"At Risk" Cardiovascular Health Profiles: Metabolic Dysregulation and Acculturative Processes for Latino Americans

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I. Introduction

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Synchronous trends have emerged in the cardiovascular health profile of the United States. Obesity rates, incidence of type II diabetes, hyperglycemia, and cardiovascular morbidity in general have all increased over the past several decades (Flegal et al. 2012; Hubert et al. 1983; Danaei et al. 2011, Isomaa et al. 2001). These and other cardiovascular health problems have been shown to have interrelated underlying biological markers, collectively expressed as the "metabolic syndrome" (Ford et al. 2002). The metabolic syndrome (henceforth MetS) refers to a combination of health indicators that impact cardiovascular morbidity through the development of insulin resistance (Grundy, 1999). Defined in various ways, definitions for MetS typically include some indicators for glucose intolerance, obesity, hypertension, and adverse serum lipid levels (Eckel et al. 2005). MetS is typically conceived as a sum total of the indicators whereby a "cut-off" for MetS is established (Ford et al. 2002). We rely on the W.H.O conception of MetS in this analysis using indications of high blood pressure, high triglycerides, low high density lipoprotein levels, central obesity, and elevated long term glucose levels (Alberti and Zimmet 1998). Indeed, MetS has been shown to worsen cardiovascular health, increasing the likelihood of heart disease, stroke, diabetes and other cardiovascular maladies (Isomaa et al. 2001; Lakka et al. 2002).

Germaine to our study, there is evidence for an increased prevalence of the MetS in Mexican Americans compared to whites and blacks (Ford et al. 2002). Further, evidence regarding acculturative processes for Latinos is decidedly mixed; some studies have shown a "protective" effect of acculturation in Hispanics in lowering the odds of MetS indicators (de Heer et al. 2011), others have shown that there is no influence (Kollannoor-Samuel et al. 2011). However, the majority of studies have demonstrated that acculturation may increase the metabolic risk profiles of Latino immigrants based on the theoretical underpinnings of the "Hispanic paradox", and the "Healthy Migrant Theory" (Gordon-Larsen et al. 2003). The former argues that despite lower overall socioeconomic status, recently emigrated Hispanic immigrants experience a 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), while the latter is based on the notion that those who emigrate have the superior health profiles (those who are in poorer health are less able to cross transnational boundaries) and therefore confound scholarship in this field as a result of selection biases (Abrafdo-Lanza et al.1999). Thus, Latino immigrants enter the U.S.with better cardiovascular profiles. Further, studies have shown that gender differentials exist in indicators of cardiovascular disease risk (Goedecke et al. 2009). Age and race too have been shown to be important predictors as hyperglycemia differing among age groups and across racial categories of the same ages (Saaddine, 2002). As with demographic variation, studies using a gamut of methodical procedures have shown that both education and income are inversely related to various elements of the metabolic syndrome (Seeman et al. 2008). Physical activity, smoking, and drinking too have been linked to poor cardiovascular outcomes (Lakka et al. 2002).

While there is general agreement that the biomarkers indicated in MetS are related to cardiovascular problems, the application has been inconsistent. The syndrome has been defined in various ways and relied on different cut off levels, sometimes defined as the presence of two or more of these indicators (Isomaa et al. 2001), other times as three or more (Alberti et al. 2009). Both notions obscure both the differences in individuals with one or two indicators (the cardiovascular "at risk" group), those who have none (the excellent cardiovascular health group). Moreover, individuals with three conditions are treated the same as those with five. Further, these conceptualizations do not allow for potentially different generative processes for MetS indicators: those who always have zero and those who may score on the count measure for MetS. Further, there is inconsistent, non-representative evidence for the relationship between acculturative processes for Latinos in the U.S. and the impact on their health profiles; there is also little research on gender gaps in the impact of Latino acculturation on cardiovascular disease.

