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Measures of Acculturation and Relations to Weight Among Mexican-Origin Youth

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MEASURES OF ACCULTURATION AND RELATIONS TO WEIGHT

AMONG MEXICAN-ORIGIN YOUTH

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ABSTRACT

Risk for obesity increases dramatically for Mexican-origin immigrants and their children among upon arrival in the United States. Many studies have shown that acculturative factors play a role in this process for adults, which suggests that this could also be the case for children and adolescents. The significance and directionality of this relation may differ based on many factors, including the multitude of methods currently used for the purpose of measuring acculturation. This study examines the relations between several measures of acculturation and child weight in a sample of 6 to 11 year old, Mexican-origin youth, cross-sectionally and longitudinally over the course of 18 months. Results indicated that two measures, greater preference for English and higher Anglo Orientation, were associated cross-sectionally with higher zBMI. Only one of these measures, English language preference, remained significant in predicting BMI in longitudinal analyses. Neither age nor gender was a significant moderator of the relation between acculturation and child weight. These findings support the theoretical hypothesis that cultural changes, such as the gradual and familial adoption of a high-calorie and low-physical activity lifestyle, may contribute to weight gain among Mexican children.

THESIS

MEASURES OF ACCULTURATION AND RELATIONS TO WEIGHT AMONG

MEXICAN-ORIGIN YOUTH

Introduction

Mexican-origin individuals make up one of the largest minority groups in the

United States (Ennis, Rios-Vargas, & Albert, 2011), and struggle with specific health-

related challenges. The prevalence of obesity among US-born Mexican immigrants and

their children is higher than the prevalence among their counterparts in Mexico

(Hernández-Valero et al., 2012), and higher than the prevalence among other subgroups

of the US population (Ogden, Carroll, Kit, & Flegal, 2014). Furthermore, the heightened

risk of obesity among this population is a growing public health concern: in adulthood,

obesity is correlated with the development of a myriad of chronic diseases, including

diabetes, heart disease, and certain cancers (Oza-Frank & Cunningham, 2010).

Meanwhile, obesity during childhood is also associated with the development of chronic

diseases in childhood, such as sleep apnea, glucose intolerance, and hypertension (Dietz,

1998). In addition, obesity during these two phases of life are not unrelated: obesity in

childhood and adolescence is a risk factor for adult obesity, which is further associated

with increased mortality from chronic disease (Dietz, 1998). Finally, studies have found

that childhood obesity may be related to negative health outcomes later in life even when

controlling for obesity in adulthood (Must, Jacques, Dallal, Bajema, & Dietz, 1992).

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Given these numerous negative outcomes, the growing percentage of the US population that Mexican-origin immigrants comprise, and the risk of obesity among these immigrants in the United States, research and interventions targeting this population are particularly necessary. However, previous interventions that aim to target obesity within this population have been largely unsuccessful. A systematic review of interventions aiming to prevent obesity among Hispanic children found that only 4 of the 9 included studies had significant effects, and calculated effect sizes ranging from small to medium (Branscum & Sharma, 2011). The authors of this review recommend that additional treatment studies consider more fully the cultural context of the population they target, suggesting that a lack of measuring or accounting for acculturative factors may be a component of the interventions' limited success. Though these findings of limited efficacy are not unique to weight-loss interventions among Hispanic youth, the current study contributes to the existing literature by delineating which aspects and measures of the acculturative process are most salient for obesity among Mexican-origin immigrant children, which should allow for greater success in preventing this highly undesirable health outcome.

Before exploring the effects of acculturation on immigrant child weight, it is necessary to define acculturation. Acculturation has been established as a critical factor in the way that immigrant groups to the US fare in terms of health outcomes and health behaviors (Alegria, 2009). A broad and multidimensional concept, acculturation aims to capture many aspects of an immigrant adult or child's life. The most widely accepted definition was created by Berry (2003), who delineated two separate processes of

acculturation: the process of maintaining the original culture and the development of relations with the new culture. In Berry's definition, an individual may score "high" or "low" in each of the two categories independently of one another. In the current literature on acculturation and child weight, however, acculturation is not often defined in such a multidimensional, methodical way. A systematic review of the concept among health-related fields indicated that there is considerable variation in acculturation's definition and measurement (Thomson & Hoffman-Goetz, 2009), which may render the results of studies on acculturation difficult to compare with one another. Acculturation is frequently measured using language preference or generational status (Van Hook & Baker, 2010), types of measures called "proxy measures" in comparison to other measures such as those that were specifically created to measure acculturation. Proxy measures are generally considered to be weaker measures of acculturation than scales specifically designed to measure it, but their presence in the literature is undeniable (Thomson & Hoffman-Goetz, 2009). This is likely because proxy measures of acculturation are most commonly found in studies that have large, broad datasets with the sample sizes necessary to conduct complex statistics.

As stated above, Mexican-Origin children living in the US seem to be at a heightened risk for obesity compared to their counterparts in Mexico (Hernández-Valero et al., 2012). However, the relation between US acculturation and obesity for these children is more complex than that for their parents, for whom systematic reviews have largely shown a positive relation (Oza-Frank & Cunningham, 2010; Delavari, Sønderlund, Swinburn, Mellor, & Renzaho, 2013). Given what the research indicates about weight differences between children living in Mexico and the US, the "US"

lifestyle, which is perceived to involve high caloric intake and low physical activity, may be a factor that helps explain this risk (Hernández-Valero et al., 2012; Rosas et al., 2011; Popkin & Udry, 1998). Indeed, studies have indicated that unhealthy dietary practices (e.g. diets high in fat and low in fruits and vegetables) and sedentary lifestyles may explain some of the acculturation-obesity link among Hispanic immigrants (Kaplan, Huguet, Newsom, & McFarland, 2004; Murillo, Albrecht, Daviglus, & Kershaw, 2014). As among adults, diet and sedentary lifestyle changes have been implicated in US acculturation leading to obesity development among Mexican-origin immigrant children (e.g., Taverno, Rollins, & Francis, 2010).

