Demography (2013) 50:993–1012
DOI 10.1007/s13524-012-0174-0

Social Patterning in Body Mass Index (BMI) Among Contemporary Immigrant Groups: The Emergence of a Gradient

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Published online: 4 December 2012

Abstract Although adult body mass index (BMI) displays considerable social patterning worldwide, the direction and strength of the relationship between BMI and socioeconomic status (SES) varies cross nationally. We examine social gradients in BMI for contemporary U.S. immigrants and evaluate whether their SES-BMI gradient patterns are shaped by underlying gradients in immigrant origin countries and whether they are further patterned by time in the United States. Data come from the New Immigrant Survey, the only nationally representative survey of contemporary immigrants. Results indicate that the inverse SES-BMI gradients observed among this population are strongest among women originating in highly developed countries. After arrival in the United States, however, inverse gradient patterns are driven largely by higher weights among low-SES individuals, particularly those from less-developed countries. We conclude that although certain immigrants appear to be uniquely protected from weight gain, poorer individuals from less-developed countries are doubly disadvantaged; this raises concerns about worsening inequalities in both diet and behavior between the rich and poor upon arrival to the United States.

Keywords Immigrants · Socioeconomic status · Gradient · BMI · Obesity

Introduction

The U.S. population has experienced dramatic increases in overweight and obesity rates over the last several decades. Between 1976 and 2008, overweight prevalence

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nearly doubled (from 37 % to 62 %), and obesity prevalence tripled (from 8.7 % to 27.8 %) (Singh et al. 2011). The increases have been large and monotonic, and have occurred at all ages and across all segments of the population (Mokdad et al. 1999; Singh et al. 2009; Taubes 1998). Coexisting with the uniform increases, however, is substantial social differentiation in prevalence (Wang and Beydoun 2007). Labeled the socioeconomic status-body mass index (SES-BMI) gradient because of the graded nature of the relationship, the pattern in the United States is generally inverse and particularly strong for women and non-Hispanic whites (Ogden et al. 2010).[1] An opposite pattern is observed in the developing world, where either flat or positive gradients prevail—that is, higher income, education, and occupational prestige are associated with higher rates of overweight and obesity (McLaren 2007).

In this article, we investigate SES-BMI gradients among contemporary U.S. immigrants, many of whom have migrated from countries characterized by SES-BMI gradient patterns that are different than those prevalent in the United States. The case of contemporary U.S. immigrants raises two sets of questions. First, do immigrants, particularly those from less-developed countries characterized by positive SES-BMI gradients, transfer these gradients to life in the United States? Second, do immigrants' gradients assume the inverse patterns observed among the native-born U.S. population the longer they remain in the United States? If so, does the pattern of convergence depend on the development level of the origin country?

Our analysis speaks to two distinct issues. The first concerns the obesity epidemic and the need to gain a better understanding of the mechanisms driving the social patterning of weight gain. In the United States, there is considerable diversity in SES-BMI gradients by race/ethnicity and nativity (Sanchez-Vaznaugh et al. 2009). One possible explanation for the existing variability is that gradient patterns in the United States are contingent on underlying gradients in immigrant origin countries. An often overlooked aspect of immigrant health patterns is the role of pre-immigration environments in influencing immigrant outcomes after arrival in the United States. We examine whether social gradients in BMI observed among immigrants in the United States are related to the Human Development Index (HDI) of the origin country, a measure that previous research has linked closely to both positive and negative SES-BMI gradients (McLaren 2007).[2] Second, our analysis examines immigrant adaptation by evaluating whether SES-BMI gradients are patterned by time in the United States. Past work has shown that immigrants tend to converge to U.S. BMI levels over time (Antecol and Bedard 2006). Depending on the U.S. social group into which they are assimilating, increased time spent in the United States may expose immigrants differentially to obesogenic environments and behaviors. In turn, the effects of these varying exposures may differ according to the development level of the origin country. In the analysis that follows, we document the SES-BMI gradients in a group of contemporary immigrants and attempt to disentangle the role of home- and host-country contexts in influencing these patterns.

[1] We use the term "gradient" in a broad sense to indicate "the SES patterning of BMI" (Sanchez-Vaznaugh et al. 2009).

[2] The Human Development Index (HDI) is a composite measure used by the United Nations based on national indicators of life expectancy, educational attainment, and income.

Background

There is considerable cross-national variability in SES-BMI gradients, largely dependent on country-specific development levels. A review piece published by Sobal and Stunkard (1989) found two distinct trends in the socioeconomic patterning of weight. Women in developed societies displayed an *inverse* gradient such that women with lower SES were at higher risk of obesity. In developing societies, a *positive* relationship was observed for all women, men, and children. An updated review analyzing articles through 2004 found the same general pattern of increasing positive associations between SES and BMI and decreasing negative associations as one moved from countries with high levels of development to countries with lower levels of development (McLaren 2007).

Explanations for either positive or inverse gradient patterns are linked to where countries are situated in their nutrition and epidemiological transitions (Popkin 1994, 1999, 2001). In general terms, the nutrition transition characterizes a shift toward a diet of more processed foods, more food of animal origin, and more added sugar and fat. In pretransition and transitioning societies where food is less available, the basic ability to afford sufficient food is an important factor in the socioeconomic patterning of weight. Cultural values favoring larger body size consequently produce positive BMI gradients, with higher SES generally linked to higher BMIs (Monteiro et al. 2004). In developed, post-transitional countries, the reverse is true: individuals in lower socioeconomic positions tend to have higher BMIs, particularly in the case of women (McLaren 2007).

Despite the continued relevance of a country's level of development in determining the direction of SES-BMI gradients, the strength of these contrasts appears to have weakened over time. The most recent large-scale review of nearly 2,000 cross-sectional associations between BMI gradients and country development level found that both positive and negative associations have become less pronounced primarily because of "large-scale societal and nutritional change having to do with economic growth, modernization, and globalization of food markets," which has attenuated variation in obesity promoting exposures (McLaren 2007:30). This is true in developing countries, where the aforementioned forces, including the popularity and prestige of imported processed foods, have begun to shift the burden of obesity onto the poor. Convergence toward lower-quality diets and changes in aspirations toward thinness among the upper classes also have the potential to weaken historically positive social gradients in weight in developing countries. Likewise, in the case of developed countries, recent evidence suggests that inverse SES-BMI gradients in the United States are beginning to flatten as higher-SES individuals become more obese (Singh et al. 2011).