To address these issues, we pose an investigation of how acculturative processes for U.S. Latinos relates to increased markers of MetS. In our analysis, MetS is not applied as a binary measure but as a count measure where predicted counts can span the range of indicators, thus illuminating subtle nuances within individual biological indicators for cardiovascular dysregulation. Additionally, we look at how different acculturative processes affect the overall count of MetS indicators and each individual indicator therein. Finally, we will test for gender variation within the relationship. The following hypotheses will be tested:

H_1: *Higher levels of acculturation for Latinos are associated with higher counts of MetS indicators*.

H_2: *Gender variation in these associations exists.*

H_3: *Health behaviors and socioeconomic status will be related to counts of MetS indicators, but will not completely account for the relationship between acculturative processes and MetS indicators.*

H_4: *Each of the MetS indicators will contribute differently to the overall relationship between MetS indicator counts and Latino acculturation.*

II. Methodology

1. Analytic Sample

For our analysis, we used three waves (1999-2000, 2001-2002, and 2003-2004) of The National Health and Nutrition Examination Survey (NHANES), a complex nationally representative multi-stage continuous survey. We drew variables from four of the NHANES modules; the demographics section, examination, laboratory, and health questionnaire. Moreover, we used a weighting schema to adjust for sampling and non-response bias. Because non-response is most prevalent in the examination and laboratory portion of the survey, we constructed six year weights using the mobile examination center weights (MEC) based on strata and PSU's as prescribed in the NHANES methodology handbook (CDC 2013). Our sample includes all "Mexican Americans" and "Other Hispanics" included in these waves. Thus, we arrive at an analytic sample of Latinos who completed all four modules and have sufficient data on all variables described anon. After adjustments using probability weights, we arrive at an analytic sample of 1,852 Latino Americans.

2. Measures

a. Dependent Variable: To investigate our research questions, we used a count measure of six indicators of MetS: 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), hyperglycemia (measured by *glycosylated hemoglobin* where 5.7% marks the "blood glucose threshold"; Osei et al. 2003), hypertension (measured with both systolic and diastolic levels with thresholds of 130 and 85 mm Hg respectively; Ford et al. 2002), High Density Lipoprotein cholesterol (measured by depressed levels of HDL with a threshold of 40 mg/dL for men and 50 mg/dL for women; Ford et al. 2002), and total triglycerides level (measured by high levels of triglycerides using a threshold of 150 mg/dL; Ford et al. 2002). Thus, we construct a six item index assessing MetS.

b. Independent Variables of Interest: To assess Linguistic Acculturation, we created a five-item scale based on individuals' 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 measure was 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).[1] Citizenship status included as a dummy variable with "1" indicating official citizenship and "0" indicating otherwise. We measure the categorical variable Nativity via three dummy variables indicating if a person is a first generation American (both the individual and at least one parent was born outside of the U.S.), a second generation 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.).[2] Note that native born was the excluded category.

c. Control Variables: We included a range of variables which have been shown to be related to cardiovascular health. Drinking alcohol was coded as a dummy variable with "1" for consuming 12+ drinks a year or "0" if they consumed less yearly. Further, we include a dummy variable coded as "1" indicating that the person reports current smoking or "0" if they do not smoke. Physical activity was scored based on self-reported "Metabolic Activity Scores", measured as a composite index of each reported activity and its analogous cardiovascular intensity; higher scores indicate increased physical activity. We controlled for Socioeconomic status using the Family Poverty Income Ratio (PRI), a ratio of family income to the poverty threshold, and a dummy variable for education with "1" indicating a bachelor's degree or higher.[3] To control for diabetes care management, we added a dummy variable indicating whether one takes blood sugar lowering pills as "1" or does not take diabetes medication "0". We also included a continuous (top coded at 85) centered variable for individual age, and gender (a dummy variable with female as "1" and male as "0"). Finally, based on analysis using ladder functions, we included a quadratic age term (based on the centered variable) to account for curvilinearity.

d. Interactions: Interaction effects were included in subsequent models to investigate the possibility of variation in relationships by gender. We interacted all three of the indicators of acculturation with the dummy variable for gender. In our analysis, the interaction between "native born" for the Nativity categorical variable and gender was the excluded category. Hence we included interaction terms between linguistic acculturation and gender, first generation and gender, second generation and gender, and citizenship status and gender.

