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Nativity Differences in Youths' Weight Trajectories: Foreign-Born Health Integration during the Transition to Adulthood

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Abstract

Nativity differences in youths' health in the United States are striking, with the children of foreign-born parents showing more favorable outcomes than those of native-born parents. Very little is known about how inequalities evolve within the same individuals over time, or more generally about life cycle aspects of the health integration of youth with migration backgrounds. Using data from the National Longitudinal Study of Adolescent Health, I examine nativity differences in trajectories of weight gain during adolescence and early adulthood, as well as the degree to which trajectories are stratified by race/ethnicity and socioeconomic status. Do nativity differences converge, diverge or remain stable over time, and how are patterns socially stratified within and across nativity groups? I find that first-generation adolescents begin at a lower weight than their third generation peers and gain weight at a significantly slower pace, producing meaningful differences by early adulthood. More complex examination of the relationship between nativity and weight gain reveals additional differences by ethnicity: the foreign-born advantage over time does not extend as strongly to Hispanic adolescents. The findings demonstrate how the health-related integration of foreign-born youth is tied to race/ethnicity and socioeconomic circumstances, and suggest the need to examine the ways in which social circumstances and health change together.

INTRODUCTION

Youth with migration backgrounds compose a large fraction of the United States population: about 25% of U.S. children and adolescents are foreign-born ("first-generation") or have at least one foreign-born parent ("second-generation"). The growing presence of youth in foreign-born families suggests that this group will have an increasingly noticeable impact on patterns observed among the total population, institutions such as the educational and health care systems, and markers of health and social inequality. Though migration to the U.S. often translates into gains in quality of life for those who held a relatively disadvantaged position in their country of origin (Tubergen, Maas and Flap 2004), contrasting gains in financial and human capital are potential declines in health with time in the U.S. Immigrant adults are more likely to begin with a health *advantage* over the native-born population that is sometimes "paradoxical" (Markides and Coreil 1986) because of their greater likelihood

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of socioeconomic disadvantage. At the same time, health assimilation theories posit that declines in health over time should be faster within the first-generation compared with later generations, producing convergence between groups (e.g., Abraido-Lanza et al. 1999).

These potentially divergent patterns of health and socioeconomic success after migration—increasing socioeconomic status alongside potentially declining health—complicate traditionally neat and linear depictions of the socioeconomic gradient in health. Yet, little is known about how nativity-based inequalities evolve beyond birth within youth over time, and how temporal patterns are socially stratified. Although the children of immigrants, on average, attain higher social status than their parents, their health may differ from that of their peers in the U.S., and they may also develop poorer health behaviors and health outcomes over time. Given the large number of first and second generation youth in the U.S., it is important to understand health trajectories among a diverse group of adolescents, in order to inform examination of both their environmental determinants and their social and economic consequences as youth transition into adulthood.

This article works toward that goal by examining weight gain as a case study for understanding nativity differences in U.S. adolescents' health-related trajectories. Weight is a useful marker of population health, given the high prevalence of overweight and obesity among the U.S. population, even at early ages, and their strong association with a number of acute and chronic illnesses. I use data from the National Longitudinal Study of Adolescent Health (Add Health) to examine several questions. First, does any healthy weight advantage among first and second-generation adolescents, relative to their third-plus generation peers, persist into adulthood, or do these adolescents more rapidly increase toward an unhealthy weight? Secondly, are these relationships stratified by race/ethnicity and socioeconomic status within and across nativity groups?

Moving Beyond Infancy: A Longitudinal Perspective

Existing research on nativity-based differences in youths' health has produced important findings, which speak primarily to the period during birth and early childhood. Babies born to foreign-born mothers are more likely to have a normal birthweight and are less likely to die as infants than their peers with native-born mothers (Landale, Oropesa and Gorman 2000; Landale and Oropesa 2001). Similarly, infants whose mothers are "less acculturated"—often measured by years in the U.S. or English language ability—are more likely to receive immunizations and be breastfed early in life (Anderson et al. 1997; Kimbro, Lynch and McLanahan 2008). A smaller body of mostly cross-sectional evidence examines patterns among adolescents, demonstrating that adolescents demonstrating low levels of cultural adaptation are less likely to smoke and engage in risky sexual behaviors, and are more likely to engage in healthy behaviors (Aneshensel et al., 1990; Chen et al., 1999; Ebin et al., 2001; Greenman and Xie 2008). Such research builds on abundant evidence among adults demonstrating "paradoxical" health outcomes among the foreign-born—lower prevalence of many diseases than native-born whites, fewer activity limitations from chronic conditions, and higher life expectancy (Albraido-Lanza et al. 1999; Palloni and Arias 2004).

An important limitation of much existing research on the incorporation of youth with migration backgrounds, other than its disproportionate focus on the period of very early

childhood, is its static perspective (for exceptions, see Balisteri and Vanhook 2009 and Harris, Perreira and Lee 2009). Several reasons make a longitudinal approach preferable to a cross-sectional design in examining the health incorporation of youth with migration backgrounds. First, longitudinal data permit identification of convergence, divergence or stability, compared to cross-sectional snapshots that nicely depict intergenerational (e.g., parents compared to children) or group differences (e.g., children in families with more vs. less recent migration histories), but not whether and how incorporation occurs over the life cycle. A life cycle lens of youths' incorporation also affords consideration of stratified trajectories within nativity groups. Secondly, a dynamic, within-person analysis permits examination of environmental changes—in families and peer environments—that co-evolve with health. I address the first challenge in this article.