The contemporary immigrant population in the United States provides a unique opportunity to evaluate what happens to social gradients in BMI when individuals move between countries characterized by different levels of development and whether changes are mitigated by general increases in obesogenic environments worldwide. Although no previous study has evaluated social gradients in BMI for a nationally representative group of contemporary adult immigrants, several studies have examined how social gradients in weight status vary across particular racial/ethnic groups in the United States (Braveman et al. 2010; Chang and Lauderdale 2005;

Sanchez-Vaznaugh et al. 2009; Singh et al. 2011). In contrast to other social gradients in health that are more uniformly positive, social gradients in weight in the United States are highly dependent on sex and race (Kimbro et al. 2008). Non-Hispanic white women consistently display the clearest inverse gradient patterns, across time and regardless of the SES measure used (Chang and Lauderdale 2005; Singh et al. 2011). The patterns for men and other racial/ethnic/nativity groups are largely inconsistent, with the direction and strength of the gradient dependent on the data source, the measure of SES selected, and the groups examined (Buttenheim et al. 2010; Chang and Lauderdale 2005; Sanchez-Vaznaugh et al. 2009). The literature is clear on one point, however: social gradients in BMI (and a host of other outcomes) are consistently more pronounced in the native-born U.S. population than in the foreign-born population (Singh et al. 2011). According to a study by Goldman et al. (2006) on the Mexican-origin population, explanations for flatter gradients among immigrants are threefold: (1) there are flatter social gradients in health in Mexico that are imported to the United States; (2) health selection operates such that healthier migrants of all social strata are more likely to migrate, thus diluting preexisting social gradients; and (3) patterns of integration may predispose native-born descendants of immigrants toward unhealthy behaviors and sharpen social gradients in health compared with their immigrant counterparts (Goldman et al. 2006). To our knowledge, no existing study has simultaneously evaluated these three explanations for SES-BMI gradients across a wide range of contemporary immigrant groups. One previous study that addresses only the first explanation does so in the case of the Mexican-origin population (Buttenheim et al. 2010). Comparing social gradients in smoking and obesity between Mexican immigrants in the United States and nonmigrants in Mexico, the authors found partial support for the "imported gradient" hypothesis for smoking but less clear results in the case of obesity. For obesity, Mexican men display minor positive gradients that are either absent or less strong among Mexican immigrants in the United States. In the case of women in Mexico, the authors found small negative gradients in obesity that differ from the curvilinear pattern observed among recently arrived Mexican immigrant women in the United States. The authors conclude that recently arrived highly educated Mexican women "do not resemble" their counterparts who remain in Mexico, a finding they attribute to selective migration and/or changes in diet and physical activity after their arrival to the United States (Buttenheim et al. 2010). Thus far, which of these processes may explain the different gradient patterns observed among the immigrant population awaits further testing.

A second study relevant to the present analysis focused on the case of children of immigrants and examined how the relationship between generational status and BMI varied by familial SES and by the economic development level of the origin country (Van Hook and Balistreri 2007). The authors found a pattern consistent with differential assimilation by SES. Generational status was positively associated with overweight among children from low-income countries with low familial SES but negatively associated with overweight among children from low-income countries with high familial SES. For children migrating from high-income countries, generational status was not associated with BMI.

The present study takes up the question of how social gradients in BMI are patterned among contemporary adult immigrants and links it to a larger literature on the worldwide social patterning of weight according to country development level.

Do immigrants from developing countries import positive SES-BMI gradients when they move? Does health selection play a role in muting preexisting gradients? A further question is what happens over time in the United States: is there variability in terms of the effect of U.S. tenure on gradients? Do negative gradients become more pronounced over time: that is, do immigrants, regardless of their origin country, take on the negative gradients characterizing the United States? Or does this process depend on the level of development in the country from which immigrants originate?

Data

To address these questions, we draw on data from the 2003 New Immigrant Survey (NIS), a representative sample of immigrants who were granted legal permanent U.S. residency between May and November 2003, which yielded 8,573 respondents 18 years of age or older. The NIS is not representative of the entire foreign-born population (more than one-quarter of which is currently unauthorized), but it is representative of the portion of the population that achieved permanent resident status at the beginning of the twenty-first century (Passel and Cohn 2011). Respondents come from virtually every country in the world and include individuals who adjusted their status while in the United States as well as those who were new arrivals, generating substantial variation with respect to time spent in the United States. Interviews were conducted in the respondent's language of choice and were carried out as soon as possible after legal permanent residence was granted. The survey response rate was approximately 69 % (Jasso et al. forthcoming).

Because of a combination of missing values on the health selection measure (missing $n = 962$), missing information on childhood SES (missing $n = 122$), the absence of Human Development Index (HDI) data for the respondent's origin country (missing $n = 405$), and missing information on other variables ($n = 703$), we have an analytic sample of 6,381 that comprises 3,188 men and 3,193 women.[3] Although this is a sample of legal permanent residents, we note here that approximately 15 % of our analytic sample had made a previous trip to the United States in an unauthorized status. We focus on BMI (kg/m^2), rather than discrete measures of obesity or overweight, precisely because of the graded and gradual nature of the relationship between SES and weight (Sanchez-Vaznaugh et al. 2009). Our measures of height and weight are self-reported. Although anthropometric measures might be considered superior because of anticipated reporting bias, background analysis done elsewhere with the same data examining obesity exclusively among Hispanics used an adjustment for self-reports and obtained qualitatively similar results to the

[3] The nearly 15 % of the sample missing on health selection is a cause for concern given that they are not missing at random and, compared with those respondents with complete data, are significantly older (42.7 years vs. 38.4 years), less educated (11.3 years vs. 13.1 years), female (55 % versus 50 %), and with more U.S. experience (6 years in the United States vs. 4 years in the United States). A sensitivity analysis that eliminated the health selection variable from the models (thereby including those respondents who were missing on health selection and not missing on any other variables) did not result in any substantive changes. Because health selection is a key hypothesis tested in this article, we have retained it in the analysis (and thereby exclude the 962 missing on health selection), but we are confident that the results would not be substantively different if they were included.

unadjusted results (Akresh 2008). We discuss this further in the section Sensitivity Analyses and Limitations. Average BMI ranges from a low of 23.90 among women from high-/very high–HDI countries to a high of 25.54 among men from high-/very high–HDI countries.

