptions of length of time spent in the U.S. Again, results differed very little as length of time in the U.S. was non-significant when accounting for other acculturation metrics for different thresholds for length of stay in the U.S. Further, published research has used the conception of length of time as presented in the analyses (Kaplan et al. 2004).

2c. Control Variables

To control for factors known to shape cardiovascular health, I included a range of covariates which have been shown to be related to cardiovascular health. Age, education level, income (both relative and absolute), physical activity levels, smoking status, and drinking behaviors have all been identified as important predictors of cardiovascular morbidities (Saaddine, 2002; Seeman et al., 2008; Lakka et al. 2002). Drinking alcohol is coded as a dummy variable with "1" indicating consumption of twelve or more alcoholic beverages drinks a month and "0" for consuming less monthly; thus I can compare non-drinkers to those who more frequently consume alcoholic beverages. I also include a dummy variable for smoking status coded as "1" indicating that the person reports current smoking or "0" if they do not smoke, thus comparing abstainers and those who have stopped smoking to current smokers.[7] Physical activity is scored based on self-reported "Metabolic Activity Scores", measured as a composite index of each reported leisure time physical activity weighted by frequency and its analogous cardiovascular intensity; higher scores indicate increased physical activity.[8] I controlled for socioeconomic status using the family income to poverty ratio, a continuous measure of the ratio of family income to the poverty threshold (where higher scores indicate higher relative incomes). For an additional socioeconomic status measure, I included a dummy variable for having a high school education with "1" indicating a high school degree or higher and "0" indicating that the respondent did not complete high school of a GED.[9] To control for those who are currently being treated for diabetes, I added a dummy variable indicating whether one takes blood sugar lowering pills as "1" or does not take diabetes medication "0" to control for those diagnosed with hyperglycemia and currently undertaking treatment. Because chronic illnesses tend to accumulate with age (in line with both to the life course literature and basic biological ageing) I also control for age using three dummy variables indicating "younger adult"

[7] Different conceptions of being a "drinker" or a "smoker" were tested including yearly and past consumption practices and results for the relationship between acculturation measures and cardiovascular health did not vary.

[8] For instance, moderate levels of running were scored with a 7 while vigorous levels were scored 10. Likewise, moderate levels of walking were scored at 3.5 while vigorous levels of walking were scored with a 5. The total number of activities, scored by frequency and cardiovascular intensity was summed to give a composite score of physical activity for each respondent.

[9] I ran models using a dummy variable indicating a college degree with less than a college degree as the reference category, as well as models with a categorical set of dummy variables for less than a high school degree, a high school degree, and a bachelor's degree or higher. The inclusion/exclusion of these variables did not change the overall relationships in the models between the acculturation covariates of interest, and their relationship with the metabolic indicators.

(20-44), "middle aged adult" (45-64), and "older adult" (65 and older) with younger adult as the reference category.[10] Based on literature noting fluctuations in biological indicators during pregnancy and in the postpartum stage for women, I removed pregnant women from the analysis to avoid biased results due to temporary fluctuations in metabolic indicator levels for gestating women and I control for the number children a woman has given birth to.[11] Finally, I include a dummy variable for sex with males as the reference category both as a control, and a potential moderator for the modeled relationship between acculturation measures and the additive count of metabolic indicators.

2d. Interaction Effects

Interaction effects were included separately in subsequent models to investigate the possibility of variation in these relationships between male and female U.S. Hispanics. I include interaction terms between sex and all four of the indicators of acculturation along with the dummy variable for gender. As mentioned before, nativity and length of time in the U.S. were inspected in different models due to multicollinearity issues therein. Hence I created and included interaction terms between linguistic acculturation and sex, nativity/generational status and sex, and citizenship status and sex, and length of time in the U.S. and sex.

3. Analytic Strategy

To investigate the relationship between these four demographic markers of acculturation and the count of biomarkers at adverse levels indicating cardiovascular disease risk, I began by looking at the relationship using a simple OLS regression model with the number of indicators of metabolic dysregulation as the outcome. However, because of the discrete count nature of the outcome variable,

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[10] Age was initially included as a continuous (top coded at 85 per the dataset) centered variable for individual age and a quadratic variable for age to account for well reported non-linear age relationships with regard to health status. Because of its inclusion as a control variable to account for obvious difference in the cardiovascular health profiles by age it is not the focus of this analysis. None of the relationships changed with the different conceptualizations of age. In line with other literature, I find it more practical to control for age categories rather than continuous change across individual years. Analyses of all models using age and age^2 are shown in the sensitivity analysis section of this paper

[11] I initially included the number of children a woman has given control variable and it had no impact on the results and was subsequently removed in the second round of analysis looking at each indicator separately. The first wave of analysis with this measure included did not vary at all when running regressions without this control.

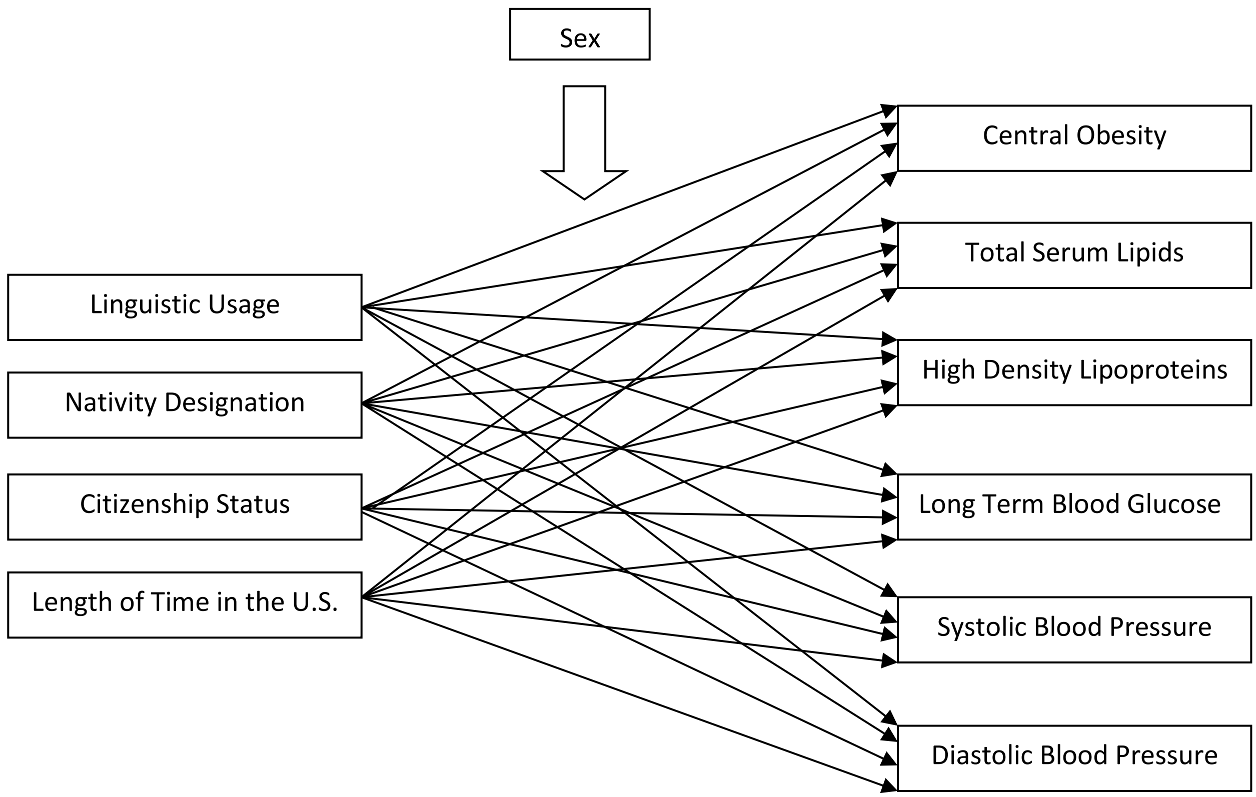
and the non-normal distribution of the number of counts, I then fitted a Poisson regression model to indicate the additive count of the six item cardiovascular risk index. Descriptive analysis, described in the following section, showed that for the sample population of U.S. Hispanics, the mean count on the metabolic risk index was 1.73 and the variance was 1.89. As a major assumption of the Poisson distribution, the variance must be equal to the mean. In this case the similitude was conspicuous. I also tested another major assumption of the Poisson regression, that there is not over-dispersion in the distribution of the outcome variable, using the vuong test (generating a Z-statistic) as a diagnostic to compare a Poisson model and a zero-inflated Poisson model. Again, I found no evidence of over dispersion ($p<.01$), indicating that this assumption was also not violated by the distribution of the dependent variable. Finally, I tested for dependency among the metabolic indicators using simple correlations. Surprisingly, there was less correlation between the metabolic indicators than one might initially speculate as only two of the indicators were correlated at 0.44, with 0.28 the second highest correlation coefficient, validating the inherent utility of a "constellation" count index;[12] correlation results are shown in appendix 3. I also ran regressions using other techniques to model count outcome variables including the ordered logit model, the negative binomial model, and zero inflated models (both Poisson and negative binomial, thus allowing for differences in the counts of zeros via two independent processes) and found tremendous durability in the estimates across all modeling techniques (results available per request). Having justified the use of the Poisson regression model to analyze individual counts of indicators for metabolic morbidity, I carried out the following analytical plan.

I start by justifying the superiority of a count indictor to a binary measure for metabolic health using descriptive statistics. I then explore aggregate difference in the metabolic risk index between Hispanics in the U.S. and the U.S. population average to assess the relative burden of metabolic dysregulation on the U.S. Hispanic population. Next, moving to the heart of the analysis, I run regression models (OLS then Poisson) with the count of metabolic indicators as the dependent variable and English

[12] The correlation coefficients range from a low of -0.016 for having high central obesity and low levels of plasma HDL, to a high of 0.44 between having high systolic blood pressure and having high diastolic blood pressure.

language usage, citizenship status, and generational designation as my key predictors. I then test for a moderating relationship for sex by adding interaction terms between sex and each of these three measures individually across models, arriving at a final model including all interaction terms. Following the analysis of the count measure of the metabolic syndrome, I disaggregate the index and run individual logistic regression models for each of the six indicators with “1” indicating the presence of the risk indicator, and “0” indicating that one does not have adverse levels of the particular indicator. I then follow these analyses with the same procedure and same variables, except I substitute nativity for length of time in the U.S. as the “temporal” acculturation metric. To make results more transparent, I calculate predicted counts of metabolic risk indicators across different levels of the acculturation measures both in total, and for men and women separately to help clarify interaction effects and elucidate variation by sex. The focal model being tested is illustrated conceptually in figure 3 and highlights the focus on how a range of specific individual markers of acculturation are related to metabolic health profiles for Hispanics in the U.S., both in terms of an overall summative count of these indicators and to each individual indicator independently, and how sex may potentially moderate these relationships.

Figure 3. General Model of Analysis of the Relationship between Demographic Acculturation Indicators and Metabolic Health Biomarkers for Hispanics in the U.S.



Lastly, I analyze stratified samples of the sample population to both assess internal heterogeneity of the sample itself, and to determine if observed patterns in the entire sample of U.S. Hispanics (non-pregnant and ages 20 and above) are governed by particular segments. I begin by looking at age differences. While, no doubt, younger members of the population should (at least in theory) have lower counts of metabolic problems than older segments, the relationship between aging and health may be more complex. Research has shown that the effect of aging on cardiovascular health is non-linear for both sexes, but especially for females (Ryan et al. 2004) as metabolic problems have been shown to accelerate with and after the onset of menopause (Carr 2003). Moreover, considerable heterogeneity in terms of cardiovascular health exits within age groups and at different levels, indeed there is more variance in the distribution of metabolic health across older populations than younger ones (Ryan et al. 1994). Hence, I will run two age sensitivity models with gender (and its interaction effects on the acculturation metrics) included in the model as a potential moderator variable in both. I begin by including age as a quadratic term "(including age and age^2) to model non-linear relationships between age and metabolic health and compare to the main results. Second, I will complete an analysis with those aged 65+ (the old age category) were removed to investigate the effect that the older population has on the entire adult population of U.S. Hispanics, and to compare health trends between young and middle aged adults. My final sensitivity test will compare the sample of Hispanics that indicated "Mexican" heritage to those whose heritage were from other sending nations.[13] Thus, I can investigate whether the overall relationships for U.S. Hispanics are driven specifically by Mexican Americans. All analytic models were run using STATA 13.

IV. Descriptive Statistics and Measurement

Using data from the pooled NHANES sample from 1999-2004 on each of the six biological indicators for the sample (as acknowledged in the IDF definition) as well as the joint measure for blood pressure (combining systolic and diastolic blood pressure into one metric as is the case in the WHO, EGIT, and NCEP ATP III) I computed the number and proportion of U.S. Hispanics in the sample population who have adverse laboratory readings for each individual indicator in the entire metabolic "constellation." Shown in table 2 are the proportion and specific number of individuals in the sample (n = 1,938) which exceed the medically defined "healthy level" for each particular cardiovascular biomarker, whereby their lab and examination reports signal that they are "unhealthy" on a certain indicator, increasing the risk of metabolic disease (note that the "cut-off" values for the individual indicators are based on the those justified in the measures section of this paper).

[13] The only sample of sending-nation specific Hispanics large enough to analyze on its own was of Mexican heritage. Thus, the data limits my ability to look at country specific differences in the relationship between acculturation processes and metabolic health.

Table 2. Prevalence of The Six metabolic Indicators across the Sample Population of U.S. Hispanics

Indicator	Number (n=1,938)	Percentage
High Triglycerides	481	24.8%
Central Obesity	529	27.3%
Elevated Blood Sugar	360	18.6%
High Diastolic B.P.	134	7.0%
High Systolic B.P.	413	21.3%
Low High Density Lipoproteins	500	25.8%
High Blood Pressure	70	3.6%

* Note that the cut-offs for clinical diagnosis for each individual indicator are described in the measures section of the paper.

While there are substantial proportions of the sampled Hispanic population with each of the six metabolic risk factors, there is considerable variability among the indicators in terms of their presence across the population. In other words, some indicators are more present than others; thus for this particular population, there are some risk factors that more strongly influence the overall cardiovascular health profile of an individual than others. At the most extreme, while 27.3% (529 persons) of the Hispanics in the sample exhibit high levels of central obesity, a mere 7.0% (136 individuals) of the sample is classified as having elevated diastolic blood pressure (even less have both high systolic and diastolic blood pressure as the proportion is only 3.6%). This is not surprising since the IDF has identified central obesity as the chief mechanism through which the metabolic syndrome operates (Alberti et al. 2006). Indeed high central obesity, elevated total triglycerides, and low levels of high density lipoproteins are much more prevalent in the sample population, while elevated blood glucose and high systolic blood pressure are moderately prevalent. Adverse levels of diastolic blood pressure (and hence adverse levels of high blood pressure in general) are much rarer in this population. This can indicate one of two possible scenarios; the three indicators which affect more of the total population are stronger players in determining the metabolic syndrome, or rather that the three indicators which are less common in the population are more influential in that they are coupled with those indicators which are more prevalent, thereby instigating a "snowballing" of metabolic risk indicators. Indubitably, these "pieces" of the metabolic syndrome are not congruent, as some are more prevalent across the sample population than others. Thus, while the metabolic indicators are summed to produce a composite score of one's metabolic health whereby a score of three/two and above represents the "metabolic syndrome" and a score of two/one or less indicates the absence of the syndrome, the differential prevalence of the indicators suggests that they do not carry equal weight in the overall picture of a person's metabolic health, casting the first shadow of a doubt on the use of a binary measure of metabolic wellbeing.