It is important to note, however, that while diet and exercise may be the factors most easily linked to acculturation and weight, these are likely not the only factors that mediate the proposed relations between the two. Considering the remaining aspects of an immigrant family's context, which includes family factors specific to food, more general family factors such as parenting, and the sociopolitical climate of the family's neighborhood and the era which they live, is of paramount importance. For example, studies have suggested that feeding practices and family mealtimes may have an impact on the weight of children in Latino families, such that mothers of this group tend to report feeding styles associated with higher child weight (Tovar et al, 2012). In addition to feeding styles impacting child weight, acculturation may also be associated with feeding styles, and may therefore have an indirect effect on weight through this mechanism. Furthermore, other more broad family factors, such as general parenting styles, have also been linked to both children's weight and acculturation, such that more US-acculturated parents have been demonstrated to use less controlling parenting styles, which are

associated with healthier child weights (Arredondo et al., 2006). This indicates that, in opposition to the previously discussed idea that immigrant parents' US acculturation leads to increases in child weight, some aspects of parental US acculturation may actually be beneficial to child health. Finally, zooming out even further, the sociopolitical context of the family's place in society and treatment by their neighbors is also closely related to acculturation, as well as stress, both of which have been demonstrated to impact weight (Thomas, 1995; Adam et al., 2011). Therefore, the relation between the two factors is more complicated and includes a greater number of potential mediating and moderating factors than the literature has been able to synthesize so far. What is clear is that each of these dynamic elements help to make up an immigrant family's acculturation process and therefore may help explain how acculturation and weight are linked.

Therefore, given the many factors that may impact the relation between acculturation and weight, it is perhaps unsurprising that while many studies' findings link higher US acculturation to higher weight, other studies' findings have indicated the opposite. For example, Liu and colleagues (2009) found that, among Hispanic adolescents, those in the first generation had lower odds of obtaining physical activity than those in the third generation, suggesting that, using generational status as a metric of acculturation, the more adolescents became involved in US culture, the more physical activity they obtained. Given these contradictions, it is possible that these findings may be muddied by the lumping together of results from studies using one of many measures or proxies of acculturation. In addition, the age and gender of the children studied may have an impact on the relation between each measure of acculturation and child weight. Finally, studies do not consistently use longitudinal measures, or account for factors that

may impact both acculturation and weight, such as socioeconomic status, and this may also contribute to the conflicting findings in the literature. This study will examine each of these factors and their influence on the relation between acculturation and child weight. A brief review of the literature for each is also presented below.

Links between Acculturation and Weight

As we have already described, one of the most notable reasons that the literature on acculturation and weight is children may be difficult to interpret has to do with the way that acculturation is measured. Since a main goal of this study is to tease apart the different measures of acculturation and whether they may differentially effect child obesity, we present a review of each of the measures of acculturation and their indicated relation to weight. For a more extensive review, see McLeod, Buscemi, & Bohnert (2016).

Many studies of the relation between acculturation and weight use the parent or child's country of birth or the child's generational status as a proxy measure of acculturation. Studies that use generational status as a proxy for acculturation have found mixed results, with a majority finding no association (e.g., Wojcicki, Schwartz, Jiménez-Cruz, Bacardi-Gascon, & Heyman, 2012), some showing a connection between a higher number of generations since immigration and higher rates of obesity (e.g., Liu, Chu, Frongillo, & Probst, 2012), and others showing a connection between higher number of generations since immigration and lower rates of obesity (e.g., Buttenheim, Pebley, Hsih, Chung, & Goldman, 2013). Notably, the studies reporting a significant relation were conducted among adolescents rather than younger children, which may indicate that there may be some impact of generational status on obesity among this specific age group. This

may be because, as adolescents age, they become closer in lifestyle to the adults for whom the link between acculturation and weight is more clearly delineated, whereas parents' influence on mediating factors in early childhood (e.g., Matheson, Robinson, Varady, & Killen, 2006) may render the effect less distinguishable.

Another potential proxy measure of acculturation is the duration of time the parent of the child has spent residing in the US. Of the studies using this measure, a majority have found there was no relation between parental duration of residence in the US and child weight (e.g., Fuentes-Afflick & Hessol, 2008), while one study found a negative relation between the two (Ritchie et al., 1995). These studies indicate that there is less support for the general hypothesis that acculturation—at least when measured using time residing in the US—is related to child weight gain. However, all four of these studies also measured children under the age of 9, which, based on the above findings, may also be a subset of the Latino child and adolescent population for which the relation between acculturation and obesity is most difficult to detect because of the presence of many mediating parent factors.

Language preference, a proxy measure in which greater use of Spanish is assumed to indicate lower acculturation, is another measure commonly used. Over half of the studies using this proxy measure found no significant effect of acculturation/language preference on weight status (e.g., Winham, 2012) and one found a positive association between English preference and weight status (Liu et al., 2012). Interestingly, more of these studies found a negative association between acculturation (as measured by English preference) and weight status than a positive association between the two (e.g., Butte et al., 2014). It seems unlikely that language preference as a proxy measure of acculturation

is so different from the other proxy measures in makeup that it actually produces a different directional effect on weight. Therefore, while the proportion of studies in this category finding a negative effect of acculturation on child weight is somewhat higher than in previous sections, the reason may be related more to the limited number of studies available.