Patterns across Nativity Groups: The Case of Weight

Overweight and obesity have attracted substantial research attention because of both their prevalence among U.S. youth and their strong relationship with physical and psychological health. Excess weight has reached "epidemic" proportions among the U.S. population: in 2003-2004, over 17% of adolescents aged 12-19 were obese, or above the 95th percentile compared to their peers of the same age and sex (Centers for Disease Control 2008). Concerns about excess weight are driven less by its prevalence, however, than by its strong association, sometimes independent of health behaviors, with a number of diseases, including type 2 diabetes, high blood pressure and cholesterol, and respiratory problems; these conditions increasingly appear early in childhood and adolescence (Centers for Disease Control 2008; Dietz 2005). Overweight and obesity during childhood are also related to lower socioeconomic and psychological well-being (e.g., Gortmaker et al. 1993). Existing evidence on nativity-based variation in overweight and obesity suggests that there should be differences in the cross-section, with first-generation adolescents exhibiting lower weight at a given age than their peers from later generations (Gordon-Larsen, Adair and Popkin 2003; Popkin and Udry 1998). When examining how differences evolve over time, previous work offers sometimes conflicting hypotheses about what pattern of change should be observed across nativity groups. These hypotheses focus on three possibilities: convergence, divergence or stability.

Convergence—Trends observed in repeated cross-sections of adults suggest that first-generation adolescents should have lower baseline levels of overweight and obesity, on average, but that they should converge over time toward the levels observed in later generational groups (e.g, Antecol and Bedard 2006). In this process of "unhealthy acculturation," the pace of weight gain among first-generation adolescents should be faster than among second and third-plus generation adolescents, even if all youth gain weight with age. Convergence could be driven by cultural, socioeconomic and migration-related (selection) factors. With respect to *social and cultural change*, immigrants may change their health behaviors upon arrival to the United States (Abraido-Lanza et al. 1999; Franzini et al. 2001; Marmot and Syme 1976). Adults, for example, may alter their diets and levels of physical activity over time (Akresh 2007; Franzini et al. 2001; Morales et al. 2002) for a number of reasons, including changes in access to healthy foods, as well as contextual shifts in kin networks and non-kin networks in neighborhoods and the workplace. These changes

may occur with or without an increase in socioeconomic status; in fact, foreign-born families living in advantaged conditions in the U.S. may adapt their behaviors more quickly than families who are relatively more disadvantaged but who live among a dense network of ethnic peers (Gordon-Larsen et al. 2003). Many of these behavioral and contextual changes among the foreign-born should also extend to adolescents in these families. Physical activity, for example, may decline if adolescents attend schools with little structured activity, or live in neighborhoods that are unsafe or lack recreational facilities (e.g., Winkleby and Cubbin 2004). The structure of adolescents' family and friendship networks at home, in school and in their neighborhoods may also influence the extent to which they initiate other health-related behaviors, including drug use, risky sexual and violent behaviors, and exhibit symptoms of poorer psychological health. To the extent that the quality of adolescents' social environments and their frequency of healthy behaviors decline over time, it is plausible that behavioral and contextual changes could produce weight convergence across nativity groups, if first-generation adolescents begin in a healthier position and gain weight at a faster pace.

With respect to *migration processes*, a complicating factor in accurately understanding nativity-based health trajectories is health selection—the possibility that those who migrate to the U.S., regardless of age, represent the healthiest members of their sending population, since they are the most able to make long-distance moves. In this framework, a degree of "regression to the mean" in health is likely to be observed over time among the foreign-born, as immigrants' relatively healthier behaviors and status gradually converge toward the levels of the native population (Jasso et al. 2004). In this scenario, a faster pace of weight gain among first-generation youth could produce convergence between nativity groups for reasons having little to do with experiences in the U.S.

Divergence—An alternative scenario suggests slower weight gain among the first-generation with age, relative to their later-generation peers. Harris, Perreira and Lee (2009) demonstrate this pattern in an examination of weight gain among first, second and third-plus generation youth. With respect to explanations focusing on *social and cultural change*, first-generation families may benefit from a combination of dense ethnic networks and increases in socioeconomic status over time, providing a layer of support that facilitates healthy behaviors; some cross-sectional evidence supports this idea among foreign-born Hispanic adolescents in Los Angeles (Frank, Cerdá and Rendón 2007). If true, foreign-born youth may be more likely to learn healthy behaviors at an early age and better maintain those behaviors as they transition out of adolescence to form their own households. If U.S.-born youth do not maintain healthy behaviors with age, this may produce divergence between nativity groups. *Migration processes* may also produce divergence due to another form of health selection. To the extent that foreign-both or second-generation youth in the poorest health are more likely to return home with their families, positive health selection may steadily increase, as the least healthy foreign-born respondents are removed from the sample. In turn, estimates of poor health among immigrants could be downwardly biased (e.g., Palloni and Arias 2004).

Stability—A final scenario is one of no nativity differences in weight trajectories during adolescence and the transition to adulthood. Though there may be strong cross-sectional weight differences, change over time may not be predicted by nativity. Evidence for youths' academic achievement, for example, shows that structural factors correlated with nativity are more salient determinants of academic trajectories than nativity itself (Fuligni and Witkow 2004; Glick and White 2003); it is unclear whether this finding extends to markers of health. If neither foreign- nor native-born youth change their behaviors substantially, nativity differences would remain stable with age: stability does not necessarily imply equality by nativity, only no significant temporal change in gaps.

