



Individual-, family-, and contextual-level variables do not explain the protective effect of parental nativity status on changes in 3–15-year-old children's BMI

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ABSTRACT

Individual-, family-, and contextual-level factors can simultaneously and interactively affect a child's body mass index (BMI). We examine parental nativity as a key determinant of changes in children's BMI over time. Prior research on this topic has been inconclusive. A longitudinal sample of households with children residing in four low-income, high minority New Jersey cities provided data on demographics, socioeconomic status, anthropometric measures, as well as dietary and physical activity behaviors for one randomly selected child. The baseline interview for two separate cohorts took place in 2009/10 and 2014-15, with a follow-up interview 2–5 years later. The outcome variable, change in BMI z-score was divided into three categories (decrease in BMI z-score; no meaningful change; increase in BMI z-score) and analyzed using ordinal logistic regressions. About 28% of the children in the sample had at least one foreign-born parent. For the two major racial/ethnic groups, i.e., Hispanics and non-Hispanic blacks, having a foreign-born parent was associated with a *favorable* change in BMI—children of foreign-born parents were more likely to experience a decrease BMI z-score between baseline and follow-up. Multivariate analyses reveal that the initial association between parental nativity and children's BMI change (OR = 0.20; $p < 0.001$) persists after controlling for an extensive set of covariates, such as child dietary and physical activity behaviors, family-level variables, census tract characteristics, and measures of food environment (OR = 0.17; $p < 0.001$). Through a series of sensitivity analyses, we verified that our results are consistent across different model specifications. In our sample, having a foreign-born parent was a protective factor for children's BMI change that operates through different pathways than might be anticipated.

1. Introduction

The number of foreign-born individuals in the United States has been steadily increasing for several decades. In 2017, the foreign-born population reached 44 million, or 13.6% of the total US population. Similarly, the number of U.S.-born children with at least one foreign-born parent (referred to as *children of immigrants* or *second-generation children*) has been increasing since the 1990s (Radford & Noe-Bustamante, 2019). In 2017, 23% (16.7 million) of the total U.S. children population (ages 0–18) was second-generation; up from 14% in 1994 (Child Trends, 2018). Because this upward trend is projected to continue (Child Trends, 2018), understanding the differences in body mass index (BMI) status and trajectory between children of immigrants and children of U.S.-born parents (i.e., *children of natives* or *third-plus generation children*) has

substantial implications for understanding the current and future health profiles and disparities of U.S. children (Jasso et al., 2004). Research has shown that a higher BMI during childhood is linked to higher BMI in adulthood as well as to a number of unfavorable health outcomes throughout the life course (Freedman et al., 1999; Lynch & Smith, 2005).

Based on the ecological model, there are several factors, at the individual-, family-, and contextual-level that can simultaneously and interactively influence children's BMI and BMI change (Ohri-Vachaspati et al., 2015). One of these factors is parental nativity status. On one hand, the *immigrant epidemiological paradox*—the relative health advantages, in spite socioeconomic disadvantages, of foreign-born individuals compared to their U.S.-born counterparts (Markides & Coreil, 1986)—poses the possibility that second-generation children may

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Table 1
Descriptive Statistics^a by parental nativity status, at baseline and change occurred between baseline (T1) and follow-up (T2).

	Baseline			Change between T1 and T2		
	Parental Nativity Status		Difference	Parental Nativity Status		Difference
	Native-born	Foreign-born		Native-born	Foreign-born	
	n = 262	n = 101		n = 262	n = 101	
Child Characteristics						
Age (years)	10.2	10.1	NS	3.3	3.3	NS
Sex (% female)	48.3	44.1	NS			
Race (%)			***			
Non-Hispanic Black	58.1	17.6				
Hispanic	23	65.9				
Non-Hispanic white	13.2	2.9				
Other	5.7	13.5				
BMI Z-score at T1	0.6	0.8	NS			
Sugar-sweetened beverage consumption (teaspoons/day)	7.6	6.4	^	1.2	1.0	NS
Fruit and vegetable consumption (cups/day)	2.3	2.1	NS	-0.2	0.1	NS
Physical activity (days/week)	4	4	NS	0	-0.5	NS
Parent's Characteristics						
Mother's education (%)			^			
Less than high school	14.5	22.7				
High school	35.1	53.3				
Some college	27	13.5				
College degree	23.4	10.5				
Parent BMI	29.7	27.2	^	0.9	0.6	NS
Poverty Level ^b	2.4	2.3	NS	0.6	-0.3	NS
Environmental Characteristics						
Block group total population	1314	1678	**	50	-92	^
Block group income (\$)	34,414	39,302	NS	119	-1135	NS
Convenience stores ^c	21.4	25.5	*	0.8	0.8	NS
Supermarkets ^c	1.3	2.1	*	0.3	0.4	NS
Small grocery stores ^c	1.9	2.3	*	0.2	0.5	NS
Pharmacies ^c	4.8	6.6	**	0.3	0.6	NS
Limited service restaurants ^c	32.9	35.2	NS	-0.7	0.6	NS

