CHILDHOOD OBESITY
July 2022 | Volume 18, Number 5
© Mary Ann Liebert, Inc.
DOI: 10.1089/chi.2021.0056

ORIGINAL ARTICLES

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Latino Children's Obesity Risk Varies by Place of Birth: Findings from New York City Public School Youth, 2006–2017

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Abstract

Introduction: Research showing that place of birth (POB) predicts excess weight gain and obesity risk among Latino adults has not prompted similar research in Latino children, although childhood is a critical period for preventing obesity.

Objective: To identify differences in obesity risk among Latino children by POB.

Methods: Longitudinal cohort observational study on public school children self-identified by parent/guardian as Latino in grades K-12 for school years 2006–07 through 2016–17 with measured weight and height ($n = 570{,}172_{\text{students}}$; $3{,}103{,}642_{\text{observations}}$). POB reported by parent/guardian was categorized as continental United States [not New York City (NYC)] ($n = 295{,}693$), NYC ($n = 166{,}361$), South America ($n = 19{,}452$), Central America ($n = 10{,}241$), Dominican Republic ($n = 57{,}0880$), Puerto Rico ($n = 9687$), and Mexico ($n = 9647$). Age- and sex-specific BMI percentiles were estimated based on established growth charts. Data were analyzed in 2020.

Results: Prevalence of obesity was highest among US (non-NYC)-born girls (21%) and boys (27%), followed by NYC-born girls (19%) and boys (25%). Among girls, South Americans (9%) had the lowest prevalence of all levels of obesity, while Puerto Ricans (19%) and Dominicans (15%) had the highest prevalence. Among boys, South Americans also had the lowest prevalence of all levels of obesity (15%), while Puerto Ricans (22%) and Mexicans (21%) had the highest. In adjusted models, obesity risk was highest in US (non-NYC)-born children, followed by children born in NYC ($p < 0.001$). Immigrant Latino children exhibited an advantage even after controlling for individual and neighborhood sociodemographic features, particularly Dominicans, South Americans, and Puerto Ricans.

Conclusions: The heterogeneity of obesity risk among Latino children highlights the importance of POB.

Keywords: body mass index; epidemiology; health disparities

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Preprint Statement: These findings have previously been uploaded to a preprint server and are available at: https://medrxiv.org/cgi/content/short/2021.03.24.21254257v1.

Introduction

Childhood obesity in the United States has been increasing since the 1980s, and Latino children continue to be disproportionately affected.[1] The latest national estimates from 2013 to 2015 show that Latino youth aged 2 to 19 years have a 23.6% prevalence of obesity (*i.e.*, BMI ≥95th percentile) and 8.4% prevalence of extreme obesity (*i.e.*, BMI ≥120% of the 95th percentile), compared to 14.7% and 4.4%, respectively, among their non-Latino white counterparts.[2–4] Widening disparities nationwide have been documented among Latino children relative to white children.[5] At the same time Latino children account for 25.6% of the US child population, and childhood obesity is predictive of a myriad of chronic health conditions in adulthood, including asthma, arthritis, and poorer cardiometabolic and psychological risk profiles.[6–8]

Research in the United States has typically characterized obesity prevalence among Latino children by comparing them in aggregate to other racial/ethnic groups.[1,2,5] This is despite research documenting a Latino ''immigrant advantage,'' or better-than-expected obesity profiles of immigrants vs. those born in the United States, despite lower socioeconomic profiles.[9–11] Obesity research among adults has also highlighted the importance of Place of Birth (POB),[12] including genetic, environmental, and sociocultural factors[13,14] that may further drive subgroup differences among Latino children.

Mexican American children have demonstrated lower obesity prevalence among children born in Mexico vs. the United States, particularly among girls.[15–17] Other research on Latino children corroborates sex differences in obesity risk irrespective of POB.[18,19] To date, limited work has studied obesity prevalence among large and diverse samples of Latino children by POB and sex.