Homogenous or Segmented Integration? Variation Within Nativity Groups

Patterns of convergence, divergence or stability may not apply equally to all subgroups of foreign-born youth. Instead, there may be a stratified pattern to the health-related integration of first and second-generation adolescents. Early accounts of immigrants' U.S. social and economic incorporation describe the social integration, or assimilation, of the foreign-born as a "straight-line," smooth and linear process through which immigrants change their cultural behaviors and begin to share language and cultural practices, social networks, residential context and economic status mirroring those of the native-born (Gordon 1964; Park 1916). Indeed, comparisons of adults have produced useful information about the level and direction of immigrants' socioeconomic incorporation into the U.S, and have shown that college completion and occupational status are higher in the second generation (Chiswick 1978; Jasso, Rosenzweig, and Smith 2000; Massey 1981; Schoeni 1997). Among descendants of skilled migrants, the educational and occupational attainment of the second generation often exceeds that of native-born, non-Hispanic whites. These trends are present in a weaker form among those of Mexican origin (Waldinger and Feliciano 2004). Critics of this simplistic depiction of the immigrant experience, however, point out several flaws in the theory—most importantly, that socioeconomic integration is not uniform across all foreign-born groups, but instead follows some degree of segmentation that causes incorporation to vary sharply according to levels of education, the quality of schooling, the reasons for migration and skin color, among other factors (Alba and Nee 2003; Zhou 1997). I focus on two key dimensions of inequality—race/ethnicity and socioeconomic status—that may reflect important environmental differences within and between nativity groups, producing variation in the pace of weight gain.

Race/Ethnicity—Race/ethnicity may produce segmentation in the pace or direction of foreign-born convergence, divergence or stability within and between generations. Foreign-born U.S. youth disproportionately come from Latin American and Asian countries. At the same time, youth in these ethnic groups, whether foreign or U.S.-born, exhibit different patterns of overweight and obesity than their native-born, non-Hispanic black and white peers. Among young children, Hispanics exhibit excess weight at higher rates than their peers at as early as age three, demonstrating the early origins of high obesity levels among the Hispanic population (Kimbro et al. 2007). Overweight and obesity are less common among Asian children, although there is evidence that rates are increasing faster among this group than among other children (Kumanyika and Grier 2006). Little is known about the health integration of foreign-born black youth.

The sources of ethnic differences are likely made up of a combination of socioeconomic, behavioral and contextual factors: black and Hispanic children, for example, are the most likely to attend schools without gyms or recess, to live in neighborhoods with high crime rates and few opportunities for exercise, to receive inadequate nutritional services, and are less likely to participate in after-school activities focused on healthy lifestyles (e.g., Timberlake 2007; Winkleby and Cubbin 2004). If foreign-born adolescents in particular ethnic groups are less likely to live in healthy environments, there may be ethnic variation in levels of overweight and in the pace of weight gain within nativity groups. If ethnic segmentation is especially pronounced among first-generation adolescents, this may also produce different weight gain trajectories across nativity groups.

Socioeconomic Status—It is well-known that families lacking high levels of human and financial capital are more likely to live in unsafe surroundings that do not lend themselves to physical activity, and are less likely to exercise and eat healthfully (Gordon-Larsen, McMurray and Popkin 2000; Hofferth and Sandberg 2001). Socioeconomic status may produce variable directionalities and paces of weight gain within the foreign-born in one of several ways. On the one hand, adolescents living in socioeconomically disadvantaged environments may lack opportunities for healthy living. On the other, these adolescents may benefit from strong ethnic networks that allow families to maintain cultural traditions, while their wealthier peers face increased exposure to “American” behaviors (e.g., Zhou and Bankston 1998). Socioeconomic status may also have a different relationship with weight gain trajectories across nativity groups. There is inconsistent evidence about whether immigrants, who in some groups are predominantly low-income, are positively selected on health. In this scenario, socioeconomic gradients could be weaker among the foreign-born because of a more equal health distribution (see Goldman et al. 2006 for the Mexican case). Contrasting this possibility, however, is weak evidence for health selection among Mexican immigrants to the U.S. (Rubalcava et al. 2008), which would suggest a similarly patterned relationship between socioeconomic and health trajectories across nativity groups. In one of the few examinations of socioeconomic segmentation of health-related outcomes across nativity groups of youth, Balistreri and Van Hook (2009) examine differences between Hispanic and non-Hispanic white young children, finding a weaker socioeconomic gradient among both foreign- and native-born Hispanic children than among non-Hispanic whites.

Moving Forward

Documentation of healthier behaviors and outcomes among the foreign-born is dominated by cross-sectional analyses that offer little insight into how patterns evolve over the life cycle. A focus constrained to one point in time precludes understanding how nativity differences evolve over time and whether change occurs equally across sociodemographic groups who occupy different positions within the American stratification system. Recently, examinations of nativity patterns in youths’ health have produced important findings that warrant further study, including a slower pattern of weight gain among foreign-born youth overall than among native-born youth (Harris, Perreria and Lee 2009), and a weaker socioeconomic patterning to health among both foreign- and native-born Hispanic youth, compared to non-Hispanic white, native-born youth (Balistreri and Van Hook 2009). I extend existing research to provide a rich description of group differences in trajectories,

while observing several ethnic groups within each nativity group, to a) examine whether the healthy weight advantage of first-generation adolescents persists or erodes over time, and b) identify whether that process occurs in a homogenous or stratified way.