Finally, the field of study of acculturation has begun to encourage the use of multidimensional acculturation scales (Alegria, 2009), such as the ARSMA (Cuellar, Harris, & Jasso, 1980), ARSMA-II (Cuellar, Arnold, & Maldonado, 1995), and Short Acculturation Scale for Hispanics (SASH; Marin, Sabogal, Marin, Otero-Sabogal, & Perez-Stable, 1987). Many of these scales, such as the ARSMA-II, include two scales that can separately measure an individual's Anglo Orientation (using the Anglo Orientation Scale; AOS) and Mexican Orientation (using the Mexican Orientation Scale; MOS). A majority of the studies using these scales found no relation between the two variables (e.g., Morello et al., 2012). Meanwhile, one found that the relation between Anglo orientation and weight was positive (Wiley et al., 2014), and one found that it was negative (Elder et al., 2010). Since most large national datasets available for use on this topic do not include a multidimensional acculturation scale, the average sample size of the studies in this section was lower than among the previous sections, and may help to explain the large number of null effects. However, even considering this possibility, this group of studies does not universally show an effect any more than the other groups described earlier, which has interesting implications for the idea that acculturation as a broad construct is related to child weight. In addition, this portion of the literature continues to include a wide variety of specific ethnicities and ages, and both genders.

Therefore, as has been suggested above, even when using multidimensional scales, links

between acculturation and weight may frequently be hidden by these other factors.

In conclusion, measure of acculturation may have an effect on the relation

between this construct and child obesity among Latino youth. The literature surrounding

this relation in this population is complicated, but some patterns emerge. Language

preference as a proxy measure of acculturation seems to be the most frequently related to

child weight gain, while null effects are more likely to be found between proxy measures

such as generational status, duration of residence, and multidimensional scale measures

and child weight. As will be discussed further below, factors such as age and gender also

seem to be closely intertwined with these findings. This study's examination of each type

of acculturation measure among a relatively homogeneous population of Mexican-origin

children and their families aims to elucidate the differential relations between each

measure and child weight.

Age and Gender as Moderators of the Relations between Acculturation and Weight

In addition to the type of acculturation measure used, other factors may help

explain the heterogeneity in findings of relations between acculturation and weight

among Latino children. In particular, as has been discussed above, there is some evidence

that the age of the children studied may impact the significance of the relation. Among

Latino adults, the link between acculturation and weight is well-established (Oza-Frank

& Cunningham, 2010); therefore, as children reach adolescence, it follows that there is a

greater likelihood of finding a link between the two (see Crosnoe & Lopez-Gonzalez,

2005; Hernández-Valero et al., 2007; Liu et al., 2012; and Popkin & Udry, 1998). In

contrast, relatively few of the studies examining acculturation in children under the age of

five have found a connection between the acculturative variable and weight (see Fuentes-Afflick & Hessol, 2008; and Wiley et al., 2014 for notable exceptions). Although evidence suggests that age may be an important moderator of the relation between acculturation and weight, to our knowledge, no study to date has empirically examined this question.

In addition to age, research suggests that gender may also moderate the relation between acculturation and weight among Latino youth. Specifically, male immigrant children's weight may be more strongly related to acculturative factors than females'. Van Hook & Baker (2010) studied acculturation and child weight among elementary-aged children from a diverse sample of immigrant families. These authors found a moderation effect of gender, such that boys whose parents were raised outside of the US weighed more at the first data collection and gained weight faster than any other group. In opposition to the general hypothesis, this indicates a negative relation between acculturation to Anglo culture and child weight. However, it also suggests that the weight of male children may be most affected by the acculturative factors inherent in moving to, or being parented by an individual who moved to the US. The authors suggest that this heightened risk overweight among male children of immigrants (vs. children of Mexican-origin natives) may have to do with the influence of immigrant parents' typically more patriarchal home culture. They posit this could lead to greater dietary indulgence of male children, as well as a greater lack of recognition of their male children's overweight status (Van Hook & Baker, 2010). Though these authors found a link between less US-acculturated parents and heavier children, providing their own theory for why this may be, as we have stated, it has more typically been theorized that moving to the United

States and beginning the process of increasing US acculturation provides increased access to calorically dense foods and decreased access to physical activity, which leads to greater rates of obesity. Borrowing from Van Hook and Baker's (2010) reasoning for their study's findings, these factors may have the largest impact on male children. Although the effect of gender on the relation between acculturation and child obesity has received relatively little attention, these findings suggest it may be another potential moderator. The current study examines both age and gender as moderators of the relation between acculturation and weight among Latino youth, utilizing several types of measures of acculturation.

Longitudinal Considerations in Relations between Acculturation and Weight

One final weakness of the current literature is that limited studies examine this relation longitudinally. A vast majority of studies are cross-sectional, though we are aware of two studies that have examined the influence of acculturation on weight over time. Fialkowski et al. (2015) found that, among Latina and Asian female adolescents, neither generation status nor language spoken were related to overweight over time. However, as discussed above, this null finding among young women may be linked to the idea that gender moderates the association between acculturation and obesity such that it is stronger among young men than women. In another longitudinal study of these relations, Butte et al. (2014) Latino children aged 8 to 10 over the course of two years, finding a negative relation between acculturation to Anglo culture, as measured by caregivers' Spanish use, and obesity, which suggests that longitudinal effects of acculturation on obesity may be present when considering mixed-gender samples. The present study is the first to examine the effects of multiple measures of acculturation on

child weight over time among Mexican-American families.

Specific Aims and Hypotheses

      In order to more accurately understand the complex role of acculturation in the weight of Mexican-origin children, the current study investigates relations between acculturation, assessed using multiple measures—including parental language preference, parental ARSMA-II (Cuellar et al., 1995) score, parental duration of residence, and the child's number of immigrant parents—and child weight among a sample of Mexican-origin children at three time points over the course of 18 months. It further examines how these effects may differ based on gender and age within a sample of children ranging from 6 to 11 years. Finally, this study inspects how acculturation relates to BMI over time, and which measures of acculturation are significant predictors of this weight across the three time points. These three aims and the respective hypotheses are detailed below:

1. *To examine relations between each measure of parent acculturation at T1 and child zBMI at T1*. Of the acculturation measures, there is the largest body of evidence to suggest that parental language preference is associated with child zBMI. This may be because of the large number of studies (particularly those with a high sample size) that have this information available, or there may be a specific aspect of acculturation captured by this measure that is itself most highly associated with weight, such as SES. However, there is the strongest theoretical evidence base suggesting that a multidimensional acculturation measure capturing Anglo Orientation, such as the ARMSA-II, would be correlated with child weight. Therefore, it is predicted that acculturation as measured by English language preference and AOS scores on the ARMSA-II

will be associated with child zBMI at T1. Because of the theorized links between acculturation and dietary and lifestyle changes that may impact weight, it is hypothesized that the relation between acculturation, as defined by English language preference or greater Anglo Orientation, and zBMI will be positive among the overall sample.