NS = Not Significant; ^ p < 0.10; *p < 0.05; **p < 0.01; ***p < 0.001.

^a For continuous variables, means are reported and t-tests used to assess the difference by parental nativity status. For categorical variables, frequencies (%) are reported and chi-square tests used to assess the difference by parental nativity status.

^b The poverty level is calculated as the ratio between household income and the Federal Poverty Line.

^c All food environment variables represent the count of specific store types within a 1-mile road network buffers from the child's residence.

benefit from their parents' advantage and have more favorable weight status than third-plus generation children. On the other hand, immigrant parents' acculturation process (Antecol & Bedard, 2006; Commodore-Mensah et al., 2016) and marginalized status can negatively impact their children's weight status (Baker et al., 2015). Second-generation children and children of natives also differ in terms of obesogenic behaviors (Cespedes et al., 2013; Echeverría et al., 2015), and neighborhood environment (Reifsnider et al., 2019), which are both factors that can play a role in children's BMI trajectories. To date, there is no conclusive evidence on whether there are differences in weight outcomes between second-generation children and children of natives. Cross-sectional studies have reported either worse weight outcomes for second-generation children (Baker et al., 2015; Liu et al., 2012; Singh et al., 2009), or no associations between parental nativity status and children's weight outcomes (Li et al., 2011; Martinson et al., 2012). Results from scant longitudinal studies are contradictory. Of the two studies that have reported null findings, the first analyzed a binary measure of child weight status (overweight vs normal weight) (Balistreri & Van Hook, 2011), while the second only looked at second-generation Hispanic children (Martinson et al., 2015). Another study, based on early 2000 data, examined BMI percentile trajectories of children between 3 and 11 years old, finding higher likelihood of overweight/obesity for second-generation male, but not female, children (Van Hook & Baker, 2010). Lastly, a study based on the first three waves of the National Longitudinal Study of Adolescent Health, using growth curve models to estimate BMI change, shows healthier weight trajectories for second-generation adolescents compared to third-generation adolescents (Jackson, 2011). Such mixed findings suggest the need for more nuanced and comprehensive examinations of the role of parental

nativity status on children's weight outcomes and the factors that may explain this association. The current paper contributes to the existing literature by providing additional empirical evidence on the association between parental nativity status and children's BMI change using a longitudinal study design and accounting for an extensive set of covariates, including individual-, family-, and contextual-factors.

2. Material and methods

2.1. Dataset

We use data from the New Jersey Child Health Study (NJCHS), a two-panel longitudinal study of households with 3–15-year-old children in Camden, New Brunswick, Newark, or Trenton. Baseline interviews took place in 2009–10 and 2014–15, with follow-up after 2–5 years. Households were eligible to participate in the study if they had at least one child between 3 and 15 years of age at baseline. Households were selected at time 1 using a random-digit dialing of landline phone numbers (panel 1) and of landline and cellphone numbers (panel 2) associated with geographical areas of the four study cities. Computer-assisted phone interviews of randomly selected households were conducted in either English or Spanish. The designated respondent was the adult primarily responsible for food purchasing decisions in the household. Typically (for 94% of households), this was either a parent or a grandparent. The adult respondent (hereafter, parent) was asked questions about themselves and a child in the household, who was randomly selected in case of multiple age-eligible children. Detailed information collected, for both the parent and the child, included socioeconomic status, demographics, anthropometric measures, food consumption

Table 2
Odds Ratios from Ordinal Logistic Regression Models Predicting BMI Change between baseline and follow-up.