DATA AND METHODS

Data

Data from waves 1-3 of the National Longitudinal Study of Adolescent Health (Add Health), a longitudinal study of adolescents' health behaviors and their determinants, are used in this investigation of the health incorporation of youth with migration backgrounds. The first wave of this nationally representative, school-based sample of adolescents was conducted in 1994-1995, when students were in grades 7-12. Information was gathered from schools, adolescents and parents. Data collection is ongoing and has resulted in three subsequent waves to date, one, six and 12 years after baseline; I use waves 1-3 here.[1] Large foreign-born and second-generation samples make the data well-suited to studying nativity and adolescent health over time. In addition, the data provide detailed information about adolescents' height, weight and social background.

Measures

Body Mass Index—I calculate respondents' body mass index (BMI) at each wave from self-reported weight and height at wave 1, and measured weight and height at waves 2 and 3.[2] BMI is a measure of body fatness that is calculated by dividing weight by the square of height (weight/height^2 [kg/m^2]). Because adolescent growth patterns vary by sex, those ages 20 and below should be compared to an age and sex-specific reference population (Centers for Disease Control and Prevention 2000). For this age group, a BMI above the 85th percentile of the appropriate reference group is sometimes categorized as overweight, while a BMI above the 95th percentile falls within the obese range (e.g., Cole 2000). Other classification schemes treat children and adolescents above the 85th percentile as at risk for overweight, and those above the 95th percentile as overweight (e.g., Ogden et al. 2002). I model BMI continuously, and use the age and sex-specific growth charts in interpreting predicted BMI values according to standardized definitions of overweight and obesity. By the third wave of data collection, many respondents have aged out of the sensitive growth period and can be evaluated using adult BMI thresholds, which define a BMI greater than 25 as overweight, and greater than 30 as obese.

Nativity—I separate adolescents born outside of the U.S. (first-generation), those born in the U.S. with at least one foreign-born parent (second-generation), and those with two U.S.-born parents (third-plus generation).

[1]At the time of this writing, data from wave 4 are not yet fully released.

[2]The Add Health measures weight and height at waves 2 and 3. Correlations between measured and reported BMI are high among the total sample (.92 and .95 at waves 2 and 3, respectively), as well as within nativity and ethnic groups; Appendix Table 1 shows these correlations. Models estimated with self-reported weight and height at all waves (to maintain measurement consistency) do not produce substantively different results.

Social and Demographic Characteristics—I include several socio-demographic markers, some of which are of primary interest and all of which will be correlated with both nativity and overweight/obesity. To measure race and ethnicity I distinguish among those who identify as non-Hispanic and white/other (reference category), non-Hispanic and black, East Asian (Chinese, Japanese, Korean), other Asian (South Asian and Filipino), Mexican and other Hispanic (Cuban, Puerto Rican, other).[3] Respondents who identify within multiple race/ethnic categories are assigned to the one that they report to best reflect their identity. Parental education is measured categorically at wave 1 through responding parents' reports: less than high school (reference), high school completion, some college, and college diploma or higher.[4] I take the natural log of family income at wave 1; income coefficients can therefore be interpreted as a percentage change. Marital status is measured at wave 1 and separates those whose parents are currently married from all other union statuses (reference). Finally, I control for adolescents' sex as well as a measure of parental obesity, which captures both genetic and environmental sources of weight and height and provides a very rough marker of health selection. I combine mothers' and fathers' reports at wave 1 into a measure indicating whether either parent has ever been told by a doctor that he or she is obese.

Analysis

Method—I estimate the relationship between nativity and BMI from a dynamic perspective, using multilevel models in which observations are clustered within adolescents as they age. This approach provides the advantage of modeling not only cross-sectional variation in BMI, but also variation in its growth or decline over time, within the same individuals—I examine the extent to which individuals' trajectories vary around a mean, as well as whether that variation can be predicted by particular covariates (Bollen and Curran 2006; George and Lynch 2003; Meadows and McLanahan 2008).[5] The metric of time is flexible and can be defined by either the wave of observation or age. Because there is no conceptual basis for using the wave of observation as the time metric, I use age as the basis for time, whereby each adolescent contributes up to three observations to the estimation. An alternative approach would be to use years in the U.S. as the metric of time. The primary

[3]Because of the small number of respondents who identify as Native American or as a race/ethnicity other than the categories listed above, I combine members of these groups with non-Hispanic whites. Findings do not change when "others" are omitted from the sample. I also replicate the analysis while separating Hispanic adolescents who identify as white vs. nonwhite, for Mexican and other-Hispanic adolescents. Though patterns are generally less favorable among adolescents identifying as non-white, these differences are often statistically insignificant. I combine whites and non-whites within each Hispanic group in order to maintain adequate sample sizes.

[4]In the majority of cases (94%) the responding parent is the mother. Including an additional measure for paternal education does not change the findings. I retain the parental education measure in the main text because of: a) much larger amounts of missing data on the paternal (non-responding parent) education measure, and b) the desire to maintain consistency in who is reporting the family and household measures (the responding parent and, therefore, primary caregiver).