2. *To examine whether age or gender moderates the relations between acculturation and zBMI at T1.* Based on the idea that less acculturated parents may be more likely to indulge and less likely to acknowledge overweight among male children, it is hypothesized that the previously predicted relation between acculturation as measured by English language preference or AOS score and zBMI will be differentially directional by gender, such that the relation between greater English preference or Anglo Orientation and weight is negative among boys but positive among girls (Figure 1). Furthermore, based on the idea that this relation is relatively well-established among adults, it is hypothesized that the relations between language preference or AOS and zBMI will be stronger among older than younger children (Figure 2).

3. *To examine the relations between each measure of acculturation and BMI over time*, *controlling for gender and age.* Because of the large body of literature and theoretical basis that support the relation cross-sectionally, it is again predicted that acculturation as measured by parent language preference or AOS score will predict obesity over time, such that greater English language preference or greater identification with Anglo culture will predict greater weight over time.

Figure 1. Proposed Model of Age as a Moderator between Acculturation Measures and Body Mass Index z-score at T1

```
                              ┌────────────────────┐
                              │ Moderator          │
                              │ - Age (child)      │
                              └────────────────────┘
                                        │
  ┌──────────────────────────────────┐  │   ┌──────────────┐
  │ Acculturation Measure            │  │   │ Obesity      │
  │ - ARSMA AOS and MOS scores       │  ▼   │ - zBMI       │
  │ - Language preference composite  │──────▶│ (child)      │
  │   score                          │      │              │
  │ - Duration of residence in US    │      └──────────────┘
  │ - Number of immigrant parents    │
  │   (child)                        │
  └──────────────────────────────────┘
```
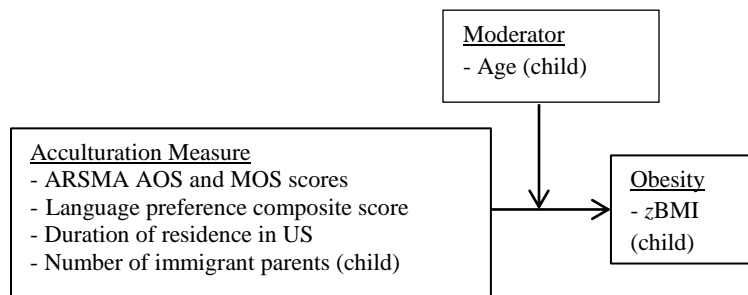
Figure 2. Proposed Model of Gender as a Moderator between Acculturation Measures and Body Mass Index z-score at T1

```
                              ┌────────────────────┐
                              │ Moderator          │
                              │ - Gender (child)   │
                              └────────────────────┘
                                        │
  ┌──────────────────────────────────┐  │   ┌──────────────┐
  │ Acculturation Measure            │  │   │ Obesity      │
  │ - ARSMA AOS and MOS scores       │  ▼   │ - zBMI       │
  │ - Language preference composite  │──────▶│ (child)      │
  │   score                          │      │              │
  │ - Duration of residence in US    │      └──────────────┘
  │ - Number of immigrant parents    │
  │   (child)                        │
  └──────────────────────────────────┘
```
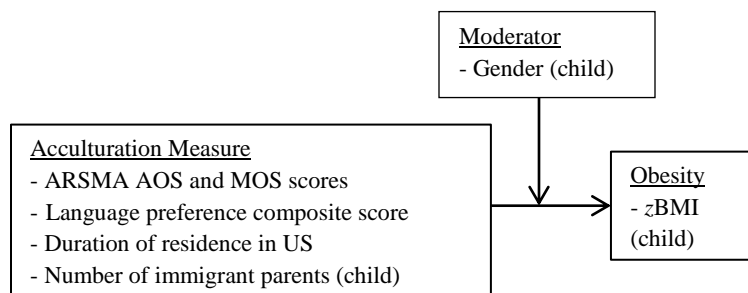
Method

Study Design and Procedure

The data for this study were drawn from a longitudinal study of parent and child health among a sample of 102 Mexican-origin immigrant families. Data for the first wave were collected at families' homes, with a second wave collected for each family at least 6 months after the date of the first data collection, and the third wave collected for each family at least 6 months following the second. The last visit took place in fall of 2015.

Prior to the first wave of data collection, participants were given an informational

handout with consent forms in either English or Spanish. A multi-method assessment

strategy utilizing family interaction tasks, separate questionnaires for each family

member, and anthropometric measures for children was used at all three time points.

Participants completed questionnaires individually with a trained research assistant, and

allowed research assistants to collect anthropometric measurements (i.e., height and

weight), both within the private home of the family.

Participants

Inclusion criteria used for the study were as follows: (a) one or more parent of

Mexican origin; (b) one child between 6-10 years of age at start of study (child may turn

11 during the study); (c) family income below 150% of the federal poverty level; (d)

proficiency in English or Spanish; (e) study participation of at least one parent/guardian;

(f) cognitive ability needed to complete questionnaires; and (g) residence within the

Chicago metropolitan area. Informed consent was obtained from all individual

participants included in the study. For inclusion in the first two aims of this study,

participants were required to have complete child weight/height and acculturation data

for the first time point (n=92). For inclusion in the third, longitudinal aim, all participants

with this data at one or more time points were included (n=102), as the statistical analyses

used to construct the growth curve models allowed for the inclusion of all participants

rather than utilizing listwise deletion. There were no significant differences between the

cross-sectional and longitudinal samples.