Variable	Model 1	Model 2	Model 3	Model 4
Foreign-born parent	0.196***	0.200***	0.185***	0.172***
Child Characteristics				
Sex (female)	0.816	0.841	0.738	0.680
Age	0.932	0.936	0.942	0.978
Race (Non-Hispanic Blacks)				
Hispanics	4.111***	3.977***	4.199**	4.732**
Non-Hispanic white/Other	0.975	0.973	0.808	0.746
Duration (months between T1 and T2)	0.990	0.989	0.991	0.991
BMI Z-score at T1	0.390***	0.385***	0.392***	0.385***
Fruit and vegetable consumption (teaspoons/day)		1.059	1.060	1.100
Sugar-sweetened beverage consumption (cups/day)		1.032	1.034	1.059
Physical activity		1.037	1.026	1.036
Family Characteristics				
Mother's education (ref: Less than high school)				
High school			1.285	1.115
Some college			0.845	0.834
College degree or more			1.388	1.322
Parent BMI			1.020	1.003
Poverty level ^a			0.972	0.987
Environmental Characteristics				
Block group total population				0.940
Block group income				1.005
Convenience stores ^b				1.095**
Supermarkets ^b				1.475
Small healthy outlets ^b				0.642**
Pharmacies ^b				0.994
Limited service restaurants ^b				1.000
N	363	363	363	363

p < 0.01 *p < 0.001.

^a The poverty level is calculated as the ratio between household income and the Federal Poverty Line.

^b All food environment variables represent the count of specific store types within a 1-mile road network buffers from the child's residence.

patterns, physical activity behaviors, as well as the home address. If the respondent could not recall a full address, they were asked for two cross streets near their home to determine their geographical location.

All parents were asked to provide the estimates of their child's height and weight. A subsample of parents agreed to weigh and measure their child using instructions adapted from the CDC (Centers for Disease Control and Prevention, 2015) and a tape measure mailed to their homes. A further subsample agreed to have a registered nurse visit their home to measure their child's height and weight. During the follow-up interview, in addition to their current address, parents were asked whether they had lived at any other address between the two interviews, besides the one reported at baseline. Most households (about 77%) did not move between baseline and follow-up.

Place of residence was used to construct food environment measures for each household. Food environment was measured as the number of different types of outlets within a 0.25-, 0.5-, and 1-mile road network buffers from the residence. Data on locations and characteristics of food outlets for each of the four cities, as well as a 1-mile radial buffer around the city boundaries, were obtained throughout the duration of the study from two commercial data companies, InfoUSA and Trade Dimension/Nielsen. By using an established protocol (Ohri-Vachaspati et al., 2011), stores were classified on a yearly basis, based on a combination of NAICS (North American Industry Classification System) codes, sales volume, name recognition, as well as availability and quantity of specific foods stocked at the store. Our final classification included convenience stores, supermarkets, small grocery stores, pharmacies, and limited-service (fast-food) restaurants. The neighborhood population and income data came from the ACS (American Community Survey) 5-year estimates corresponding to the year interviews were conducted; data were merged

using respondent's residential address as the geographic identifier.

Baseline interviews were available for 2211 respondents. Of these, 599 completed time 2 interviews, and were included in the longitudinal sample. Respondents lost at follow-up did not differ from the rest of the sample on any baseline characteristics, except for age, being slightly older.

2.2. Variables

The outcome variable is change in children's BMI z-scores between time 1 (baseline) and time 2 (follow-up). Age- and sex-specific BMI z-score was calculated by using the method developed by the Centers for Disease Control and Prevention (CDC) (CDC Division of Nutrition PA and Obesity, 2019), using parent-estimated height and weight. This measure was chosen because it was available for a larger number of children. To maximize our sample size, we supplemented parent-estimated data (available for most participants) with either parent-measured or nurse-measured data (both available for a subsample), as previous research showed that these three measures do not substantially differ from each other in this dataset (Ohri-Vachaspati et al., 2019). Based on previous research showing that a decrease of at least 0.5 BMI z-score units can be considered a biologically meaningful change, as it corresponds to a reduction in adiposity (Hunt et al., 2007), we categorized the change in BMI z-scores into three groups: (1) Decrease in BMI z-score (BMI z-score change < -0.50); (2) No meaningful change (|BMI z-score change| ≤ 0.50); (3) Increase in BMI z-score (BMI z-score change > +0.50).