Human Development Index (HDI)

Previous research has linked a country's level of development to both positive and negative SES-BMI gradients (McLaren 2007). We examine whether social gradients in BMI observed among immigrants in the United States are related to the origin country's development level by using the Human Development Index (HDI), a composite measure used by the United Nations based on national indicators of life expectancy, educational attainment, and income.[4] All immigrants are given an HDI value that corresponds to the value held by their country the year they first migrated to the United States. Doing so provides an indication of the conditions present in the origin country when the immigrant departed. It also indirectly addresses the issue that immigrants from a single origin country (i.e., Mexico) may be driving the results because a single country may be coded as having a high-/very high–HDI level or a low-/medium-HDI level depending on the year in which the immigrant departed. Countries with an HDI lower than 0.698 are classified in the low-/medium-HDI category, and countries with an HDI of 0.698 and higher are classified in the high-/very high–HDI category; these cutoffs are consistent with those used by the United Nations Development Program. Collapsing HDI categories in this manner is necessary because of the HDI distribution in the data.[5]

Measures of Socioeconomic Status (SES)

One of the strengths of the current study is the ability to consider multiple measures of SES taken at the time of the interview. The majority of existing studies focus only on education; or, if they consider two measures, education and income. We incorporate two additional dimensions that past studies have shown to be important: namely, an assessment of the SES of the childhood household (measured retrospectively) and occupational prestige. We examine the relationship between BMI and each indicator of SES separately, rather than combine all measures of SES in the same equation. This decision stems from our primary interest in describing the SES gradients in BMI, rather than attempting to demonstrate the causal effect of unique dimensions of SES on BMI. Further, the indicators of SES are weakly to moderately correlated, ranging from 0.189 to 0.479, suggesting that our examination of the BMI gradient by single measures of SES is not seriously undermined by omitted variable bias. Our four measures of SES are childhood socioeconomic status, years of education abroad, occupational prestige, and individual annual earnings.

[4] The HDI data were retrieved from a site maintained by the United Nations Development Program (http://hdr.undp.org/en/media/HDR_2010_EN_Table2_reprint.pdf).

[5] However, using a dichotomous division may obscure differences, for example, between low- and medium-HDI countries (McLaren 2007). This may especially apply to medium-HDI countries that are often in the process of a nutrition transition, shifting the burden of obesity toward low-SES individuals (i.e., more negative SES-BMI gradients).

1. **Childhood SES**. This was measured in response to the question, "Thinking about the time when you were 16 years old, compared with families in the country where you grew up, would you say your family income during that time was far below average, below average, average, above average, or far above average?" For the current analysis, responses of "far below average" and "below average" were designated as "below average," responses of "average" remained a separate category, and responses of "above average" and "far above average" were coded as "above average." Less than 3 % of the sample migrated before the age of 16 and thus likely used the U.S. population as a comparison group.
2. **Years of education abroad**. Nearly all the schooling for the sample of adult immigrants in the NIS occurred outside the United States. Eighty-two percent of the sample had 0 years of education in the United States. Of those who had any schooling in the United States, the median was three years. For this reason, we do not distinguish years of schooling in the United States versus the sending country.
3. **Occupational prestige**. This was measured using the International Socioeconomic Index (ISEI), which is an internationally standardized measure of occupational status (Ganzeboom et al. 1992; Ganzeboom and Treiman 1996). It is a continuous measure ranging from 16 (e.g., domestic helpers) to 90 (e.g., judges).
4. **Individual annual earnings**. Information for this measure was taken from salaried workers and wage workers. For salaried workers, their reported annual salary was used. For wage workers, their hourly wage was aggregated to an annual amount, using information provided on hours worked per week and weeks worked per year.

Health Selection

To test the hypothesis that immigrant BMI-SES gradients are affected by health selection processes, we include a measure of health selection that has been used elsewhere with the same data (Akresh and Frank 2008). Individuals are classified according to a series of algorithms using the following survey questions: (1) "Compared with your health right before you most recently came to the United States to live, would you say that your health is better now, about the same, or worse?," (2) "If you compared your current health to people in your home country, how would you rate it — excellent, very good, good, fair, or poor?," and (3) "At the time of that first filing that started the process for the immigrant visa that you now have, would you say your health was excellent, very good, good, fair, or poor?" For respondents who said that their health now is the same as prior to coming to the United States (almost 75 % of the sample), health selection is defined using their reply to the second question: that is, how they rate their health in comparison with the health of people in their home country. Responses of "very good" and "excellent" were coded as positive selection, "fair" and "poor" were coded as negative, and "good" was coded as neutral. For the remaining individuals who say that their health has changed since coming to the United States, the following sequence was used: if they were not in the United States or were in the United States for fewer than 5 years at the time they began the visa filing process, their response to question 3 is coded positive if the response was very good or excellent, neutral if reported as good, and negative if reported as fair or

poor. Individuals who had been in the United States for more than five years when they began filing for a visa were classified based on consistent responses to questions 2 and 3 as well as an additional question on their evaluation of their health while growing up (see Akresh and Frank 2008 for additional details).