In both samples, the distribution of male and female children was slightly

weighted toward the females, with 63% of the cross-sectional sample and 61% of the

longitudinal sample identifying as female. At T1, families reported a mean income-to-needs ratio of .89, indicating risk for inadequate income to support needs. The stipulation that families fall at 150% of the poverty line or below in order to be included in the study likely led the sample to fall at this level of income-to-needs ratio. Additionally, at T1, the participants reported a mean zBMI of 1.01, placing the average weight of the sample in approximately the 75th percentile for weight status and within normal range. However, there was a great deal of variability in weight among participants. At T1, 41 (44.57%) children were classified as normal weight, while 14 (15.22%) were classified as overweight and 37 (40.22%) were classified as obese. This approximate distribution remained across all three time points (see Figure 3). Full means and standard deviations for all study variables can be found in Table 1.

Figure 3. Percent of Sample at Each Weight Status, T1-T3
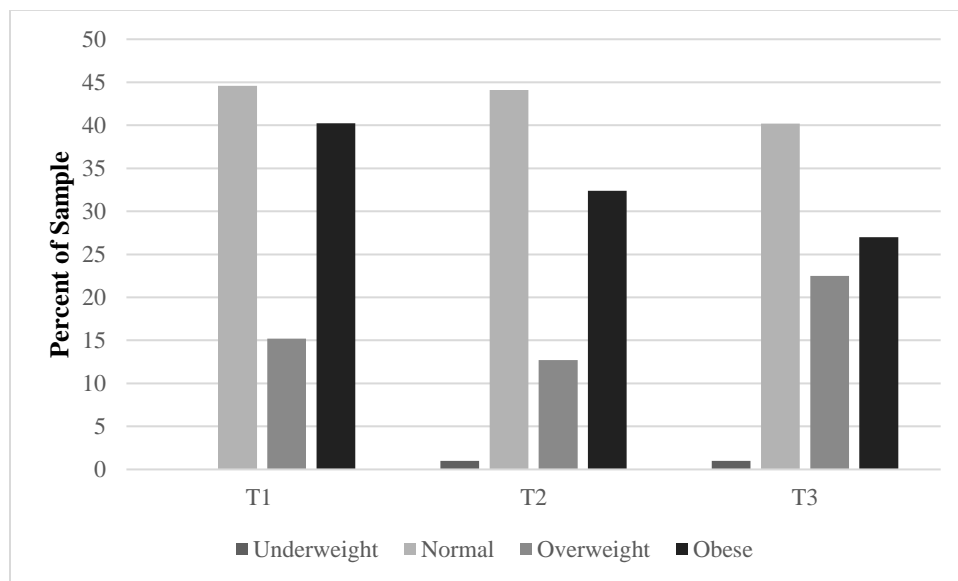
Measures

   Demographics. Parents and secondary caregivers reported on demographic information. This included information on parent and child age, gender, and

race/ethnicity. The sample comprised more female than male children, with 62 females and 40 males across all three time points. Mean age among the sample was 8.94 using the full sample at the first time point. Parents were also asked to report information about their monthly income and the number of individuals supported, and an income-to-needs ratio was calculated by dividing reported family income by the 2013 federal poverty level guideline for a family of that size. Risk was considered to be present for families with income-to- needs ratios less than one.

Body Mass Index. A trained research assistant assessed weight and height in the home of the participants, measured to the nearest 0.1 kg, and to the nearest .01 cm. Each measure was conducted twice, and a third time if there was significant discrepancy between the two measures (>.3 kg; > .5 cm). These measures were used to calculate BMI, zBMI, and weight status using calculations developed by the Children's Hospital of Philadelphia and based on the Center for Disease Control (CDC) growth charts. In addition, in order to approximate parent BMI, parents reported on their own body weight and height via survey measures, and these data were used to calculate parental self-reported BMI.

Scales of Acculturation. Parents completed the Acculturation Scales-P, adapted from the Brief Acculturation Rating Scale for Mexican Americans-II (ARSMA-II; Cuellar et al., 1995). The acculturation scales comprise the AOS (Anglo Orientation Subscale) and MOS (Mexican Orientation Subscale) of the ARSMA-II, which are rated using a 5-point Likert scale, in which higher scores indicate higher affiliation with either Mexican or Anglo culture, depending on the subscale. Parent report of acculturation was used due to the high level of influence that parents have on the child food environment and general

obesity risk before adolescence (e.g., Matheson et al., 2006). For the analyses described in this study, the primary caregiver's score on the AOS and MOS were used together as an indicator of acculturation, allowing for the possibility of the four dimensions described by Berry (2003).

    Proxy Measures of Acculturation. A 5-question measure of language preference in different settings, taken from the language scale of the SASH (Marin et al., 1987), was also computed as a component of acculturation. On this measure, higher scores indicated greater use of English (or greater US acculturation), while lower scores indicated greater use of Spanish (or lower US acculturation). The concept of language preference is frequently used as a standalone measure of acculturation (McLeod et al., 2016). Furthermore, duration of residence in the US for the immigrant parent, another common proxy measure of acculturation, was also collected. For this measure, greater duration of residence is equated with greater US acculturation (McLeod et al., 2016). Finally, each child participant's number of immigrant parents (1 or 2) was coded as a final measure of acculturation. This serves to approximate the "generational status" acculturation proxy measure that was found to be used frequently in McLeod and colleagues' 2016 review, despite the fact that all of the children in this study are technically of the same generation. For this measure, having two immigrant parents is presumed to indicate less US acculturation than having only one immigrant parent. As researchers have called into question the frequent use of unidimensional, proxy constructs of acculturation (Alegria, 2009), this study aimed to collect data on multiple aspects of this complex process.