The main predictor was parental nativity status indicating whether parents were born in the United States. Parents were asked a question about the place of birth, "Were you born outside of the United States, Puerto Rico, or other U.S. territories?" Parental nativity status was a binary variable coded 1 if at least one parent was foreign born and 0 for U.S.-born parents. Child-level control variables included sex (1 = Female); age (continuous); race/ethnicity (Hispanic, Non-Hispanic Black, Non-Hispanic white, and Other); BMI z-score at time 1; dietary behaviors, specifically fruit and vegetable consumption (cups per day), and sugar-sweetened beverage consumption (teaspoons per day); physical activity (number of days per week child engages in at least 60 min of physical activity). Family-level controls included mother's education (less than high school, high school degree, some college, college degree or more), parent BMI, and household poverty level (measured as the ratio between household income and the federal poverty line for the year of data collection). Environment-level controls included block group total population and inflation-adjusted income, as well as measures of food environment (number of convenience stores, supermarkets, small grocery stores, pharmacies, and limited-service restaurants within a mile from children's homes).

2.3. Statistical analysis

All analyses were conducted in Stata 15. We used ordinal logistic regression (Agresti, 2018) to model the categorical specification of BMI z-score change. Under the proportional odds assumption, the model estimates a single set of coefficients that applies to each pair of outcome categories (e.g., the odds of being in the low category vs middle/high are assumed to be the same as the odds of being in the low/middle categories vs high). We ran a set of nested models, starting with a model including only parental nativity status, BMI z-score at time 1, and child-level demographics (Model 1); then, in a stepwise fashion, we added child dietary consumption and physical activity behaviors (Model 2), family characteristics (Model 3), and lastly, environment characteristics (Model 4). All time-varying variables were entered as the difference between time 1 and time 2 to capture the socioeconomic, behavioral, and environmental changes that occurred between baseline and follow-up. Age is the only exception, as we used both age at baseline and time elapsed between time 1 and time 2. All models were run on the

