Neighborhood socioeconomic status and BMI differences by immigrant and legal status: Evidence from Utah

Ming Wen
Associate Professor
Department of Sociology
University of Utah
Email: ming.wen@soc.utah.edu
Telephone: 801-581-8041
Fax: 801-585-3784

Thomas N. Maloney *****
Professor
Department of Economics
University of Utah
260 S. Central Campus Dr., Rm 343
Salt Lake City, UT 84112
Email: maloney@economics.utah.edu
Telephone: 801-581-7704
Fax: 801-585-5649

* Corresponding author

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Abstract

We build on recent work examining the BMI patterns of immigrants in the US by distinguishing between legal and undocumented immigrants. We find that undocumented women have relative odds of obesity that are about 10 percentage points higher than for legal immigrant women, and their relative odds of being overweight are about 40 percentage points higher. We also find that the odds of obesity and overweight status vary less across neighborhoods for undocumented women than for legal immigrant women. These patterns are not found among immigrant men: undocumented men have lower rates of obesity (by about 6 percentage points in terms of relative odds) and overweight (by about 12 percentage points) than do legal immigrant men, and there is little variation in the impact of neighborhood context across groups of men. We interpret these findings in terms of processes of acculturation among immigrant men and women.

Key words: obesity; immigrant; health; neighborhood; Latinos; Hispanics

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Obesity has been confirmed to be a serious risk factor for a wide range of health problems (Billington et al., 2000; Majed et al., 2008). In the United States, the prevalence rates of overweight and obesity rose considerably for most segments of the population over the last three decades of the 20th century and have since remained high (Burkhauser et al., 2009; Komlos and Brabec, 2011). Evidence consistently shows that Latinos and blacks generally have greater risks of being overweight or obese relative to non-Hispanic whites (Flegal et al., 2002). Motivated by high proportions of foreign-born individuals in many subgroups of Asian or Latino origin or descent, a growing number of researchers of racial/ethnic differences in body weight have recently included immigrant status as an additional consideration that parallels traditionally studied racial and ethnic categories (Oza-Frank and Cunningham, 2009). Findings that there are significant, positive relationships between body weight and duration of residence among immigrants in the US (Bates et al., 2008; Goel et al., 2004) point to the importance of considering nativity and acculturation in addition to race/ethnicity to improve understanding of the distribution and etiology of body weight.

However, there is yet another dimension that should be considered in studying racial/ethnic differences in body weight and obesity, namely the legal status of immigrants. There is a lack of research concerning body weight differences between documented and undocumented immigrants. Legal status may affect factors that directly influence body weight, such as the timing and pace of acculturation as well as length and extent of exposure to the U.S. environment. Presumably, undocumented immigrants are less assimilated into American mainstream society and are less acculturated than their documented counterparts due to the

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stronger structural barriers they face on a daily basis. This lack of acculturation may have a "health protecting" effect, as the undocumented might be less exposed to the influences that lead to deteriorating immigrant health in many cases. Of course, the generally poorer socioeconomic conditions in which the undocumented live (Maloney and Kontuly, 2011)will at the same time have negative health consequences. Insofar as large-scale social environmental forces and cultural factors jointly influence human behaviors (Abraido-Lanza et al., 2006), expanding the focus of studies of racial/ethnic and immigrant differences in body weight to include immigrants' legal status would provide further refinement of our understanding of patterns of body weight distribution and the etiology of obesity, with implications for the role of acculturation in body weight changes and the corresponding prevention strategies.

Concomitant with the increase in obesity in the United States, there has been a growing recognition of contextual impacts of neighborhood social and built environments on health-related behaviors and outcomes including obesity(Kawachi and Berkman, 2003; Salois, 2012; Sandy et al., 2013; Wen and Kowaleski-Jones, Forthcoming). Among neighborhood socio-demographic characteristics, neighborhood socioeconomic status (SES),typically measured by aggregate income and education (Davey Smith et al., 1998; Fiese et al., 2012; Robert and Reither, 2004), has been most frequently examined in previous work regarding health and place (Pickett and Pearl, 2001). In theory, neighborhood SES should be a protective factor against obesity as it is positively associated with better access to health-promoting resources such as exercise/recreational facilities (Moore et al., 2008)and quality food(Do et al., 2007). However, evidence is mixed with regard to whether neighborhood SES has a positive, negative, or any effect on overweight or obesity (Robert and Reither, 2004; Rundle et al., 2008; Shrewsbury and Wardle, 2008).

An important limitation in the literature is that subgroup variations in the neighborhood SES effect on body weight have rarely been examined. It is conceivable that the impacts of neighborhood SES on body mass vary by gender such that women are on average more influenced by local neighborhood contexts than men. Women tend to spend more time at home and in the surrounding areas taking care of the family, and they seem to be more responsive to contextual factors than men(Rand and Kuldau, 1990; Renna et al., 2008). Limited evidence shows the associations between body mass (and the related lifestyle factors) and neighborhood SES are stronger for women compared to men(Chang et al., 2009; Do et al., 2007; Robert and Reither, 2004; Wen et al., 2007a; Wen and Zhang, 2009).

The impacts of neighborhood SES may also interact with race/ethnicity or immigrant background. For example, the negative relationship between individual SES and obesity seems more apparent among white youth than among African American or Mexican American adolescents (Troiano and Flegal, 1998). A review article also indicated that when income was used as a SES indicator the relationship between SES and weight gain was very weak for black samples but strong for whites (Ball and Crawford, 2005). However, other research found no interaction effect between race/ethnicity and life course SES in determining the risk of obesity (Scharoun-Lee et al., 2009). These interaction effects need to be further explored.

Underlying group differences in body weight and obesity, neighborhood SES may play a mediating role. Whites are more likely than ethnic minorities to live in more affluent neighborhoods even after individual SES is controlled for (South and Crowder, 1997). If neighborhood SES is linked to race/ethnicity and/or immigrant/legal status, and if higher neighborhood SES is negatively related to the risk of obesity, then group differences in neighborhood SES might explain some of the group differences in obesity. Indeed, extant

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research has shown that racial/ethnic differences in self-rated health among older adults can be partially explained by neighborhood contexts (Cagney et al., 2005). Another study also reported that SES at both the individual and neighborhood levels partly explained the higher average body mass index (BMI) among black women (Robert and Reither, 2004). Whether neighborhood SES contributes to differences in overweight and obesity by both immigrant background and legal status has not been examined.

In this study, we extend the literature by exploring differences in body weight and obesity by race/ethnicity (white, Latino), immigrant status (foreign-born vs. US-born), and legal status (documented vs. undocumented) using large-scale population data for the state of Utah. Specifically, we first explore prevalence rates of overweight and obesity for subgroups defined by race/ethnicity, immigrant background, and legal status. Because Latinos constitute the largest US-born minority group in Utah as well as the great majority of the foreign-born residents in the state, we focus on this ethnic group in our fine-grained analysis of differences in body mass. We then examine the associations between neighborhood SES and risk of being overweight or obese. Next, we test the interaction effects between neighborhood SES and ethnic/immigrant/legal status. Because patterns and predictors of overweight/obesity likely vary by gender, we conduct these analyses separately for men and women.

We find that undocumented women have higher rates of overweight status than do legal immigrant women. We also find that the odds of obesity or overweight status vary less across neighborhoods for undocumented women than for legal immigrant women. These patterns are not found among immigrant men: undocumented men have lower rates of obesity and overweight than do legal immigrant men, and there is little variation in the impact of neighborhood context across groups of men. We interpret these findings in terms of processes of

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acculturation among immigrant men and women. We also identify patterns of obesity prevalencein our data that corroborate results in the wider literature: women's obesity rates are more closely related to neighborhood context than are men's obesity rates, immigrants in general have lower rates of obesity than do natives, and native Latinos in particular have high rates of obesity and overweight status, relative to both other US natives and Latino immigrants.