The metabolic syndrome, as previously discussed, can be conceptualized as a measuring stick for overall cardiovascular health. While some work has looked at individual indicators of metabolic health independently, most research has applied a "cut-off" level to the metabolic syndrome, thus diagnosing individuals as either metabolically "healthy" or "unhealthy." However, considerable variation exits in which individuals are defined as metabolically "unhealthy" and "healthy" as discussed extensively in previous sections. The fundamental variation in the conceptualizations of the metabolic syndrome, as usually applied in prior literature, is governed by two requisite alternatives whereby the metabolic syndrome can be defined in four different ways. The distinction in the application of the "syndrome" is illustrated in the four by four matrix shown in figure 4, where the two main decisions for diagnosis are shown in the vertical and horizontal axes, the first interior cells represent the two options derived from this decision (denoted by 1 vs. 2, and A vs. B), and the most internal four cells represent the four subsequent clinical definitions of the metabolic syndrome (denoted by 1A, 1B, 2A, and 2B). The following discussion makes use of these four widely used definitions and the issues therein. In this section I attempt to illustrate the superiority of a metabolic risk index to the standard binary metabolic syndrome based on descriptive data for the metabolic indicators across the sample population. Therefore I will proceed to justify the superiority of a count indicator to a cut-off "syndrome" per say in the analysis of the metabolic health of the U.S. Hispanic population.

Figure 4. Visual Depiction of the four most widely used Definitions to Clinically Diagnose the Metabolic Syndrome and the Decision Process used to Derive them

	Decision 2: To measure blood pressure as a combined metric, or separately for systolic and diastolic blood pressure		
Decision 1: Define the syndrome as being comprised of ***two*** or more adverse indicators*, or ***three*** or more adverse indicators		A: 5-indicator conception (adverse indicator for blood pressure is based on the total blood pressure reading)	B: 6- indicator conception (two adverse indicators for blood pressure, based on the both systolic and diastolic blood pressure reading)
	1: Metabolic Syndrome equal or more than 2 adverse indicators	1A: Metabolic Syndrome diagnosed by two or more of the following indicators at adverse levels (blood pressure, blood sugar, total cholesterol, HDL cholesterol, waist circumference)	1B: Metabolic Syndrome diagnosed by two or more of the following indicators at adverse levels (diastolic blood pressure, systolic blood pressure, blood sugar, total cholesterol, HDL cholesterol, waist circumference)
	2: Metabolic Syndrome equal or more than 3 adverse indicators	2A: Metabolic Syndrome diagnosed by three or more of the following indicators at adverse levels (blood pressure, blood sugar, total cholesterol, HDL cholesterol, waist circumference)	2B: Metabolic Syndrome diagnosed by three or more of the following indicators at adverse levels (diastolic blood pressure, systolic blood pressure, blood sugar, total cholesterol, HDL cholesterol, waist circumference)

*Note that the organizations which rely on a definition of the metabolic syndrome where two or more adverse indicators designates the metabolic syndrome include the prerequisite that the individual must have glucose intolerance/resistance as well as two or more of these symptoms (specifically the EGIR and the WHO).

Therefore, Not only are the indicators of the metabolic syndrome unequal in their prevalence across the sample population of U.S. Hispanic adults, the diagnosis of the metabolic "syndrome" is inconsistent when applying different definitions used by a range of studies and investigative agencies. I obtain strikingly different results when classifying the metabolic syndrome as having *two* or more of the indicators at elevated levels (in addition to glucose intolerance) vs. having *three* or more of the indicators present[14], and measuring five or six individual indicators in the metric. Shown in table 3 are the proportions of the sample population in terms of the presence/absence of the metabolic syndrome under differing definitional conceptualizations of the metabolic syndrome (five vs. six indicators), and different cut-off levels (two or more vs. three of more problematic indicators).

[14] Note that while there was no way to identify individuals as insulin resistant in the sample of U.S Hispanics from the 1999-2004 pooled NHANES data, I controlled for the diagnosis of diabetes using a control variable for whether an individual takes blood sugar medication. Further, despite this prerequisite, agencies using the two or more indicator conception of the metabolic syndrome (the WHO and EGIR) still measure the entire range of indictors for clinical diagnosis.

Table 3. Presence vs. Absence of the metabolic Syndrome under Different Definitional Conceptions

Definition	Five Indicator Definition of the Metabolic Syndrome		Six Indicator Definition of the Metabolic Syndrome	
	Number	Percentage	Number	Percentage
Three or More Indicators Elevated				
Metabolic Syndrome	353	18.2%	492	25.4%
Healthy Metabolic Profile	1,585	81.8%	1,446	74.6%
Two or More Indicators Elevated				
Metabolic Syndrome	793	40.9%	924	47.7%
Healthy Metabolic Profile	1,145	59.1%	1,014	52.3%
Three Category Conception of the Metabolic Syndrome				
0 indicators Elevated	538	27.8.%	475	24.5%
1-2 indicators Elevated	1,047	54.0%	971	50.1%
3+ indicators Elevated	353	18.2%	492	25.4%
Mean Total Score	1.52		1.73	

The differences in the sample population which are characterized as having the metabolic syndrome differ drastically across the competing definitions of the syndrome. Recall figure 4, where approaches differed based on how many indicators were being used, and how many needed to be adverse to diagnose a person with the metabolic syndrome. First, differences arise when comparing the difference in using two or three as a threshold for the classification of the metabolic syndrome (compare the WHO and EGIT definitions to the NCEP ATP III definition). For this sample of adults who indicate their own ethnicity as Hispanic, those who are characterized as being afflicted with the metabolic syndrome differs by 22.7% (18.2% vs. 40.9%) for the five indicator conception of the metabolic syndrome, and 22.3% (25.4% vs. 47.7%) for the six indicator definition of the metabolic syndrome when using either a three or two indicator threshold respectively (in essence comparing 1A to 2A, and 1B to 2B inform figure 4). This difference is startling considering that the metabolic syndrome is typically operationalized as a binary, absence vs. presence measure in most prior sociological and epidemiological literature (Isomaa et al., 2001; Ford et al., 2002; Cook et al., 2003; Alberti et al. 2009). However, the relative spread between the two and three indicator thresholds is relatively consistent when using the five or six indicator index (22.7% and 22.3% respectively). This, as with other descriptive information on the sample population, casts further doubt on the effectiveness of the binary operationalization of the metabolic syndrome; again, this seems to justify the use of the metabolic indicators as an index measure as opposed to a binary threshold indicator.

Matters are additionally complicated when considering that some prior literature has focused on five indicators of the metabolic syndrome, while other studies have utilized six measures. The difference, as shown in figure 4 is stems from the use of elevated blood pressure in total, where one is classified as having high blood pressure when they are elevated in both diastolic and systolic blood pressure and the use of elevated systolic blood pressure (as in the five indicator index), and diastolic blood pressure as two distinct indictors (as in the six indicator index). Moving the focus from the comparison between the first decision illustrated in figure 4 to the second also yields rather inconsistent results. Shown in table 3 are the differences between the 5-indicator version and the 6-indcator version of the metabolic syndrome across three different definitions of the metabolic syndrome (focusing on the second the decisions outlined in figure 4).

As was the case when comparing differences between defining the metabolic syndrome as having two or more indicators elevated to defining it as having three or more indictors elevated for the five and six indicator conception of the metabolic syndrome, the differences are rather compelling. Comparing the 1A and 1B definitions from figure 4 (using the two indicator threshold), 40.9% of the sample is characterized as having the metabolic syndrome for the five item conception, and swells to 47.7% when using the six item conception. Similarly comparing the 2A and 2B definitions from figure 4 (this time using the three indicator threshold), 18.2% of the sample is characterized as having the metabolic syndrome for the five item conception compared to 25.4% when using the six item conception. Just as in the comparison between outcomes for decision 1 in the figure 4, the proportion of the sample defined as metabolically unhealthy is quite different when comparing the two outcomes across decision two in the same figure. However, and also similar to decision one, the relative spread between the five and six indicator conception is relatively consistent when using the five or six indicator index (6.8% and 7.2% respectively).

Differential conclusions abound in table 4 when considering the proportion of the population which is defined as in good metabolic health. While 81.8% of the sample population is classified as "metabolically healthy" when using definition 2A in figure 4, only 59.1% of the sample population is still considered in good metabolic health when the threshold for the metabolic syndrome is lowered to having two or more elevated indicators (as in 1A in the figure 4). Similarly, when comparing the 2B definition to the 2A definition from figure 4, the proportion of individuals defined as metabolically healthy shrinks from 74.6% to 52.3%. These disproportionate deductions again illustrate the need for meticulous consideration of how the metabolic health profile is defined.

For these reasons, rather than a simple binary indicator of one's overall metabolic health, perhaps a more appropriate conception of a person's metabolic profile would be a categorical designation, in essence separating individuals who do not have any problematic indicators, those who have one or two, and those who have three or more. Shown in table 3 are the proportions of the sample population who fit into each of the three categories of metabolic health. Those with no problematic metabolic indicators can be conceived as in excellent metabolic health and those with one or two indicators that are aberrant can be conceptualized as having fair/average metabolic health (note that the sample population has an mean number of problematic metabolic indicators of 1.5 and 1.7, depending on whether the five or six indicator conception of the metabolic syndrome is used as indicated in table 3). Those who have three or more metabolic health problems can be thought of as in poor metabolic health. For both the five and six indicator conceptions, approximately a quarter of the sample population has a clean bill of metabolic health while the majority of the population (not surprisingly) has one or two metabolic health issues. Further, the proportion of the sample population in "poor" metabolic health is slightly higher than the proportion without any maladies for the five indicator conception, and roughly the same for the six item conception of the metabolic index. This conceptualization of the metabolic syndrome represents a marked improvement over the binary/threshold conception of the syndrome in that it differentiates among those who are in excellent health, those who are in fair health, and individuals with poor metabolic health profiles, aiding both in the understanding of how metabolic health is distributed across the sample population and in separating those who are "at risk" for slipping into poor metabolic health from those who are, metabolically speaking, unblemished. Coupled with the fact that each of the indicators do not occur in comparable proportions across the sample population (shown in table 2), breaking the metabolic health profile down into three categories exhibits a marked improvement over a binary conception of overall metabolic health (table 3).

If splitting the metabolic health index into three categories is more beneficial than a binary threshold measure, parsing out the metabolic health profile into the count total of symptoms provides an additional upgrade in characterizing metabolic health, both in terms of consistency across the different conceptions of the disorder, and in untying the varying degrees to which individuals are exposed to cardiovascular health risk factors (roughly an excellent, fair, poor categorical comparison). Table 4 illustrates the sample population's distribution of metabolic health symptoms in even more detail, displaying both the count and proportion of the sample population for each number of problematic indicators for both the five and six indicator conceptions of the metabolic syndrome. This conception shows the greatest amount of congruence between both the five and six indicator conception of the metabolic syndrome, and further validates the need for a more nuanced approach to conceptualizing one's metabolic health profile. In both the five and six indicator conceptions of the syndrome, the modal number of metabolic problems is one, followed by zero. Though in general the six item index is slightly more skewed towards higher scores (note that about 64 more people register zero metabolic problems when using blood pressure as a single metric as in the 5-indicator conception of the metabolic syndrome), the balance across the counts is remarkably consistent, and provides even greater congruency between the varying conceptions of the metabolic syndrome as used in the academic research and clinical diagnosis. Indeed, from a theoretical and distributional standpoint, a "count" conception of the metabolic syndrome seems the most suitable barometer of one's metabolic health profile.

Table 4. Distribution of the Count of Metabolic Indicators at Unhealthy Levels for the Sample Population of Adult U.S. Hispanics using the Five and Six Indicator Indices

Number of Metabolic Problems	Five Indicator Conception of the Metabolic Syndrome		Six Indicator Conception of the Metabolic Syndrome	
	Number	Proportion	Number	Proportion
0	539	27.8%	475	24.5%
1	607	31.3%	539	27.8%
2	440	22.7%	432	22.3%
3	261	13.5%	283	14.6%
4	83	4.3%	151	7.8%
5	8	0.4%	50	2.6%
6	-	-	8	0.4%

Though of considerably less consequence to the conclusions of this research than the discussion of the descriptive and distributional information for the dependent variable, it is important to similarly consider the descriptive information for the independent variables as well. Shown in table 5 are the means and standard errors of the main variables of interest, as well as all control variables used in the analysis. Of primary interest for the analysis I note that the linguistic acculturation metric has a mean between nine and ten (recall that this scale is scored from 0-20) indicating a relatively normal distribution with the mean right about at the central value on the scale. Also of importance, while 27% of the sample are U.S. born Hispanics and 27% are second Generation Hispanics, 46% of the sample population is comprised of first generation U.S. Hispanics. The dominance of the sample by first generations Hispanics (those who were born outside of the U.S. and immigrated during their lifetimes) has been observed in other data sources collected around the same time as well, specifically the National Latino and Asian American Survey and the (Bates et al,. 2008). For the length of time in the U.S. measure there is relative consistency, though (not surprisingly based on the information for generational designation) Hispanics who have been in the U.S. for less than 10 years outnumber those who have been in the U.S. for more than 20 years by 4% and those who have been in the U.S. for between 10 and 19 years by 8%. Lastly, 72% of the sample is comprised of naturalized U.S. citizens. The only seemingly problematic independent variable, in terms of distribution is the sex variable as 43% of the sample is female and 57% are male. Though I test the sex variable heavily (both on its own and as a moderating interaction effect as described previously) to limit induced bias from this unusual sex distribution, I acknowledge this concern in the sample population.

Table 5. Descriptive Statistics for the Independent Variables Used in the Analysis

Independent Variable	Mean	S.E.
Native Born Generation	0.27	0.06
First Generation	0.46	0.06
Second Generation	0.27	0.05
Linguistic Acculturation Score	9.44	0.72
Citizenship Status	0.72	0.05
Poverty to Income Ratio	2.18	0.15
College Degree	0.35	0.04
Young Adult (20-44)	0.71	0.05
Middle Age (45-64)	0.21	0.04
Old Age (65+)	0.08	0.02
Female	0.43	0.04
Drinker	0.83	0.04
Smoker	0.53	0.05
Metabolic Activity Score	11.90	0.96
Diabetes Pill	0.05	0.01
Number of Births	0.68	0.10
Less than 10 years in the U.S.	0.37	0.08
Less than 20 years, more than 10 years in the U.S.	0.29	0.06
More than 20 years in the U.S.	0.33	0.07
Mexican Origin	0.55	0.06

V. Results

To begin at the beginning, it is necessary to first inspect and explore the metabolic health trends for the entire U.S. Hispanic population, and compare their descriptive data to the overall U.S. population statistics for metabolic wellness. However, the issues that underlie the classification of the metabolic syndrome for Hispanics as discussed in the measurement section previously, namely those of using a five or six indicator metric for the metabolic syndrome and applying a two or three indicator threshold for increased cardiovascular risk, materialize again when comparing the sample of U.S. Hispanics to that of the entire U.S. population. Shown in table 6 is a comparison of Hispanics to the entire U.S. population for the distribution of the metabolic syndrome accounting for differences between the 5-indicator version and the 6-indcator version of the metabolic syndrome across both the three different definitions of the metabolic syndrome, and the count index. Note that this table is in the same format as table 3 and table 4 combined, previously presented in the descriptive statistics section of the paper.