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[1] Principle component analysis was performed on the linguistic acculturation scale and eigenvalues loaded on one component, justifying the composite measure.

[2] We originally planned on using a fourth indicator of acculturative status for Hispanics, the number of years in the United States. However, we excluded this variable due to high multicollinearity between years in the U.S. and nativity designation.

[3] We initially included a dummy variable indicating a high school degree but the inclusion/exclusion of this variable did not change an relationships in the models.

III. Initial Results

Table I illustrates a series of regression results using count models to estimate the factor change in the expected count of indicators of the MetS for every single unit increase in the specific independent variable (reported in incidence risk ratios with standard errors in parenthesis). Model I estimates the covariates using a standard Poisson regression, model II uses zero inflated Poisson (ZIP) regression, which estimates using two different models: a count model predicting expected counts of MetS indicators for people with counts greater than zero, and a binary model predicting those in the "not always zero group". Model III uses a ZIP regression but includes interaction terms. Based on these there models we can begin to test our hypotheses.[4]

The findings are relatively consistent across the first two models. Not surprisingly, age (included as a curvilinear covariate) and taking blood sugar lowering pills are positively associated with higher expected counts of MetS indicators. More importantly, linguistic acculturation is a highly significant predictor in models I and II. In both models, and increase of five on the scale increases the expected number of MetS indicators by 20%, ceteris paribus. Though this could be accomplished via a number of ways (for example shifting from only speaking Spanish to only speaking English with friends, or moving from mostly Spanish to both equally on all five items), it indicates a general move of one degree on the Linguistic continuum from Spanish to English (0 to 5, 5 to 10 etc.). Also in line with our hypotheses, the incidence rate of the number of metabolic indicators for second generation Latinos (born in the U.S., but at least one parent born outside the U.S.) is between 32%(model I) and 28% (model II) lower than for Latinos born in the U.S. whose parents were also born in the U.S. Both of these evidences indicate that acculturative processes for Latinos are associated with increased numbers of MetS indicators. We see no significance in the binary portion of the ZIP model, indicating that neither age nor physical activity is related to sorting based on always zero and not always zero indicators of MetS. Figure I illustrates the predicted probabilities for all Latinos in the sample across different levels of linguistic acculturation (all else held at their means). For models I and II, we see an essentially stable pattern of higher expected counts of MetS indicators as linguistic scores move from Spanish to English. For instance, the expected number of MetS indicators is less than one for those Latinos who speak exclusively Spanish compared to less than two for those who speak exclusively English.

Model III adds significant interaction terms to the ZIP model specified in model II. Linguistic acculturation remains significant for both males and females, however the effect of adding the interaction terms changes the relationship observed in prior models for women. It seems that while linguistic acculturation exhibits an adverse effect for men, it apparently is protective for women to move from using more Spanish to more English in daily life. This is demonstrated in Model III as the interaction between females and the linguistic acculturation scale is related to lowers the expected count of MetS indicators for female Latinos. Figure II illustrates this point visually; as the expected number of MetS indicators increases from less than one in Spanish only speaking Latino men to nearly two and a half in their English only speaking counterparts. For Latino women, the relationship is much less dramatic, but in the opposite direction as expected counts of MetS indicators drop from 1.54 to 1.2 across Spanish only and English only language usage. This is juxtaposed with Figure III (based on models I and II in Table I) which shows that predicted probabilities for the number of MetS indicators increases across linguistic acculturation for both men and women, though these trends begin at lower levels and are much less salient for women (lending some credence to the differential relationships by gender found in model III when interactions between acculturation and gender were included). Further, we see that physical activity is marginally significant in the binary portion of the ZIP model, indicating that physical activity is decreases the odds of being in the not always zero group for MetS indicators. Thus, high levels of physical activity for Latinos are related to never experiencing any MetS symptoms. Nonetheless, we are hesitant to interpret these results too thoroughly as we have high standard errors and have not yet completed sophisticated model diagnostics.[5]