In New York City (NYC), one of the most urban and diverse areas in the United States, statistically significant decreases are reported in the prevalence of obesity among Latino children, from 26.5% in 2006–07 to 25.8% in 2016–17 compared to 17.6% in 2006–2007 to 13.1% in 2016–2017 among non-Latino white children.[20,21] Yet, significant disparities remain among Latinos relative to their non-Latino white counterparts despite a comprehensive approach to curb obesity by the NYC Departments of Health and Mental Hygiene (DOHMH) and Education (DOE) among vulnerable communities of color.[22–24]

In this present study, we examine whether there is heterogeneity in obesity risk among Latino children attending NYC public schools by POB, while accounting for important individual and neighborhood level SES and sociocultural factors associated with obesity risk among Latino adults.[25,26] We hypothesized that POB would be associated with obesity, but more strongly among US-born children compared to their NYC-born and immigrant counterparts.

Our rationale is based on the social science literature that has taken a much more nuanced approach to the long-term adaptations of immigrant children in the United States—and as such we contend that NYC is a place where the point of reference for most Latino children are conationals and coethnics.[27–29] This is in contrast to other areas of the country where immigrant and first generation children may have more contact with middle-class, white, European American culture. For example, over 170 languages are spoken by children in the NYC public school system.[30]

Further, experts believe that NYC is home to as many as 800 languages, making it the most linguistically diverse city in the world.[31] This is a level of cultural diversity that is unprecedented, even in those areas of the country that have also served as immigration hubs for Latinos (*e.g.*, Miami, Los Angeles). Taken together, we believe that our study will help identify differences in obesity risk among Latino children by POB, which is important for forecasting trends in prevalence and related outcomes among this growing population.

Methods

Participants

Data for this study were drawn from the NYC Fitnessgram dataset jointly managed by NYC Department of Education (DOE) and DOHMH, and have been described elsewhere.[20,21,32–34] In brief, teachers collected child-level student height and weight annually in NYC public schools.

Students' height and weight measurements were taken annually during physical education classes among K-12 students as part of the NYC Fitnessgram curriculum using a standard protocol. The study population included all NYC Latino students enrolled in a general education public school during the 2006–07 through 2016–17 school years with at least 1 year of height and weight measurements. Age was defined as student age on December 31st of the given school year based on NYC Fitnessgram measurements that are collected annually within 3 months of this date based on testing schedules.[30]

All child-level student demographic data were drawn from NYC DOE student enrollment records linked to Fitnessgram data by a unique identifier. The DOE uses demographic information, including Latino ethnicity, only for programmatic, instructional, and administrative planning and decision-making.[35] Parents and guardians were asked to identify whether the child was ''Hispanic'' (defined as ''a person of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish origin'') regardless of race. Hereafter, we use the term Latino since our sample included children from, or descended from, Spanish-speaking people from Latin America. This study was approved by the City University of New York (IRB File #2015–0582) and DOHMH (Protocol # 14–019) Institutional Review Boards.

Measures

Independent Variable

Parents/guardians reported all demographics, including child POB, which was used to derive seven categories:

continental United States (not NYC or US territories, including Puerto Rico) ($n = 295{,}693$ unique students), NYC ($n = 166{,}361$ unique students), South America ($n = 19{,}452$ unique students), Central America ($n = 10{,}241$ unique students), Dominican Republic ($n = 570{,}880$ unique students), and Mexico ($n = 9647$ unique students). These subgroups were selected based on prior literature documenting important POB differences in obesity risk in national samples of adults and NYC.[12,36] These documented differences also drove the decision to separate Puerto Rican children from their continental US counterparts ($n = 9687$), despite the fact that Puerto Rican children are all US-born by definition. Cuban children ($n = 282$) were excluded due to insufficient sample size to generate reliable estimates.

Dependent Variable

The primary outcome of interest was age- and sex-specific BMI percentiles in accordance with the CDC[37] growth charts.[38] Baseline age in months was calculated from the measurement date, and students' date of birth was drawn from school enrollment records. Extreme or biologically implausible values (BIV) were identified for height, weight, weight-for-height, and BMI using CDC's age- and sex-specific criteria.[37] An observation identified as BIV for a student in a single school year was excluded only for that school year ($n = 1756$ observations). The final analytic sample included 570,172 students or 3,103,642 observations from 2006–07 through 2016–17 school years, with individual children having 1 to 11 repeated annual observations and 56% of the sample having at least five repeated annual observations.