Table 6. Presence vs. Absence of the Metabolic Syndrome under Different Definitional Conceptions and the Distribution of the Count of Metabolic Indicators at Unhealthy Levels: Comparing the Sample Population of Adult U.S. Hispanics to the Aggregate U.S. Population

Definition	Five Indicator Definition of the Metabolic Syndrome		Six Indicator Definition of the Metabolic Syndrome	
	Hispanics	Total U.S. Population	Hispanics	Total U.S. Population
Three or More Indicators Elevated				
Metabolic Syndrome	18.2%	16.3%	25.4%	23.1%
Healthy Metabolic Profile	81.8%	83.7%	74.6%	76.9%
Two or More Indicators Elevated				
Metabolic Syndrome	40.9%	37.9%	47.7%	44.4%
Healthy Metabolic Profile	59.1%	62.1%	52.3%	55.6%
Three Category Conception of the Metabolic Syndrome				
0 indicators Elevated	27.8.%	30.9%	24.5%	27.9%
1-2 indicators Elevated	54.0%	52.8%	50.1%	49.0%
3+ indicators Elevated	18.2%	16.3%	25.4%	23.1%
Metabolic Risk Index: Number of Metabolic Problems				
0	27.8%	30.9%	24.5%	27.9%
1	31.3%	31.2%	27.8%	27.8%
2	22.7%	21.6%	22.3%	21.2%
3	13.5%	11.8%	14.6%	13.0%
4	4.3%	4.1%	7.8%	7.2%
5	0.4%	0.4%	2.6%	2.5%
6	-	-	0.4%	0.5%
Mean Total Score	1.52	1.28	1.73	1.53

The first and most obvious conclusion when comparing U.S. Hispanics to the total U.S. population in terms of their distribution across the various conceptions of the metabolic syndrome is that in general, Hispanics as a group do have a somewhat worse metabolic health profile than the entire U.S. population as a whole. Looking at the first two conceptions of the metabolic syndrome for the five indicator count (1A and 1B from figure 4), the proportion of Hispanics who are diagnosed with the metabolic syndrome exceeds the total U.S. proportion by 1.9% when using a cut off of three or more indicators to define the syndrome (1B from figure 4), and 3.0% when using a cut off of two or more indicators to define the syndrome (1A from figure 4),. Likewise, when using the six-indicator count of the metabolic syndrome, the proportion of U.S. Hispanics who are classified as having the metabolic syndrome outnumber the entire population by 2.3% when using a cut off level of three to define the syndrome (2B from figure 4), and 4.6% when using a cut off of two or more indicators (2A from figure 4). Despite the variation in the spread (resulting for the four possible conceptualizations of a binary metabolic syndrome), the general finding is this that U.S. Hispanics have a worse overall metabolic health profiles than the aggregate U.S. population, replicates a general finding from the extant literature (Ford et al. 2002; Beltrán-Sánchez et al. 2013). The basic relationship continues to hold when considering the three category conception of the metabolic syndrome shown in table 6. Indeed, for both the five and six item definition of the metabolic syndrome, the proportion of the sample in excellent metabolic health (those with no adverse metabolic markers) is less for U.S. Hispanics (27.8% for the five item indicator and 24.5% for the six item indicator) than for the aggregate U.S. population (30.9% for the five item indicator and 27.9% for the six item indicator). Concurrently, the proportion of U.S. Hispanics with one or two adverse indicators, and the proportion of U.S. Hispanics with three or more adverse indicators both outnumber their aggregate U.S. equivalents (though slightly more strongly for those with "poor" metabolic health). More importantly perhaps, because the difference between Hispanics and the entire U.S. population switches direction (in favor of the aggregate U.S. population) when comparing the zero-indicator group (excellent health) to those with one or two adverse indicators (the fair/average health group), Hispanic disparities in cardiovascular health are even further exposed. If, under the three categorical conception of the metabolic syndrome, we conceptualize those with one or two adverse metabolic indicators as the group "at risk" of developing the metabolic syndrome proper, it is particularly troubling that the already present gap between U.S. Hispanics and the entire U.S. population who are diagnosed with the metabolic syndrome tips even further against U.S. Hispanics when separating those with a clean bill of metabolic health from those with one or two adverse markers.

Above and beyond the previously discussed issues with the measurement instrument for the metabolic syndrome, the conclusions are even more variable when comparing populations. Comparing the means of the analytic sample to the full sample of adult participants in the NHANES from 1999-2004, I find that while the U.S. population has an average score on the metabolic risk index of 1.53, the sample of Hispanics has an average score of 1.73 for the six count indicator; while the difference is 1.28 and 1.53 for the total U.S. population and U.S. Hispanics respectively. Thus, again confirming my hypothesis, U.S. Hispanics have somewhat worse metabolic risk profiles than the total U.S. population on average. Further, I note more consistent patterns across the five and six item conceptions of the metabolic syndrome in the metabolic health index than either the binary or categorical conceptions. Having established a reasonable amount of both population incongruence (justifying this analysis from an academic perspective) and health exigency (justifying it from the practitioners view) it is necessary to investigate the heterogeneity within the U.S. Hispanic population. To these ends, I now limit my discussion to only the analytic sample of 1,938 adult U.S. Hispanics whose descriptive statistics for each in dependent variable are presented previously in table 5.

Having illustrated both the need for a "wider" metabolic health metric, specifically a count indicator as opposed to a binary threshold diagnostic, I move to the central findings of this research. Table 7 models the relationship between three of the demographic acculturation metrics[15], language usage, citizenship status, and generational designation in a series of analytic models. I began by running a basic OLS regression in model 1 for initial estimates.[16] Shown in table 7 model 1 are the OLS regression results reported in beta-coefficients. Despite a non-normal distribution for the metabolic indicators, there is a moderate statistically significant ($p<.05$) positive relationship between increased use of English and the count of metabolic risk indicators when controlling for all other variables for Hispanics residing in the United States. Also of note is that age significantly affects one's metabolic health ($p<.01$); though this is

[15] Recall that measures for generational designation and length of time in the U.S. were too highly correlated to run together in the same models. Hence, one was substituted for the other in two analogous series of Poisson Regression models.

not a surprising result as increased blood pressure levels (Kotchen et al. 1982), obesity, insulin resistance (Lönnroth and Smith 1986), and adverse cholesterol levels (Kreisberg and Kasim 1987) have all been positively associated with aging. This expected result for age helps buttress the significant relationship between linguistic usage and metabolic health for U.S. Hispanic adults observed in model 1.

However, more precise estimates based on the distribution of the dependent variable required a Poisson regression model (recall that the sample population had a mean 1.73 of and a variance of 1.89); results for these models are shown in table 7 models 2 through 6 and reported in incident risk ratios (IRR) to aid in interpretability. First, model 2 illustrates that the basic relationship found using OLS estimates is indeed robust as directionality of the significant relationships do not change. Because the Poisson regression is more precise and a better fitted statistical model, owing to the distribution of the observed counts of metabolic indicators, the standard errors decline from model 1 to model 2. Shown in model 2, an increase of five points on the English usage scale is significantly ($p<.01$) associated with a 20% increase in the expected number of cardiovascular indicators which are unfavorable when holding constant all covariates and other acculturative measures (specifically citizenship and generational status). Yet a disparity of five points on the linguistic scale can indicate a variety of differences in the population and generate more than a few comparisons. For example, a U.S. Hispanic adult who uses both languages equally (a score of two on the scale) in all five contexts (language(s) read and spoken, languages(s) used as a child, language(s) spoken at home, language(s) used to think, and language(s) used with friends) compared to a Hispanic who speaks more English than Spanish (a score of three) in all five contexts would account for a 5 point difference. Likewise, a comparison between a Hispanic who only speaks Spanish (a total score of zero), to one who speaks only English (a score of four) in ***one*** context, and speaks “more Spanish than English” in one other context with the other three contexts reported as “only Spanish” would account for the same five point difference. Thus, when interpreting the results for linguistic usage metric, it is necessary to consider the range of comparisons generated by the five item index, and the underlying meaning of the linguistic usage index as it pertains to linguistic preference in a range of social network contexts. Expectedly, there is also a particularly strong positive effect for age as

Hispanics in middle or late adulthood exhibit higher expected counts on the cardiovascular risk index; specifically U.S. Hispanics ages 45-64, and those ages 65+ are expected to have a 45% increase in the expected number of metabolic health indicators when compared to the 20-44 year old population (ceteris paribus).

More intriguingly, U.S. Hispanics who are first generation North Americans have higher expected counts of metabolic indicators compared to native U.S. Hispanics (those born in the U.S. with at least one parent born in the U.S). Specifically, being a first generation U.S. Hispanic compared to a native U.S. Hispanic is associated with an increase of more than 40% on the expected count of unhealthy metabolic indicators. This seems to run counter to selection based theoretical models such as the healthy migrant theory and is a trend that must be investigated further as I proceed with more complex models. The final acculturation variable in this model, citizenship status, was not significant. However, when considering only directionality, non-citizens had higher expected counts of metabolic indicators than U.S. Hispanic citizens.

Control covariates did not yield and significant results in model 2, though the basic patterns lend credibility to the effectiveness of the measures and dependability of the model. First, Income to Poverty ratio is associated with lower expected counts of adverse metabolic indicators, replicating a common finding that higher levels of SES are associated with better physical health (Link and Phalen, 1995). Drinking and smoking too are non-significant but display a directionality common to findings in the literature, as deleterious health behaviors such as smoking and drinking are associated with higher metabolic indicator counts than abstainers in both respective categories. Additionally, higher numbers of births reported by women were associated (albeit non-significantly) with higher metabolic counts, again in line with extant research in the field. Not surprisingly, taking medication for diabetes was strongly associated with higher adverse metabolic indicator counts as specific indicators on the metabolic risk index such as obesity and cholesterol levels have been linked with diabetes diagnosis (Mokdad et. al, 2003); model 2 indicates that being diagnosed with diabetes and taking medication for the disease is associated with a 59% increase in the expected counts of unhealthy metabolic indicators for the U.S. Hispanic population holding all acculturation dissimilarities constant (p<.001).

Table 7. Results for Regression of the Metabolic Risk Indicator Count Index on Three Indicators of Hispanic Acculturation

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Linguistic Acculturation	0.07 (.03)**	1.04 (.01)***	1.05 (.02)***	1.04 (.01)***	1.05 (.01)***	1.06 (.02)***
First Generation	0.55 (.36)	1.41 (.26)*	1.38 (.24)*	1.22 (.25)	1.47 (.25)**	1.54 (.33)*
Second Generation	-0.37 (.34)	0.79 (.16)	0.81 (.16)	0.66 (.17)	0.8 (.16)	0.67 (.17)
Citizen	-0.27 (.32)	0.89 (.14)	0.86 (.13)	0.85 (.14)	0.99 (.18)	0.99 (.16)
Income to Poverty Ratio	-0.06 (.06)	0.98 (.03)	0.97 (.03)	0.96 (.03)	0.98 (.03)	0.96 (.03)
Less than High School	-0.05 (.23)	0.98 (.14)	1.02 (.13)	0.99 (.13)	1.02 (.13)	1.07 (.14)
Middle Age	0.68 (.22)***	1.45 (.17)***	1.4 (.17)***	1.42 (.17)***	1.46 (.17)***	1.44 (.16)***
Old Age	.069 (.25)***	1.45 (.19)***	1.45 (.18)***	1.52 (.20)***	1.45 (.19)***	1.44 (.18)***
Female	-0.42 (.36)	0.76 (.17)	1.13 (.33)	0.51 (.13)**	1.23 (.42)	1.84 (1.16)
Drinker	0.09 (.27)	1.07 (.18)	1.05 (.18)	1.12 (.19)	1.02 (.17)	1.05 (.19)
Smoker	0.14 (.20)	1.09 (.10)	1.12 (.10)	1.08 (.11)	1.09 (.10)	1.09 (.11)
Metabolic Activity Score	0.01 (.01)	1.00 (.01)	1.00 (.01)	1.00 (.01)	1.00 (.01)	1.00 (.01)
Diabetes Pill	1.16 (.03)****	1.59 (.19)****	1.6 (.20)****	1.63 (.19)****	1.57 (.19)***	1.69 (.22) ****
Number of Births	0.07 (.09)	1.05 (.05)	1.02 (.05)	1.05 (.05)	1.05 (.04)	1.01 (.06)
Female * Linguistic Acculturation			0.97 (.02)*			0.96 (.03)*
Female * First generation				1.77 (.53)*		1.29 (.35)
Female * Second generation				1.05 (.41)		2.29 (1.01)
Female * Citizen					0.55 (.19)*	0.60 (.23)

Notes: Model 1 reported in OLS beta coefficients, Models 2 to 6 reported in Incident Risk Ratios. Numbers in parentheses are standard errors.
Number of observations = 1,938 ****p<.001, ***p<.01, **p<.05, * p<.10

Having established these basic relationships using a regression model prudent to the distribution of the dependent variable, I add interaction effects to investigate the potential *moderating* effect of sex in the relationship between acculturation and the metabolic risk index in models 3 through 5 shown in table 7. I added each interaction term individually across the models with the interaction between sex and language, sex and generational status, and sex and citizenship status added in models 3, 4, and 5 respectively. Model 3 shows the Poisson regression results when including the interaction between linguistic acculturation and sex. The overall relationship between linguistic usage and metabolic health remained significant ($p<.01$), and the interaction effect was also moderately significant ($p<.10$), though in the opposite direction. Because of the interaction effect with gender, the interpretation of the relationship changes from model 2 to model 3, specifically a difference of five on the (English) linguistic usage scale was associated with a 25% increase in the count of unhealthy metabolic indicators for adult U.S. Hispanic males, and this relationship is weaker for women. Model 4 in table 7 demonstrates a significant interaction effect between generational designation and metabolic health. Similarly to the results when including the interaction effect between sex and linguistic usage, the relationship found in model 2 between first generation Hispanics and metabolic health is altered in model 4 with a moderately significant ($p<.10$) interaction effect between sex and the first generation dummy variable. The anomalous relationship found in model 2 is clarified here somewhat as the relationship between higher expected counts of metabolic indicators and being first generation rather than a native U.S. Hispanic is driven primarily by females. Model 5 shows that citizenship status, while not significant for men, does operate significantly ($p<.10$) for women, as female non-citizens have higher metabolic indicator counts than female U.S. citizens. Like linguistic usage and generational status, the relationship between citizenship status and metabolic health too is moderated significantly by sex.