Lastly, we "decompose" MetS to investigate the indicators that are driving the relationships shown in Table I. Table II shows logistic regression models for each biomarker; model I regresses high levels of total triglycerides on the covariates, model II regresses high diastolic blood pressure, depressed high density lipoprotein levels are regressed in model III, model IV is a logistic model for hyperglycemia, model V looks at obesity, and model VI regresses high systolic blood pressure on the independent variables (using the same sample of 1,852 Latinos). Interestingly, greater linguistic acculturation for Latinos increases the probability of high serum triglyceride levels, high diastolic blood pressure, obesity, and lower high density lipoprotein levels (holding all else constant). Acculturation does not seem to be associated with hyperglycemia or systolic blood pressure. Relationships are predominantly in the direction of the ZIP model including interaction terms. Once more, gender has an interesting

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[4] We also ran models on the sample using ordered logistic, negative binomial, and zero inflated negative binomial regression and found virtually identical patterns

[5] We have inspected multicollinearity issues and a gamut of different model specifications (using "link test"), finding no immediate issues.

interaction effect with linguistic acculturation and the categorical nativity variable where acculturation seems to lower probabilities of the six indicators for Latino women, and increase probabilities for Latino men. Again, based on high standard errors and the need for further model diagnostics prevents us from interpreting the subtle nuances of the findings.

IV. Discussion/Next Steps

We have rather strong evidence for a relationship between more linguistic acculturation and increased counts of MetS indicators and more modest evidence for nativity, despite including SES and healthy behavior covariates thus giving credence to H_1 and H_3. We see initial support for H_2 but are hesitant to draw final conclusions at this time. H_4 must be further investigated; however there does seem to be some initial evidence that there is variability in the influence of indicators (some drive the relationship, others do not, or are less important) on the relationship between acculturative processes and the expected counts of MetS for Latinos. We will continue to build on already promising findings regarding acculturative processes and the indicators of MetS in future analyses. We anticipate expanding interaction effects to investigate the effects of interacting age with all three acculturation variables; data visualization techniques (graphs, charts and trend lines) will be utilized to investigate nuances in the findings, especially with regards to interaction effects. Further, we will use diagnostics to inspect models for fitness and explanatory power. Our theoretical underpinnings and literature review were quite abridged and will be amplified (already completed) in further iterations of this project.

Table I: Regression Models Showing the Effects of Covariates on the Number of Indicators of Metabolic Syndrome in a Nationally Representative Sample of Latino Americans (Reported in Incidence Risk Ratios)

Independent Variables	Model I	Model II	Model III
Linguistic Acculturation	1.04 (.01)***	1.04 (.01)***	1.06 (.01)****
Citizenship	0.81 (.17)	0.81 (.16)	0.99 (.15)
First Generation	1.17 (.22)	1.14 (.20)	1.49 (.26)**
Second Generation	0.68 (.16)*	0.72 (.15)*	0.44 (.11)***
Bachelor's Degree	0.90 (.14)	0.93 (.13)	0.92 (.13)
PIR	0.99 (.04)	1.00 (.03)	1.00 (.03)
Age (centered)	1.03 (.01)****	1.03 (.01)****	1.03 (.01)****
Age^2	1.00 (.00)***	1.00 (.00)****	1.00 (.00)***
Female	0.75 (.10)**	0.72 (.09)***	3.32 (1.76)**
Drinker	0.83 (.12)	0.85 (.11)	0.83 (.11)
Smoker	1.00 (.11)	1.05 (.10)	0.95 (.11)
MET Score	1.00 (.01)	1.00 (.01)	1.00 (.01)
Diabetes Pill	1.48 (.17)***	1.53 (.39)**	1.58 (.23)***
Female/Linguistic Acculturation			0.93 (.02)**
Female/Citizen			0.51 (.21)
Female/First Generation			0.43 (.14)**
Female/Second Generation			3.81 (1.43)***
Inflated Variables (reported in unstandardized coefficients)			
MET Score		-0.36 (.32)	-10.93 (5.97)*
Age (centered)		0.51 (.51)	-0.12 (.24)
Age^2		-0.03 (.02)	-0.04 (.03)

Note: Significant Effects Denoted by *p<.1, **p < .05, ***p < .01, *****p < .001.