Weight status was defined according to CDC's growth chart-derived norms for sex and age in months and used to compute the BMI percentile for each child as follows; underweight (BMI <5th percentile), normal (5th percentile≤ BMI <85th percentile), overweight (85th percentile≤ BMI <95th), and obese (BMI ≥95th percentile). Obesity was stratified in accordance with previous reports[37,39] as follows; class I (BMI ≥95th percentile), class II (BMI >120% of the 95th percentile for age and sex or a BMI of ≥35), and class III (BMI ≥140% of the 95th percentile for age and sex or a BMI of ≥40 or greater).

Covariates

Factors known to be associated with both youth obesity and POB were included as covariates or potential effect modifiers in the models.[21,25,26,32,34] To categorize students in terms of SES, individual student household poverty (high vs. low) was based on student eligibility/noneligibility for free/reduced-price school meals through the National School Lunch Program, which provides meal assistance according to household income at or below 185% of the federal poverty level.[40] Area-based SES was defined according to the American Community Survey (ACS) 2012–2016 data as the percentage of households in the student's home zip code receiving food aid from the Supplemental Nutrition Assistance Program[41] and then categorized into quartiles [low (<15.9%), medium (15.9%–29.7%), high (≥29.7%–41.2%), and very high (>41.2%)].

Neighborhood linguistic isolation was included given its significant association with BMI and obesity-related outcomes among Latinos in NYC[26,42]; it was measured based on the percentage of Spanish-speaking only households in the home zip code drawing from the ACS 2012–2016 and then categorized into quartiles [low (<10.6%), medium (10.6%-18.0%), high (≥18.0%–24.8%), and very high (>24.8%)]. We drew ACS data from the most recent 5-year estimates aligning to individual youth fitness data. Missing demographic information, including home addresses were imputed using data recorded for the same child in other years.

Statistical Analyses

Data were analyzed in 2020. Descriptive statistics were computed to summarize sample characteristics. Means and SDs were generated for all continuous data (BMI percentile, area poverty, and linguistic isolation), while categorical data (sex, POB, weight category, household poverty status, categorized area poverty, and linguistic isolation) were reported as frequencies and percentages for all students. Weight categories were also reported as frequencies and percentages across sex and POB. Chi-square tests of homogeneity were performed to compare the distribution of weight categories across sex and POB subgroups. Chi-square tests were adjusted for multiple testing using Bonferroni correction.

Next, repeated measures mixed models were used, where repeated observations were nested within individual children who in turn were nested within home zip codes. These models estimated the association between individual-level POB and BMI percentile over time, taking into account individual-level factors, and also both individual-level and area-level factors for all students, and also stratified by sex. Additional models were run to test whether slopes in BMI percentile over time (calendar year) were significantly different across the POB subgroups given our interest in population shifts according to POB.

For all models, random intercepts for area effects (home zip code) and random slopes for time point of observation (school year, to examine period cohort effects) were included with participants and zip codes as the subjects for levels 2 and 3, respectively, to account for between-child and between-zip code variations. A first-order autoregressive covariance structure was used to represent the correlated repeated measurements over time within participants in all models. The autoregressive structure was selected based on Akaike's information criterion to assess relative goodness-of-fit across models comparing other covariance structures (unstructured, Compound Symmetry, and first-order autoregressive structure).

Adjusted models included sex (unstratified models), baseline age at time of BMI measurement (continuous variable), household poverty status (binary variable), and time (an integer value increasing from 0 to 10 corresponding to the number of repeated observations or years that each child was observed in the dataset) as covariates. Additional adjusted models included all individual-level covariates listed above, and also home area poverty (categorical variable) and linguistic isolation (categorical variable). Models testing whether slopes in BMI percentile over time (calendar year) were significantly different across the POB subgroups also included calendar year as a categorical variable in the models. A p-value of <0.05 was considered statistically significant, and all p-values were two-sided. Statistical analyses were performed using SAS v.9.4.[43]

Results

Descriptive characteristics for Latino children in grades K-12 ($n_{\text{children}} = 809{,}418$; $n_{\text{observations}} = 3{,}103{,}642$) appear in Table 1. The majority, 52%, of the analytic sample was born in the continental United States or NYC (29%). Of the children born outside the continental United States, most were from the Dominican Republic (10%), followed by South America (3%), Puerto Rico (2%), Mexico (2%), and Central America (2%). There was an equal proportion of females and males, with a high household (81%) and neighborhood (44%) poverty rate, and half of the sample resided in areas with high (quartile 3) or very high (quartile 4) linguistic isolation. More than half of the children (57%) were in the healthy weight category, 21% experienced overweight, 19% were in one of the three obesity categories, and 2% experienced underweight.