However, when combining all interaction effects into a final model (shown in model 6 of table 7), more English language usage remains a significant ($p<.01$) predictor for higher counts of metabolic health indicators as does being a first generation Hispanic compared to a native (U.S.) born Hispanic ($p<.10$). However, for the interaction effects, only gender differentials in language usage is robust enough to retain moderate statistical significance ($p<.10$). The strong relationship between English language usage and the count of metabolic risk indicators and its sex variability, shown in the final model (model 6), specifies that linguistic acculturation may be the most important pathway towards increased counts of metabolic risk indicators. Nonetheless, the peculiar significance of generational designation in the final model is worth noting, as the expected number of metabolic risk indicators for first generation Hispanic males is 54% higher than native born Hispanic males (the third generation in the U.S. or greater) ceteris paribus. This is curious as the relationship is both in the opposite direction of what is hypothesized, and seems to be acting in a different direction than linguistic acculturation. Similar to the results for linguistic acculturation which is significant and divergent for both males and females, the generational finding seems to be also be governed by variance in sex. For males, this finding seems to in line with the healthy migrant theory, as Hispanic males who were born in the U.S. have higher expected counts of adverse metabolic health indicators than those who were born outside of the U.S. and emigrated at some point during their lifetime. The plot thickens when considering that this anomalous finding indeed *reverses* for women as first generation Hispanic women have higher expected counts of adverse metabolic indicators than those born in the U.S., countering the healthy migrant theory (the female first generation interaction effect has an IRR of 1.29). Without a doubt, this gender variation warrants careful attention to how these acculturative demographic processes differ for Hispanic males and females. To more fully investigate these three acculturation predictor variables and to understand the gender heterogeneity within this population, I depict these relationships graphically in figures 5-7using predicted probabilities.[17] Expected counts of cardiovascular risk indicators are shown across the linguistic usage scale, among the three generational categories, and between citizens and noncitizens. For each of these figures, results are reported in expected counts of metabolic indicators in total, for men, and for women for comparative purposes. Figure 5 is based on model 3, Figure 6 is based on model 4, and figure 7 is based on model 5.

[17] Expected counts were calculated using the “prcounts” command in STATA 13.

Figure 5. Expected Counts of Metabolic Risk Indicators across Linguistic Acculturation Levels for Hispanic Men, Women, and Total

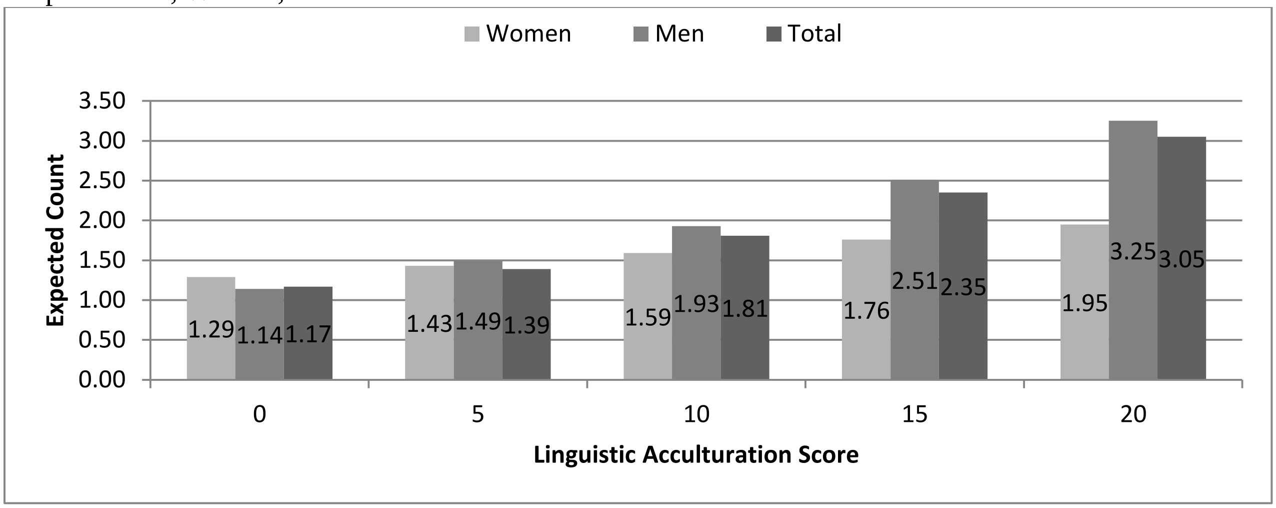


Figure 6. Expected Counts of Metabolic Risk Indicators between Citizens and Non-Citizens for Hispanic Men, Women, and Total

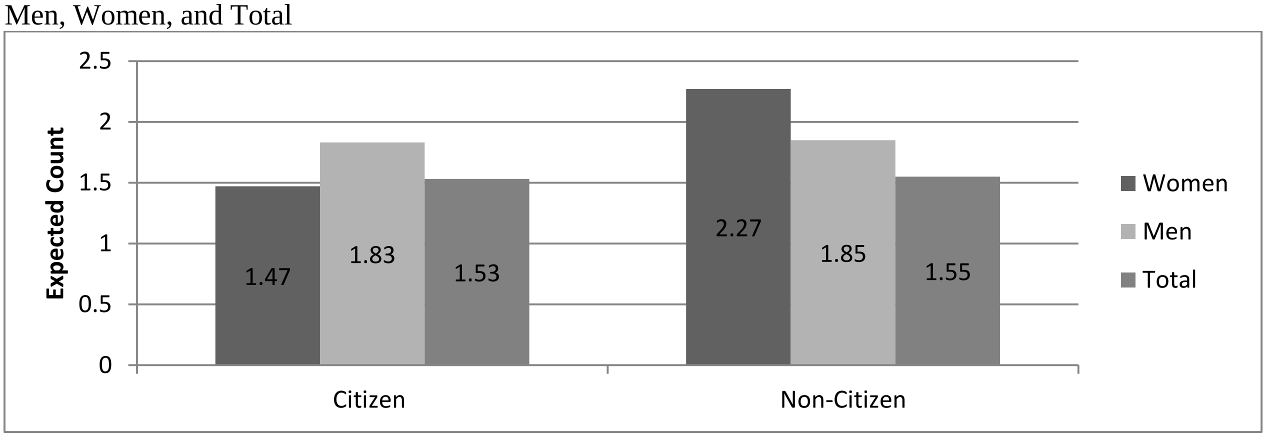
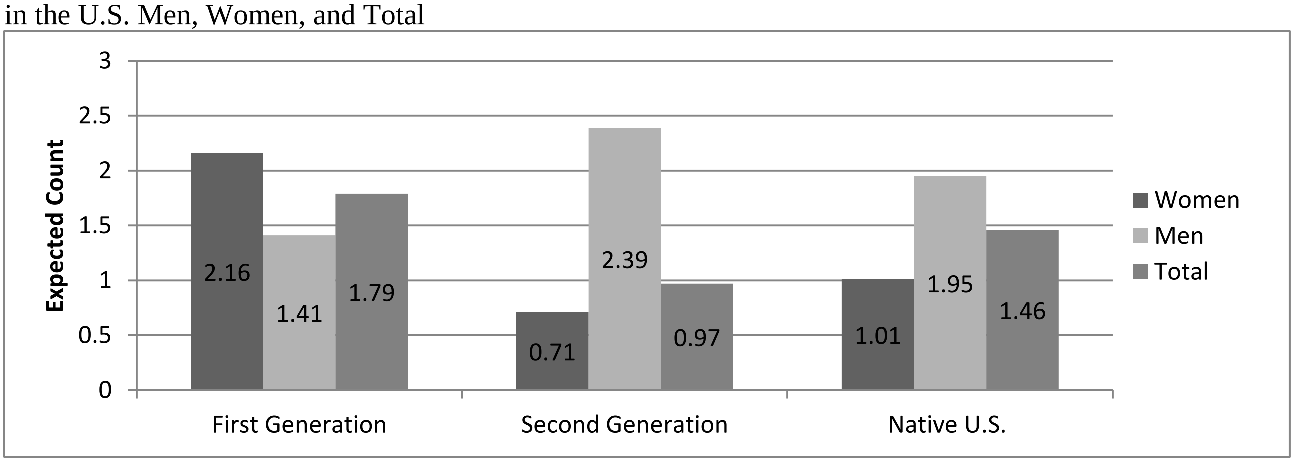


Figure 7. Expected Counts of Metabolic Risk Indicators across Generational Status Levels for Hispanics in the U.S. Men, Women, and Total



As anticipated in the regression results, linguistic acculturation shows the strongest and most cohesive pattern overall. What is striking is that this relationship, whereby increased use of English for Hispanics in the U.S. (relative to Spanish) is associated with higher expected counts of metabolic risk indicators, is that the overall trend is driven decidedly by men. As shown in both model 3 and model 6 of table 7, the significant interaction between linguistic acculturation and sex ($p<.10$) is below one, thus it is not surprising that sex moderates this relationship in such a way that it is stronger for males. For Hispanic men, the difference in speaking exclusively Spanish (a score of zero) to exclusively English (a score of twenty) is associated with an increase of about two units on the metabolic risk index, indicating a difference of two more indicators at adverse levels. For females this association is unambiguously diminished. The same change from one extreme of the language use to the other generates only a 0.66 increase in the expected count of metabolic risk indicators for females. Though significant for both men and women, and in the same direction, sex undeniably moderates the overall relationship between linguistic usage for Hispanics in the U.S. and their overall metabolic health profiles.

Citizenship status is not significant in the model, but (as shown in model 5 in table 7) gender does significantly moderate the overall relationship. Shown in Figure 6, no variation exists for men on this acculturation metric (only a negligible difference of 0.02 exists between males who are citizens and those who have not been naturalized), but women who are not citizens have higher expected counts of metabolic risk indicators than women who are citizens; specifically non-citizens have expected counts of adverse metabolic indicators of 2.27, while female citizens have expected counts of only 1.47. Again, sex moderates a relationship between an acculturative indicator (in this particular instance, one which is non-significant overall) and one's metabolic health profile. However, it is unknown whether those who are "non-citizens" are undergoing to naturalization process, are permanent green card holders, are migrant worker, or are simply avoiding the tedious naturalization process, indeed there is no way to parse out these differences given the NHANES data at hand.

Truly, generational designation is the acculturation marker with the most complex relationship with metabolic health. In figure 7, patterns are extremely different for men and women. The finding from the final model in table 7, which runs counter to my hypothesis and migratory selection effects, as discussed above is driven primarily by females. In stark contrast to the health migrant theory, first generation U.S. Hispanic women (those born outside of the U.S.) have the highest expected counts of adverse metabolic indicators than any other generational group of females. However, lending credence to the health migrant hypothesis, first generation men demonstrate the healthiest metabolic profiles. In sum, for females in the sample population, the ranking order of healthiest metabolic profiles goes from second, to native, to first generation, while for males the healthiest generational categorization belongs to the first, native, and second generation. This indubitably cases doubt on the healthy migrant theory's explanatory power, instead favoring divergent destinies for Hispanics within the orthogonal assimilation matrix.

To disentangle these relationships further, I disaggregated the metabolic risk index and analyzed the relationship between the three acculturative measures and each of the six indicators individually (obesity, low HDL, high total cholesterol, elevated long term blood sugar, elevated diastolic blood pressure, and elevated systolic blood pressure). Shown in table 8 are sequential logistic regression models for each of the six metabolic indicators reported in logged odds. As was the case for the summative count indicator of the metabolic syndrome, there is clear variation across indicators in terms of their associations with the linguistic acculturation measure. Linguistic acculturation is positively associated with high levels of triglycerides in the blood, high systolic blood pressure, high diastolic blood pressure, and elevated abdominal circumference. Minding the included interaction effects, linguistic acculturation for men is most associated with elevated diastolic blood pressure such that a mere one unit increase on the linguistic acculturation increases the odds of high systolic blood pressure for men by 22%.[18] For women, the relationship between linguistic acculturation and high levels of total triglycerides in the blood, high systolic blood pressure, and high diastolic blood pressure is attenuated as evidenced in the significant for the interaction between linguistic usage and sex. Thus while the overall relationship between linguistic acculturation and the odds of having one of the three aforementioned metabolic indicator at an adverse level is positive, the relationship is driven mostly by men, similar to the conclusion

[18] Logged odds reported in table 8 were converted into odds ratios by simply exponentiating the coefficients.

from figure 5. For central obesity, there is not a significant difference for men and women, thus linguistic acculturation works similarly for men and women in increasing the odds of increased central adiposity. Thus, not only does linguistic acculturation relate to metabolic health differently for men and women, but it also relates to the individual indicators in slightly different ways, again accentuating the heterogeneous nature of an analytic inquiry such as this and underscoring the importance of accounting for this heterogeneity.

Table 8. Results for Logistic Regressions for Each Metabolic Risk Indicator on Three Indicators of Hispanic Acculturation

	High Serum Triglycerides	**High Diastolic BP**	**High Systolic BP**	**Elevated HbA1c**	**High Central Adiposity**	**Low serum HDL**
Linguistic Acculturation	0.13 (.04)***	0.20 (.07)***	0.18 (.05)***	0.05 (.06)	0.13 (.07)**	0.02 (.05)
First Generation	-1.62 (.71)**	-2.26 (.91)**	0.64 (.89)	0.54 (.97)	-0.57 (1.08)	-0.03 (.81)
Second Generation	-0.24 (.48)	0.15 (.86)	-0.92 (.69)	0.07 (.70)	-1.11 (.63)*	-1.74 (.50)***
Citizen	0.31 (.63)	-0.76 (.65)	-1.15 (.90)	0.26 (.78)	0.06 (.69)	0.58 (.76)
Income to Poverty Ratio	-0.07 (.11)	0.04 (.15)	0.03 (.14)	0.07 (.18)	-0.25 (.11)**	-0.13 (.14)
Less than High School	0.42 (.47)	-0.27 (.85)	0.3 (.59)	-0.33 (.55)	-0.42 (.48)	0.52 (.36)
Middle Age	0.81 (.47)*	1.29 (.64)**	1.65 (.37)****	0.78 (.61)	0.52 (.46)	-0.06 (.48)
Old Age	0.41 (.68)	0.39 (.67)	2.41 (.98)**	2.02 (1.00)*	1.03 (.64)	-1.8 (.61)***
Female	2.72 (1.46)*	5.60 (2.38)**	7.73 (2.46)***	-1.85 (1.44)	0.25 (2.22)	-4.25 (2.5)*
Drinker	0.80 (.61)	1.57 (.83)*	0.5 (.59)	-0.37 (.66)	-0.98 (.77)	-0.42 (.54)
Smoker	0.35 (.34)	1.68 (.30)***	-0.27 (.47)	0.12 (.54)	-0.05 (.43)	0.27 (.41)
Metabolic Activity Score	0.03 (.02)	0.01 (.03)	-0.01 (.02)	-0.03 (.02)	-0.01 (.02)	0.01 (.02)
Diabetes Pill	1.42 (.07)**	-0.63 (1.02)	1.21 (.71)*	6.69 (2.5)***	1.52 (.66)**	0.96 (.60)
Female * Linguistic Acculturation	-0.21 (.06)***	-0.39 (.09)****	-0.38 (.07)****	-0.03 (.11)	0.17 (.12)	0.12 (.13)
Female * First generation	2.57 (1.29)*	3.38 (1.87)*	6.3 (2.09)***	1.82 (1.34)	3.79 (2.00)*	2.09 (2.15)
Female * Second generation	2.43 (1.54)	-5.32 (1.76)***	-6.29 (2.07)***	-1.29 (1.92)	-0.58 (1.76)	0.22 (2.28)
Female * Citizen	0.55 (1.3)	-1.93 (1.94)	-2.9 (2.08)	-0.77 (1.64)	-2.88 (1.79)	-1.53 (1.45)

Notes: Models 1 through 6 reported in Logged Odds. Numbers in parentheses are standard errors.
Number of observations = 1,938 ****p<.001, ***p<.01, **p<.05, * p<.10

Generational status, as in the count model, exhibits the most discontinuous variation. For men, first generation Hispanic immigrants exhibit higher odds of high triglyceride levels and elevated diastolic blood pressure than native U.S. Hispanics, though they do not differ on other indicators.[19] For women, these associations are moderated such that first generation Hispanic women have higher odds of high serum triglycerides, elevated systolic blood pressure, central obesity, and elevated diastolic blood pressure than native born Hispanic women. Again, these desegregations lend seem to counter the healthy migrant theory, especially for women. Differences between second generation Hispanics and native born Hispanics are most evident for low levels of "good" (HDL) cholesterol where second generation Hispanic men show adverse levels at higher odds than native born Hispanic males, and as evidenced by the non-significant interaction effect with sex, for females too. For second generation Hispanic women the differences are more pronounced, specifically they have higher odds of both systolic and diastolic blood pressure compared to native born women. Citizenship status is not significant across models but it is surprising that the direction of its association with the six outcome variables is twice in the negative direction (for the blood pressure measures) and four times in the positive direction. Again mirroring the results from table 8 and figure 7, citizenship status is much more weakly linked to one's metabolic health, though it does exhibit some heterogeneity in terms of sex. Significant heterogeneity of the relationship between each of the metabolic measures and the other (control) variables exists too. Smoking dramatically increases the odds of high diastolic blood pressure ($p<.01$) as does (to a lesser statistically significant extent) drinking ($<.10$), consistent with literature on the detrimental cardiovascular effects, especially relating to blood pressure levels, of both tobacco use and regular alcohol consumption (Puddey et al., 1987; Neaton et al. 1984). Poverty too, shown in the significant relationship between the income to poverty ratio and waist circumference ($p<.05$), is associated with increased odds of obesity, again consistent with extant literature on the relationship between socioeconomic status and metabolic health in the U.S (Link and Phalen 1995). Further, while age is positively related to most indicators of adverse

[19] As an aside, the difference in significance for the relationship between diastolic blood pressure and generational status (significant), and systolic blood pressure and generational status (insignificant) add credence to an analysis that treats the two as separate indicators in on the metabolic health metric.

metabolic health (specifically high triglycerides, high systolic and diastolic blood pressure, and elevated blood sugar) it is not significantly associated with increased odds obesity indicating that obesity occurs evenly across all age groups for the U.S. Hispanic population rather than increasing (as do most morbidities) as individuals age, a disquieting result for public health initiatives targeting obesity early in the life course.[20] Not surprisingly, receiving medical treatment for diabetes (vs. no diagnosis of diabetes) is associated with high blood sugar levels (p<.01), obesity (p<.05), high levels of total cholesterol (p<.05) and elevated systolic blood pressure (p<.10).