[5]An alternative modeling strategy would be estimate a model with individual fixed effects, which would not allow for examination of nativity's main effect, but would permit examination of how changes in age are differentially related to changes in weight across nativity groups. Though this approach has its merits in controlling for unobserved heterogeneity, it does not directly model the growth process, instead examining the presence or absence of a healthy weight at each time point. In addition, this approach involves an assumption that the value of the unobserved factors does not change over time. This may be unrealistic in the context of this question: if, for example, first generation youth experience a faster pace of weight gain because of dietary changes at the family level, and this behavioral change is not captured by the measures I observe, then omitted variable bias would still be a concern. This suggests that possible unobserved behaviors are an interesting part of the process. My goal here is to describe the pace of weight gain across and within groups using the best available dynamic approach, in order to inform next steps that can examine underlying (and changing) pathways.

benefit of using age as the time metric, however, is that it permits modeling BMI growth for not only the first generation, but also for the second and third-plus generations, who provide an important comparison group. As Fuligni (2001) nicely describes, comparing first-generation youth to their second and third-plus generation peers avoids confounding acculturative changes with normal developmental changes that occur among all youth. There is clear evidence, for example, that all young adults gain weight with age (e.g., Flegal et al. 1998), which would be reflected in a measure indicating years in the U.S. Examining nativity-based differences in BMI growth with age accounts for the fact that all youth may gain weight with age, on average, but that this process will be particularly fast among the first generation if convergence occurs.[6]

I center age around age 11, the youngest observed age at wave 1, in order to provide a more intuitive basis for the intercept. The unconditional model estimates an individual-specific (*i*) and age-specific (*t*) trajectory of BMI (measured continuously), (*y)*, as a function of an individual-specific intercept (π_0), and individual and time-specific slopes (π_1), age (*A*) and errors (ε). This individual-level trajectory equation can be written as follows:

$$Y_{ti}=\pi_{0i}+\pi_{1i}A_{ti}+e_{ti} \quad (1)$$

The second level of the growth model allows individuals' trajectories to vary as a function of not only age, but of covariates that vary across individuals. This amounts to equations for the random intercepts and slopes:

$$\begin{aligned}\pi_{0i} &= \gamma_{00}+\gamma_{01}X_i+\mu_{0i}\\ \pi_{1i} &= \gamma_{10}+\gamma_{11}X_i+\mu_{1i}\end{aligned} \quad (2)$$

where *X* denotes time-invariant measures (e.g., nativity, sex) that predict group differences in intercepts and slopes. μ denotes random error terms. These equations result in a combined model:

$$Y_{ti}=\gamma_{00}+\gamma_{01}X_i+\gamma_{10}A_{ti}+\gamma_{11}X_iA_{ti}+\mu_{1i}A_{ti}+\mu_{0i}+e_{ti} \quad (3)$$

I use this technique to examine nativity differences in patterns of weight gain over time, estimating separate models for first, second, and third-plus generation adolescents.[7] Do trajectories remain stable, converge or diverge over time? Secondly, do trajectories of weight gain vary by race/ethnicity and socioeconomic status within or across nativity groups? By estimating separate models by nativity, the model fully interacts nativity with race/ethnicity, parental education and the other covariates. I compare coefficients across models using a standard Wald test of equality (Allison 1995; Clogg, Petkova and Haritou 1995; Lynch and George 2003).[8] The literature reviewed above predicts that, at a minimum, there should be nativity differences in weight *levels*. Previous evidence offers mixed insight into the *changing* relationship between nativity and weight over time, however. From these

[6]In supplementary analyses I disaggregate first-generation youth by age at migration and years in the United States. Though I do not present these findings because of sample size limitations, these analyses (available by request) show that patterns are quite consistent across subgroups of first-generation respondents.

[7]I find no evidence of significant non-linearities in the relationship between nativity and weight over time.

[8]I use the formula: $t = (b_1 - b_2) / \sqrt{se(b_1)^2 + se(b_2)^2}$

estimates I compute predicted values of BMI at the mean age in each wave, assessing values based on appropriate age and sex-specific thresholds.

Missing Data & Sample Restrictions—Missing values on item non-response (but not wave non-response) are imputed using multiple imputation techniques, which use complete data from theoretically relevant predictor variables to fill in missing values (Allison 2002; Rubin 1987).[9] Females who are pregnant at any of the three waves are excluded from the analytic sample.

Health Selection—Adolescents' behaviors and health are determined in part by their parents' behaviors and genes, and youth are often migrants themselves; migration processes related to health are therefore potentially important contributors to patterns observed among adolescents. As discussed earlier, two forms of health selection could underlie the relationship between nativity and changes in BMI over time. First, if foreign-born adolescents or their parents represent the healthiest members of their native population, they may not fully represent the sending population, driving estimates of the foreign-born health advantage upward. Among second-generation adolescents, to the extent that the healthier parents of this group confer healthier traits and behaviors, any observed health advantage of the second-generation group may also be driven upward. For first- and second-generation adolescents, I partially address this as it relates to weight by including a measure of parental obesity, which will reflect, in part, differences in parental health by nativity. It is not possible to tell from these data, however, whether first-generation adolescents represent the healthiest of the adolescent population in their sending countries. For these reasons, any baseline health advantage observed among the first-generation group should be interpreted as an upper bound. Similarly, any estimated changes over time should be interpreted as a result of several potential processes, including health selection, rather than solely a result of U.S. experiences.