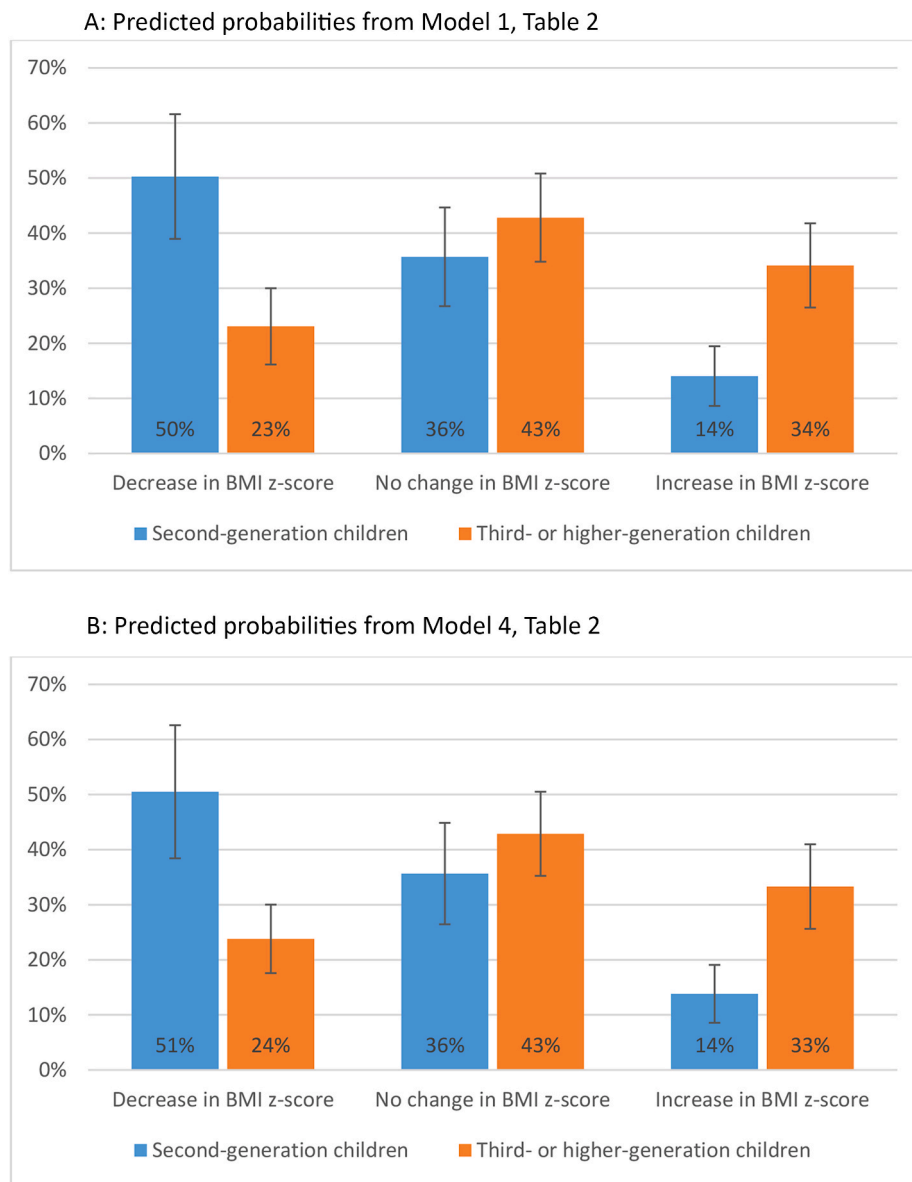


Fig. 1. Predicted probabilities of experiencing a decrease, no meaningful change, or an increase in BMI z-scores between baseline and follow-up. Panel A: Predicted probabilities from Model 1 (Table 2), controlling for individual-level demographic variables. Panel B: Predicted probabilities from Model 4 (Table 2), controlling for all individual-, family-, and contextual-level factors.

subsample of children (n = 363) who had complete data for all of the variables, included longitudinal survey weights accounting for attrition, and adjusted for the clustering at the city level. In addition, we performed an extensive series of sensitivity analyses aimed at checking the robustness of the results across different model specifications.

3. Results

3.1. Main results

The analytic sample (n = 363 with complete data on all variables) included 101 (27.8%) second-generation children and 262 children of natives (72.2%). As shown in Table 1, the race/ethnic composition of the two groups of analysis was different; most (66%) second-generation children were Hispanic, while most (58%) children of natives were African Americans. BMI z-score at baseline was similar, and so were most health behaviors, except for consumption of sugar-sweetened beverages, slightly higher among children of natives. At the family-level, both

parental education and parental BMI tended to be lower for second-generation children, while the poverty level did not differ. Lastly, there were some differences at the neighborhood level, as second-generation children tended to live in more populated areas, with a higher number of convenience stores, supermarkets, small grocery stores, and pharmacies.

Model results are shown in Table 2, where coefficients are reported as odds ratios (ORs). Model 1, including individual-level demographics and BMI z-score at time 1, indicates that second-generation children have healthier BMI trajectories than children of natives. Specifically, their OR of being in a higher BMI z-score change category is approximately 80% lower. Fig. 1 panel A shows the estimated probabilities (from model 1) of experiencing a decrease, no change, or an increase in BMI z-score for second-generation children vs children of natives. The pattern of change is markedly different across the two groups; the majority of second-generation children (50.3%) experience a decrease in BMI z-score over time, vs only 23.1% of children of natives (p for difference < 0.001). On the other hand, over a third children of natives but

Table 3

Results from multiple sensitivity analyses predicting the change in BMI z-score categories (decrease; no change; increase) by using different model specifications.^a

Model	Models with interactions	Odds Ratio (OR) ^b	p-value	N
1	Interaction between parental nativity and race/ethnicity			363
	Non-Hispanic Blacks	0.161	0.029	
	Hispanics	0.074	0.000	
2	Interaction between parental nativity and years in the US			363
	15+ years in the US	0.145	0.001	
	0–14 years in the US	0.237	0.006	
3	Interaction between parental nativity and sex			363
	Females	0.224	0.012	
	Males	0.136	0.001	
Model	Separate models by race/ethnicity	Odds Ratio (OR)	p-value	N
4	Model for non-Hispanic Blacks	0.151	0.034	219
5	Model for Hispanics	0.027	0.000	112
Model	Additional or alternative predictors	Odds Ratio (OR)	p-value	N
6	Addition of predictors at baseline	0.098	0.000	363
7	Additional measure of physical activity (active commuting to school)	0.171	0.000	362
8	1/2-mile buffer for food environment variables	0.161	0.000	363
9	1/4-mile buffer for food environment variables	0.205	0.001	363
Model	Adjustments for missing values (item non-response)	Odds Ratio (OR)	p-value	N
10	Inverse probability weighting	0.176	0.000	363
11	MID (Multiple Imputations then Deletion)	0.188	0.000	449
Model	Different algorithm to calculate BMI z-score	Odds Ratio (OR)	p-value	N
12	Modified z-score	0.186	0.000	363
Model	Different specification of the outcome variable	Coefficient ^c	p-value	N
13	Y = Continuous version of BMI z-score	-0.336	0.032	363

NOTES.