I now move to the second phase of my analysis, substituting length of time spent in the U.S. for generational status in the model as the time varying acculturation metric, while retaining both citizenship status and linguistic acculturation in the model for continuity. Table 9 shows regression results in the same manner as table 7, with an OLS regression (model 1) followed by a Poisson with no interaction effects (model 2), interaction effects for each of the three acculturation measures and sex separately (models 3 through 5) and a final model with all interaction effects with sec included (model 6). Results shown in table 9 are remarkably similar to those shown in table 7 regarding some variables such as the linguistic usage and citizenship status, though they differ regarding some of the control variables and the sex moderation effects.

To begin, the majority of the basic conclusions from table 7 (models including generational status as opposed to length of time in the U.S.) were replicated for the two acculturation metrics in both models (linguistic usage and citizenship status). The association between increased English language usage (relative to the amount of Spanish used) and higher counts of metabolic risk indicators and for U.S. Hispanic males holds in this model when controlling for length of time in the U.S. as opposed to generational status as shown in table 7. Though the overall relationship was slightly less significant in model 6 of table 9 compared to model 6 of table 7 (p<.01 compared to p<.05), the direction remained consistent with the same basic conclusion, that a difference of four on the linguistic usage scale is

[20] Because the sample is limited to U.S. Hispanics over the age of 20, we can say little about childhood obesity. Nonetheless the notion that obesity is does not vary across adult age groups is startling, especially in light of the preceding results noting variation across income, language usage, and generational status for Hispanics.

associated with a 20% higher expected count of dysregulated metabolic indicators. However, the moderating effect for women was moderately significant (p<.10) in model 3 where only the single interaction effect was added, and non-significant in the final model (with all three interaction effects added). While in the same direction as the corresponding models from table 7, the results from table 9 illustrate that the moderating effect of sex is weaker when accounting for time spent in the U.S. vs. generational designation for U.S. Hispanics. Also similarly to the overall trends shown in table 7, comparing citizens and non-citizens showed little variation, and little effect when controlling for length of time in the U.S. rather than generational designation.

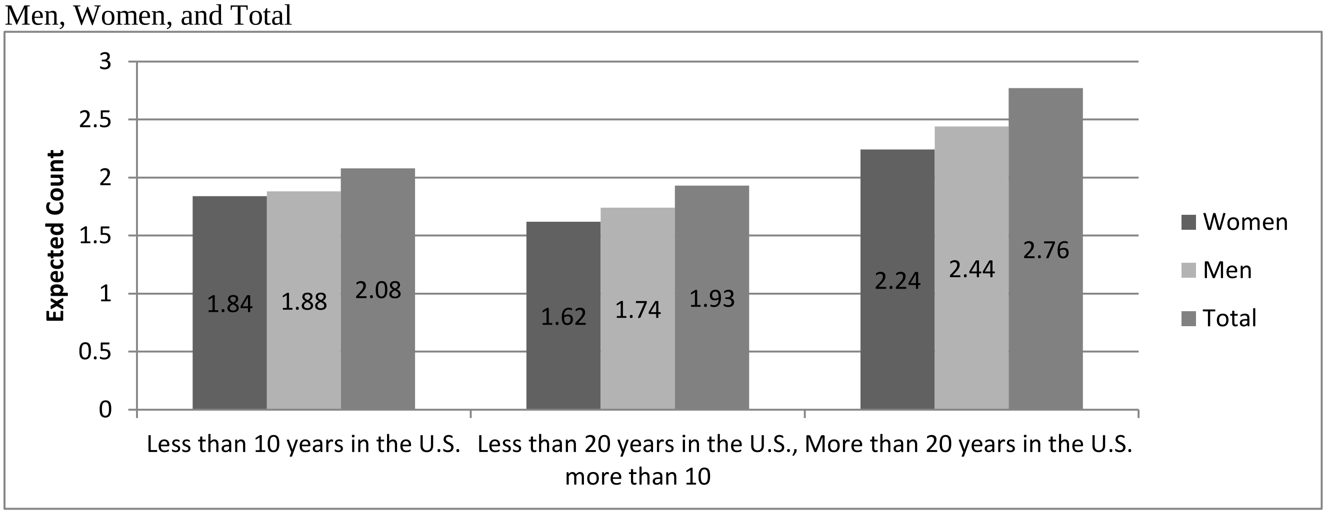
Table 9. Results for Regression of the Metabolic Risk Indicator Count Index on Three Indicators of Hispanic Acculturation

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Linguistic Acculturation	1.07 (.05)	1.04 (.02)	1.05 (.03)**	1.04 (.02)**	1.05 (.02)**	1.05 (.02)**
Less than 10 Years in the U.S	-0.48 (.41)	0.84 (.15)	0.85 (.16)	0.77 (.14)	0.8 (.13)	0.79 (.15)
Less than 20 Years in the U.S, More than 10	-0.54 (.53)	0.78 (.23)	0.8 (.23)	0.71 (.20)	0.79 (.21)	0.75 (.20)
Citizen	-0.36 (.36)	0.88 (.14)	0.92 (.15)	0.92 (.15)	1.01 (.16)	1.01 (.17)
Income to Poverty Ratio	-0.14 (.11)	0.94 (.06)	0.94 (.06)	0.93 (.07)	0.95 (.06)	0.93 (.07)
Less than High School	-0.11 (.24)	0.97 (.12)	1.08 (.15)	0.99 (.14)	1.01 (.12)	1.01 (.15)
Middle Age	0.23 (.43)	1.2 (.28)	1.2 (.28)	1.22 (.25)	1.27 (.27)	1.24 (.25)
Old Age	0.25 (.42)	1.23 (.27)	1.21 (.26)	1.18 (.23)	1.14 (.23)	1.12 (.21)
Female	0.52 (.56)	1.44 (.58)	1.96 (.88)	0.92 (.32)	1.92 (.65)*	1.66 (.85)
Drinker	0.39 (.34)	1.24 (.26)	1.27 (.29)	1.11 (.19)	1.05 (.16)	1.06 (.18)
Smoker	0.33 (.30)	1.14 (.15)	1.12 (.15)	1.14 (.15)	1.16 (.15)	1.15 (.15)
Metabolic Activity Score	0.01 (.01)	1.01 (.01)	1.00 (.01)	1.00 (.01)	1.00 (.01)	1.00 (.01)
Diabetes Pill	1.54 (.38) ****	1.9 (.27)****	1.92 (.28)****	1.91 (.26)****	1.93 (.28)****	1.93 (.28)****
Number of Births	-0.21 (.21)	0.86 (.15)	0.82 (.15)	0.9 (.13)	0.88 (.11)	0.89 (.10)
Female * Linguistic Acculturation			0.95 (.02)*			0.98 (.03)
Female * Less than 10 Years				1.6 (.43)*		1.11 (.36)
Female * Less than 20 Years				2.3 (.68)***		1.61 (.65)
Female * Citizen					0.48 (.14)**	0.58 (.19)

Notes: Model 1 reported in OLS beta coefficients, Models 2 to 6 reported in Incident Risk Ratios. Numbers in parentheses are standard errors.
Number of observations = 1,938 ****p<.001, ***p<.01, **p<.05, * p<.10

Time spent in the U.S. was not a significant predictor of the number of metabolic risk indicators for men, though there is a significant interaction effect (p<.01) shown in model 4 indicating that there is notable variation for Hispanic females in terms of length of time spent in the U.S. Though, like the female moderation effect for linguistic usage, the interaction effect for females and length of time spent in the U.S. loses statistical significance in the female model of table 9 (though directionally is maintained). Overall, relationships between the variables and their metabolic health are much more attenuated when controlling for the length of time spent in the U.S. for Hispanics. As in the analysis with generational designation as the acculturation time metric, I looked at predicted probabilities across length of time in the U.S. for Hispanics to investigate the interaction effects and sex differences more directly. These results are presented in expected counts across the acculturation measures for the entire sample, and stratified by sex, again in a similar manner to figures 5-7. The figures representing the expected counts of metabolic risk indicators across linguistic acculturation are very similar to the results shown in figure 5 with increasing English language use increasing the expected counts for both men and women, though this effect is strongest for men. Citizenship status too showed little variation when controlling for generational status (as in figure 6) or length of time in the U.S. Thus, the findings for these two measures of acculturation were strikingly similar when including either generational acculturation measure or the length of time spent in the U.S. (results not shown but available per request). However, in order to compare differences in metabolic health for Hispanics based on the time they have spent in the U.S., I generated a similar predicted probabilities figure to compare this measure (similar to those in figures 5-7). Figure 8 replaces generational status with length of time spent in the U.S. as the acculturation with time metric; hence, figure 8 depicts the relationship between length of time in the U.S. and expected counts of metabolic risk indicators in total, and stratified by sex.

Figure 8. Expected Counts of Metabolic Risk Indicators across Length of Time in the U.S. for Hispanic Men, Women, and Total



In contrast to the generational status acculturation measure, the length of time in the U.S. depicts more streamlined differences between Hispanics who have been in the U.S. for less than 10 years, those who have been in the U.S. for more than 10 but less than 20 years, and those who have been in the U.S. for more than 20 years. This relationship is in the hypothesized direction, as increased temporal acculturation is linked to higher expected counts of metabolic risk indicators, though there is a slight decline from the earliest category (less than 10 years) to the second (10-20). Results on this acculturation metric, like the linguistic usage metric, are rather uniform in that more acculturation increases the expected count of metabolic indicators. However, like the generational status metric there is a benefit in terms of lower metabolic risk indicator counts for the middle amount for time spent in the U.S. compared to the least amount of time (similar to the second generation having a better metabolic profile compared to the first generation Hispanics in total). Also similar to generational status, there is an increase in expected counts between the middle amount of time (10-20 years), and Hispanics who have been in the U.S. for the longest amount of time (20+ years). However, the divergence for men and women is much less pronounced for the length of time measure than for generational status, as Hispanic women and men in the early years of U.S. residence are very similar in their expected counts (1.84 and 1.88 respectively). Over time men diverge slightly and have slightly higher expected counts after living in the U.S. for more than 20 years (a difference of 0.20). Hence, both women and men seem to follow a pattern very consistent with the selection effects and healthy migrant literature in terms of acculturation by length of time in the U.S. Thus, the length of time metric exhibits considerably less drastic variation between Hispanic men and women than did generational status.

Consistent with the presentation of the results from table 8 using generational status as the time metric of acculturation, I present the disaggregated logistic regressions for each metabolic indicator with linguistic acculturation, citizenship status, and length of stay in the U.S. as the acculturation measures in table 10. Results for the individual indicators illustrate that for Hispanic men and women, increased English usage is significantly associated ($p<.05$) with higher odds of having high levels of "bad" cholesterol (triglycerides) and elevated waist circumference when controlling for length of time spent in the U.S. (and the other covariates in the model). While this is similar to the results found for this indicator and linguistic acculturation when controlling for generational status rather than length of time in the U.S. (shown in table 8), the other indicators do not show differences by linguistics in the odds of having the particular indicator. However, for women, the effect of English language usage is associated with lower odds of having high systolic blood pressure ($p<.05$). Thus, significant results observed for the association between linguistic acculturation and increased odds of elevated metabolic indicators are somewhat attenuated when controlling for length of time in the U.S.

Length of time spent in the U.S. is most salient for men (as noted in figure 8) as men who have been in the U.S. for less than 10 years have lower odds of hyperglycemia, and central obesity than men who have been in the U.S. for more than 20 years. Further, Hispanic men who have been in the U.S. for more than 10 but less than 20 years also display lower odds of having being centrally obese compared to their counterparts who have lived in the U.S. for more than 20 years. Again, obesity is a rather salient indicator after the disaggregation of the metabolic index. Nonetheless, like in table 8, there is considerable variation regarding the degree of relationship between the acculturative measure and the individual indicators. While results show far less significance, basic directionality in the associations is consistent when comparing tables 8 and 10. The magnitude of the influence of the acculturation measure shows considerable variation across each indicator both in tables 8 and 10 indicating the importance of accounting for both the variance in effects of different acculturation metrics on the specific indicators, and intrinsic differences in the relationships across the separate indicators of metabolic dysregulation.