Secondly, return migration may partially explain changes over time: if the least healthy foreign-born adolescents are more likely to return home with their families, then rates of convergence over time toward natives' levels of overweight/obesity may be lower than they would be otherwise (or, conversely, rates of divergence may up upwardly biased). Examining differential attrition by nativity and health in the Add Health indicates that first-generation adolescents are slightly more likely to drop out over the three waves: 34% of first-generation adolescents do not participate in wave two, compared to 31% of second-generation and 27% of third-generation respondents. 26% of first-generation respondents who are interviewed in wave two do not participate in wave three, compared to 21% and 19% of second and third-generation adolescents, respectively. It is not possible to identify whether attrition among first-generation adolescents is caused by migration out of the United States. There is no systematic variation in health status (adolescent-rated health) or in weight/height (whether measured and reported) between those who remain and those who drop out.[10] Any convergence or divergence should nonetheless be viewed as lower and upper bounds, respectively.

[9]Analyses limiting the sample to respondents with non-missing weight and height information (i.e., analyses that do not impute BMI values) do not produce different findings. Similarly, analyses using mean imputation produce substantively identical findings.

FINDINGS

Sample Characteristics

Table 1 displays weighted descriptive characteristics of the analytic sample; distributions are presented for the entire sample and separately by nativity. The sample has a sizeable proportion of first- and second-generation respondents (6% and 11%, respectively). Among the foreign-born, 31% were born in Asian countries, 45% in Latin America (20% white, 25% nonwhite), 17% identify as white/"other" and non-Hispanic, and 6% as black. Blacks and non-Hispanic whites make up a large fraction of the total sample and of later generations.

Consistent with previous research, mothers of first-generation respondents are overrepresented in the lowest educational category: 41% have less than a high school education, relative to 32% and 13% of mothers of second and third-generation respondents. Mothers of first-generation adolescents are evenly distributed in the highest education category (college or more), however, consistent with evidence that many immigrants arrive to the U.S. as "human-capital" migrants (Alba and Nee 2003). First-generation adolescents are less likely to have at least one parent who has been told that they are obese (15%, relative to 25% of adolescents in the third and higher generation).

Observed and Predicted Trends in BMI

Table 1 displays raw BMI, by nativity, over the three waves of the study: at baseline, one year and six years later. The table reveals a clear foreign-born weight advantage: first-generation adolescents have a lower BMI at baseline, on average, and experience a slower increase over time. The raw BMI values below age 20 are not meaningful without comparing them to age and sex-specific growth charts, which will be done in the next section by computing predicted values. This is particularly important at waves one and two, when most respondents were under age 20; at wave three, when 95% of respondents are over age 20, interpretations are more straightforward. To highlight one comparison, at wave three the difference in mean BMI between first-generation respondents, who have the lowest value (24.6), and third-plus generation respondents, who have the highest (25.8), is the difference between being in the high range of normal weight and being overweight. These observed trajectories suggest that nativity differences in weight gain during adolescence and the transition to adulthood, and the health integration of the foreign-born more broadly, may not adhere to a simple story of convergence or unhealthy acculturation. I examine this possibility more rigorously in the next sections.

Table 2 presents estimates from the multilevel model relating nativity and BMI for the total sample. The first two columns display the findings from an unconditional model predicting the level of and rate of change in BMI. This model shows that the average third-plus generation respondent (the reference category, or intercept of the intercept) gains weight with age, starting at a BMI of 19.5 at age 11 (the age at which the sample is centered) and

[10]Similarly, although about 40% of respondents do not participate in all three waves of the Add Health, there are no systematic differences in baseline BMI, or other covariates, between adolescents who participate only in the first wave, and those who participate in all three waves. This is also true when I examine differential attrition on these characteristics across nativity groups.

increasing in BMI at a rate of about 0.61 points per year (the growth factor, or intercept of the slope). Examining the coefficients for first and second-generation adolescents reinforces the descriptive findings in Table 1: although all respondents are predicted to gain weight with age, the pace of weight gain is slowest among first-generation adolescents, who are predicted to begin with a lower BMI (−0.593) and gain weight more slowly (0.610-.0993). This finding suggests weight *divergence* across nativity groups—though this result does not follow what might be expected from the predictions of convergence theories, it is consistent with recent evidence among adolescents and adults (Harris, Perreira and Lee 2009; Park et al. 2009). The pace of weight gain is also predicted to be slower among second-generation respondents than among their third-plus generation peers, though this difference is smaller.

The unconditional models, however, do not consider key omitted variables in the relationship between nativity and weight change. I next estimate conditional models on the total sample that include sex, race/ethnicity, socioeconomic status and other socio-demographic characteristics as predictors of baseline BMI levels. The foreign-born BMI advantage does not disappear, instead becoming slightly larger after controlling for respondents' baseline social and economic characteristics. There is a consistently strong intergenerational component to weight patterns—parental obesity has a positive association with BMI levels and growth.

Homogenous or Segmented Weight Gain within and across Nativity Groups?

The findings presented thus far, though useful for establishing nativity differences, neither consider the degree of stratification in weight gain within and across nativity groups, nor provide an intuitive sense of how meaningful the predicted nativity differences in BMI are. Table 3 presents findings disaggregated by nativity, with separate panels for first, second and third-plus generation respondents. Within each nativity-specific model, race/ethnicity and parental education predict both baseline BMI and BMI growth, amounting to interactions between each variable and age. Examining the intercepts across nativity groups reveals that both baseline BMI levels and the pace of BMI growth are slowest among first-generation respondents. The slope is lowest within the first-generation (0.468), revealing a slower average pace of weight gain among this group than among second (0.536) and third-plus generation (0.660) adolescents. Tests of coefficient equality across models, indicated with superscript letters in Table 3, reveal that these differences are statistically significant at the 0.05 level between the first and third generations, and between the second and third generations, but not between the first and second generations. Instead of faster weight gain among first and second generation adolescents, relative to those in the third-plus generation —a pattern of convergence —these findings suggest slower rates of weight gain among youth in immigrant families over the course of adolescence and into early adulthood.