Table II: Logistic Regression Models Showing the Effects of Covariates on Each Indicator of Metabolic Syndrome in a Nationally Representative Sample of Latino Americans (Reported in Unstandardized Regression Coefficients)

Independent Variable	Model I	Model II	Model III	Model IV	Model V	Model VI
Linguistic Acculturation	0.13 (.05)***	0.21(.07)**	0.17 (.05)***	0.07 (.06)	0.18 (.06)***	0.01 (.05)
Citizenship	0.12 (.62)	-0.25 (.83)	-1.37 (1.05)	0.55 (.71)	0.46 (.66)	0.35 (.72)
First Generation	1.44 (0.80)*	2.55 (.99)**	0.57 (1.10)	0.90 (.95)	1.14 (.93)	-0.33 (.79)
Second Generation	-1.57 (.87)*	-2.5 (.98)**	-1.61 (1.27)	-0.60 (.96)	-2.20 (.85)**	-1.32 (.89)
Bachelor's Degree	-0.45 (.42)	1.23 (.72)*	0.52 (.50)	-0.53 (.68)	-0.17 (.50)	-0.49 (.36)
PIR	0.02 (.12)	-0.22 (.22)	-0.07 (.14)	-0.13 (.19)	0.15 (.13)	0.08 (.14)
Age (centered)	0.04 (.03)	0.13 (.05)**	0.06 (.03)*	0.09 (.03)***	0.08 (.02)***	0.02 (.02)
Age^2	0.00 (.00)	0.00 (.00)*	0.00 (.00)	0.00 (.00)	-0.01 (.00)**	-0.01 (.00)*
Female	2.87 (1.50)*	6.25 (2.17)***	7.72 (2.19)***	1.85 (2.12)	4.11 (1.56)**	-4.57 (2.63)*
Drinker	0.16 (.44)	1.14 (.79)	-0.07 (.51)	-0.82 (.62)	-1.84 (.66)***	-0.62 (.52)
Smoker	-0.20 (.38)	-1.48 (.47)** *	-0.10 (.50)	-0.19 (.52)	0.50 (.35)	0.31 (.43)
MET Score	0.03 (.02)	0.00 (.02)	-0.01 (.02)	-0.01 (.02)	-0.01 (.02)	0.01 (.02)
Diabetes Pill	1.50 (.70)**	-1.05 (1.21)	-1.36 (.78)*	5.05 (1.00)***	1.42 (.61)**	1.22 (.63)*
Female/Linguistic Acculturation	-0.23 (.07)***	-0.45 (.12)****	-0.38 (.07)****	-0.14 (.10)	0.02 (.08)	0.12 (.16)
Female/Citizen	0.69 (1.33)	-2.14 (1.96)	-3.15 (2.00)	-0.93 (1.88)	-4.53 (1.38)***	-1.22 (1.45)
Female/First Generation	-3.11 (1.03)***	-4.41 (1.49)***	-6.83 (1.75)****	-2.15 (1.62)	0.34 (1.18)	2.06 (2.24)
Female/Second Generation	2.55 (1.66)	6.05 (1.76)***	7.02 (2.11)***	0.90 (1.74)	2.68 (1.45)*	-0.05 (2.69)

Note: Significant Effects Denoted by *p<.1, **p < .05, ***p < .01, *****p < .001.