Data and Methods

Ourstudy is based on a unique source, the Utah Population Database (UPDB) (Mineau 2007). Specifically, we use the driver license records in the UPDB collected between 1999 and 2008, which allow researchers to identify undocumented immigrants in Utah through the use of "Individual Taxpayer Identification Numbers" by these immigrants when they apply for the driver licenses anddriving privilege cards that are available to undocumented immigrants under Utah law.[1] The UPDB is one of the world's richest sources of linked population-based information for demographic, genetic, epidemiological, and public health studies. More detail on the breadth and quality of each component data source is available on the UPDB website *http://www.hci.utah.edu/groups/ppr/*and further described elsewhere (Stewart and Jameson, 2010).Our choice of Utah as the location for our study is certainly driven by the availability of this unique data set and the opportunity it presents for comparing undocumented and legal immigrants. Still, it is worth noting that Utah became an important new magnet for immigration in the 1990s. The foreign born share of Utah's population grew twice as rapidly as did the foreign born share of the national population during this decade, and

[1] In a small number of cases, legal residents may use ITIN's to apply for driver licenses and for other purposes. For the period from 1979 to 1998, before the undocumented driver license program was implemented in Utah, fewer than 1,000 individuals received driver licenses with ITIN's (Stewart and Jameson 2011, p. 22). This is our best estimate of the number of such individuals – about 50 such documents issued per year, or perhaps 500 cases in our 10 year window. This figure includes all immigrants, not just Latinos, so the potential impact on our sample is actually smaller.

the foreign born population of the Salt Lake City-Ogden metropolitan area nearly doubled (Singer 2004).

The study sample consists of 742,948 cases (83,627 men and 359,321 women) collected in Utah from 1999 to 2008, living in 477 census tracts (based on tract definitions from the 2000 census for Utah). Census tracts have been used as the level of analysis for many area-level variables in the study of neighborhood effects on health (Robert and Reither, 2004; Ross, 2000; Wen et al., 2007b) because they are considered a good approximation for local neighborhoods. Individuals aged 25 to 64 years were included to focus on prime-age adults, as young adults typically have not established their post-adolescence residence, while BMI patterns are complex among adults over age 64 (Smith et al., 2008). Individuals whose BMI was greater than 60 or less than 18 were excluded from the analysis as outliers.

The individual-level variables available to us include BMI, age, gender, and race/ethnicity/immigrant/legal group (i.e., US-born non-Latino whites, US-born Latinos, undocumented non-Latino white immigrants, documented non-Latino white immigrants, undocumented Latino immigrants, and documented Latino immigrants). To narrow our comparisons to the most prominent population subgroups, we excluded individuals who classified themselves as neither white nor Latino.[2] Categories of body weight were constructed based on BMI, with overweight defined as BMI$\geq$25 kg/m^2 and obesity defined as BMI $\geq$ 30 kg/m^2. Normal weight was the reference group. In all of the tables and results, then, "overweight" means "overweight or obese." That is, the obese are a subset of those who are overweight. A

[2]The race/ethnicity classifications are self-reported by individuals in their driver license documents and in other sources linked to these documents through the UPDB. The "Latino" classification in our data is somewhat different from the Hispanic classification in Census sources. In US Census data, the Hispanic/non-Hispanic categorization is distinct from the "race" classification, so it is relatively easy to distinguish individuals who identify as white and Hispanic from those who identify as black and Hispanic. In our data, the "Latino" classification is usually a choice that is parallel to "white," "black," etc. We therefore cannot consistently distinguish "white and Latino" from "black and Latino." In the cases where we can make this distinction (generally because of the availability of a variety of sources for an individual), between 90 and 95% of Latinos in our data set identify as "white."

very small share of the initial sample, less than one percent, had BMI's in the "underweight" range, below 18 kg/m^2. We excluded these cases from the analysis. We also excluded about 13 percent of the sample for whom country of birth was not reported, preventing us from making the native /immigrant distinction that is central to our analysis.

Tract-level SES was measured by a composite index based on five socioeconomic variables: percent of households in poverty, percent of population with at least some college, percent of households with incomes of $75,000 or greater, percent of households receiving public assistance (general assistance or TANF), and percent of families that are single headed and include a child under 18. Principal component factor analyses were performed to construct the composite index of census tract-level SES. Principal component analysis is a data reduction technique concerned with finding a small number of common factors that linearly reconstruct the original variables (Harman, 1976).[3] In addition to examining the effect of this SES index on obesity and overweight status, we also report estimates of the effect of each individual component. Multilevel (random effects) logistic regression models were fit to examine our research questions.

Descriptive Results

Table 1 presents descriptive statistics for the sample, including neighborhood socioeconomic indicators, separately for men and women. The overall prevalence rate of overweight/obesity, for men and women combined, is 57% in our sample (covering the years from 1999 to 2008). Data from the Behavioral Risk Factor Surveillance System (BRFSS) report

[3]Factor loadings ranged from 0.78 to 0.87, with percent of households in poverty having the highest loading.Higher factor loadings indicate stronger correlations of the item with the latent factor; and factor loadings greater than .6 are typically deemed as acceptable as a convention. The scale of neighborhood SES has a Cronbach's α (alpha) coefficient equal to 0.83. The alpha coefficient is a coefficient of internal consistency; it is commonly used as an estimate of the reliability of a psychometric test of an instrument. As a rule of thumb, internal consistency is good if alpha is in the range of 0.8 and 0.9.

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an average of 55% prevalence of overweight/obesity across this same period (Center of Disease Control and Prevention (CDC), 2009). Our sample thus exhibits a similar prevalence rate of the overweight problem in Utah compared to the BRFSS results. Both data sets rely on self-reported measures of weight and height to construct BMI. The prevalence of overweight differs substantially between men and women, with men more likely to be overweight overall and in all of our sub-populations. Gender differences in the prevalence of obesity are not as large: overall, 22 percent of men and 18 percent of women are obese. Men have higher rates of obesity in all categories except among undocumented Latino immigrants. There is a clear gradient in terms of neighborhood socioeconomic characteristics along racial/ethnic/immigrant/legal lines. US-born non-Latino whites enjoy the highest levels of neighborhood socioeconomic resources. They are followed (at some distance) by US-born Latinos, documented Latino immigrants, and undocumented Latinos.

(Table 1 about here)

As a first illustration of the relationships we examine, Figures 1 to 6 plot mean BMI against our SES index, by Census tract, for men, women, white non-Latino natives, Latino natives, documented Latino immigrants, and undocumented Latino immigrants. The distinction between the male and female plots is clearly visible, with average BMI declining more substantially for women than for men as SES increases. The plot also appears to slope down and to the right for both native non-Latinos and native Latinos, though there is more dispersion in the latter case. When we divide immigrants into documented and undocumented groups, there is not an obvious difference in the plotted BMI-SES relationships other than the greater dispersion in the means for the undocumented. There are confounding factors that may obscure the relationships illustrated here, including differences in age and in date of BMI measurement (as obesity rates in general rose throughout our period of observation.). Our multi-level regression analysis will allow us to control for these factors while simultaneously investigating differences by gender, ethnicity, immigrant, and legal status.

(Figures 1 to 6 about here)

Regression Results of the Correlates of Obesity and Overweight Status

In our analyses of both obesity and overweight status, we estimate a series of nested models. First, we examine group differences (with US-born non-Latino whites as the baseline group), controlling forage (in quadratic form) as well as for the date of measurement of the individual's BMI (either 1999-2003 or 2004 to 2008), to account for the broad increase in obesity rates over this decade.[4] Next, we add our tract-level SES index. Finally, we add interactions of SES and group status. All analyses are conducted separately for men and women. Results are presented as effects on odds ratios. Point estimates and 95% confidence intervals are reported.