Results

Descriptive Statistics and Correlations

Examination of the descriptive statistics for the variables indicated no outliers or

significant skewness (Tabachnick & Fiddel, 1996). In order to ensure the accuracy of

weight measurements, a single data point that indicated a weight gain greater than 20% of

total body weight between consecutive time points was attributed to measurement error

and excluded from analyses (n=1). Means, standard deviations, and correlations for

study variables are presented in Table 1. Notably, the various measures of acculturation

were not each correlated with one another. Parent language preference was the proxy for

acculturation that was most correlated with the other measures, and was significantly

correlated with each at the .05 level or below. Parental score on the AOS was also highly

correlated with the other measures, significant at the .01 level for each measure except for

parental score on the MOS. The remaining measures were less highly correlated with one

another, with number of immigrant parents and score on the MOS being the only other

significant correlation (p<.05). Therefore, the two measures that we predicted would be

most related to child weight, language preference and AOS score, were also those that

were most correlated with one another, indicating they shared some conceptual

similarities.

Table 1. Correlations between study variables at T1-T3

	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	-											
2. Gender	.01	-										
3. T1 zBMI	-.04	-.22*	-									
4. T2 zBMI	-.00	-.16	.95**	-								
5. T3 zBMI	-.05	-.15	.93**	.91**	-							
6. Parent Time in US	.06	.03	.17	.16	.19	-						
7. Number of Immigrant Parents	.13	.16	-.15	-.22*	-.26*	-.13	-					
8. Parent Language Preference	-.13	-.20*	.32**	.33**	.38**	.35**	-.55**	-				
9. Parent Mexican Orientation	-.02	.05	.05	.04	.02	.06	.26**	-.25*	-			
10. Parent Anglo Orientation	-.10	-.14	.26*	.22*	.27**	.45**	-.49**	.80**	-.07	-		
11. Parent BMI (self-report)	-.05	-.12	.23*	.15	.24*	.26**	-.10	.13	-.03	.17	-	
12. Parent Income-to-Needs	-.10	.07	.05	.09	.12	.13	-.17	.47**	-.18	.40**	-.10	-
Mean	8.94	0.61[a]	1.01	.96	.97	18.21	.80[a]	1.69	4.19	2.76	28.48	.89
SD	1.41	NA	1.06	1.06	1.09	7.00	NA	.79	.42	.87	5.27	.43
n	102	102	92	92	92	102	102	102	102	102	102	102

[a]Percent (dichotomous variable)
*$p<0.05$ level; **$p<0.01$ level

Relations between Acculturation and *z*BMI at T1

Hierarchical linear regressions were conducted in order to address cross-sectional relations between acculturation and body weight as well as whether age and gender were moderating influences. To determine main effects of the acculturation variables on *z*BMI, one of the acculturation variables (e.g., language preference) was entered on the first step. Next, in order to determine main effects of the proposed moderator variable, the moderator variable (e.g., gender) was entered on the second step. Finally, in order to determine whether there was a significant interaction effect of the two variables, an interaction term (e.g., age x duration of residence) was entered on the third and final step. Separate regressions were conducted for each acculturation index and for each moderator (Tables 2 and 3). All continuous variables in the model were centered prior to analyses. Given the sample size of 92 at T1, the regressions were powered to detect a medium effect (Cohen, 1992). For the moderation analyses, the total model R-squared value or moderated effect was required to be relatively high (either a total R-squared above .70 or a moderator effect close to .3) in order to detect the moderated effect (Champoux & Peters, 1987).

Results from these hierarchical regressions indicated that there were several significant main effects of acculturation variables on *z*BMI at T1. Mean score of the scale of language preference was significantly related to *z*BMI (β=.32; *p*=.002), as was Anglo Orientation, which was entered on the same regression as Mexican Orientation (β=.26; *p*=.011). However, neither gender nor age was found to be a significant moderator of the relations between any of the acculturation variables and *z*BMI at T1 (see Tables 2 and 3).

Notably, each of these regressions was also run with income-to-needs ratio and parent-reported parent weight added in an additional first step as covariates, to determine whether these factors, often demonstrated to be associated with weight among adults and children in the population of interest (Balistreri & Van Hook, 2009; Fuentes-Afflick & Hessol, 2008; Hernández-Valero et al., 2007), additionally influenced the outcomes. However, while parent-reported parent weight was associated with child zBMI at T1, neither of the two covariates influenced the direction or significance of any of the above findings. Therefore, in order to present the most parsimonious model given the current sample size, models that are presented here do not include these covariates (see Tables 2 and 3).

Table 2. Results of Regressions Examining Acculturation Variables, Child Age, and zBMI at T1

		Language Preference				
Step	Variable	B	$SE\ B$	β	Adj. R^2	R^2 Change
1	Language Preference	0.409	0.13	0.315*	.089	.099**
2	Language Preference	0.409	0.131	0.315*	.079	.000
	Age	-0.001	0.078	-0.001		
3	Language Preference	0.408	0.135	0.314*	.069	.000
	Age	-0.002	0.08	-0.002		
	Language Preference x Age	-0.003	0.11	-0.003		

*p<0.05 level, **p<0.01 level

Time in the US

Step	Variable	B	SE B	β	Adj. R²	R² Change
1	Time in the US	0.025	0.015	0.172	.019	.030
2	Time in the US	0.025	0.015	0.175	.010	.002
	Age	-0.035	0.081	-0.045		
3	Time in the US	0.026	0.015	0.179	.007	.008
	Age	-0.042	0.081	-0.054		
	Time in the US x Age	0.01	0.011	-0.09		

*p<0.05 level, **p<0.01 level

Scores on the ARSMA-II

Step	Variable	B	SE B	β	Adj. R²	R² Change
1	MOS	0.165	0.254	0.066	.051	.072*
	AOS	0.318	0.123	0.264*		
2	MOS	0.164	0.255	0.066	.041	.001
	AOS	0.317	0.124	0.263*		
	Age	-0.018	0.08	-0.023		
3	MOS	0.137	0.256	0.055	.044	.025
	AOS	0.314	0.127	0.261*		
	Age	-0.016	0.082	-0.021		
	MOS x Age	0.305	0.203	0.155		
	AOS x Age	0.032	0.092	0.037		