Table 10. Results for Logistic Regressions for Each Metabolic Risk Indicator on Three Indicators of Hispanic Acculturation

	High Serum Triglycerides	**High Diastolic BP**	**High Systolic BP**	**Elevated HbA1c**	**High Central Adiposity**	**Low serum HDL**
Linguistic Acculturation	0.24 (.10)**	-0.01 (.08)	-0.03 (.07)	0.00 (.07)	0.19 (.08)**	-0.03 (.06)
Less than 10 Years in the U.S	0.07 (.76)	-0.39 (.99)	-0.01 (.78)	-1.15 (.60)*	-1.45 (.55)**	-0.44 (.74)
Less than 20 Years in the U.S, More than 10	0.28 (.87)	-0.42 (1.02)	-0.77 (.76)	0.25 (.56)	-1.31 (.71)*	-0.9 (.08)
Citizen	0.03 (.65)	-1.28 (.92)	-0.48 (.58)	0.37 (.48)	-0.13 (.91)	0.46 (.46)
Income to Poverty Ratio	0.03 (.21)	0.00 (.26)	-0.44 (.20)**	-0.14 (.27)	-0.07 (.20)	-0.06 (.22)
Less than High School	0.44 (.56)	-1.26 (.56)**	-0.38 (.58)	0.17 (.48)	0.10 (.46)	0.40 (.42)
Middle Age	0.66 (.75)	1.54 (.89)*	0.80 (.63)	1.20 (.69)*	0.08 (.70)	-0.52 (.52)**
Old Age	0.34 (1.15)	0.56 (.82)	2.03 (.86)	1.78 (.86)**	0.71 (.92)	-1.45 (.68)**
Female	-1.16 (1.29)	-1.36 (1.28)	1.44 (1.41)	-0.41 (1.06)	1.74 (.99)*	-2.99 (1.39)
Drinker	-0.32 (.55)	-0.36 (.70)	-1.27 (.77)	-0.36 (.57)	-0.10 (.72)	0.52 (.50)
Smoker	-0.3 (.56)	1.10 (.66)	1.32 (.43)***	0.05 (.53)	-0.54 (.43)	-0.36 (.35)
Metabolic Activity Score	0.02 (.04)	-0.01 (.04)	0.02 (.03)	0.00 (.03)	-0.02 (.02)	-0.01 (.02)
Diabetes Pill	1.21 (1.06)	-0.76 (1.09)	-0.09 (.58)	5.75 (.81)****	0.55 (.69)	-0.85 (.85)
Female * Linguistic Acculturation	-0.18 (.15)	-0.2 (.29)	-0.49 (.20)**	0.04 (.09)	0.04 (.13)	0.12 (.14)
Female * Less than 10 Years	1.43 (1.52)	2.49 (1.56)	-0.97 (1.89)	-2.1 (1.47)	1.29 (.82)	-0.05 (1.36)
Female * Less than 20 Years	2.66 (1.54)	-0.53 (1.17)	-2.25 (1.65)	-0.87 (.121)	0.37 (.104)	0.68 (1.14)
Female * Citizen	0.75 (1.41)	-1.49 (1.52)	-2.55 (1.24)**	-1.16 (1.07)	-0.56 (1.12)	-0.99 (.83)

Notes: Models 1 through 6 reported in Logged Odds. Numbers in parentheses are standard errors.
Number of observations = 1,938 ****p<.001, ***p<.01, **p<.05, * p<.10

To summarize the results for the logistic regression of the acculturation variables on each individual indicator of the metabolic health index, I offer figure 9 as a summative depiction between the four acculturation measures, and the six individual metabolic indicators in a matrix form to indicate the direction of the relationship and the sex variation as derived from tables 8 and 10. Several overarching themes arise from figure 9 which are less obvious in the regression tables. First is the tremendous diversity in directionality across the relationships between the acculturation measures and the six metabolic indicators. While the linguistic measure and the temporal length of time in the U.S. measure display uniformity in direction (positive and negative relationships respectively), the generational status measure is oscillates between positive and negative relationships across the individual indicators of metabolic health. As discussed, Hispanic generational designation is the most complex of all the relationships between the acculturative metrics and metabolic health, while the other three metrics have a more "cohesive" story across the metabolic indicators. In addition to this variation, figure 9 illustrates another source of heterogeneity, specifically the relative roles that each of the indicators play in the overall relationships. Relating to the considerable variance in the proportions of the sample population with adverse levels on each of the six metabolic indicators (shown in table 2), obesity and high blood pressure levels (both systolic and diastolic) seem to be the strongest pathways through which the acculturation status of Hispanics relates to their count of metabolic health indicators at adverse levels while blood sugar, and cholesterol are less influential. The third major conclusion displayed in figure 9 relates to the moderation of the relationships by sex as well as the heterogeneity in the relationships both across the individual metabolic indicators and the acculturation measures. Obesity displays a strong, consistent patter across sex as it is positively related to English language use and negatively associated with increased time spent in the U.S. for Hispanics, demonstrating results consistent with Hypothesis two, parts and d. Though the results for the relationship between obesity and generational designation is more mixed (both supporting hypothesis 3 in the comparison between second generation Hispanics and native U.S. Hispanics, and refuting it in the comparison between first generation Hispanics and native U.S. Hispanics), the general conclusion is that obesity is the most significant biological measure of metabolic health through which acculturation differences among Hispanic in the U.S. manifest in different counts of adverse metabolic biomarkers, and this pattern is relatively consistent for both women and men (running counter to hypothesis three). However, unlike obesity, total plasma triglycerides ("bad cholesterol") is a much more powerful pathway to higher counts of adverse metabolic indicators for men than women, while systolic blood pressure operates more powerfully for females. Indeed, these findings support hypothesis 3 as sex variation governs both the relationships of the acculturation indicators and the individual metabolic indicators, as well as the overall counts of metabolic indictors at adverse levels (shown in figures 5-8). Taken together, these results highlight both important independent acculturative variables operating idiosyncratically, specifically linguistic acculturation and generational status, and the relative power of the metabolic indicators themselves on the overall count on the metabolic health index. Heterogeneity dominates the relationship between acculturation and cardiovascular health for Hispanics in the U.S.

Figure 9. Summary of the Relationships between the Four Individual Acculturation Markers and the Six Individual Metabolic Biomarkers

	High Triglycerides	**High Diastolic BP**	**High Systolic BP**	**Low HDL**	**Hyperglycemia**	**Central Obesity**
Acculturation Metric:						
Linguistic Acculturation (English Speaking Scale)	**Positive**	**Positive**	**Positive**			**Positive**
Citizen vs. Non-Citizen			**Negative**			
First Generation vs. Native U.S.	**Positive**	**Positive**	**Negative**			**Positive**
Second Generation vs. Native U.S.		**Positive**	**Positive**	**Negative**		**Negative**
Less Than 10 Years in the U.S. vs. More than 20					**Negative**	**Negative**
10-20 Years in the U.S. vs. More than 20						**Negative**

***Legend:**

Significant relationship; same for males and females
Significant relationship; stronger for females than males
Significant relationship; stronger for MALES than females

VI. Sensitivity Analyses

To attempt to lend even further credence to the results shown in the foregoing section, I present a few sensitivity analyses to address principle concerns and limitations of the sample data. I present three useful checks on the robustness of the findings sequentially, focusing first on the notion of “Hispanics” as a group, followed by a check on the measurement decisions for age, and finally a comparison between different age groups. These stratified models serve to bolster the primary results, and inform ensuing conclusions.

Extant literature has long recognized certain heterogeneity within the U.S. Hispanic population in terms of origin nation and racial identity. Indeed to amalgamate all Hispanics into one group seems to run counter to the fundamental core value of this research, specifically a focus on disparateness of independent variables (the acculturation metrics), dependent variable(s) (the metabolic health indicators), and their intrinsic relationships for both men and women. However, while NHANES does collect data on the “origin nation” for those who identify their ethnicity as Hispanic, only Mexican Americans were sampled in great enough number to provide enough statistical power to differentiate Hispanics. Shown in table 11 are the results for the regression models using generational designation as the temporal metric when including a dummy variable indicating that the individual is of Mexican origin (=1) or some other nation (=0), thus mirroring table 7 and stratifying by race. Similarly, in table 7 are the results for the regression models using length of time in the U.S. as the temporal metric when including a dummy variable indicating that the individual is of Mexican origin (=1) or some other nation (=0), thus mirroring table 9 and stratifying by race. Note that the inclusion of the dummy variable indicating Mexican heritage reduced the sample size from 1,938 to 1,852.

Table 11. Results for Regression of the Metabolic Risk Indicator Count Index on Three Indicators of Hispanic Acculturation Stratified by Race

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Linguistic Acculturation	0.07 (.03)**	1.04 (.02)**	1.06 (.02)***	1.04 (.02)**	1.05 (.02)***	1.07 (.02)****
First Generation	0.31 (.30)	1.23 (.21)	1.19 (.21)	1.12 (.22)	1.28 (.22)	1.63 (.32)**
Second Generation	-0.39 (.28)	0.78 (.13)	0.78 (.13)	0.68 (.17)	0.79 (.13)	0.69 (.16)
Citizen	-0.44 (.38)	0.80 (.16)	0.74 (.15)	0.78 (.17)	0.89 (.20)	0.97 (.17)
Income to Poverty Ratio	0.01 (.07)	1.00 (.04)	1.00 (.04)	1.01 (.04)	1.00 (.04)	1.02 (.03)
Less than High School	-0.06 (.22)	0.99 (.13)	1.04 (.12)	0.99 (.12)	1.04 (.11)	1.11 (.12)
Middle Age	0.80 (.22)***	1.57 (.19)***	1.51 (.19)***	1.56 (.19)***	1.57 (.19)***	1.51 (.17)***
Old Age	1.08 (.25)****	1.80 (.25)****	1.75 (.23)****	1.89 (.26)****	1.81 (.26)****	1.60 (.18)****
Female	-0.39 (.24)	0.79 (.12)	1.14 (.22)	0.64 (.18)	1.27 (.36)	3.48 (1.90)**
Drinker	-0.22 (.25)	0.87 (.13)	0.90 (.14)	0.87 (.13)	0.83 (.12)	0.82 (.12)
Smoker	-0.01 (.19)	0.98 (.11)	0.93 (.11)	0.99 (.11)	0.97 (.11)	0.96 (.11)
Metabolic Activity Score	0.01 (.01)	1.00 (.01)	1.00 (.01)	1.00 (.01)	1.00 (.01)	1.00 (.01)
Diabetes Pill	1.04 (.29)***	1.48 (.18)***	1.53 (.18)***	1.49 (.17)***	1.45 (.17)***	1.62 (.22)***
Mexican	0.21 (.19)	1.13 (.13)	1.15 (.12)	1.16 (.14)	1.12 (.13)	1.12 (.12)
Female * Linguistic Acculturation			0.96 (.01)**			0.93 (.02)***
Female * First generation				1.34 (.45)		0.43 (.18)**
Female * Second generation				1.09 (.40)		3.78 (1.46)***
Female * Citizen					0.54 (.19)*	0.56 (.22)

Notes: Model 1 reported in OLS beta coefficients, Models 2 to 6 reported in Incident Risk Ratios. Numbers in parentheses are standard errors.
Number of observations = 1,852 ****p<.001, ***p<.01, **p<.05, * p<.10

Comparing tables 8 and 11, and tables 9 and 12, results are indeed consistent. Most importantly, the inclusion of the dummy variable indicating that a person was of Mexican origin was insignificant indicating that there was no difference in the relationships between the four main acculturation measures and metabolic health for Mexican and Non-Mexican Hispanics. Though I am limited in my comparison of Hispanics from other origin nations, that the results are not driven by Mexicans vs. non-Mexicans is reassuring the general conclusions about Hispanic acculturation and cardiovascular health. If anything, results are seemingly stronger in table 11 than table 7 in terms of the relationships between linguistic acculturation and generational status (for both men and women) when accounting for Mexican origin.

Nonetheless, results are quite robust to the inclusion of a variable identifying those U.S. Hispanics of Mexican origin.

Table 12. Results for Regression of the Metabolic Risk Indicator Count Index on Three Indicators of Hispanic Acculturation Stratified by Race

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Linguistic Acculturation	0.11 (.05)*	1.06 (.03)**	1.08 (.03)***	1.07 (.02)***	1.07 (.03)***	1.07 (.02)***
Less than 10 Years in the U.S	0.02 (.43)	1.04 (.22)	1.01 (.19)	0.83 (.15)	0.92 (.16)	0.85 (.15)
Less than 20 Years in the U.S, More than 10	-0.06 (.58)	0.96 (.30)	0.95 (.29)	0.79 (.24)	0.91 (.25)	0.82 (.23)
Citizen	-0.53 (.43)	0.78 (.16)	0.83 (.14)	0.88 (.15)	0.97 (.17)	0.96 (.17)
Income to Poverty Ratio	0.00 (.11)	1.00 (.06)	1.01 (.06)	1.00 (.07)	1.01 (.06)	1.01 (.07)
Less than High School	-0.11 (.28)	0.98 (.16)	1.09 (.20)	1.07 (.20)	1.04 (.17)	1.08 (.21)
Middle Age	0.65 (.40)	1.46 (.32)*	1.37 (.29)	1.42 (.29)*	1.48 (.31)*	1.42 (.29)*
Old Age	0.84 (.48)*	1.61 (.39)**	1.48 (.31)*	1.42 (.28)*	1.37 (.28)	1.33 (.27)
Female	-0.26 (.28)	0.87 (.16)	1.14 (.30)	0.50 (.12)	1.39 (.32)	0.81 (.34)
Drinker	-0.08 (.35)	0.97 (.20)	1.01 (.22)	0.86 (.13)	0.84 (.14)	0.83 (.14)
Smoker	-0.14 (.32)	0.93 (.17)	0.92 (.16)	0.95 (.17)	0.93 (.17)	0.94 (.17)
Metabolic Activity Score	0.02 (.02)	1.01 (.01)	1.00 (.01)	1.01 (.01)	1.00 (.01)	1.00 (.01)
Diabetes Pill	1.68 (.32)****	1.97 (.25)****	1.93 (.28)****	1.96 (.33)****	1.93 (.31)****	1.94 (.35)***
Mexican	0.20 (.24)	1.15 (.17)	1.14 (.17)	1.08 (.14)	1.12 (.14)	1.08 (.13)
Female * Linguistic Acculturation			0.94 (.04)			0.99 (.04)
Female * Less than 10 Years				2.48 (.94)**		1.77 (.69)
Female * Less than 20 Years				3.10 (1.21)***		2.28 (.96)*
Female * Citizen					0.38 (.14)**	0.60 (.19)

Notes: Model 1 reported in OLS beta coefficients, Models 2 to 6 reported in Incident Risk Ratios. Numbers in parentheses are standard errors.
Number of observations = 1,852 ****p<.001, ***p<.01, **p<.05, * p<.10

As a second sensitivity check, I included age as a continuous, rather than categorical variable. Because of the statistically derived non-linear nature of the association between age and one's count of metabolic indicators(I used ladder functions in STATA 13 to justify the use of a quadratic measure for age), when modeled as a continuous variable, I included age (as a centered variable) and age squared. Again, I performed separate regression for the two temporal acculturation metrics; as such, table 13 is analogous to table 7, while table 14 mirrors table 9. The level of consistency lends credibility to the findings with the categorical age designation. If anything, results for the relationship between linguistic acculturation and metabolic health are stronger when using age as a continuous variable, though the story remain the same. Generational status is slightly affected in terms of significance level, though the directionality of the relationships is quite consistent. Sex differences, notably the female difference between Hispanic citizens and non-citizens and generational differences also show up when using the continuous age metric. Indeed, none of the major conclusions change when using a continuous quadratic age term; this supports the overall findings of the research and justifies the use of a categorical age designation which, as will be shown in the ensuing sensitivity analysis, is more suitable to an analysis of population health such as this.