For both men and women, US-born Latinos have the highest odds of obesity, about 30 percentage points higher than among US-born non-Latino whites (see Table 2, Model 1 for both men and women). Overall, the odds of obesity rose by about 17 percentage points for women and 21 percentage points for men between the first half and the second half of our observation period. Among both men and women, immigrants experience lower odds of obesity, though the "immigrant advantage" is larger among men than among women. Undocumented Latina women

[4] We use a 10 year observation window for the purpose of increasing cell sizes for each group in each of our Census tracts. The length of this interval raises two issues: the potential impact of rising obesity rates over time, and the relevance of neighborhood conditions measured in 2000 for individuals observed at the end of our window. We examined the potential impact of rising obesity rates over time in a variety of ways, including by limiting our analysis to BMIs observed between 2004 and 2008. We also constructed a similar measure of neighborhood SES from the pooled 2005-2009 American Community Survey data for Utah and incorporated this into our analyses in place of our Census measure (and again limiting the observations to 2004-2008). None of these alternative specifications had any substantial impact on the results. With regard to the potential change in neighborhood conditions over time, note that the correlation coefficient between our Census 2000 measure and our ACS 2005-2009 measure (constructed from the same component variables) is .91.

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seem to be at greater risk to be obese than their documented counterparts, while this pattern is reversed for Latino men. The differences between legal and undocumented immigrants are statistically significant among men but not among women in this baseline model. Controlling for neighborhood SES (Model 2) has little impact on these group-level differences. This does not mean that neighborhood SES has no impact on obesity itself. In fact, a one-standard-deviation increase in our SES index is associated with a reduction of the odds of obesity among women by about 29percentage points. The effect for men is smaller but still substantial – about 12 percentage points.

When we allow the impact of neighborhood SES to vary across groups (Model 3), we do find some evidence of weaker SES effects among undocumented Latino women: the "SES*Latino Undoc" variable has a positive and statistically significant coefficient in the estimation for women. The implication is that a one-standard-deviation improvement in the SES index is associated with a reduction of the odds of obesity by about 18 percentage points for undocumented Latina women (.71*1.15=.82), a little over half of the 29 percentage point reduction experienced by non-Latino white natives and by documented Latinos (for whom the SES interaction is not statistically significant). In addition, the baseline advantage of undocumented women relative to native non-Latina women, evident in Models 1 and 2, disappears when we add these interaction effects in Model 3. Moreover, in this full model, undocumented women have a higher general prevalence of obesity than do legal immigrant women.[5]

These combined changes tell a somewhat subtle story. Neighborhood SES is strongly correlated with the odds of obesity for women in general. This correlation is weaker for

[5] The p-value for the difference between the "Latino Doc" coefficient, 0.92, and the "Latino Undoc" coefficient, 1.06, is .005.

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undocumented Latina women. Because these women generally live in worse-than-average neighborhoods (see Table 1), this weaker correlation means they are less harmed by these poor neighborhood conditions, and less aided by good neighborhood conditions, than natives or documented immigrants would be. This pattern appears as a lower obesity rate for undocumented women relative to native women in Model 2, when we do not allow neighborhood effects to vary across group. It appears as a weaker effect of neighborhood SES on these women in Model 3, and as higher overall odds of obesity relative to documented immigrant women, when we do allow for this interaction. For men, the correlation of neighborhood SES and odds of obesity does not vary across groups, and the presence of these interactions has little effect on the observed cross-group differences.

(Table 2 about here)

Table 3 presents the results for a similar set of models examining the determinants of overweight status. As was the case with regard to obesity, US born Latinos have much higher odds of being overweight than do US born non-Latino whites. Foreign born Latinos also often have higher odds of being overweight than do native non-Latinos, though they generally have lower rates of obesity. Among immigrants, the same pattern emerges in terms of the role of legal status as was observed in our examination of obesity: female undocumented immigrants are at greater risk of being overweight than are female documented immigrants, while male undocumented immigrants have lower risk of being overweight than do male documented immigrants. The gap between the undocumented and the documented immigrant women is considerably larger for risk of being overweight than for risk of obesity. Higher neighborhood SES corresponds to lower risk of being overweight among women, but it does not have a statistically significant effect among men in general. For women, neighborhood SES again has a weaker effect on overweight status for undocumented Latina immigrants. On the other hand, there appears to be a modestly "intensified" effect of SES on overweight status among native Latina women, so that a one-standard-deviation increase in the SES index is associated with a reduction of their odds of obesity by nearly 30 percentage points (.75*.93=.70), though their baseline incidence of being overweight is very high. For men, neighborhood SES does not have an impact on overweight status for native non-Latino whites or native Latinos. It appears to have a small, negative effect on overweight status for Latino immigrants, both documented and undocumented.

(Table 3 about here)

In general, then, US-born Latinos, both men and women, have especially high rates of obesity and overweight status. Relative to US-born whites, foreign-born Latinos typically enjoy an advantage with regard to obesity, but they are often at a disadvantage with regard to overweight status. These patterns generally hold for both the documented and the undocumented except for undocumented Latina women who have the highest prevalence of overweight across all the groups. Neighborhood SES has a more substantial impact on both overweight and obesity for women than for men and a greater impact on the odds of obesity than on the odds of being overweight among men. In addition, the obesity and overweight status of undocumented Latina women is less correlated with neighborhood conditions than is the case for other groups of women, including documented immigrants. The impact, in this case, appears to be that undocumented immigrant Latinas are less harmed by the poor conditions of their neighborhoods than other groups of women would be.

To gain some insight into which neighborhood characteristics might be driving the relationships found above, we re-estimated our models using each neighborhood SES characteristic, rather than the composite SES index. We entered each component separately, due to the high level of correlation between these measures. We report the results in Table 4 for obesity and Table 5 for overweight status. (Each of these tables reports the results of five distinct regressions for men and five distinct regressions for women, one for each of the neighborhood characteristics used to construct our SES index.) The results for age and for the main group differences are very similar to those in Tables 2 and 3, so we report only the effects of the neighborhood characteristics and the interaction terms here. All neighborhood characteristic variables are entered in standardized (mean 0, standard deviation 1) form. Note that three of these characteristics – poverty, public assistance, and the share of families that are single-headed – are neighborhood "disamenities," and we would expect higher levels of these measures to correspond to higher odds of obesity and overweight status (we expect them to have odds ratios greater than 1). The other two – the share of neighborhood residents with some college education, and the share of neighborhood households with high incomes – are "amenities," and we would expect higher levels of these measures to correspond to lower odds of obesity and overweight status (we expect these variables to have odds ratios less than 1).

These anticipated patterns hold uniformly in our estimation of the odds of obesity, though the correlation of neighborhood poverty and obesity for men is not statistically significant. Moreover, the general finding that women are more affected by neighborhood conditions than are men is replicated for all measures in Table 4. Comparing across measures, single headship and receipt of public assistance have quite strong effects on obesity rates among women, substantially higher than the effect of neighborhood poverty, and much higher than the effects of either of these factors on men. That is, women face high risks of obesity in neighborhoods in which many families are single-headed and reliant on public aid. This finding makes intuitive

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sense. Neighborhoods with high rates of single headship and reliance on public aid are likely to be characterized by very high concentrations of particularly deprived women with limited resources both within their own households and in their neighborhood networks. Differences in the effects of these components across groups, identified by the interaction terms, are not very systematic, though notably undocumented female Latina immigrants experience diminished effects of three of these five neighborhood characteristics (higher education, higher income, and single headship) measured at the tract level, driving the generally weaker correlation of obesity and neighborhood SES for these women identified in Table 2.

In our analysis of overweight status, the effects of neighborhood characteristics for women are generally "right-signed" and significant, and we again observe weakened correlations for undocumented Latinas with regard to the neighborhood incidence of college education, high income, and single-headship. For men, the main effects of neighborhood characteristics on overweight status are sometimes insignificant or "wrong-signed" –for instance, in the cases of local poverty levels and single headship. It may be that men who have BMIs in the "overweight" range actually have high levels of muscle mass rather than fat. This confounding effect may be more common for men than for women, producing the weak and varied relationships found in the overweight estimation for men.