*p<0.05 level, **p<0.01 level

Number of Immigrant Parents

Step	Variable	B	SE B	β	Adj. R²	R² Change
1	Number of Imm. Parents	-0.393	0.266	-0.154	.013	.024
2	Number of Imm. Parents	-0.388	0.27	-0.152	.002	.000
	Age	-0.013	0.082	-0.017		
3	Number of Imm. Parents	-0.373	0.279	-0.146	-.009	.001
	Age	-0.064	0.227	-0.083		
	Number of Imm. Parents x Age	0.059	0.244	0.242		

Table 3. Results of Regressions Examining Acculturation Variables, Gender, and zBMI at

T1

Language Preference

Step	Variable	B	SE B	β	Adj. R²	R² Change
1	Language Preference	0.409	0.13	0.315*	.089	.099**
2	Language Preference	0.371	0.131	0.286*	.106	.027
	Gender	0.362	0.22	0.166		
3	Language Preference	0.367	0.177	0.283*	.096	.000
	Gender	0.362	0.222	0.165		
	Language Preference x Gender	0.008	0.264	0.004		

*p<0.05 level, **p<0.01 level

Time in the US

Step	Variable	B	SE B	β	Adj. R²	R² Change
1	Time in the US	0.025	0.015	0.172	.019	.030
2	Time in the US	0.026	0.015	0.181	.059	.050*
	Gender	0.489	0.222	0.224*		
3	Time in the US	0.023	0.019	0.159	.049	.001
	Gender	0.49	0.224	0.224*		
	Time in the US x Gender	0.008	0.031	0.035		

*p<0.05 level, **p<0.01 level

Scores on the ARSMA-II

Step	Variable	B	SE B	β	Adj. R²	R² Change
1	MOS	0.165	0.254	0.044	.051	.072*
	AOS	0.318	0.123	0.264*		
2	MOS	0.195	0.251	0.264	.078	.035
	AOS	0.287	0.123	0.264*		
	Gender	0.411	0.223	0.264		
3	MOS	0.233	0.331	0.264	.056	.002
	AOS	0.32	0.165	0.264		
	Gender	0.415	0.226	0.264		
	MOS x Gender	0.133	0.527	-0.034		
	AOS x Gender	-0.092	0.255	-0.05		

*p<0.05 level, **p<0.01 level

Number of Immigrant Parents

Step	Variable	B	SE B	β	Adj. R²	R² Change
1	Number of Imm. Parents	-0.393	0.266	-0.154	.013	.024
2	Number of Imm. Parents	-0.295	0.268	-0.155	.039	.036
	Gender	0.424	0.229	0.194		
3	Number of Imm. Parents	-0.428	0.379	-0.167	.030	.003
	Gender	0.219	0.470	0.100		
	Number of Imm. Parents x Gender	0.269	0.539	0.110		

*p<0.05 level, **p<0.01 level

Longitudinal Relations between Acculturation and BMI

In order to examine the longitudinal relation between acculturation at T1 and child weight growth over time, growth curve models were estimated using the Mixed Procedure in SPSS, modeled closely on Peugh and Enders (2005). Models such as these have been called many things depending on the field of study, including growth curve models and hierarchical linear models. However, the distinguishing trait of the model by any of these names is the ability to model change at both aggregate and individual levels, using predictor variables to predict variability in the change process (Jandasek, Holmbeck, DeLucia, Zebracki, & Friedman, 2009). In the present study, these models were used to test each acculturation measure separately, resulting in four two-level models (as in all other aims, AOS and MOS were entered together), such that the first level was within-person, tracking the repeated measures of BMI at each age, and the second level was between-person, including T1 acculturation measures. For these analyses, we used BMI (rather than zBMI) because it is a more sensitive measure of

change, but unlike zBMI, one that does not inherently control for age and gender. In all

growth models, centered age was used as the time variable, which accounted for its

effects on BMI. However, gender remained to be accounted for; therefore, it was entered

into the model separately. Our approach for all models took the following steps.

First, for all models, we initially tested for the functional form of obesity growth

among all children, determining whether the average trajectory of obesity development fit

a flat, or intercept-only model, a linear model, or a quadratic model. Next, we used the

model that was determined to be most appropriate as a baseline model onto which we

added the additional predictors. In this case, since gender may impact BMI but was as-yet

unaccounted for in the model, gender was first entered as a covariate. Finally, the

predictors—in this case, each T1 measure of acculturation—were also added to the best-

fitting baseline models. Entering these predictors as fixed effects allowed us to collect

information about the average trajectory of weight among the sample. Meanwhile, age,

the time variable, was entered as a random effect, allowing us to model variability

between individuals in the sample (Jandasek et al., 2009). Taking this approach to

longitudinal analysis allowed for complete flexibility in the treatment of the time variable

(given that individuals in this study vary in age and were assessed at slightly differing

intervals), as well as the ability to include individuals with missing data. In addition, this

approach maximized potential power by capitalizing on the repeated measures in the

study and maximizing sample size by allowing individuals with missing data to be

included in the model rather than utilizing listwise deletion (DeLucia & Pitts, 2006).

Results of these analyses found first that a linear model was the most appropriate

for demonstrating change in BMI over time. Therefore, a baseline linear model formed

the basis for each of our models adding acculturation factors as predictors. After entering

these predictors, the final four models of acculturation on BMI partially reflected

longitudinally what was demonstrated cross-sectionally at T1. Whereas parent time in the

US, number of immigrant parents, and Mexican Orientation were not associated with

BMI across development, language preference was positively associated with BMI

measurements over time, such that greater English preference was related to higher BMI

(est=.78, *SE*=.34, *p*=.027). However, whereas greater Anglo Orientation was associated

with higher *z*BMI at T1 in regression analyses, this effect was not demonstrated

longitudinally with BMI (est=.42, *SE*=.32, *p*=.192). As a final step, to mirror the cross-

sectional regression analyses, each of the models was re-run with income and parent BMI

as covariates. However, neither of these variables was significantly associated with BMI

over time, and their addition did not affect the original findings. Even after accounting for

these potential covariates, the effect of language preference on weight remained

significant and positive in nature (est=.73, *SE*=.36, *p*=.047). This indicates that, over the

course of 18 months, language preference at T1 was associated with greater BMI, even

accounting for age, gender, parent weight status, and parent income.