These slope differences, however, capture the growth of only an adolescent with reference-category traits—a non-Hispanic white adolescent with poorly educated, low-income and unmarried parents—and do not account for segmentation in the magnitude and direction of weight gain by race/ethnicity or socioeconomic status. To fully interpret nativity differences, it is useful to compute predicted scores from the weight growth curve: that is, the predicted BMI for an adolescent with a particular set of characteristics. As discussed earlier, varying

activity patterns and environmental circumstances across groups of youth, as well as previous research among adults, suggest that the pace of weight gain—and, therefore, the extent to which convergence, divergence or stability are observed—may differ by race/ethnicity and socioeconomic status.

Race/Ethnicity—Tables 3 and 4 allow for consideration of racial/ethnic segmentation in the relationship between nativity and BMI over time, within and across nativity groups. Table 3 demonstrates that divergence across nativity groups is segmented by race and ethnicity. *Within* the foreign-born group, divergence occurs at a significantly slower pace among Hispanic adolescents, both Mexican and non-Mexican, and among blacks. Predicted baseline BMI is significantly higher among blacks (1.506 BMI points), Mexicans (1.093) and non-Mexican Hispanic adolescents (0.766). Moreover, the pace of growth among Mexican and non-Mexican Hispanic is significantly faster than among their non-Hispanic white peers (0.122 and 0.085 points per year, respectively). A Wald test of coefficient equality, shown in the bottom rows of Table 3, confirms that coefficient BMI growth differences among foreign-born race/ethnic groups are significant at the 0.001 level.

Table 4 and Figure 1 demonstrate these differences more intuitively. The predicted BMI at age 12 for an average first-generation, non-Hispanic white respondent is 18.9—around the 60^{th} percentile for girls and the 65^{th} percentile for boys. Among Mexican and non-Mexican Hispanic adolescents, the predicted BMI at age 12 is closer to the 80^{th} percentile (20 and 19.7, respectively)—very close to the overweight threshold, as defined by Cole (2000). By age 23, these ethnic differences remain meaningful. The predicted BMI values for Mexican adolescents (25.4) and non-Mexican Hispanics (25.0) fall in the overweight range, compared to values within the healthy weight range for non-Hispanic whites (24.2). Though foreign-born black adolescents experience a slower pace of weight gain than their non-Hispanic white peers, this does not compensate for their significantly higher average baseline BMI, resulting in a higher likelihood of being overweight (BMI of 25.7) by early adulthood. Patterns for Asian foreign-born adolescents are more mixed, and not significantly different from those for non-Hispanic whites. East Asian adolescents are predicted to have a higher BMI at age 11 (0.634—not significant), though they experience a slower pace of weight gain than non-Hispanic whites, on average.

Comparison *across* nativity groups reveals that the finding of weight divergence in nativity differences over time holds among all race/ethnic groups. Among second and third-plus generation respondents, Mexican and non-Mexican Hispanic adolescents also gain weight more quickly than their non-Hispanic white peers (with the exception of second-generation non-Mexican Hispanics), as do blacks; these race/ethnic differences are statistically significant within nativity groups, as shown by the tests of coefficient equality at the bottom of Table 3. Coefficient tests of the ethnicity coefficients across models, indicated by superscripts, are not significant at the 0.05 level, except among blacks. This suggests that, though divergence takes place more slowly among first-generation Hispanics than among other race/ethnic groups, it occurs nonetheless.

Overall, examining race/ethnic segmentation in foreign-born adolescents' health-related integration demonstrates that the foreign-born weight advantage, as well as the maintenance

of that advantage over time, is significantly weaker for Hispanic adolescents than for non-Hispanic whites. Similar patterns are observed in the second and third-plus generations, meaning that divergence is slower for Hispanics, but that nativity differences in BMI diverge among these adolescents as well—that is, first-generation Hispanics are not predicted to surpass the BMI of their later-generation peers in the same ethnic group by early adulthood.

Socioeconomic Status—Tables 3 and 4 also present an examination of stratified health-related integration across parental education groups. Table 3 shows the relationship between parents' education (at wave 1) and BMI over time. The table reveals no significant socioeconomic segmentation among foreign-born respondents: predicted baseline BMI is not significantly lower among adolescents with a college-educated parent than among their peers in more poorly-educated families. This finding is displayed clearly in Table 4 and Figure 2A: though the differences are not significant, predicted BMI at age 12 among foreign-born respondents is actually higher for those with college-educated mothers (19.6) than for those with a less than high-school educated parent. Though there is no socioeconomic gradient in BMI among the foreign-born, there is among later-generation respondents: second and third-plus generation adolescents with college-educated mothers have significantly lower baseline BMI values than those with the most poorly-educated responding parents. Among third-plus generation respondents, adolescents with the most highly-educated parents also have also a significantly slower pace of weight gain than their peers with poorly-educated mothers. An equality test of the parental education coefficients across nativity groups is significant at the 0.05 level between the first and third, as well as second and third, generations. This pattern of a weaker socioeconomic health gradient among the foreign-born is consistent with recent findings among young children (Balistreri and Van Hook 2009), and with cross-sectional evidence among adults (Goldman et al. 2006). Despite differences across nativity groups in the relationship between parental education and BMI, however, the pattern of BMI divergence between nativity groups holds across all socioeconomic groups—by early adulthood, foreign-born youth with the most highly educated parents remain less likely to be overweight (average BMI of 24.7) than their later-generation peers with similarly educated parents (27.4 among third generation).