Supplementary Figures S1, S2 and Table 2 illustrate weight categories for all children by POB and sex, derived from Fitnessgram measurements collected annually from each child. Among Latina girls born in the continental United States but not NYC, 21% experienced overweight, 14% were affected by Class I obesity, 5% were affected by Class II, and 2% were affected by Class III. NYC-born girls showed similar prevalence rates for all obesity categories (13%, 4%, and 2%, respectively).

Girls born outside the United States had a similar or lower proportion of overweight (not including youth with obesity) compared with those in the United States, except for Mexican (24%) and Central American girls (22%). South and Central American, Dominican, Puerto Rican, and Mexican girls had a lower proportion of obesity in all categories compared to their US- and NYC-born counterparts except for Classes I and II obesity in Puerto Rican girls (13% and 4%, respectively), which was consistent with NYC-born girls.

Latino boys (Supplementary Fig. S2 and Table 2) had a higher proportion of overweight and obesity compared to girls. Specifically, among Latino boys born in the continental United States but not NYC, 19% experienced overweight, and 18%, 7%, and 2% experienced Classes I–III obesity, respectively. Boys born in NYC showed comparable prevalence for all obesity categories (17%, 6%, and 2%, respectively).

Among children born outside the United States, boys generally had a higher proportion of overweight but a lower proportion of Class I obesity (ranging from 12% to 16%) and Class II (ranging from 3% to 4%) than girls. The sole exception was Puerto Ricans, where boys had a lower prevalence of overweight (17.8%) than girls (19.1%) but a higher Class II obesity prevalence (5.6%) than girls (4.2%). Puerto Rican boys also had a comparable prevalence of Class III obesity compared to continental US- or NYC-born children ($\sim$2%). All other subgroups born outside the continental United States or NYC had $\sim$1% of boys in the Class III category.

Crude and adjusted repeated measures mixed models for the association between POB and BMI percentile for all children and stratified by sex are presented in Tables 3 and 4, respectively (Type III Fixed Effects Estimates $p < 0.001$ for all). Models adjusted for sex (unstratified model), baseline age at time of BMI measurement, household poverty status, home area poverty, linguistic isolation, calendar year, and time as covariates showed the strongest association between POB and BMI percentile in Dominican [$b = -3.67$, 95% confidence interval (CI): –3.79, –3.56], South American ($b = -3.21$, 95% CI: –3.40, –3.02), and Puerto Rican ($b = -3.15$, 95% CI: –3.44, –2.87) children, relative to the reference group (US-, non-NYC-born; Table 3).

After stratifying by sex, Dominican ($b = -3.42$, 95% CI: –3.58, –3.26) and South American ($b = -3.24$, 95% CI: –3.51, –2.98) girls demonstrated significantly lower BMI percentile than US- non-NYC-born girls. Among boys, Puerto Ricans ($b = -4.18$, 95% CI: –4.59, –3.78), Dominicans ($b = -3.94$, 95% CI: –4.11, –3.78), Central Americans ($b = -3.39$, 95% CI: –3.73, –3.04), and South Americans ($b = -3.19$, 95% CI: –3.46, –2.92) showed lower BMI percentile than US- non-NYC-born children. Also, the largest disparities by sex within the same POB subgroup were observed in Central American ($b = -1.94$, 95% CI: −2.30, −1.58 vs. $b = -3.39$, 95% CI: −3.73, −3.04) and Puerto Rican ($b = -2.16$, 95% CI: −2.56, −1.78 vs. $b = -4.18$, 95% CI: −4.59, −3.78) girls and boys, respectively.