(Tables 4 and 5 about here)

Discussion

To our knowledge, this is the first U.S. study to examine body mass differences across groups jointly defined by race/ethnicity, immigrant background, and legal status. Due to data paucity, extant health research has not paid much attention to undocumented immigrants in the United States, most of whom have no health insurance, are not fluent in English, are faced with many life hardships, and are not well assimilated and acculturated into American mainstream society. Considering the detrimental health consequences of obesity and the related high healthcare costs, it is important for the public health field to grasp a thorough understanding of obesity differences, including overweight and obesity prevalence in less served and less researched groups, in order to be better prepared for meeting the healthcare needs of these groups and to more effectively allocate scarce healthcare resources.

Legal status partly captures immigrants' position in the assimilation and acculturation process, given that undocumented immigrants are, on average, more recent arrivals and face more severe structural barriers to assimilation. For instance, we know that undocumented immigrants are more highly segregated from natives than are documented immigrants in Salt Lake County, Utah, where most of the individuals in our sample reside. For residences observed between 1999 and 2007, the segregation index for the undocumented compared to the native born is 54 (on a scale of 0 to 100, calculated at the block group level); for legal immigrants compared to natives it is 26 (Maloney and Kontuly 2011).[6] Numerous studies have shown that acculturation, often measured by English skills, duration of residence, and generational status, is positively associated with risks of being overweight/obese among immigrants (Oza-Frank and Cunningham, 2009; Park et al., 2008). Therefore, assuming that undocumented immigrants are, all else equal, less likely to be acculturated than documented immigrants, our findings that Latino undocumented immigrant men are less likely to be overweight or obese compared to documented male immigrants provides indirect support for this acculturation effect (Hao and Kim, 2009).[7] However, this difference between the undocumented and the documented is not apparent among

[6]These indexes are calculated as $50{*}\sum_i |a_i - b_i|$, where i indexes block group, and a_i and b_i are the shares of populations a and b found in block group i. They can be interpreted as indicating the share of one population that would have to be moved across block groups to create identical residential patterns for the two populations.
[7] See the coefficients in Table 2 for men. The undocumented Latino coefficient is significantly smaller than the coefficients for native Latinos and documented male immigrants in all three models (at the 5% level).

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women, and in fact when we allow for SES interaction effects we find higher baseline levels of obesity among undocumented women than among documented women (this difference is statistically significant at the 5% level). This gender difference is intriguing and worth further investigation. Moreover, Cawley et al. (2009) find that obesity and overweight status are negatively correlated with employment outcomes for recently-arrived legal female immigrants from developing countries. They do not find such a relationship for male immigrants. To the extent that these effects might extend to the undocumented, their findings amplify the importance of understanding the obesity patterns we have identified, including the gender differences in these patterns.

It is also noteworthy that group-level differences in the risk of overweight status do not match group level differences in the risk of obesity. In terms of the risk of obesity, immigrant groups are typically at an advantage relative to the US-born, based on the results in Table 2. For the risk of being overweight, Latino immigrants are clearly disadvantaged regardless of gender, relative to native non-Latinos, based on the results in Table 3. On the other hand, US-born Latinos are at a disadvantage relative to US-born whites with regard to both obesity and overweight status. Therefore, Latino/non-Latino obesity differences can be obscured if the effect of immigrant status is not accounted for. This finding is consistent with recent evidence from nationally representative survey data (Hao and Kim, 2009). All in all, these results exhibit a complex picture of body weight differences by race/ethnicity and immigrant/legal status.

In addition to exploring the patterns of body mass differences across groups, we also examined the link between neighborhood SES and risks of weight problems. A growing number of multi-level studies have examined and documented contextual effects of neighborhood SES on obesity risk (Boardman, Saint Onge, Rogers & Denney, 2005; Chang, 2004; Grafova,

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Freedman, Kumar & Rogowski, 2008; Robert & Reighter, 2004; Singh, Siahpush & Kogan, 2010). These studies typically controlled for a range of individual-level socio-demographic characteristics using multilevel statistical techniques and found residual effects of neighborhood SES on individual-level obesity risk, often significant and negative, net of individual controls. However, few of them conducted gender-specific estimates of neighborhood SES associations with both overweight and obesity risks; and none, to our best knowledge, included legal status to distinguish immigrants in their analyses and examined interaction effects of neighborhood SES with ethnic/immigrant/legal group membership.

Our findings suggest that the effects of neighborhood SES differ by gender and body mass cutoffs. Generally, neighborhood SES effects are greater for women compared to men. For women, neighborhood SES is a strong and negative correlate of risk of overweight and obesity, whereas for men, neighborhood SES seems to matter only for the risk of obesity. Even for obesity, the magnitudes of neighborhood SES effects are larger for women than for men. This gender difference is to some extent expected considering that women spend more time at home and in the surrounding neighborhoods(Wen et al., 2007a). It is also consistent with previous findings that the impacts on physical activity and body mass of neighborhood contexts are stronger for women compared to men (Chang et al., 2009; Do et al., 2007; Doyle et al., 2006; Robert and Reither, 2004; Wen et al., 2007a). It thus highlights the need to conduct gender-stratified analyses when examining environmental correlates of body-mass-related outcomes in future research. One possible reason why neighborhood SES is not correlated with the risk of overweight for men is that BMI is not an ideal measure of weight problems insofar as it punishes individuals with high muscle-to-fat ratios, who are more likely to be socioeconomically advantaged men, complicating the relationship between SES status and BMI.

Our finding on the negative effect of neighborhood SES on risks of obesity for men and women is consistent with *a priori* theoretical expectation that higher SES places are less obesogenic via their positive influences on physical activity and healthful eating habits. It is also consistent with previous work conducted in Western societies reporting individual or neighborhood SES as a protective factor against overweight/obesity (McLaren, 2007). Of course, from our cross-sectional study, we cannot infer that higher neighborhood SES causally lowers one's risk of being obese.

We also found significant interaction effects between immigrant and legal status and neighborhood SES, with undocumented Latina(female) immigrants less affected by neighborhood SES (both our composite index measure and its individual components) in terms of risk of obesity than were members of other groups. Although interaction effects of neighborhood SES and ethnicity or immigrant status have rarely been examined in previous work, limited evidence suggests that neighborhood SES may play a weaker role in preventing overweight/obesity for ethnic minorities compared to whites (Ball and Crawford, 2005; Troiano and Flegal, 1998).It is possible that less acculturated groups have less contact with neighbors or local institutions because of cultural (e.g., language barrier and cultural distinction) or structural barriers (e.g., long work hours and little leisure time) and are thus less exposed to and influenced by neighborhood features. We are not aware of any studies addressing this issue. More work is needed to investigate how and why the place and health link may vary according to different groups defined by a wide range of socio-demographic factors such as race/ethnicity and immigrant/legal status.

Other than the abovementioned cross-sectional nature and its limitation on making causal inferences, several additional limitations of this study need to be acknowledged. First, self-

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reported height and weight were used to calculate BMI, which is less reliable than objectively measured height and weight due to response bias (Burkhauser and Cawley, 2008; Danubio et al., 2008; Gil and Mora, 2011). Accuracy of self-reported weight and height could vary by groups according to different norms and understandings regarding body weight (Lee, 2005). An earlier investigation of this issue found that self-reporting of weight and height were reasonably accurate for immigrant and nonimmigrant Mexican Americans, except among those who self-reported to be underweight (Rowland, 1990). Using data from the Third National Health and Nutrition Examination Survey (NHANES III) conducted in 1988-1994, a study found self-reported data generated greater underestimates of overweight and obesity among Mexican Americans than among non-Latino blacks and non-Latino whites (Gillum and Sempos, 2005). However, more recent NHANES data collected in 2007-2008 showed that under-reporting one's body mass index (BMI) was common across gender and racial/ethnic groups and that women under-reported their BMI more than men do and white women weremore likely to do so compared to non-white women (Wen and Kowaleski-Jones, 2012). In any event, evidence has consistently confirmed a strong correlation of self-reported BMI with objective BMI and a small magnitude of BMI underreporting (Dahl, Hassing, Fransson, & Pedersen, 2010; Rowland, 1990; Wen &Kowaleski-Jones, 2012), suggesting the reliability of using self-reported BMI in epidemiological studies of body weight. That said, BMI, although commonly used as a conventional measure in obesity research (Burkhauser et al., 2009; Ogden et al., 2006), has its limitations as a measure of body fat. It does not take into account body composition (ratio of body fat versus lean mass), bone density, or fitness. It is a crude measure based on height and weight missing details of weight-related information that are relevant to health. Examples of alternative measures are waist circumference, hip-waist ratio, and fat proportion of body weight.