Discussion

This study presents two types of findings: first, those that have implications for

the understanding of how acculturation impacts weight, and second, those that have

implications for the study and measurement of acculturation itself. For the former, this

study found that one measure of acculturation, English language preference, was

consistently associated with child weight among a sample of 6-11 year old Mexican-

origin children in both cross-sectional and longitudinal analyses, such that parents who

endorsed more preference for the English language had children with higher body weights. In addition, greater Anglo orientation was associated with higher body weight, though only cross-sectionally. This supports the theoretical hypothesis that the behavioral or emotional changes that accompany integration into US culture, such as the adoption of a high-calorie and low-physical activity lifestyle, may contribute to weight gain among Mexican children (Hernández-Valero et al., 2012; Rosas et al., 2011; Popkin & Udry, 1998). This is in keeping with the standing popular view on US culture and the ways in which it may differ from immigrants' "home" culture of Mexico. Interestingly, even when we included two potential covariates, income-to-needs ratio, and parent weight (measured by self-report), the identified relations between acculturation and weight remained the same. This may be because the study itself adjusted for variance in income-to-needs ratio by requiring families' incomes to fall at or below the poverty line, and because parent weight was measured by parent report rather than empirical measurement, a noted inferior measure for accuracy (Gorber, Tremblay, Moher, & Gorber, 2007).

Furthermore, while these findings did suggest that acculturation and weight are related, they did not support the idea of the theorized moderation effect of either gender or age on the relation between acculturation and weight. There are several possible explanations for these null findings of moderation effects. For the moderation effect of gender, at a methodological level, it is possible that our study's low sample size and low ratio of male children did not allow us to detect the hypothesized differences. At a conceptual level, is also possible that the differences hypothesized between the genders are more salient at younger age ranges, such as among the Kindergarteners with whom Hook and Baker (2010) originated this hypothesis. With regard to the moderation effect

of age, similar methodological explanations are possible: it may be that our study was not able to identify these moderation effects because of the relatively low power to detect them. At a more conceptual level, it may be the case that the hypothesized moderation effect of age exists among a different age range than that sampled here. In the systematic review by McLeod and colleagues (2016), the differences in findings based on age were found only across the full span of childhood (i.e. comparing preschool age, school age, and adolescence). Therefore, perhaps our study did not span a wide enough age to capture the potential moderation effects of development on the relation between acculturation and weight.

In addition to these results' implications for understanding the link between acculturation and weight among Mexican-origin children, they also provide guidance on acculturation should be studied and measured. Specifically, these findings suggest that language proxy measures of acculturation, at least for the purposes of examining acculturation's effect on weight, present similar findings to the more commonly recommended multidimensional measures (Alegria, 2009). The rationale behind encouraging the use of multidimensional measures is that they are standardized and comprehensive (Alegria, 2009). These are certainly a helpful set of traits for improving the literature, which is currently difficult to interpret. However, our results suggest that in this case, language preference was a useful proxy measure of acculturation, and could be revisited as a quick way to capture this variable. Perhaps a better takeaway from these results, however, is that we should question on a deeper level the concept of acculturation itself: for example, we might ask what piece of acculturation both language preference and Anglo Orientation share, and why it would be most related to weight. The literature

review presented for the current study suggested that diet and physical activity may be two factors to consider when theoretically explaining the link between acculturation and weight. However, the review also emphasized the myriad of other dynamic, contextual factors that may have an impact on this relation, such as feeding practices, parenting styles, and immigration stress. Perhaps English language preference, and to a lesser extent, Anglo orientation, are the best indicators of these potentially mediating and moderating lifestyle characteristics. Since both the basis for English language preference and Anglo Orientation score deal directly with the degree of embracing of and identification with US culture, this seems plausible. Furthermore, perhaps English language preference may serve as a proxy, not just for acculturation, but also for Anglo Orientation, given the necessity of a shared language in order for cultural integration to occur (Portes & Hao, 2002). While not directly examined by this study, this conceptual model ties together these two acculturation variables *and* links them to obesity, and may be beneficial to test in future studies.

Limitations and Future Directions

Though this study makes an important contribution to the literature, it is not without limitations. Primarily, the sample size was relatively small, and therefore was under-powered to detect less than a medium effect in the regression analyses. If the field of study that examines acculturation intends to continue breaking down these processes, it is imperative that larger studies that similarly compare multiple acculturation measures and their effects both cross-sectionally and longitudinally be funded and conducted. Studies that continue to examine the way that we are able to measure acculturation will pave the way for the literature, which is currently difficult to interpret, to become clearer.

Finally, studies that replicate the current work's longitudinal design will go a long way in providing a greater understanding of the ways in which acculturative processes unfold over time, an important point for such a lengthy cultural process, and one that has been largely absent from the literature.

In summary, both of the goals of this study—clarifying acculturation measures and further exploring links between acculturation and weight among children—represent essential parts of the solution for combating the dangerous and rising levels of obesity among Mexican-origin children. Moreover, finding new parts of this solution is imminently necessary, as a systematic review of obesity interventions among Latino children concluded that fewer than half of interventions among this population have any effect at all. Notably, the authors of this review suggest that a greater understanding and incorporation of acculturative factors into interventions would likely increase their applicability and effect (Branscum & Sharma, 2011). This supports the idea that efforts such as this study, which aimed to delineate the aspects and measures of the acculturative process that are most salient for obesity among Mexican-origin immigrant children, will allow researchers to identify behavioral or cognitive sequelae on which interventions can be designed to act. The findings of the present study suggest that popular perceptions of US culture's unhealthy influence on immigrant children's weight are supported by empirical data. This conclusion, particularly if confirmed by a similarly well-designed but larger study, should allow for greater success in intervening on and even preventing this undesirable and increasing epidemic.

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