^a All models are a modification of model 4 (Table 2). Thus, they all control for the same set of individual, family, and contextual variables, unless otherwise specified.

^b The Odds Ratio (OR) column reports the odds ratio for the variable 'parental nativity status' for the models listed. The OR refers to the likelihood of experiencing a change in BMI (based on the change between baseline and follow-up for a second-generation child vs a third-plus generation child).

^c Because model 13 is a linear regression, the coefficient indicates the expected difference in BMI z-score change between a second-generation and a third-plus generation child, with otherwise similar characteristics.

only 14.0% of second-generation children experience an increase in BMI z-score over time (p for difference < 0.001). Adding child food consumption and physical activity behaviors (model 2), family-level controls (model 3), or environmental measures (model 4) does not modify the association between parental nativity status and changes in children's BMI observed in model 1. Notably, the predicted probabilities from model 4 are almost identical to those from model 1 (see Fig. 1, panel B).

In addition, several individual- and environmental-level control variables were significant. Hispanic children are at higher risk of experiencing an increase in BMI z-score, while children with higher BMI z-score at time 1 are more likely to experience a decrease in BMI z-score—perhaps because of a regression to the mean phenomenon. Changes in the food environment also affect the observed changes in

BMI. Specifically, a higher number of convenience stores increases the odds of being in higher BMI z-score change category, while a higher number of small grocery stores has the opposite effect.

3.2. Sensitivity analysis

All sensitivity analyses performed are a modification of model 4 (Table 2) to check the robustness of the results across different model specifications. Results from these alternative models are summarized in Table 3. First, we tested for the interactions between parental nativity status and race/ethnicity (model 1, Table 3), because of the different prevalence of second-generation children by race/ethnic groups, and the fact that both factors are independently associated with BMI z-score change. The results indicate that even though Hispanic and African American children differ in terms of BMI and BMI trajectory, within both groups having a foreign-born parent is associated with lower odds of experiencing an increase in BMI (see Fig. 2 for predicted probabilities from model 1, Table 3). To further verify the consistency of this finding, we ran separate models for the two major racial/ethnic groups (i.e., Hispanics and non-Hispanic Blacks) and confirmed that despite group differences, the observed relationship between parental nativity and changes in BMI among children is observable within both groups (models 4 and 5, Table 3). Then, we explored whether duration of stay in the United States, a typical measure of acculturation (Singh et al., 2009), would modify the protective effect of parental nativity status. Results show that in this sample second-generation children experience healthier BMI trajectories irrespective of parental duration in the United States (model 2, Table 3). Because a previous study showed that the association between parental nativity status and children's BMI change was different for male vs female children (Van Hook & Baker, 2010), we added an interaction term to test whether this occurred in our sample as well—it did not. For both male and female children, having a foreign-born parent was associated with a healthier BMI change (model 3, Table 3). In further analyses (models 6–13 in Table 3), we included as predictors time 1 values of all time-varying variables, an indicator for active commuting to school (based on a yes/no variable) and different distances to food environment variables (½ and ¼ mile road network buffers, rather than one mile). To check whether missingness might affect our results, we adopted two different strategies. First, we used *multiple imputations then deletion* (MID), a statistical technique whereby all analytical variables with missing values are imputed, but in the final model the original (i.e., unimputed) version of the outcome variable is used (Von Hippel, 2007). Second, we adjusted the survey weights by a factor indicating the likelihood of having complete data (thus, of being in the analytic sample), following the *inverse probability weighting* approach (Lee & Forthofer, 2006). Lastly, we checked the robustness of our findings, by using two alternative versions of the outcome variable. One, we calculated the *modified* BMI z-score, sometimes preferred for case of children with extreme BMI values (CDC Division of Nutrition PA and Obesity, 2019). Then, we modeled the change in BMI z-score as a continuous variable, thus using a linear regression. The results of all sensitivity analyses (Table 3) are statistically and substantially consistent with our main results (model 4, Table 2).