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More studies are needed to use these alternative measures to examine etiology of body weight problems.

Second, few individual variables were available to us through the UPDB, thus making our conclusionsabout "neighborhood effects" less precise. Ideally, we would want to control for a wide range of individual-level factors related to overweight or obesity risks including, say, education, occupation and hours worked, to distinguish individual SES from neighborhood SES. We are unaware of any data sets that incorporate such individual-level detail while providing a means for distinguishing between documented and undocumented immigrants. Given the growth in the size of the undocumented population in the early 2000s, along with concerns about the relative deprivation and marginalization of this population, our findings regarding distinct obesity patterns among undocumented female immigrants, while suggestive and subject to revision, remain important. Whether their obesity disadvantage relative to documented women arises from individual-level deprivation for which we have not accounted, or whether it reflects different processes of acculturation conditional on individual SES, the relative health status of this group deserves particular attention. We also lack more qualitative measures of neighborhood contexts such as perceived neighborhood satisfaction and safety that may operate as mediators of the neighborhood SES and obesity link. Having more detailed and subjective measures of neighborhood contexts may also help shed light on the finding that prevalence rates of single-headed households and households receiving public assistance have stronger effects on women's obesity risk than a simple poverty measure. It is possible these specific measures of neighborhood deprivation are more telling indicators of neighborhood contexts such as subcultural orientation directly relevant to health behaviors like diet and exercise and in turn weight status. That said, evidence is not readily available to support or refute this hypothesis.

In addition to individual SES measures, we also lack specific measures of acculturation such as English proficiency, length of residence, and social networking patterns in the U.S. We used immigrant-legal status to tap acculturation. Undocumented immigrants are arguably less acculturated and assimilated than their documented counterparts given the stronger structural barriers they have to face on a daily basis and considering the plausibility that they are less fluent in English and have fewer native friends of other ethnicities to socialize with. Little work has been done to study health and well-being of this special group of immigrants due to data paucity. More work is definitely needed to better understand their life circumstances and multifarious needs.

Third, it should be kept in mind that this study, albeit of an impressive sample size and unique in its ability to distinguish undocumented immigrants, was conducted in one state. Whether these patterns hold elsewhere is an empirical question, though the requisite data, particularly with regard to undocumented status, are not widely available. Another caveat is that our sample of undocumented immigrants is not complete but includes only those who participated in the driver license / driving privilege card program. While participation in the program appears to have been quite widespread, this sub-population likely represents more men than women and more economically active undocumented immigrants relative to their counterparts who have never attempted to get a driver license in Utah. To the extent that this group is therefore more well-integrated into Utah than is the random undocumented immigrant, we believe this form of selection ought to work against our identifying any differences between the documented and the undocumented.

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Conclusion

Our primary findings indicate that undocumented Latina women have somewhat higher rates of obesity and overweight than do legal immigrant Latinas, and also that undocumented women are less affected by neighborhood context in terms of their health status than are legal immigrant women. These patterns are not present among male immigrants. For them, the documented have somewhat higher rates of obesity and overweight than do the undocumented, and the effects of neighborhood context are rather uniform across groups. In addition, we find, as have others, that neighborhood context is more salient for the health status of women than men, that immigrant groups often exhibit lower rates of obesity than do natives, and that native Latinos have particularly high rates of overweight and obesity.

It has been increasingly recognized that public health messages may be more effective in closing the wide differences in body mass in the United States if they are specifically tailored to target audiences (Denney et al., 2004; Gregory et al., 2008). The results of the present study underscore the need for a public health research agenda that more completely documents gender-stratified differences in body mass, at both the local and national level. It has been estimated that there are approximately 11 million undocumented immigrants, constituting 28% of all foreign-born residents in the United States (Passel et al., 2004). However, a national study similar to the present one is not likely to be conducted in the foreseeable future because of the difficulty in identifying such individuals. As a result, little information about them is available. Given the current heated debate around immigration and healthcare reforms, it is warranted to seriously consider ways of incorporating this previously ignored segment of the U.S. population into public health research and the health policy agenda.

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Table 1: Individual and Neighborhood Characteristics, Utah Residents

		US Born		Latino Immigrant	
	All	**White**	**Latino**	**Doc**	**Undoc**
MEN					
Overweight	.69	.69	.76	.73	.68
Obese	.22	.23	.28	.19	.16
Age	40.3	40.7	39.5	38.6	34.3
Pre-2004	.29	.30	.27		
Standardized SES	-.01	.08	-.47	-.64	-.86
Share College	.64	.65	.57	.55	.51
Share $75,000+	.24	.25	.20	.16	.15
Share Public Assistance	.03	.03	.04	.04	.04
Share Poverty	.08	.08	.09	.11	.12
Share Single-Headed	.10	.09	.12	.12	.13
N	383,627	336,244	13,673	16,322	17,388
WOMEN					
Overweight	.44	.43	.54	.51	.55
Obese	.18	.17	.24	.18	.19
Age	40.0	40.3	38.5	37.6	34.4
Pre-2004	.31	.32	.27		
Standardized SES	.01	.08	-.47	-.49	-.81
Share College	.64	.65	.56	.57	.52
Share $75,000+	.24	.25	.20	.18	.15
Share Public Assistance	.03	.03	.04	.04	.04
Share Poverty	.08	.07	.09	.10	.11
Share Single-Headed	.10	.09	.12	.12	.13
N	359,321	323,459	14,722	12,153	8,987

Notes:
Overweight and Obese are both individual-level, binary variables.
Age is an individual-level variable ranging from 25 to 64.
"Pre-2004" =1 if the individual's BMI was measured between 1999 and 2003. It equals 0 if BMI was measured between 2004 and 2008.
Standardized SES is a standardized, tract-level index with mean 0 and standard deviation 1 for the full regression data set. It ranges from -3.54 to 2.76.
All other variables are tract-level neighborhood characteristics. "Share College" ranges from .19 to .97; "Share $75,000+" ranges from 0 to .75; "Share Public Assistance" ranges from 0 to .22; "Share Poverty" ranges from 0 to .57; "Share Female Headed" ranges from 0 to .31. We present the means weighted by individuals.