Methods

Our approach allows for an empirical test of the three explanations driving gradient differences between the immigrant and native U.S. populations. First, we address whether origin-country social gradients in health are imported to the United States by distinguishing the sample by the HDI level of the origin country (explanation 1). Second, we evaluate whether there are health selection effects by including a health selection measure (explanation 2); and third, we evaluate the possibility that immigrant gradient patterns reflect patterns of integration by including a detailed measure of time in the United States (a sum of the duration of each U.S. trip), which we use to proxy for the respondent's level of adaptation (explanation 3). All analyses are specified separately for men and women given that the SES-BMI gradient is known to differ along this dimension (McLaren 2007). The SES-BMI gradient in the United States also has been shown to vary by race/ethnicity (Wang and Beydoun 2007). We do not examine gradients net of race because past work has suggested that the ways in which self-reported race/ethnicity are consequential for immigrants are not well captured by self-reported race in this sample (see Frank et al. 2010 for more detail).[6] Our inability to account for racial effects in the United States will most likely affect the results pertaining to explanation 3: namely, that BMI-SES gradients may reflect patterns of integration. Without netting out the effects of race, any conclusions regarding the relationship between time spent in the United States and BMI-SES gradients necessarily encompass the possibility of racially differentiated integration patterns.

Our presentation of the findings is as follows. First, the results of eight separate ordinary least squares (OLS) specifications are presented in which BMI is a function of each SES measure. All models control for age and marital status given their predictive power of BMI and close associations with SES. Second, we build on these models by accounting for health selection and disaggregating the sample by HDI category. Third, an additional table presents the interactions between the SES measures and time in the United States. Fourth, the predicted values of BMI for three levels of each SES measure are graphically presented. These predicted values are generated from models of BMI predicted using the same covariates as in the models. The sole difference is that the predicted values are generated by distinct models for each category of time in the United States (i.e., less than or equal to 1 year and more than 1 year) as well as by sex. Finally, we present the predicted values for separate

[6] One possibility that we explored (as an alternative to self-identified race) was to control for skin color as a way of capturing the role of the U.S.-based racial stratification system in influencing SES-BMI gradient patterns among immigrants. Unfortunately, the NIS collected skin color only for the in-person interviews. As a result, we would lose an even larger proportion of our sample if we attempted to control for skin color than if we controlled for self-reported race.

HDI levels using education as the SES measure; other covariates are identical to those in the models.

Findings

Table 1 presents the descriptive statistics for the sample, distinguished by sex and HDI of the origin country. The mean age for men and women in the sample is about 38 years, and the majority of the sample is married. On average, respondents have resided in the United States for about four years. There are significant differences within sex by HDI for all SES measures. Compared with their counterparts from low-/medium-HDI countries, men and women from high-/very high–HDI countries have significantly higher occupational prestige levels, higher annual earnings, higher percentages with college educations, and higher percentages with above-average childhood SES. In terms of BMI, men from high-/very high–HDI countries have significantly higher BMIs than their counterparts from low-/medium-HDI countries. The pattern is opposite for females. Women from low-/medium-HDI countries have marginally significantly higher BMIs than their high-/very high–HDI country counterparts. There are also significant differences by HDI in terms of U.S. tenure and marital status, with immigrants from low-/medium-HDI countries less likely to be married and more likely to have resided in the United States longer.

What Are the SES-BMI Gradient Patterns for the Contemporary Immigrant Population?

Table 2 illustrates the relationship between each of the SES measures and BMI observed among contemporary U.S. immigrants, controlling for age and marital status. The SES-BMI gradients for contemporary U.S. immigrants are uniformly inverse. This is true for men and women for every SES outcome except for income, which is positive but not significant for male immigrants. Gradients are more strongly negative for women than men in every case.

The results presented in Table 3 distinguish the sample by the HDI level of the country of origin and account for the role of health selection in influencing variation in BMI by HDI. Comparing across sexes, the inverse gradients are considerably stronger for women than for men, regardless of the SES measure and regardless of the HDI contrast (i.e., it is evident when comparing men and women from low-/medium-HDI countries and when comparing men and women from high-/very high–HDI countries). For women, the inverse SES-BMI gradients are observed for all female respondents regardless of the HDI level of their origin country, although they are stronger among women from high-/very high–HDI countries. The single exception is income. Women from low-/medium-HDI countries display a significant inverse gradient, whereas women from high-/very high–HDI countries do not display a gradient at all. For men, negative and significant SES-BMI gradients are observed only for those respondents from low-/medium-HDI countries. Men from high-/very high–HDI countries do not display any significant SES

Table 1 Descriptive statistics

	Total		Men		Women	
	Men	Women	Low/ Medium HDI	High/Very High HDI	Low/ Medium HDI	High/Very High HDI
Outcome						
BMI (mean)	25.25	24.20	25.18*	25.54	24.28†	23.90
	3.99	4.78	4.03	3.80	4.77	4.79
SES Measures						
Occupational prestige (mean)	43.48	38.42	42.74***	46.40	38.07*	39.76
	18.62	17.03	18.45	19.03	16.72	18.13
Annual earnings (mean)	34,582	21,284	32,213***	43,916	20,596***	23,928
	35,313	21,685	29,255	51,794	19,616	28,159
Childhood SES (%)						
Below average	25.46	25.22	25.84*	25.46	25.02**	25.97
Average	54.42	57.06	55.09	54.42	58.35	52.09
Above average	20.12	17.73	19.06	20.12	16.63	21.94
Education (%)						
<12 years	26.76	31.47	27.90***	22.29	32.09*	29.10
12 years	14.00	16.37	14.88	10.53	16.90	14.33
>12 years	59.24	52.16	57.23	67.18	51.01	56.57
Health Selection (%)						
Negative	2.81	4.10	2.48†	4.12	4.20†	3.73
Neutral	20.77	25.25	20.77	20.76	26.03	22.24
Positive	76.42	70.65	76.75	75.11	69.77	74.03
Age (mean)	38.26	38.57	38.22	38.41	38.49	38.89
	12.72	13.28	12.72	12.73	13.25	13.39
Years of U.S. Experience (mean)	4.25	3.73	4.61***	2.84	4.12***	2.22
	5.69	5.43	5.96	4.16	5.76	3.57
Married (%)	70.95	69.02	69.97*	74.81	67.91**	73.28
N	3,236	3,244	2,581	655	2,574	670

Notes: Standard deviations are shown below the point estimates for all means.