Table 13. Results for Regression of the Metabolic Risk Indicator Count Index on Three Indicators of Hispanic Acculturation Using a Continuous Quadratic Age Variable

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Linguistic Acculturation	0.07 (.03)***	1.04 (.01)****	1.05 (0.01)****	1.04 (.01)***	1.05 (.01)***	1.06 (.01)****
First Generation	0.27 (.35)	1.20 (.23)	1.20 (.22)	1.13 (.25)	1.26 (.22)	1.63 (.34)**
Second Generation	-0.45 (.29)	0.76 (.14)	0.79 (.14)	0.68 (.18)	0.78 (.14)	0.68 (.17)
Citizen	-0.41 (.38)	0.82 (.16)	0.79 (.16)	0.81 (.16)	0.92 (.19)	1.04 (.17)
Income to Poverty Ratio	-0.01 (.06)	0.98 (.03)	0.99 (.03)	0.99 (.03)	0.99 (.04)	1.00 (.03)
Less than High School	0.03 (.21)	1.02 (.13)	1.06 (.12)	1.02 (.13)	1.07 (.12)	1.13 (.13)
Age	0.05 (.01)****	1.03 (.01)****	1.03 (.01)****	1.03 (.01)****	1.03 (.01)****	1.03 (.01)****
Age Squared	0.01 (.00)**	1.01 (.00)***	1.01 (.00)***	1.01 (.00)***	1.01 (.00)***	1.01 (.00)***
Female	-0.51 (.23)**	0.73 (.10)**	1.01 (.19)	0.63 (.17)	1.19 (.34)	2.14 (1.74)
Drinker	0.29 (.24)	0.88 (.12)	0.87 (.12)	0.85 (.13)	0.87 (.11)	0.88 (.12)
Smoker	-0.02 (.19)	1.03 (.11)	1.03 (.12)	1.02 (.12)	1.04 (.11)	1.03 (.11)
Metabolic Activity Score	0.01 (.01)	1.01 (.01)	1.00 (.01)	1.00 (.01)	1.00 (.01)	1.00 (.01)
Diabetes Pill	1.00 (.30)***	1.45 (.18)***	1.45 (.19)***	1.47 (.18)***	1.41 (.18)	1.56 (.22)****
Female * Linguistic Acculturation			0.97 (.01)**			0.94 (.02)***
Female * First generation				1.18 (.38)		1.34 (.17)**
Female * Second generation				1.17 (.44)		2.39 (1.11)**
Female * Citizen					0.54 (.20)*	0.49 (.21)*

Notes: Model 1 reported in OLS beta coefficients, Models 2 to 6 reported in Incident Risk Ratios. Numbers in parentheses are standard errors.
Number of observations = 1,852 ****p<.001, ***p<.01, **p<.05, * p<.10

Table 14. Results for Regression of the Metabolic Risk Indicator Count Index on Three Indicators of Hispanic Acculturation Using a Continuous Quadratic Age Variable

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Linguistic Acculturation	0.11 (.06)*	1.06 (.02)**	1.08 (.02)***	1.07 (.02)***	1.07 (.02)***	1.08 (.02)****
Less than 10 Years in the U.S	0.29 (.51)	1.22 (.33)	1.22 (.30)	0.98 (.23)	1.09 (.27)	1.01 (.23)
Less than 20 Years in the U.S, More than 10	-0.11 (.52)	0.93 (.28)	0.94 (.28)	0.77 (.23)	0.89 (.26)	0.80 (.22)
Citizen	-0.39 (.42)	0.85 (.16)	0.92 (.15)	0.94 (.17)	1.04 (.19)	1.02 (.18)
Income to Poverty Ratio	-0.03 (.12)	0.92 (.07)	0.92 (.06)	0.93 (.07)	0.94 (.07)	0.94 (.07)
Less than High School	0.05 (.27)	1.08 (.18)	1.22 (.23)	1.15 (.22)	1.16 (.19)	1.19 (.24)
Age	0.03 (.02)**	1.02 (.01)*	1.02 (.01)*	1.02 (.01)	1.02 (.01)	1.02 (.01)*
Age Squared	0.01 (.00)	1.00 (.00)	1.00 (.00)	1.00 (.00)	1.00 (.00)	1.00 (.00)
Female	-0.47 (.32)	0.75 (.17)	1.05 (.27)	0.44 (.13)**	1.25 (.31)	0.77 (.33)
Drinker	-0.18 (.38)	0.90 (.20)	0.96 (.22)	0.81 (.14)	0.79 (.14)	0.80 (.15)
Smoker	0.07 (.30)	1.02 (.18)	1.02 (.18)	1.02 (.18)	1.02 (.18)	1.02 (.18)
Metabolic Activity Score	0.01 (.02)	1.01 (.01)	1.00 (.01)	1.00 (.01)	1.00 (.01)	1.00 (.01)
Diabetes Pill	1.67 (.37)****	1.99 (.28)****	1.95 (.30)****	1.94 (.36)****	1.97 (.35)****	1.93 (.38)***
Female * Linguistic Acculturation			0.93 (.04)*			0.97 (.03)
Female * Less than 10 Years				2.43 (.93)*		1.66 (.66)
Female * Less than 20 Years				1.59 (1.36)*		2.59 (1.10)**
Female * Citizen					0.38 (.14)**	0.63 (.20)*

Notes: Model 1 reported in OLS beta coefficients, Models 2 to 6 reported in Incident Risk Ratios. Numbers in parentheses are standard errors.
Number of observations = 1,852 ****p<.001, ***p<.01, **p<.05, * p<.10

For my final sensitivity check, I looked at models stratified by the categorical designations for age. As discussed, females experience different metabolic aging process than men, relating to the onset of menopause (Ryan et al., 1994; Carr 2003). Shown in table 15 are results analogous to table 7 with those who are ages 65 and above (old age in my categorical conception) excluded. Again, like with the sensitivity check for the continuous age measure, the uniformity in the conclusions demands results with only one of the two temporal metrics. Note that the exclusion of the old age category (along with the inclusion of sex as moderating variable) allows for both a direct comparison of young adult females with middle adult females (those who are entering the menopause range), and an analysis of whether results were chiefly driven by the 65+ U.S. Hispanic population. Note that the exclusion of the old adult population reduces the sample size from 1,938 to 1,329.

Encouragingly, the associations between linguistic usage, citizenship status, and generational designation with metabolic health do not change when excluding the 65+ portion of the population. Indeed, these results are even more robust as those U.S. Hispanics ages 45-64 (middle age) have significantly ($p<.01$) higher expected counts of adverse cardiovascular indicators than those ages 20-44 (young adults). The general trends shown in the results section hold in this, and the previous two sensitivity checks, thus increasing the confidence in the findings. Moreover, this sensitivity check supports the use of a categorical age designation when looking at population health differences by sex as variable processes and factors arise at different stages of the life course for females. Having assured that the findings are not driven my latent heterogeneity of the sample, and/or measurement choices, I can now move to the overall conclusions of this research.

Table 15. Results for Regression of the Metabolic Risk Indicator Count Index on Three Indicators of Hispanic Acculturation with Those Ages 65 and Over Excluded

	Model 1	Model 2	Model 3	Model 4	Model 5
Linguistic Acculturation	1.04 (0.02)***	1.05 (0.02)***	1.04 (0.01)***	1.05 (0.02)***	1.06 (0.02)***
First Generation	1.46 (0.29)	1.42 (0.27)	1.25 (0.27)	1.57 (0.30)**	1.68 (0.38)**
Second Generation	0.78 (0.18)	0.80 (0.18)	0.64 (0.18)	0.80 (0.18)	0.65 (0.18)
Citizen	0.90 (0.15)	0.86 (0.15)	0.87 (0.16)	1.02 (0.19)	1.03 (0.19)
Income to Poverty Ratio	1.03 (0.04)	1.03 (0.04)	1.05 (0.03)	1.03 (0.04)	1.03 (0.04)
Less than High School	0.95 (0.14)	0.99 (0.14)	0.95 (0.13)	1.00 (0.13)	1.07 (0.14)
Middle Age	1.45 (0.17)***	1.40 (0.17)***	1.42 (0.17)***	1.47 (0.17)***	1.54 (0.19)***
Female	0.77 (0.17)	1.16 (0.37)	0.48 (0.12)	1.34 (0.47)	2.40 (1.52)
Drinker	1.07 (0.21)	1.04 (0.21)	1.13 (0.24)	1.00 (0.20)	0.92 (0.19)
Smoker	0.92 (0.12)	0.89 (0.12)	0.91 (0.12)	0.90 (0.12)	0.95 (0.12)
Metabolic Activity Score	1.00 (0.01)	1.00 (0.01)	1.00 (0.01)	1.00 (0.01)	1.00 (0.00)
Diabetes Pill	1.64 (0.29)***	1.67 (0.30)***	1.70 (0.29)***	1.63 (0.30)**	1.73 (0.33)**
Number of Births	1.03 (0.06)	1.00 (0.06)	1.02 (0.06)	1.02 (0.05)	1.02 (.06)
Female * Linguistic Acculturation		0.97 (0.02)*			0.96 (0.03)
Female * First generation			2.01 (0.65)**		0.61 (0.31)
Female * Second generation			1.07 (0.48)		2.91 (1.53)**
Female * Citizen				0.49 (0.19)*	0.42 (0.18)**

Notes: Model 1 through 5 reported in Incident Risk Ratios. Numbers in parentheses are standard errors. Number of observations = 1,329
****p<.001, ***p<.01, **p<.05, * p<.10

VII. Discussion

The preceding analysis provides the framework by which to examine the proposed hypotheses regarding Hispanic acculturative processes and metabolic dysregulation as detailed previously. First, I demonstrated how the wide variation in the classification of metabolic health across a range of definitional approaches and conceptualizations necessitated a count, rather than a binary “cut-off” measure. Additionally, in line with prior research (Ford et al., 2002; Steffen et al., 2006; Go et al. 20014) I find evidence for higher aggregate counts on the metabolic risk index for Hispanic adults in the U.S.

than the U.S. population average, confirming the first proposed hypothesis.[21] However, the ultimate goal of this research is to understand intra-Hispanic heterogeneity and the main analysis focused on this variability.

Investigating overall acculturation trends for U.S. Hispanics and their association with metabolic risk indicators yielded mixed results which in general confirmed our hypotheses but occasionally countered them. As the most robust acculturation metric in the modeled relationship, increased English usage (as opposed to Spanish use) for Hispanic immigrants in the U.S. is positively related to higher counts of metabolic risk indicators. This unidirectional relationship exists for the entire U.S. adult Hispanic population but is most salient for men; therefore I find solid support for the first part of hypothesis two, as well as support for hypothesis four with regard to the linguistic acculturation measure as gender variation is evident for language usage. Considering that this linguistic metric taps into linguistic patterns in a variety of contexts (the measure includes reported language(s) read and spoken, language(s) usually spoken at home, language(s) usually used with friends etc.), a potential mechanism driving acculturative change reflected in this metric is one's social network. Research focusing on acculturation processes and social support has indicated a strong positive effect of larger Spanish speakingsupport networks for Hispanic immigrants including better overall health (Finch and Vega 2003). Thus, this linguistic metric could be capturing changes in one's social network as the amount of English one could be reflective to what types of people a person is connected to in the social milieu and the results of changes in these linguistic connections. Indeed this process of assimilating toward the dominant (English) language in the U.S. could operate in two ways; Hispanic immigrants could be losing connective ties with Spanish speakers as they move from more Spanish to more English usage, or this could signal increased connections to English only speakers, indeed a bidirectional process. This finding gives credibility to acculturation theories overall and allows for variation between the typology of acculturative pathways (*integration*, *assimilation*, *marginalization*, and *separation).* Indeed this variation

[21] In addition to having higher scores than the aggregate population, Hispanics had lower average scores than blacks; they had decidedly higher scores than whites.

in acculturative strategies seems to expose differences in the cardiovascular health profiles between assimilation and separation strategists (the poles of the typology) as the later fares better in terms of metabolic health, particularly for males, in terms of their linguistic usage. U.S. Hispanics opting for more integrative approaches to their new culture exist somewhere in between when it comes to their language use in different social settings. While I have no way to investigate the marginalization pathway, for the other three pathways the results show that linguistic assimilation (in the totalizing sense) is detrimental to metabolic health while linguistic integration and linguistic separation are acculturative pathways for immigrants to maintain better cardiovascular disease profiles.

However, I find little evidence that citizenship is a meaningful acculturation metric for assessing metabolic health of Hispanics in the U.S. in total, but there is meaningful variation for women. I have evidence to counter the second part of hypothesis two but support hypothesis four in terms of citizenship status. Hispanic females who are not citizens exhibit higher expected counts of metabolic risk indicators than their counterparts who are citizens. While this contradicts a unidirectional assimilation relationship in terms of moving from a non-U.S. citizen to a naturalized U.S. citizen, there are other factors that could be driving this relationship. I cannot disentangle the motivations for non-citizenship status as these individuals could be undocumented migrant workers, immigrants who are going through the naturalization process but have not reached the (egregious) citizenship qualifications, permanent via holders, or simply immigrants who do not wish to undertake this tedious process. Studies have indicated that immigrant women who are not citizens are more likely to have low SES, and less likely to have a regular physician and/or health insurance (Marshall et al. 2005). Particularly for adult women as they age (as the sample only includes Hispanic ages twenty and above), lacking access to health care is calamitous for individual health profiles. Extending the network mechanism to this acculturative measure, there is also the potential that female non-citizens lack ties to institutional health care nodes or information networks, or are less likely to seek or procure treatment for metabolic maladies (as a result of their marginalized status). Nevertheless, the process of Citizenship is one that, if anything (especially considering the relationship between language use and metabolic health), is advantageous for overall cardiovascular health for Hispanics in the U.S., though (as discussed previously), I cannot differentiate between the many routes towards naturalization.

The final two parts of hypothesis two deal with temporal acculturative measures, specifically generational status and length of time in the U.S. While these two metrics provide somewhat comparable results, there is much less uniformity in the generational status measure than the length of time measure. Overall there are significantly higher expected counts of the metabolic risk indicators for Hispanics who have been in the U.S for more than 20 years than those who have spent less than 10 years in the U.S. This relationship is supportive of the hypothesis two. Though there is some divergence for men in women for length of time spent in the U.S. for Hispanics, somewhat supporting hypothesis four, there is an relatively consistent pattern where Hispanics who have been in the U.S. for longer periods of time have worse metabolic profiles than those who are new arrivals. Thus, despite differences among the four types of assimilation strategists in terms of their linguistic use, time in the U.S. seems to be an indiscriminate stimulus toward slightly worse metabolic health for U.S. Hispanics. This finding underscores the importance of including different measures for acculturation, some that are amendable (citizenship status and linguistic usage), and others which are not (generational status and length of time spent in the U.S.). This finding could be attributed to a more “Americanized diet” due to a difference in food available in the U.S. vs. that which was available in the sending nations. Indeed, research has shown that first generation Hispanics have healthier diets in their home nations in terms of fat and vitamin intake than those born in the U.S., and have lived in the U.S. for longer periods of time (Dixon et al. 2000).

The second temporal metric, generational status yielded the most anomalous results. As was the case for length of time spent in the U.S., I cannot formally test immigrant selection bias (I have no way to compare those who migrate with those who do not). However, I do observe that for women, first generation migrants have the highest expected counts for the metabolic risk indicators. For men however, it is the second generation U.S. Hispanics who have the highest expected metabolic risk indicator counts. In congruence with the findings for length of time spent in the U.S. I question the healthy migrant theory at least for women. Further, in light of the findings for citizenship status, it seems that the initial transition from sending to receiving country is more burdensome for women than men, however over the long term, this relationship switches as acculturation is more burdensome for Hispanic men's cardiovascular profiles. This is in line with scholarship observing a stress response mechanism as the link between acculturation and health; acculturation has higher stress effects for females than males and reduction of stress is accomplished through mastery/increased self-efficacy (Nicholson et al. 2013). Further, the loss of social support networks for women may be more important in predicting metabolic health than acculturative measures. This mechanism helps clarify some findings. For females, the stress burden from the initial migration is mitigated over time as women become more comfortable with the host society. This explains the worse metabolic health observed early for women followed by steady declines. This could also explain why women do not have the same marked increase in the number of metabolic risk indictors across linguistic acculturation as men as there may be a benefit to integration and assimilation strategies for women that are not present for men.