Table 2: Logit Estimates of Correlation of Individual Characteristics and Neighborhood SES Index with Relative Odds of Obesity

	Women			Men		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Age	**1.05** [1.05,1.05]	**1.05** [1.05,1.05]	**1.05** [1.05,1.05]	**1.05** [1.05,1.05]	**1.05** [1.05,1.05]	**1.05** [1.05,1.05]
Age squared	**1.00** [1.00, 1.00]	**1.00** [1.00,1.00]	**1.00** [1.00,1.00]	**0.99** [0.99,0.99]	**0.99** [0.99,0.99]	**0.99** [0.99,0.99]
US Born White	Reference	Reference	Reference	Reference	Reference	Reference
US Born Latino	**1.31** [1.26,1.37]	**1.30** [1.25,1.36]	**1.28** [1.22,1.35]	**1.29** [1.24,1.34]	**1.28** [1.23,1.33]	**1.28** [1.23,1.34]
Immigrants						
Latino Doc	**0.91** [0.87,0.96]	**0.90** [0.86,0.95]	**0.92** [0.87,0.97]	**0.77** [0.73,0.80]	**0.76** [0.73,0.79]	**0.76** [0.72,0.80]
Latino Undoc	**0.94** [0.89,1.00]	**0.93** [0.88,0.99]	1.06 [0.98,1.14]	**0.69** [0.66,0.72]	**0.68** [0.65,0.71]	**0.70** [0.66,0.74]
Pre-2004	**0.83** [0.81,0.84]	**0.83** [0.81,0.84]	**0.83** [0.81,0.84]	**0.79** [0.78,0.80]	**0.79** [0.78,0.80]	**0.79** [0.78,0.80]
Neighborhood SES		**0.71** [0.69,0.73]	**0.71** [0.69,0.73]		**0.88** [0.86,0.90]	**0.88** [0.86,0.90]
SES*US Born Latino			0.98 [0.94,1.02]			1.01 [0.97,1.05]
SES*Latino Doc			1.03 [0.98,1.08]			1.00 [0.95,1.04]
SES*Latino Undoc			**1.15** [1.08,1.23]			1.04 [0.99,1.09]
N	359,321	359,321	359,321	383,627	383,627	383,627

Notes:
Based on multilevel (random effects) logit regressions for 477 census tracts.
Coefficients presented as effects on odds ratio of obesity relative to normal weight. An odds ratio higher than one indicates increased odds of obesity, while an odds ratio less than one indicates reduced odds of obesity. 95% confidence intervals in brackets. **Bold** => significantly different from 1.00 at the 95% confidence level. Age and age squared entered as "age – 25" and "(age – 25) squared."

Table 3: Logit Estimates of Correlation of Individual Characteristics and Neighborhood SES Index with Relative Odds of Overweight Status

	Women			Men		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Age	**1.04** [1.04,1.04]	**1.04** [1.04,1.04]	**1.04** [1.04,1.04]	**1.08** [1.07,1.08]	**1.08** [1.07,1.08]	**1.08** [1.07,1.08]
Age squared	1.00 [1.00,1.00]	1.00 [1.00,1.00]	1.00 [1.00,1.00]	**0.99** [0.99,0.99]	**0.99** [0.99,0.99]	**0.99** [0.99,0.99]
US Born White	Reference	Reference	Reference	Reference	Reference	Reference
US Born Latino	**1.42** [1.37,1.47]	**1.41** [1.36,1.46]	**1.37** [1.32,1.42]	**1.52** [1.46,1.58]	**1.52** [1.46,1.58]	**1.50** [1.44,1.57]
Immigrants						
Latino Doc	**1.30** [1.25,1.35]	**1.29** [1.24,1.34]	**1.28** [1.23,1.34]	**1.23** [1.18,1.27]	**1.22** [1.18,1.27]	**1.19** [1.14,1.25]
Latino Undoc	**1.57** [1.50,1.64]	**1.56** [1.49,1.63]	**1.71** [1.61,1.82]	**1.14** [1.10,1.18]	**1.13** [1.09,1.17]	**1.07** [1.02,1.12]
Pre-2004	**0.87** [0.85,0.88]	**0.75** [0.73,0.77]	**0.87** [0.85,0.88]	**0.85** [0.84,0.86]	**0.85** [0.84,0.86]	**0.85** [0.84,0.86]
Neighborhood SES		**0.75** [0.73,0.77]	**0.75** [0.73,0.77]		0.98 [0.96,1.00]	0.99 [0.97,1.01]
SES*US Born Latino			**0.93** [0.90,0.97]			0.97 [0.93,1.01]
SES*Latino Doc			0.99 [0.95,1.03]			**0.95** [0.92,0.99]
SES*Latino Undoc			**1.12** [1.07,1.18]			**0.93** [0.89,0.96]
N	359,321	359,321	359,321	383,627	383,627	383,627

Notes:
Based on multilevel (random effects) logit regressions for 477 census tracts.
Coefficients presented as effects on odds ratio of overweight relative to normal weight. An odds ratio higher than one indicates increased odds of overweight, while an odds ratio less than one indicates reduced odds of overweight. 95% confidence intervals in brackets. **Bold** => significantly different from 1.00 at the 95% confidence level. Age and age squared entered as "age – 25" and "(age – 25) squared."

Table 4: Logit Estimates of Correlation of Specific Neighborhood Conditions with Relative Odds of Obesity

	Poverty	**College**	**Income > $75,000**	**Pub. Assistance**	**Single Headed**
		Women			
Neighborhood Main Effect	**1.11**	**0.68**	**0.71**	**1.24**	**1.24**
Neigh*US-Born Latino	**1.08**	1.04	**0.93**	1.02	1.00
Neigh*Latino Doc	1.04	**1.05**	1.02	1.00	0.97
Neigh*Latino Undoc	1.01	**1.23**	**1.21**	0.98	**0.92**
N	359,321	359,321	359,321	359,321	359,321
		Men			
Neighborhood Main Effect	1.02	**0.84**	**0.87**	**1.07**	**1.04**
Neigh*US Born Latino	**1.04**	**1.06**	0.97	1.00	0.99
Neigh*Latino Doc	1.03	**1.05**	1.02	1.01	**1.04**
Neigh*Latino Undoc	1.03	**1.07**	**1.12**	0.99	1.00
N	383,627	383,627	383,627	383,627	383,627

Notes:
Based on multilevel (random effects) logit regressions for 477 census tracts.
Coefficients presented as effects on odds ratio of obesity relative to normal weight. An odds ratio higher than one indicates increased odds of obesity, while an odds ratio less than one indicates reduced odds of obesity. **Bold** => significantly different from 1.00 at the 95% confidence level. Age, age squared, date of BMI measurement (pre-2004 or later), and Latino/immigrant/legal status also controlled (as in Tables 2 and 3).

Table 5: Logit Estimates of Correlation of Specific Neighborhood Conditions with Relative Odds of Overweight Status

	Poverty	College	Income > $75,000	Pub. Assistance	Single Headed
			Women		
Neighborhood Main Effect	**1.08**	**0.71**	**0.76**	**1.19**	**1.18**
Neigh*US-Born Latino	**1.10**	0.97	**0.91**	**1.05**	**1.05**
Neigh*Latino Doc	**1.06**	1.02	0.96	1.02	0.99
Neigh*Latino Undoc	0.99	**1.17**	**1.14**	0.97	**0.93**
N	359,321	359,321	359,321	359,321	359,321
			Men		
Neighborhood Main Effect	**0.96**	**0.93**	**0.97**	0.99	**0.97**
Neigh*US Born Latino	**1.05**	1.01	0.97	1.03	**1.04**
Neigh*Latino Doc	**1.04**	**0.96**	0.98	**1.04**	**1.04**
Neigh*Latino Undoc	**1.06**	0.99	0.95	**1.06**	**1.08**
N	383,627	383,627	383,627	383,627	383,627

Notes:
Based on multilevel (random effects) logit regressions for 477 census tracts.
Coefficients presented as effects on odds ratio of overweight relative to normal weight. An odds ratio higher than one indicates increased odds of overweight, while an odds ratio less than one indicates reduced odds of overweight. **Bold** => significantly different from 1.00 at the 95% confidence level. Age, age squared, date of BMI measurement (pre-2004 or later), and Latino/immigrant/legal status also controlled (as in Tables 2 and 3).