DISCUSSION

Forming alongside the longstanding body of work on social mobility within immigrant families has been a growing interest in the health-related incorporation of the foreign-born, which is often portrayed as a process leading to increasingly unhealthy outcomes as children age. Before trying to understand the potentially contradicting patterns of health and socioeconomic success subsequent to migration—increasing socioeconomic status alongside potentially declining health—it is necessary to understand how inequalities between nativity groups change over time, and whether temporal patterns exhibit any stratification. I use longitudinal data on a diverse sample of adolescents to study nativity differences in the direction and pace of weight gain, as a way of examining the health-related integration of youth with migration backgrounds. The methods I use here represent a substantial improvement over many previous approaches by providing a dynamic picture of weight;

existing literature is dominated by a cross-sectional focus, prohibiting analysis of change or stability in group differences over time. In addition, I provide a more complex examination of the relationship between nativity and weight than currently exists, by considering whether integration is stratified by race/ethnicity and socioeconomic status. It is unlikely, of course, that these factors work in isolation of one another to produce variation in the health-related integration of foreign-born youth. Examining the importance of these factors within and across groups nonetheless provides a marked improvement in our understanding of the directionality and pace of immigrants' health integration.

Contrary to the process of homogenous convergence suggested by some cross-sectional research, and by application of straight-line assimilation theories to the study of health-related outcomes, youth with migration backgrounds—first-generation adolescents and their second-generation peers, to a lesser extent—begin at a significantly lower BMI than their third-plus generation peers and gain weight at a significantly slower pace. These trajectories produce meaningful predicted differences in weight status by early adulthood. More complex examination of the relationship between nativity and BMI growth reveals that the maintenance of the foreign-born BMI advantage builds on baseline conditions that are segmented across racial/ethnic lines: the foreign-born BMI advantage over time does not extend as strongly to Hispanic or black adolescents. Though weight divergence from third-generation youth occurs for all foreign-born adolescents, it does not result in the equal distribution of weight by early adulthood. These results are consistent with evidence on the integration of foreign-born youth in other domains (e.g., education) and the predictions of contemporary assimilation theories (e.g., Alba and Nee 2003) that allow for variation in the pace and direction of incorporation across population subgroups.

Of course, the analysis is not without limitations. Though the data are the best available for the purposes of this examination, small sample sizes in combined categories of nativity/ethnicity, and nativity/socioeconomic status, prevent an even richer analysis. In particular, it will be useful in future work to further explore variation among the foreign-born according to age at migration and time in the U.S., to examine how resources such as parental education vary in their effects across ethnic and country of origin groups. Secondly, because the data do not permit comparison of first-generation adolescents to their peers in sending countries, or how BMI changes over time relative to those peers, the findings must be interpreted only relative to the U.S. population. Accordingly, the baseline BMI values and rates of change that I observe should be viewed as upper bounds. Processes of selection are certainly plausible as partial explanations of these results. For example, first-generation adolescents and their families may comprise the healthiest members of their native populations, given recent evidence of socioeconomic gradients in smoking and obesity among women in countries with previously inverse relationships between socioeconomic status and health behavior (Buttenheim et al. 2009). This prospect, combined with the possibility that the unhealthiest adolescents may be more likely to return home with their families, might upwardly bias estimates of the immigrant health advantage. Though I measure parental BMI and examine health-related attrition, I cannot adequately consider the role of selection in generating the findings.

An equally likely explanation for the nativity differences observed here comes from the role of environmental factors in children's families, neighborhoods and peer networks that change alongside weight. Differences in the proximity and quality of adolescents' kin and non-kin networks, as well as group variation in adolescents' behaviors in and out of the home, may have important consequences for health behaviors and status. Racial/ethnic segmentation in BMI within nativity groups, for example, raises questions about whether the greater prevalence of overweight and obesity among black and Hispanic youth, and the less protective role of immigrant status among these youth, is driven by environmental factors. Hispanic youth, for example, are less likely to be physically active than their non-Hispanic white peers (Hofferth and Sandberg 2001). It is quite plausible that poorer-quality physical environments among black and Hispanic adolescents in all nativity groups contribute to their higher prevalence of excess weight. I offer a detailed description of the pace of weight gain within and across nativity groups, in order to inform the very important next step of examining these underlying, and potentially co-evolving, environmental pathways.

Given substantial numbers of foreign-born and second-generation youth in the U.S., as well as the demonstrated socioeconomic consequences of health during adolescence, it is vital to examine health as a marker of immigrant youths' incorporation into a new society. Favorable health behaviors and outcomes among foreign-born youth and their families, despite their greater likelihood of disadvantaged socioeconomic circumstances, also adds complexity to what is typically thought to be a fairly neat and linear relationship between socioeconomic status and health. Moreover, if the degree of this advantage varies widely across sociodemographic groups over time, then it is plausible to think that patterns of health among immigrants may affect the population-level population-level relationship between social circumstances and health. The next step is to examine how patterns of weight gain, as well as other health markers, change alongside youths' contextual circumstances in their families and peer networks. In the meantime, the current findings offer important insight into the trajectories of a diverse group of adolescents, and incorporate an understudied but equally socially patterned domain—health—into considerations of the long-term social integration of youth with migration backgrounds.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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