†$p < .10$; *$p < 0.05$; **$p < .01$; ***$p < .001$ (two-tailed t tests and chi-squared tests for differences across HDI level, within sex)

contrasts except for a marginally significant coefficient for occupational prestige. Thus, although both men and women generally display negative SES-BMI gradients, the patterns diverge after we distinguish the sample by HDI. Except for income, the inverse gradient patterns are strongest for women from high-/very high–HDI countries and for men from low-/medium-HDI countries. Health selection as measured here does not appear to be a significant factor influencing BMI or altering the SES gradients (results not shown, analysis available upon request).

Table 2 Baseline SES-BMI gradients by sex

	Men (total) 1	Women (total) 2
Panel A. Childhood SES (ref. = below average)		
Average	−0.456**	−1.384***
	(0.167)	(0.195)
Above average	−0.149	−1.633***
	(0.208)	(0.252)
Panel B. Education (ref. = <12 years)		
12 years	−0.587*	−0.879***
	(0.231)	(0.252)
>12 years	−0.574***	−1.709***
	(0.164)	(0.190)
Panel C		
Occupational prestige	−0.013***	−0.034***
	(0.004)	(0.005)
Panel D		
Earnings	0.079	−0.091†
	(0.050)	(0.049)
N	3,236	3,244

Notes: Standard errors are shown in parentheses. Models control for age and marital status (coded as married or not). Separate models are estimated for each SES measure and by sex.

Source: NIS data.

†$p < .10$; *$p < 0.05$; **$p < .01$; ***$p < .001$

How Do Gradients Differ With Time in the United States?

Our next question asks whether the gradients that are evident among immigrants with more time in the United States differ from those that are present among immigrants who have recently arrived—and if so, in what ways? Comparing the solid with dashed lines for men and women separately, Fig. 1 illustrates that U.S. tenure is associated with higher BMIs for all groups at all SES levels (i.e., the solid lines are above the corresponding dashed lines). For men, the SES-BMI gradients for recent immigrants are either positive or flat (i.e., the data points on the dashed line for those in the United States for ≤1 year) but then display a negative gradient pattern for those immigrants with more time in the United States (the darker solid line). The negative gradient evident among longer-term immigrants is largely due to disproportionately higher BMIs among lower SES men, particularly in the cases of education, occupational prestige, and childhood SES.

For women, the inverse gradients are evident regardless of the amount of time in the United States, although they are more pronounced among immigrants with increased U.S. tenure, largely because of higher BMIs among lower-SES women in the cases of education and childhood SES. Another way to explain the patterns in Fig. 1 is to say that although the effect of time in the United States on BMI is

Table 3 SES coefficients from OLS models predicting BMI by HDI and accounting for health selection

	Men		Women	
	Low/Medium HDI	High/Very High HDI	Low/Medium HDI	High/Very High HDI
	1	2	3	4
Panel A. Childhood SES (ref. = below average)				
Average	−0.539**	−0.124	−1.214***	−1.851***
	(0.188)	(0.375)	(0.219)	(0.427)
Above average	−0.214	0.005	−1.543***	−1.644**
	(0.239)	(0.433)	(0.292)	(0.510)
Negative health selection (ref. = neutral)	−0.361	−1.222	0.539	0.251
	(0.529)	(0.790)	(0.481)	(0.961)
Positive health selection	−0.117	0.254	−0.208	−0.476
	(0.196)	(0.369)	(0.212)	(0.416)
Panel B. Education (ref. = <12 years)				
12 years	−0.564*	−0.851	−0.613*	−1.910***
	(0.256)	(0.553)	(0.281)	(0.565)
>12 years	−0.657***	−0.477	−1.363***	−2.846***
	(0.185)	(0.370)	(0.215)	(0.420)
Negative health selection (ref. = neutral)	−0.392	−1.340†	0.505	0.182
	(0.529)	(0.788)	(0.481)	(0.942)
Positive health selection	−0.067	0.289	−0.103	−0.260
	(0.197)	(0.366)	(0.213)	(0.410)
Panel C				
Occupational prestige	−0.014***	−0.013†	−0.032***	−0.033***
	(0.004)	(0.008)	(0.006)	(0.010)
Negative health selection (ref. = neutral)	−0.378	−1.288	0.504	0.566
	(0.529)	(0.782)	(0.482)	(0.963)
Positive health selection	−0.087	0.313	−0.216	−0.497
	(0.196)	(0.366)	(0.212)	(0.418)
Panel D				
Earnings	0.076	0.045	−0.123*	0.024
	(0.056)	(0.117)	(0.056)	(0.103)
Negative health selection (ref. = neutral)	−0.345	−1.215	0.565	0.560
	(0.530)	(0.784)	(0.484)	(0.971)
Positive health selection	−0.128	0.214	−0.256	−0.591
	(0.196)	(0.366)	(0.213)	(0.421)
N	2,581	655	2,574	670

Notes: Standard errors are shown in parentheses. SES coefficients are from separate specifications. HDI refers to the Human Development Index for the respondent's country of origin. All specifications also control for age and marital status.

Source: NIS data.

†$p < .10$; *$p < 0.05$; **$p < .01$; ***$p < .001$

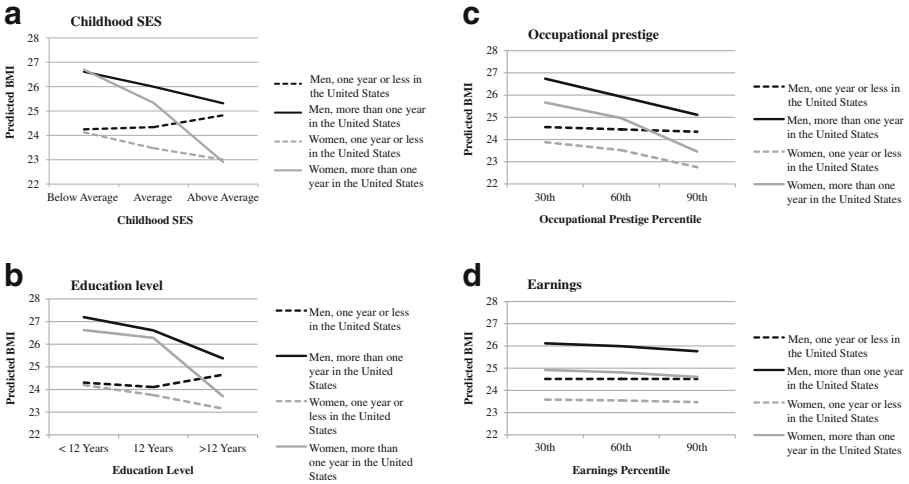

Fig. 1 SES-BMI gradient for men and women, by time in the United States. All regressions in Fig. 1 that generate predicted BMI values also control for age, time in the United States, health selection, and marital status. Control variables are set to their means. *Source*: NIS Data