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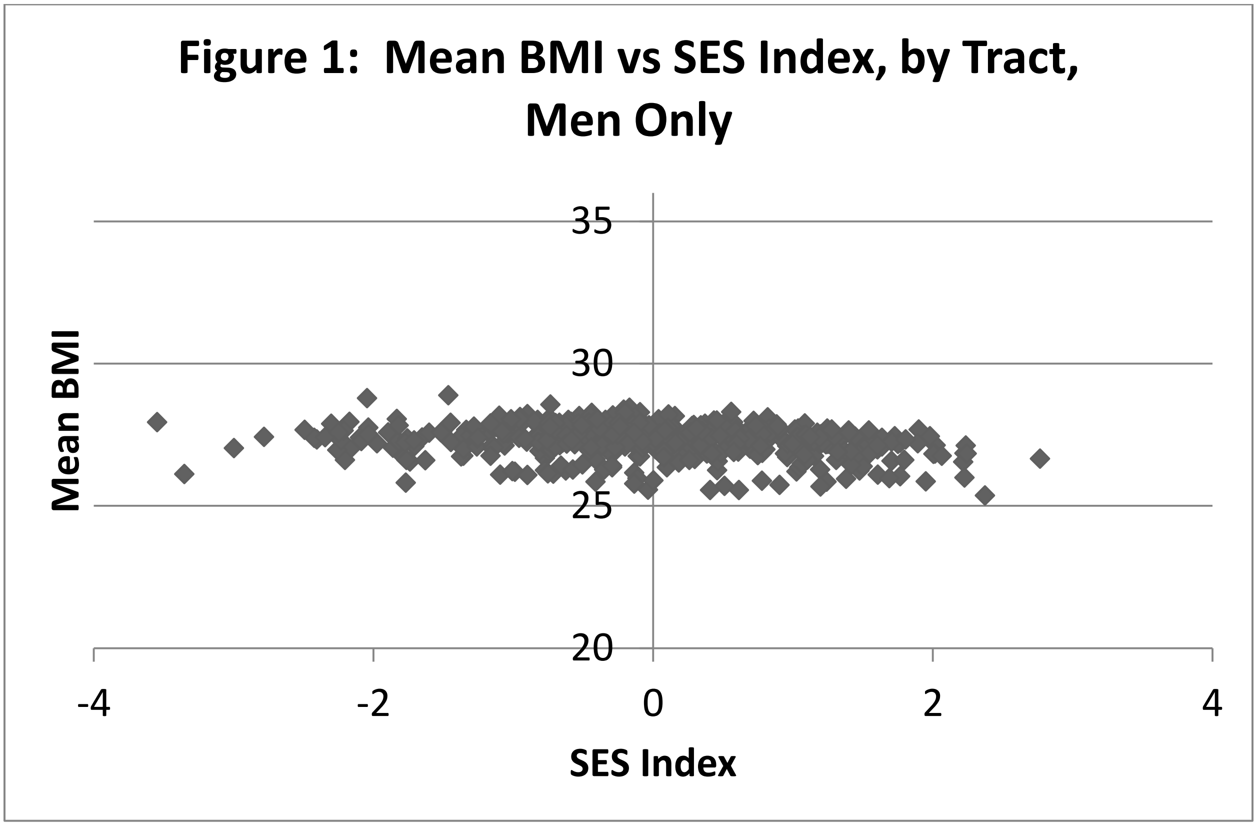
Figure 1: Mean BMI vs SES Index, by Tract, Men Only
Mean BMI
35
30
25
20
-4
-2
0
2
4
SES Index

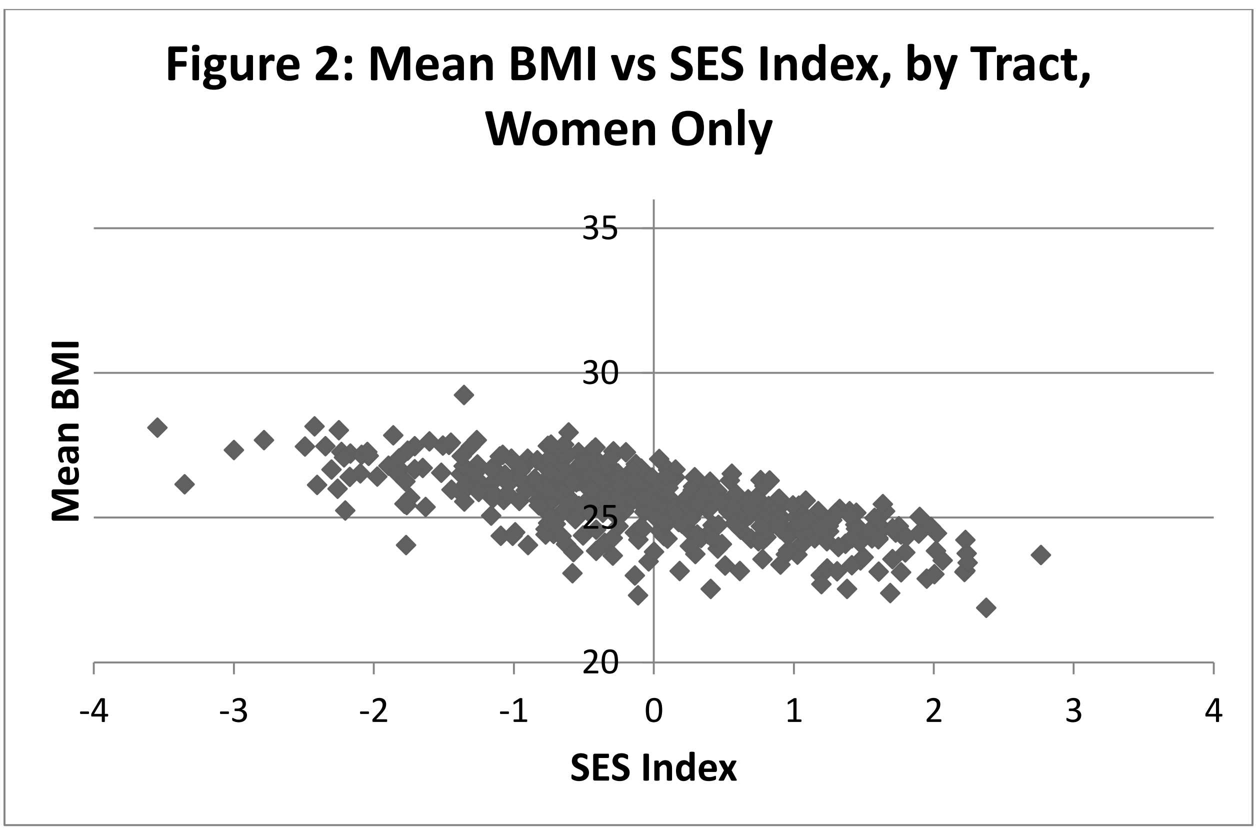
Figure 2: Mean BMI vs SES Index, by Tract, Women Only
Mean BMI
35
30
25
20
-4
-3
-2
-1
0
1
2
3
4
SES Index