Additional models examining whether slopes over time (calendar year) were significantly different across the POB subgroups showed that Puerto Rican children had the greatest decline in BMI percentile over time ($b = -2.38$, 95% CI: −3.31, −1.44), followed by Dominican ($b = -1.99$, 95%CI: −2.33, −1.65) and Central American ($b = -1.70$, 95% CI: 2.42, −0.98) children (Type III Fixed Effects Estimates $p < 0.001$ for all; Supplementary Table S1 and Supplementary Fig. S3).

Models stratified by sex showed similar findings among boys ($b = -2.79$, 95% CI: –4.13, –1.44, $b = -2.40$, 95% CI: −2.89, −1.91 and $b = -2.31$, 95% CI: −3.30, −1.32 for Puerto Rican, Dominican, and Central American children, respectively). However, among girls, Puerto Rican

Table 1. Descriptive Characteristics for Latino New York City Public School Students ($n_{students} = 570,172$), 2006/07–2016/17

	n^a (%)
Sex	
Female	283,598 (49.7)
Male	286,574 (50.3)
POB[a]	
US (non-NYC)	295,693 (52.0)
NYC	166,361 (29.3)
South America	19,452 (3.4)
Central America	10,241 (1.8)
Dominican Republic	57,088 (10.0)
Puerto Rico	9687 (1.7)
Mexico	9647 (1.7)
Weight category[b] (all years[c])	
Underweight	11,988 (2.4)
Healthy weight	282,796 (57.2)
Overweight	105,584 (21.4)
Obese I	62,975 (12.7)
Obese II	21,257 (4.3)
Obese III	8803 (1.8)
Household poverty status[d]	
Qualifies for free/reduced price school meals	462,156 (81.1)
Does not qualify for free/reduced price school meals	108,016 (18.9)
Area poverty[e] (% qualifying for food stamps at home residence the zip code level)	
Low [<15.9%]	180,067 (31.6)
Mid [15.9%–29.7%]	137,632 (24.1)
High [≥29.7%–41.2%]	118,381 (20.8)
Very high [>41.2%]	134,092 (23.5)
Linguistic isolation[f] (% speaking only Spanish at home residence the zip code level)	
Low [<10.6%]	165,767 (29.1)
Mid [10.6%–18.0%]	121,452 (21.3)
High [≥18.0%–24.8%]	113,607 (19.9)
Very High [>24.8%]	169,346 (29.7)

[a] $n_{Missing\ Place\ of\ Birth} = 1756$.

[b] Weight category was based on annual Fitnessgram measurements for each child, and was defined according to Centers for Disease Control growth chart-derived norms for sex and age in months, and used to compute the BMI percentile for each child. Weight categories categorized as underweight: <the 5th percentile; healthy weight: ≥5th to <85th percentile; overweight: ≥85th to <95th percentile; obesity class I: ≥95th percentile-120% of the 95th percentile; obesity class II: ≥120% of the 95th percentile; obesity class III: ≥140% of the 95th percentile.

[c] Based on all years, $n_{observations} = 3,103,642$.

[d] Individual student household poverty (high vs. low) was based on student eligibility/noneligibility for free/reduced-price school meals through the National School Lunch Program, which provides meal assistance according to household income at or below 185% of the federal poverty level.

[e] Based on percentage of households in the home zip code receiving food stamps/Supplemental Nutrition Assistance Program drawing from ACS 2012 to 2016 data.

[f] Based on percentage of Spanish-speaking only households in the home zip code drawing from ACS 2012 to 2016 data.

ACS, American Community Survey; NYC, New York City; POB, Place of Birth.