4. Discussion

While prior research has documented that immigrants (both adults and children), typically have healthier weight status than their native counterparts, such advantage tends to decrease over time (Antecol & Bedard, 2006; Singh et al., 2009). Whether the initial health advantage observed among immigrants extends to their U.S.-born children is not clear yet. The current study sought to examine the association between parental nativity status and children's BMI change, by comparing second-generation children with children of natives (third-plus generation). This comparison provides the opportunity to focus on the potential spillover effects of parental nativity on children's health, without

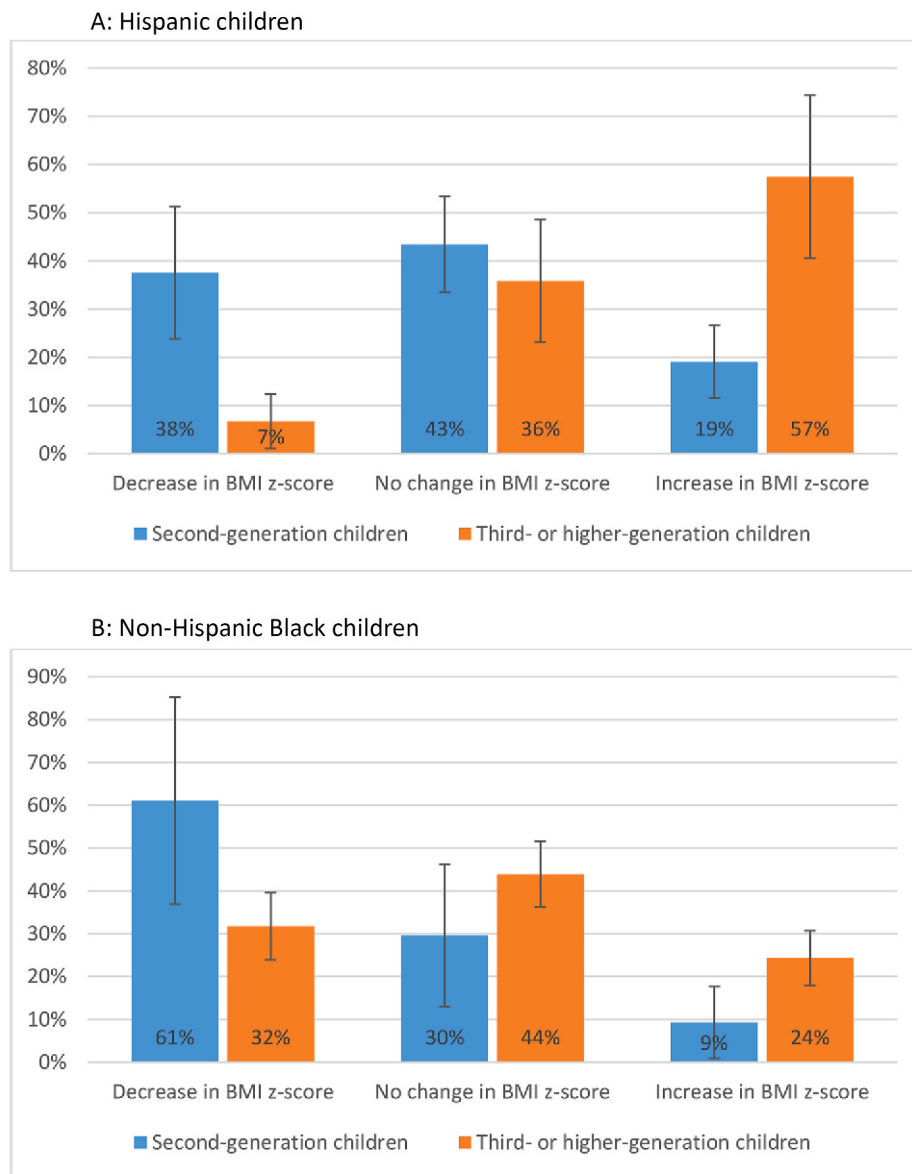


Fig. 2. Race-specific predicted probabilities of experiencing a decrease, no meaningful change, or an increase in BMI z-scores between baseline and follow-up. Panel A: Predicted probabilities for Hispanic children. Panel B: Predicted probabilities for non-Hispanic Black children. All probabilities were calculated from model 1 (Table 3), which is an extension of model 4 (Table 2) that includes an interaction term between parental nativity status and race/ethnicity.

complexities from children’s own nativity and acculturation processes, given that there is no variation in immigration or citizenship status across second-generation children and children of natives.