When taken together the combined picture for this relationship between acculturation and metabolic health indicates that for men, those whose acculturation patterns are characterized by unidirectionality (the assimilation strategists), experience increasingly worse cardiovascular health, while for women there seems to be a more pronounced increase in metabolic dysregulation due to the social and mental consequences tied to international migration that is steadily mitigated by mastery and increased social bonds. The root of the much less pronounced effect of linguistic acculturation for women's metabolic health could be due (in part) to the countervailing process of improvements in metabolic health due to a heightened sense of mastery, reinvigorated social networks, and better access to health care (especially important as females age into menopause). For men, while there is a general negative effect of temporal acculturation (indeed a decidedly less malleable process), retaining one's cultural ties (marked by linguistic use in social settings), specifically those who opt for more integrationist strategies, is metabolically beneficial. While a similar process exists for women in terms of maintenance of Spanish speaking cultural contexts, temporal duration in the U.S. is somewhat more beneficial (or if anything neutral), diverging from the pattern exhibited by Hispanic males. Truly there is considerable variation in metabolic health outcomes both among acculturative processes and between males and females in the U.S. Hispanic population.

Finally, I find a great deal of support for the penultimate hypothesis where I account for difference in acculturative processes between the individual metabolic indicators themselves. While directionality remained virtually unchanged across the individual indicators, the magnitude of these associations ebbed and flowed in such a way that necessitated a detailed disaggregation of each of the indicators. The relationship between linguistic acculturation and the indictors varied from highly significant (as with high levels of serum triglycerides, and central obesity), to no relationship (as with hyperglycemia). Variation across the other acculturative measures is apparent, though less robust. Therefore, I continue to assert that linguistic acculturation is the most powerful pathway by which Hispanics vary in their metabolic health profiles as it is the most malleable towards unique strategies for Hispanic immigrants in the U.S. Other covariates such as income, physical activity and age also showed significant effects in these individual indicator models illustrating again the heterogeneity of effects across these indicators. Like the heterogeneity of the relationships between the four acculturative markers and the metabolic health index, the extant variation in those relationships and the individual markers themselves highlights the utility in allowing for variation both in terms of process and relationship.

VIII. Limitations and Directions for Future Research

This study is limited, as all cross sectional studies are limited, in its explanatory power. Because I cannot investigate individual acculturative change over time, I can say nothing about the relationship between acculturative processes and cardiovascular health which manifest over the life course. However, the representativeness of this sample, the inclusion of a variety of acculturation metrics , and the operationalization of metabolic health in an index rather than an "all or none" syndrome does provide some interesting avenues for longitudinal research of this kind, if not some essential findings to guide this scholarship. I also am limited to a sample of adult Hispanics, prohibiting any discussion of these during childhood and adolescence. However, this concern is mitigated by the fact that biological changes during puberty can confound the measurement of metabolic health (for instance, many boys gain central adipose tissue around the waist as they advance closer to puberty, shedding this extra fat as they grow). The fact that this study is limited to adults only limits the scope of the study, but opens the door for future scholarship to investigate these trends for youth/adolescent Hispanics and across the entire life course. Lastly, I did not include a measure of dietary intake in my model. While NHANES does provide (rather complex) dietary information based on self-report food diaries, I did not include it in the model so two reasons. First, dietary intake would potentially over control for the acculturation measures. By definition acculturation indicates the adoption of the dominant culture, including a more "Americanized" diet (fundamentally characterized by high levels of salt and sugar); therefore my model assumes that, like social bonds with English speakers, diet changes across the acculturation measures, both temporally and with different acculturative strategies. Controlling for diet would account for differences in the level of acculturation between Hispanics in the U.S.; but because I wish to make comparisons within the U.S. Hispanic population across levels of acculturation, it would make little sense to control for this variation with diet. Secondly, research has shown that acculturation is linked to metabolic dysregulation above and beyond dietary intake and physical activity (Steffen et al. 2006). Lastly, my outcome measure of the cardiovascular risk index is limited in that in only includes six indicators. While these indicators are crucial in defining a person's cardiovascular disease risk, there is the potential for a number of other biological markers to be implicated in affecting the likelihood of developing cardiovascular diseases including C-reactive protein and albumin levels. Future scholarship should pay attention to medical advances which seek to identify a host of other indicators of metabolic dysregulation to provide even greater detail on how this constellation of metabolic risk indicators operates by different socio-cultural processes to affect individual cardiovascular risk profiles.

Perhaps most importantly, exploratory scholarship of this kind tends to raise more questions than it can answer. While I demonstrated that adaptable acculturative decisions for U.S. Hispanics are linked to metabolic health, specifically that English language usage (as an indicator of one's relative acculturative decisions) is linked with a more negative metabolic profile, I cannot explain why or how this occurs. Certainly social networks, eating habits, access to healthcare/health information, and other lifestyle decisions (linked to linguistic usage in certain settings) certainly factor into the causal mechanism. However, there is no way to test this, hence future scholarship should focus on mechanisms and by which adaptive choices for U.S. Hispanics affect the range of metabolic health profiles across the population. Further, the causal mechanism behind the variation by sex observed in the population can only be hypothesized; future work should continue to account for sex variability to elucidate this divergence in the female and male Hispanic experience across the acculturation process. Finally, the variation in the relationships between the four acculturative indictors and the six metabolic indicators provides a good signpost for future research in this area, though again, mechanistically this research offers little. I implore future research on Hispanic acculturative processes and metabolic health to mind the heterogeneity of process and relationship exposed in this study, and to seek out specific mechanistic engines. Qualitative investigations would be especially adept at uncovering the how these particular processes, notably linguistic usage, manifest in cardiovascular health in a variety of contexts, and which particular settings carry more relative importance. Despite the shortfalls, this research provides some interesting conclusions, as well as several auspicious markers for the direction of future investigations to these ends.

IX. Conclusion

Limitations notwithstanding, this study contributes to the literature in two major ways. First, I use measures for both the independent acculturation variables and the dependent variable which allow for more variation of processes than has been accomplished in any other nationally representative study of this kind. Indeed the findings, substantive conclusions aside, demonstrate the need for more complex measures as there is considerable heterogeneity both in process (acculturation metrics), specific outcomes (individual indicators, and the index of counts), and sex. Not only do these more refined measurement instruments allow for important nuances in the findings, but they also are in line with current acculturation theories which observe variation in strategies for immigrants as they are confronted with the “majority culture” of the receiving nation. Furthermore, my analysis identifies key processes and divergent relationships between acculturation and metabolic health which speak to these variant coping techniques (integration, assimilation, marginalization, and separation) and how they differ by sex. I also conclude that linguistic acculturation provides the most salient metric by which to assess acculturation for males, while time spent in the U.S. and generational status is a more significant process for women (though these processes are operative for both male and females, the variation in the strength of the relationship among acculturation metrics by sex is essential to understanding these relationships). Indeed linguistic usage allows for the more dynamic bidirectional acculturative process for U.S. Hispanics outside of temporal unilinearity. While acculturation processes do seem to increase the risk of cardiovascular maladies for Hispanics, I do not find congruent processes across measures indicating that these acculturation processes are more complex than is accounted for in models looking only at a single metric of acculturation as in prior scholarship. Nevertheless, I conclude that increased acculturation for Hispanics in the U.S. is generally associated with worsening cardiovascular disease risk profiles, though this relationship is characterized by key differences between males and females. Indeed temporal positioning for Hispanics in the U.S. relates negatively to metabolic health for men and slightly positively for Hispanic woman, while acculturative decisions on the sending/receiving (U.S.) nation continuum are much more dire for males than females as males who retain their Spanish speaking contexts fare much better than their counterparts who do not. For women, interestingly, while the maintenance of Spanish speaking social contexts is beneficial to metabolic health (though less so than men), the naturalization process also is associated with better metabolic health (a countervailing trend). The overall trends (and the underlying heterogeneity) can be attributed to a range of decision processes by different Hispanic acculturation strategists. Eating habits, social contexts/attachments, healthcare access, information networks, neighborhood/spatial location, and other decisions made within the matrix of acculturation decisions for Hispanics entering the U.S. could all attribute to these various aforementioned conclusions. And while there is more incongruence among the temporal measures, there is a more constant trend for linguistic usage in which these decision making processes are embedded. In summary, while overall the acculturation process is related more strongly to metabolic health for men, women experience unique circumstances which yield divergent destinies by sex.

This study also adds to the growing literature emphasizing heterogeneity of social change. I accounted for heterogeneity in both my independent and dependent variables and found significant results with complex and idiosyncratic patterns, justifying this logical framework. In this way I demonstrated the superiority of using both a metabolic index and acculturation measures accounting for the variation in process. Furthermore, a decidedly more philosophically governed conclusion, an underlying contribution of this study is the use of precise health measurement derived from biological samples. Sociological research on health outcomes is stymied by inexact measurements including (but not limited to) inaccurate self-reported health, binary "symptom" definitions of constellations of "upstream" health indicators related to morbidity/mortality outcomes, and obesity measures which rely on imprecise conceptions like body mass index. I implore future scholars investigating the socio-cultural influence of health to use more exacting health measures based on laboratory and biological assay/serum analysis lest the field remain mired in an imbroglio of mixed results.

Apart from the theoretical and measurement based conclusions there are also pragmatic uses to be considered; this research is both academically and practically germane. As the growing Hispanic population in the U.S. population reaches historic highs, researchers and clinicians are presented with a range of new health issues and dynamics affecting the aggregate health profile of the U.S. Because Hispanics on the whole have a more adverse metabolic profile than the aggregate U.S. population, they constitute and important demographic segment for which to target metabolic health initiatives. Cardiovascular health, an area identified by the CDC as a major target for public and private health initiatives, for the Hispanic population must be understood in relation to specific social processes unique to immigration and acculturation routes within both the matrix of social decision making processes and temporal progression. I have identified linguistic acculturation as a specific acculturative measure that is critically important to both the overall metabolic health index, as well as several individual biomarkers (specifically obesity, HDL cholesterol, systolic and diastolic blood pressure) which are more strongly linked than others. Indeed, health officials would do well to understand the metabolic health benefit for Hispanics in retaining Spanish linguistic capabilities (relative to English usage) in a range of contexts. As newly arriving Hispanic immigrants develop acculturative strategies in the U.S., linguistic use is considerably more malleable than temporal acculturation and provides a relatively straightforward focal point to alter metabolic health. Temporally, there is less consistent evidence, though the results call the healthy migrant theory into question, conceivably suggesting a more complex mechanistic process. Additionally, sex plays an important role in moderating this relationship as females seem less negatively impacted by the shift towards U.S. culture than do men. This research adds to the current understandings regarding a medically important phenomenon (declines in cardiovascular health in the U.S.) and an important demographic transition in the U.S. (the growth of the Hispanic population), and fuses these unrelated tends to make a range of substantive and methodological conclusions. Indeed this work should serve as a catalyst to the clarification the underlying causal mechanisms controlling these critical conclusions.

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Appendices

Appendix A. Logistic Regression of the Metabolic Syndrome (Binary) with a Threshold of Three Adverse Indicators on Four Indicators of Hispanic Acculturation: Five and Six Item Definition of the Metabolic Syndrome[22] with Separate Results for Both Acculturative Time Metrics

	Six Item Metabolic Syndrome	**Six Item Metabolic Syndrome**	**Five Item Metabolic Syndrome**	**Five Item Metabolic Syndrome**
Linguistic Acculturation	0.14 (.07)**	0.14 (.08)	0.11 (.08)	0.08 (.07)
First Generation	0.70 (.94)		0.70 (.95)	
Second Generation	-0.50 (.72)		-0.24 (.68)	
Less than 10 Years in the U.S		-2.34 (1.37)		-2.91 (1.61)
Less than 20 Years in the U.S, More than 10		-0.94 (.92)		-0.55 (.88)
Citizen	-0.17 (.77)	0.45 (.83)	-0.17 (.77)	0.16 (.94)
Income to Poverty Ratio	-0.12 (.10)	-0.10 (.25)	-0.30 (.12)**	-0.37 (.26)
Less than High School	0.67 (.51)	0.59 (.80)	1.17 (.62)*	1.31 (.94)
Middle Age	0.79 (.38)**	0.31 (.83)	0.54 (.41)	0.58 (.86)
Old Age	0.34 (.51)	1.72 (1.21)	-0.67 (.52)	2.03 (.98)*
Female	2.37 (1.74)	2.87 (2.14)	1.70 (1.49)	1.46 (1.94)
Drinker	-0.03 (.69)	2.87 (1.29)	0.37 (.61)	2.95 (1.20)**
Smoker	-0.37 (.39)	0.10 (.61)	-0.57 (.38)	-0.37 (.76)
Metabolic Activity Score	-0.02 (.02)	-0.02 (.04)	-0.01 (.02)	0.04 (.04)
Diabetes Sugar Pill	2.32 (.83)***	3.62 (1.35)***	2.82 (.81)****	4.27 (1.51)***
Female * Linguistic Acculturation	-0.19 (.09)**	-0.28 (.15)*	-0.18 (.08)*	-0.19 (.15)
Female * First generation	-3.49 (1.91)*		-1.23 (1.29)	
Female * Second generation	1.26 (1.31)		1.62 (1.34)	
Female * Less than 10 Years		0.72 (2.53)		0.45 (2.46)
Female * Less than 20 Years		0.22 (1.62)		0.31 (1.54)
Female * Citizen	-2.21 (1.44)	-3.02 (1.53)*	-0.80 (1.11)	-2.45 (1.56)

Notes: Models 1 through 6 reported in Logged Odds. Numbers in parentheses are standard errors.
Number of observations = 1,938 ****p<.001, ***p<.01, **p<.05, * p<.10

[22] Note that the Five Item Definition of the Metabolic Syndrome is based on total blood pressure, waist circumference, total triglycerides, HDL cholesterol, and long term blood glucose levels. The Six item definition for the metabolic syndrome simply divides the blood pressure measure into both systolic and diastolic blood pressure while retaining the other indicators. Both definitions use a threshold of three or more adverse indicators to indicate the metabolic syndrome.

Appendix B. Inter-Item Reliability Test of the Linguistic Acculturation Scale using Cronbach's Alpha

	Observations	Sign	Item-Test Correlation	Item-Rest Correlation	Average Inter-Item Covariance	Alpha
Language Used to Read	1,938	+	0.94	0.91	1.94	0.93
Language Used as a Child	1,938	+	0.85	0.76	2.02	0.95
Language Used at Home	1,938	+	0.92	0.87	1.86	0.93
Language Used to Think	1,938	+	0.93	0.89	1.79	0.92
Language Used with friends	1,938	+	0.91	0.86	1.86	0.93

Appendix C. Correlations Among the Six Indicators Used on the Metabolic Risk Index

	High Triglycerides	High Diastolic BP	High Systolic BP	Low HDL	High HbA1c	Central obesity
High Triglycerides	1.000					
High Diastolic BP	0.026	1.000				
High Systolic BP	0.104	0.441	1.000			
Low HDL	0.280	0.0503	0.018	1.000		
High HbA1c	0.2471	-0.008	0.094	0.080	1.000	
Central obesity	0.164	0.0290	0.052	-0.016	0.126	1.000