uniformly positive (i.e., increased time in the United States is associated with higher BMI), it is less positive for those from higher-SES groups and more positive for those from lower-SES groups. Thus, there is a protective effect of being an immigrant from a high-SES group in that the higher one's SES, the less "harmful" of an effect time spent in the United States has on BMI. The opposite is true for individuals from lower-SES groups. For them, time in the United States has a disproportionately positive effect on their BMI.

Not only do men and women from low-SES backgrounds demonstrate higher BMIs with U.S. tenure, but Fig. 2 demonstrates that with increased U.S. tenure, immigrants migrating from low-/medium-HDI countries have considerably higher BMIs than do their counterparts from high-/very high–HDI countries (i.e., comparing the dashed and solid lines for men and women separately). Both men and women from low-/medium-HDI countries (the dashed lines) have significantly steeper slopes than individuals migrating from high-/very high–HDI countries (the solid lines). In fact, a crossover occurs whereby longer-term immigrants from low-/medium-HDI countries (who begin residence in the United States with lower BMIs than their high-/very high–HDI counterparts) display considerably higher BMIs than longer-term immigrants from high-/very high–HDI countries. The starkest difference in BMI between immigrants from high-/very high–HDI and low-/medium-HDI countries occurs among immigrants who have been in the United States for more than five years.

Do Changes in Gradients Depend on Origin Country?

Our final question is whether gradient trends by time in the United States vary by the development level of the country of origin. Table 4 presents the results from models that interact time in the United States with each SES measure. Significant and negative interaction terms are evident for men and women coming from low-/medium-HDI countries only. For every SES outcome, for both men and women,

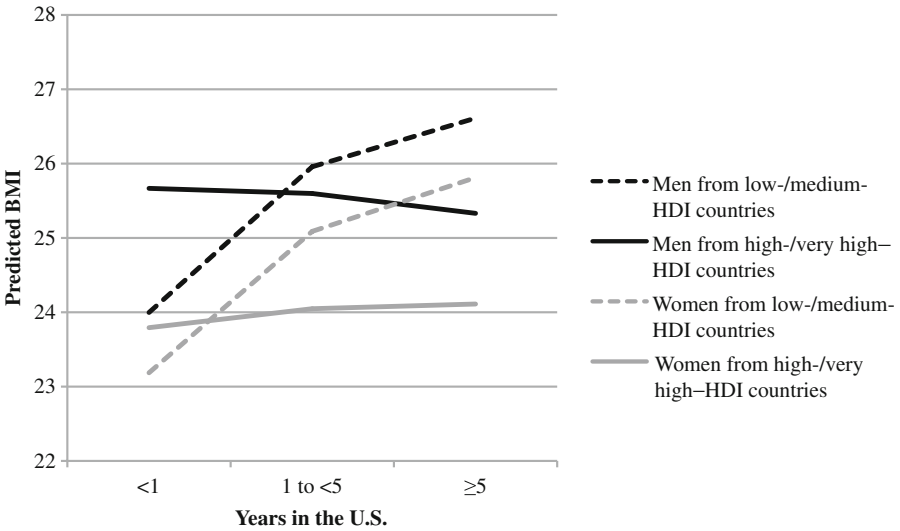

Fig. 2 BMI-time in the U.S. gradient, by level of HDI. All regressions in Fig. 2 that generate predicted BMI values also control for age, time in the United States, health selection, and marital status. *Source*: NIS Data

the interaction terms indicate that the more pronounced negative gradients evident among longer-term immigrants are being driven by men and women from low-/medium-HDI countries. For education and childhood SES, the contrasts are significant for only the highest SES category versus the lowest (i.e., more than high school versus less than high school, and higher childhood SES versus less than average childhood SES). There are likely two reinforcing trends driving the interaction effects. On one hand, higher-SES individuals from low-/medium-HDI countries may have/maintain lower BMIs with time in the United States: that is, there is a less "harmful" influence of time spent in the United States on BMI for higher-SES individuals migrating from countries with low/medium levels of development. On the other hand, lower-SES individuals from low-/medium-HDI countries may have/maintain higher BMIs with time in the United States: that is, they are doubly disadvantaged in that the positive influence of time in the United States on BMI is especially pronounced for them.

Discussion

The NIS data reveal inverse SES-BMI gradients for both men and women across three different measures of SES: education, childhood SES, and occupational prestige. Consistent with what has been established previously for the general U.S. population, contemporary U.S. immigrants are also characterized by an inverse relationship between SES and BMI that is stronger for women than for men. Even the weakest inverse gradients for women are stronger than the strongest inverse gradients for men. Past research on the gendered nature of SES-BMI gradients has attributed this difference to women's heightened experience of weight-based discrimination relative to men (Gortmaker et al. 1993).