To date, most of the previous studies examining the differences in weight outcomes between second-generation children and children of natives reported no association (Balistreri & Van Hook, 2011; Li et al., 2011; Martinson et al., 2012; Martinson et al., 2015) or worse weight outcomes for children of immigrants (Baker et al., 2015; Liu et al., 2012; Singh et al., 2009). However, most of these studies did not use an ecological framework, with simultaneous consideration of individual-, family-, and contextual-level factors, and often omitted relevant controls, such as dietary or physical activity behaviors. A study that employed a longitudinal design, produced results consistent with ours. Based on a nationally representative sample of children and adolescents (Jackson, 2011), it found that second-generation children had a similar baseline BMI compared to children of natives, but experienced a significantly lower increase in BMI over time. Possible explanations for such findings include differences between second and third-plus generation children in (1) genetic factors (i.e. healthy-immigrant selection,

whereby individuals who decide to migrate are a particularly healthy subgroup) (Jackson, 2011; Li et al., 2011); (2) obesogenic behaviors, such as eating habits and physical activity (Commodore-Mensah et al., 2016; Echeverría et al., 2015); and (3) contextual factors, such as household socioeconomic status, and school and neighborhood characteristics. (Jackson, 2011; Reifsnider et al., 2019). In the current study, we empirically tested several of these explanations, but found no evidence in support of these hypothesis. For instance, we controlled for (1) parental BMI (which is arguably related to both genetic and contextual factors) (Jackson, 2011); (2) dietary and physical activity behaviors; and (3) environmental variables by including objective neighborhood characteristics and detailed measures of the food environments. However, none of these factors modified the association between parental nativity and child’s weight trajectory.

Strengths of the current study are a prospective cohort design, a comprehensive set of covariates at the individual-, family-, and contextual-level (Glick, 2010; Noah, 2015; Ohri-Vachaspati et al., 2015), as well as findings that are robust to several sensitivity tests. This study is also not without limitations. For instance, the sample includes

four predominantly low-income, high-minority cities in New Jersey; thus, results may not be generalizable to other populations. In addition, the dataset includes two time points. Even though this represents an improvement compared to some of the prior studies, to better evaluate BMI trajectories, more measurements may be necessary. Another limitation of the dataset is that it does not include any measure of social support, which is typically associated with better health among immigrants (Van Hook & Baker, 2010), and thus could be another possible factor contributing to the observed association between parental nativity status and children's BMI change.

5. Conclusion

Understanding the health status of second-generation children—nearly a quarter of the U.S. children population—has significant implications for the total U.S. children population (Jasso et al., 2004) and the adult population of the next decades. Our study shows that over time, second-generation children are more likely to experience a decrease in BMI z-score than children of natives. The healthier BMI change experienced by second-generation children is not explained by dietary and PA behaviors, parental BMI, family SES, or food environment. Future research should keep using an integrative multilevel framework that accounts for multiple spheres of influence by considering individual, family, and community contexts (Glick, 2010; Noah, 2015; Ohri-Vachaspati et al., 2015) to investigate the interconnected factors that may be at work. For example, the specific mechanisms through which parental nativity affects children's BMI are likely to vary by contexts of immigration (e.g., year of entry, socioeconomic and political contexts of both sending and receiving countries) as well as contexts of receptions (e.g., characteristics of neighborhoods, social networks). These mechanisms could also depend on the interaction between individual characteristics and environmental factors (e.g., black immigrants navigating the racial dynamics in the US), or on often unobserved, yet critical, characteristics, such as legal status of immigrant parents. The exploration of such mechanisms is critical to obesity prevention for children of immigrants and the overall US population.

Ethics approval

The Institutional Review Boards of Arizona State University and Rutgers University approved study protocols.

CRedit authorship contribution statement

Francesco Acciai: Conceptualization, Methodology, Software, Data curation, Writing - original draft, Visualization. **Aggie J. Yellow Horse:** Conceptualization, Writing - original draft. **Punam Ohri-Vachaspati:** Conceptualization, Methodology, Writing - review & editing, Funding acquisition.

Declaration of competing interest

None declared.

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