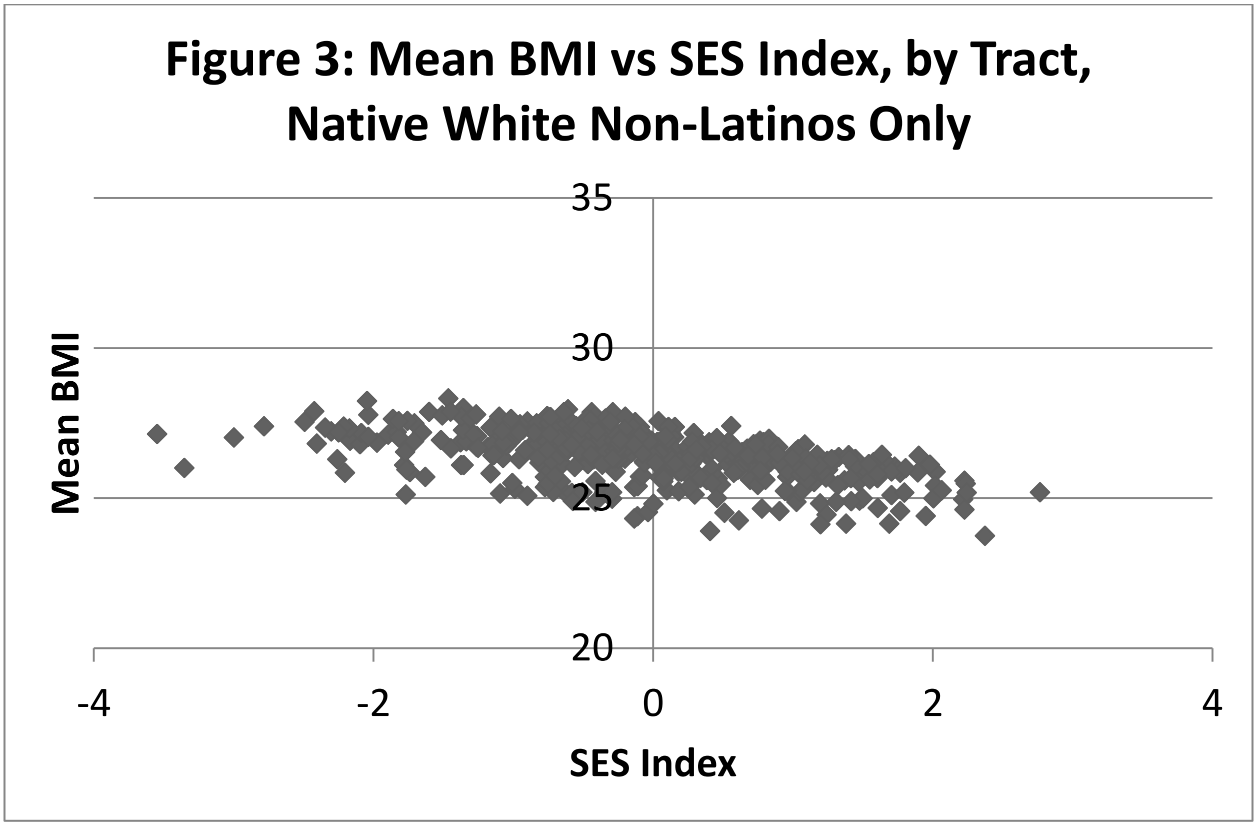
Figure 3: Mean BMI vs SES Index, by Tract, Native White Non-Latinos Only
35
30
25
20
-4
-2
0
2
4
Mean BMI
SES Index

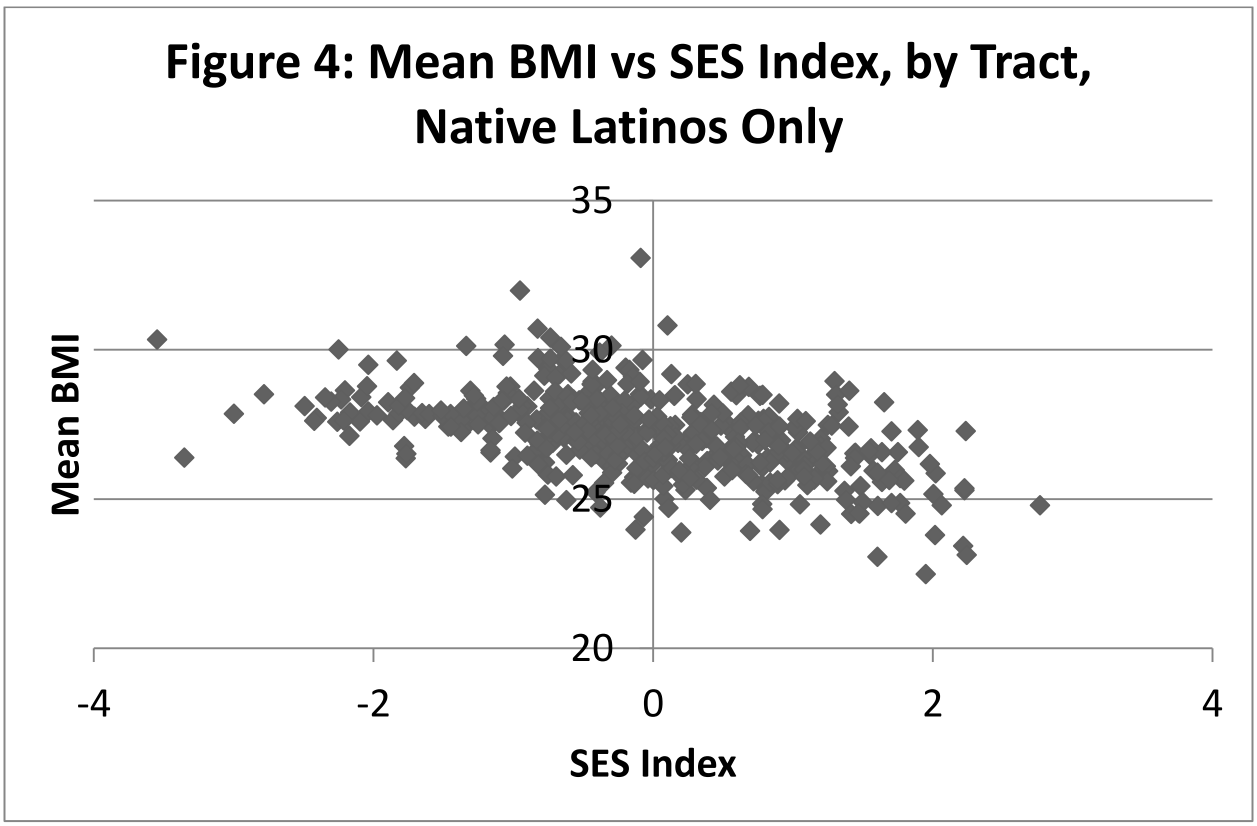
Figure 4: Mean BMI vs SES Index, by Tract, Native Latinos Only
35
30
25
20
-4
-2
0
2
4
Mean BMI
SES Index

Figure 5: Mean BMI vs SES Index, by Tract, Documented Immigrants Only

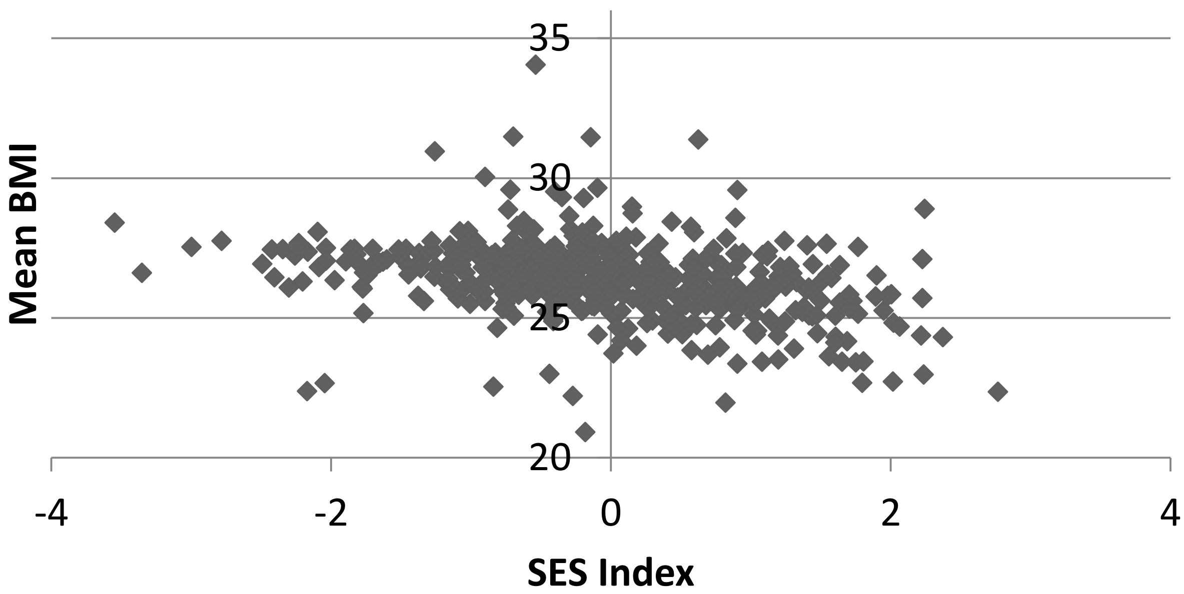

Figure 6: Mean BMI vs SES Index, by Tract, Undocumented Latino Immigrants Only