Table 4 SES coefficients from OLS models predicting BMI with time in the U.S. interaction

	Men		Women	
	Low/Medium HDI	High/Very High HDI	Low/Medium HDI	High/Very High HDI
	1	2	3	4
Panel A. Childhood SES (ref. = below average)				
Average	−0.126	0.167	−0.681*	−2.306***
	(0.230)	(0.442)	(0.271)	(0.489)
Above average	0.344	−0.158	−0.500	−1.736**
	(0.305)	(0.529)	(0.365)	(0.627)
Years of U.S. experience	0.199***	−0.008	0.218***	−0.249*
	(0.020)	(0.086)	(0.026)	(0.115)
Average × Years of U.S. experience	−0.006	−0.105	−0.022	0.265*
	(0.028)	(0.100)	(0.034)	(0.130)
Above average × Years of U.S. experience	−0.074†	0.046	−0.177***	0.136
	(0.039)	(0.106)	(0.051)	(0.156)
Panel B. Education (ref. = <12 years)				
12 years	−0.143	−0.665	−0.291	−1.734*
	(0.307)	(0.624)	(0.338)	(0.676)
>12 years	0.106	−0.333	−0.423	−3.145***
	(0.229)	(0.420)	(0.261)	(0.479)
Years of U.S. experience	0.214***	0.010	0.233***	−0.159
	(0.019)	(0.111)	(0.023)	(0.211)
12 years of education × Years of U.S. experience	0.011	−0.073	−0.002	0.025
	(0.041)	(0.147)	(0.044)	(0.262)
>12 years of education × Years of U.S. experience	−0.077**	−0.047	−0.139***	0.220
	(0.028)	(0.118)	(0.035)	(0.218)
Panel C				
Occupational prestige	−0.011†	−0.013	−0.016*	−0.041***
	(0.006)	(0.010)	(0.007)	(0.012)
Years of U.S. experience	0.240***	−0.092	0.308***	−0.218
	(0.032)	(0.127)	(0.038)	(0.146)
Occupational prestige × Years of U.S. experience	−0.001†	0.001	−0.003***	0.004
	(0.001)	(0.002)	(0.001)	(0.003)
Panel D				
Earnings	0.001	0.024	−0.166*	0.048
	(0.065)	(0.138)	(0.069)	(0.115)
Years of U.S. experience	0.439***	−0.579	0.178*	−0.260
	(0.109)	(0.393)	(0.082)	(0.426)
Earnings × Years of U.S. experience	−0.025*	0.049	0.002	0.017
	(0.011)	(0.037)	(0.009)	0.041
N	2,581	655	2,574	670

Notes: Standard errors are shown in parentheses. SES coefficients are from separate specifications. HDI refers to the Human Development Index for the respondent's country of origin. All specifications also control for age, marital status, and health selection. *Source*: NIS data.

†$p < .10$; *$p < 0.05$; **$p < .01$; ***$p < .001$

Beyond confirming that previously documented gender contrasts are duplicated among contemporary immigrants in the United States, our analysis also reveals substantial variability in SES-BMI gradients by time in the United States and the development level of the origin country. We find that although both men and women generally display inverse SES-BMI gradients, after we distinguish the sample by HDI, the gender patterns diverge. For women, the inverse gradient patterns are clearly strongest for immigrants originating in high-/very high–HDI countries. These patterns provide some evidence supporting the gradient importation hypothesis. Although immigrants are usually a select sample of their home countries' populations, for women, the weaker inverse gradients for immigrants from low-/medium-HDI countries and considerably stronger presence of negative gradients among female immigrants from high-/very high–HDI countries across nearly every SES outcome suggests that gradient patterns characterizing origin countries likely are exerting some degree of influence on those in the United States.

For men, a different pattern emerges. Except for income, men display negative gradients for each SES outcome, but these negative gradients attain statistical significance only for men from low-/medium-HDI countries. The lack of significant contrasts for men from high-/very–HDI countries may partially be a function of the combined effects of sample size and the generally weaker inverse gradients than those observed among women. There were more than three times as many male respondents from low-/medium-HDI countries than men from high-/very high–HDI countries. When we test for significant differences between the SES coefficients across the HDI categories within sex (e.g., in Table 3, we test whether the coefficient for "greater than 12 years of education" for men from low-/medium-HDI countries was significantly different than the corresponding coefficient for men from high-HDI countries) we find no significant differences.

Although most of the SES outcome variables perform similarly, the case of income diverges from the general gradient patterns. In the case of men, the coefficients for earnings display the only positive associations in the analyses, although they do not attain statistical significance. In the case of women, the general pattern identified earlier (whereby female respondents from high-/very high–HDI countries demonstrate the strongest negative gradients) does not hold for income. Women from low-/medium-HDI countries display the only negative and significant contrast with income. One possible explanation why income behaves differently than the other SES measures is that it is the one that most proximately determines a person's economic capacity to engage in behaviors that directly impact BMI, such as purchasing healthy foods and exercising. Unlike education, occupational prestige, and childhood SES—which tap into concepts of class and social status—income also indicates direct access to tangible material items. In the case of men in developing countries, other work has demonstrated that income and material possessions are the SES measures most likely to display positive relationships with body weight (McLaren 2007; Monteiro et al. 2004; Sobal and Stunkard 1989). For women, our data suggest that access to expendable income in low-/medium-HDI countries influences the emergence of inverse SES-BMI gradients in a more pronounced way than in high-/very high–HDI countries.

Although the SES-BMI gradient patterns by HDI that we discuss earlier differ by gender, when we examine how gradients are associated with U.S. tenure, a more

gender-neutral pattern emerges. For both men and women, the observed negative gradient patterns are stronger among longer-term immigrants, largely driven by higher weights among low-SES individuals, particularly those from low-/medium-HDI countries. We find that the higher an immigrant's SES, the less "harmful" influence time spent in the United States has on BMI. The opposite is true for individuals from lower-SES groups. For the latter group, time spent in the United States has a disproportionately positive association with their BMI. One way to interpret these findings is that they illustrate a segmented assimilation story (Van Hook and Balistreri 2007). Immigrants of high SES may be somewhat protected from the obesogenic U.S. environment because they assimilate into the higher-SES segments of U.S. society, which are characterized by lower levels of BMI. As a result, high-SES individuals are protected from the positive influence of time spent in the United States on BMI by either adapting to the BMI profiles of higher-SES native-born in the United States or because they maintain previously held healthy habits from their home country that allow them to minimize weight gain upon arrival to the United States. In contrast, individuals with low SES become more like lower-SES native-born individuals from the United States and gain increasing amounts of weight with time in the United States.