Figure I: Expected Counts of Metabolic Syndrome Indicators for Models I, II, and III from Table I Across Scores of Linguistic Acculturation in a Nationally Representative Sample of Latino Americans

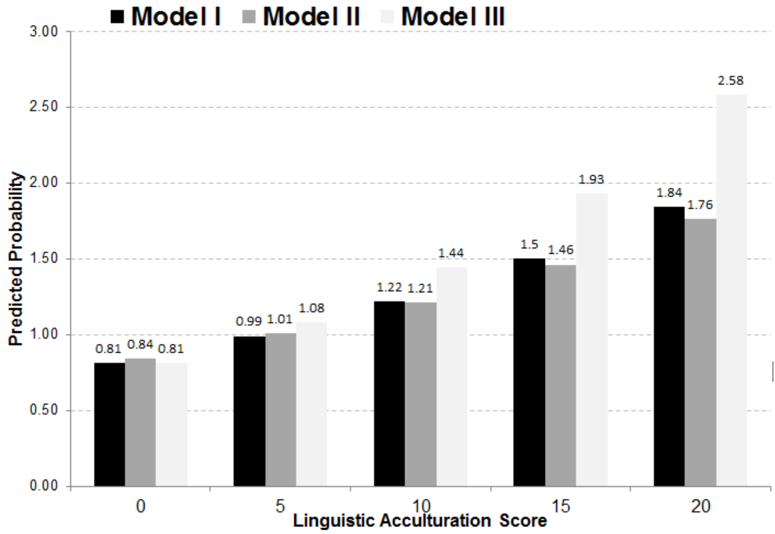


Figure II: Expected Counts of Metabolic Syndrome Indicators for Males and Females from Model III in Table I Across Scores of Linguistic Acculturation in a Nationally Representative Sample of Latino Americans

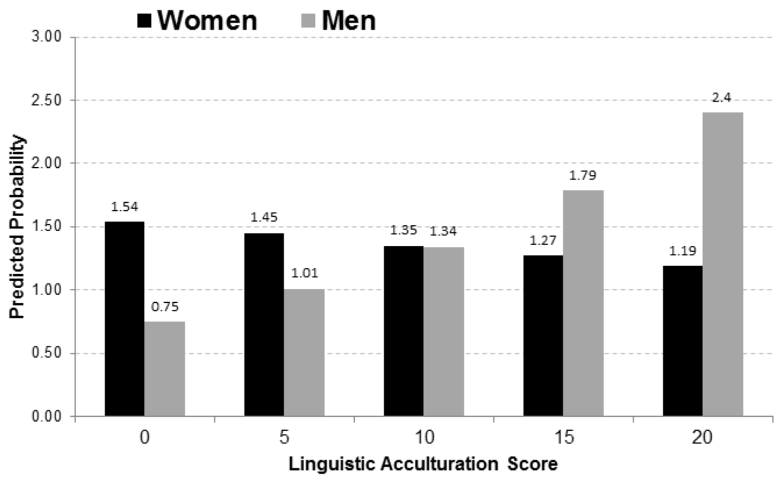
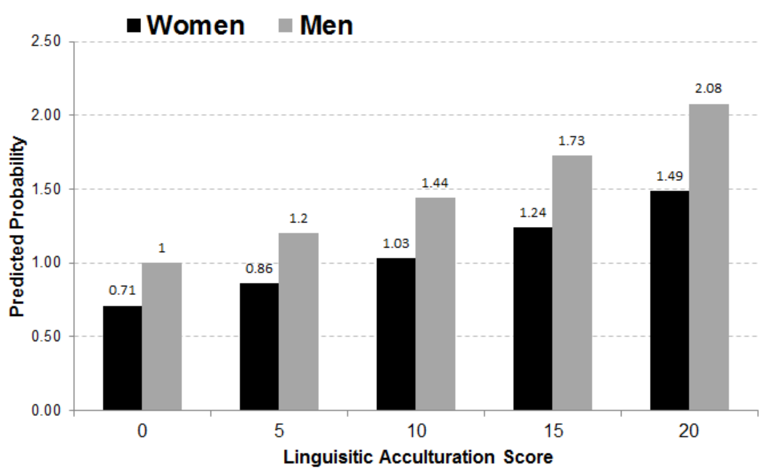


Figure III: Expected Counts of Metabolic Syndrome Indicators for Males and Females from Models I & II in Table I Across Scores of Linguistic Acculturation in a Nationally Representative Sample of Latino Americans



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