The disproportionately positive influence of U.S. tenure on the BMI of low-SES individuals is even more pronounced among immigrants of low SES from low-/medium-HDI countries. These individuals are doubly disadvantaged in terms of displaying higher weights after arrival to the United States. They stand in stark contrast to immigrants from high-SES groups from low-/medium-HDI countries who appear to be uniquely protected from weight gain after arriving in the United States. We offer two interpretations for these findings. On the one hand, well-off individuals migrating from low-/medium-development countries are likely a highly select group. Although we control for health selection in our models, there are likely other types of selection processes operating that serve to protect these individuals from the obesogenic U.S. environment. The opposite is true for lower-SES individuals from low-/medium-HDI countries, who experience the effects of the obesogenic U.S. environment more strongly than any other group. Low-SES individuals migrating to the United States from low-/medium-HDI countries experience the most extreme large-scale societal and nutritional change in the immigration process. Our findings provide support for the possibility that these immigrants experience an accelerated nutrition transition upon arrival to the United States and are disproportionately vulnerable to increased exposure to high levels of processed foods, limited availability of low-cost nutritious food options, and sedentary lifestyles.

Sensitivity Analyses and Limitations

Several issues deserve further comment regarding the SES-BMI gradient patterns documented in this article, including the generalizability of the findings. The NIS sample is unique in that it is the only survey that is nationally representative of any broad part of the U.S. foreign-born population, specifically immigrants who achieved legal permanent residency at the beginning of the twenty-first century. As such, it presents a unique opportunity to examine the health and well-being of

U.S. immigrants. However, the NIS is not representative of unauthorized immigrants. Sensitivity analyses that controlled for whether the respondent had a prior unauthorized trip found that the negative SES gradients observed in the full NIS sample are not nearly as robust. This is likely due to the lower SES of those with prior unauthorized trips. Consequently, care should be taken in generalizing the findings beyond the U.S. foreign-born population with legal permanent residency.

The analysis uses a continuous measure of BMI based on self-reported height and weight. The lack of anthropometric measures raises the possibility of bias. Most concerning is the possibility of differential underreporting or overreporting by HDI. For instance, women from high-/very–HDI countries where a high premium is placed on thinness may systematically underestimate their weight regardless of their SES. We conducted a sensitivity analysis that respecified the models inflating the weight of individuals from high-/very high–HDI countries by 5 %. In a separate analysis, we similarly deflated the self-reported weight of individuals from low-/medium-HDI countries by 5 % to account for the possibility that they may be overreporting their weight. Comparing across models, we found only minor differences in the magnitude of the SES coefficients. In fact, when we inflated weight, the SES negative gradients for individuals from high-/very high–HDI countries were slightly larger, suggesting no evidence that they are systematically underreporting their weight.

We model BMI continuously to reflect its graded relationship with SES. In doing so, we are restricted to speaking about increases in BMI, and not about the more clinically relevant outcome of obesity. In general, immigrants are considerably less obese than the general U.S. population, and our findings are generally below the cutoff for obesity (see Figs. 1 and 2). They suggest cause for concern, nonetheless. In particular, the increasingly negative SES-BMI gradients that immigrants display with increasing time in the United States primarily are being driven by higher weights among poor individuals from developing societies. To examine how the patterns would change with a different categorization of BMI, we reestimated the models to predict the probability of being obese versus not obese. All substantive conclusions remained the same, save for the significant and negative interactions presented in Table 4 for those from low-/medium-HDI countries that did not attain statistical significance after the outcome was categorized as obese. We interpret this difference as the result of the relatively high threshold created by using obesity as an endpoint compared with the incremental differences in weight modeled when BMI is used.

This article was motivated by three possible explanations for the SES-BMI gradient patterns documented among contemporary immigrants. Although we find support for the possibility of the importation of origin-country gradients and for differential patterns of adaptation, we find no support for health selection. In none of the specifications is health selection significant nor does it significantly affect the SES-BMI gradient patterns. However, because our measure relies on a subjective assessment of health that asked individuals to assess their health in comparison to "people in your home country," it may not be capturing selection processes accurately and/or may be unduly influenced by an individual's selection of their reference group. Health selection remains an important and oftentimes unaccounted factor in influencing immigrant health patterns. Continued attention to the ways in which it can be operationalized is needed.

One of the interesting findings in this article concerns the effect of time spent in the United States on the observed gradients. We interpret these patterns to indicate a pattern of differential integration whereby immigrants increasingly take on the negative gradients characterizing the larger U.S. population (Van Hook and Balistreri 2007). However, we are limited in our ability to speak more definitively about how these processes unfold over time because of the cross-sectional nature of the data. True estimates of change over time and a more precise disentangling of the age, period, and cohort effects likely at work in these data necessitate longitudinal data.

Conclusion

Despite worldwide increases in obesogenic exposures, our study documents that significant differences in weight patterning by socioeconomic status remain relevant for U.S. immigrants, who originate in an array of countries with varying levels of HDI and, therefore, are likely at different stages of the nutrition transition. Our analysis of contemporary U.S. immigrants suggests that several different processes account for the observed gradient patterns. First, we find that immigrants are likely influenced by the SES-BMI gradients characterizing their home countries. This is evidenced by the strong inverse gradients found among women from high-/very high–HDI countries and the weaker gradients in women from low-/medium-HDI countries. The fact that we find almost no support for the existence of positive gradients for immigrants from low-/medium-HDI countries in our sample may be an indication that even in developing countries, the burden of obesity is being shifted onto the poor. Second, although we find no evidence that health selection influences immigrant BMI by diluting preexisting social gradients from the origin country, we find some evidence suggesting that well-off individuals from developing countries are a highly select group who are uniquely protected from the obesogenic U.S. environment. Most noteworthy, the analysis provides evidence in support of a classic assimilation process, whereby immigrants increasingly take on the negative gradients characterizing the larger U.S. population over time in the United States. These patterns suggest a process of worsening inequalities in both diet and behavior between the rich and poor upon arrival to the United States that warrants close attention.

Acknowledgements We are grateful to the editor, several anonymous reviewers, and Mauricio Avendano Pabon for their helpful comments in preparation of this manuscript. We would also like to acknowledge the support of the Institute for Population Research at the Ohio State University, supported by a grant from the Eunice Kennedy Shriver National Institute for Child Health and Development (R24 HD058484).

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