Table 2. Weight Category for New York City Latino Public School Students, by Place of Birth and Sex, 2006/07–2016/17

POB	United States (non-NYC)	NYC	South America	Central America	Dominican Republic	Puerto Rico	Mexico
Girls	(n_{obs} = 815,285)	(n_{obs} = 494,589)	(n_{obs} = 42,910)	(n_{obs} = 18,062)	(n_{obs} = 112,670)	(n_{obs} = 21,697)	(n_{obs} = 29,622)
Weight category[a–c]	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Underweight	19,455 (2.4)	11,988 (2.4)	941 (2.2)	379 (2.1)	3396 (2.8)	539 (2.5)	559 (1.9)
Healthy Weight	453,121 (55.6)	282,796 (57.2)	29,072 (67.8)	11,208 (62.1)	75,122 (61.2)	12,895 (59.4)	17,899 (60.4)
Overweight	173,929 (21.3)	105,584 (21.4)	8694 (20.3)	3995 (22.1)	25,709 (21.0)	4135 (19.1)	7192 (24.3)
Obese I	113,927 (14.0)	62,975 (12.7)	3214 (7.5)	1788 (9.9)	13,143 (10.7)	2782 (12.8)	3077 (10.4)
Obese II	38,689 (4.8)	21,257 (4.3)	647 (1.5)	463 (2.6)	3790 (3.1)	917 (4.2)	578 (2.0)
Obese III	14,329 (1.8)	8803 (1.8)	188 (0.4)	167 (0.9)	1230 (1.0)	343 (1.6)	189 (0.6)
Boys	(n_{obs} = 831,849)	(n_{obs} = 498,349)	(n_{obs} = 43,326)	(n_{obs} = 19,951)	(n_{obs} = 124,104)	(n_{obs} = 20,985)	(n_{obs} = 30,243)
Weight category	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Underweight	25,903 (3.1)	15,929 (3.2)	1157 (2.7)	472 (2.4)	4280 (3.5)	764 (3.6)	882 (2.9)
Healthy Weight	422,248 (50.8)	262,278 (52.6)	26,687 (61.6)	11,953 (59.9)	71,660 (57.7)	11,832 (56.4)	16,678 (55.2)
Overweight	159,349 (19.2)	95,736 (19.2)	8846 (20.4)	4003 (20.1)	23,699 (19.1)	3739 (17.8)	6410 (21.2)
Obese I	147,206 (17.7)	82,589 (16.6)	5080 (11.7)	2512 (12.6)	17,192 (13.9)	2912 (13.9)	4767 (15.8)
Obese II	55,358 (6.7)	30,057 (6.0)	1137 (2.6)	715 (3.4)	5358 (4.3)	1180 (5.6)	1202 (4.0)
Obese III	19,862 (2.4)	10,631 (2.1)	307 (0.7)	218 (1.1)	1610 (1.3)	503 (2.4)	262 (0.9)

[a]N = missing weight category, Boys: United States (non-NYC) *n* = 359,307; NYC *n* = 290,524; South America *n* = 23,832; Central America *n* = 13,012; Dominican Republic *n* = 77,498; Puerto Rico *n* = 18,720, and Mexico *n* = 21,848; Girls: United States (non-NYC) *n* = 311,662; NYC *n* = 259,604; South America *n* = 19,155; Central America *n* = 9680; Dominican Republic *n* = 66,510; Puerto Rico *n* = 17,052, and Mexico *n* = 17,111.

[b]Over half (56%) of students had at least five repeated annual observations (range 1 to 11).

[c]Weight category was defined according to Centers for Disease Control growth chart-derived norms for sex and age in months, and used to compute the BMI percentile for each child. Weight categories categorized as underweight: <the 5th percentile; healthy weight: ≥5th to <85th percentile; overweight: ≥85th to <95th percentile; obesity class I: ≥95th percentile-120% of the 95th percentile; obesity class II: ≥120% of the 95th percentile; and obesity class III: ≥140% of the 95th percentile.

(b = 2.53, 95% CI: −3.83, 1.24), Dominican (b = −2.17, 95% CI: −2.65, −1.70), and South American (b = −2.07, 95% CI: −2.95, −1.19) children showed the greatest declines in BMI percentile.

Discussion

These findings show that Latino children attending NYC public schools in grades K-12 have a high burden of excess weight and obesity risk; however, this burden is not distributed evenly across POB. Specifically, children born in the continental United States had the highest proportion of excess weight and obesity risk, followed by children born in NYC. This is consistent with acculturation research among Latino adults that shows greater obesity risk among US-born compared to their immigrant counterparts,[10] and hypothesized to be driven by less healthful diets.[44,45]

Our findings are also consistent with research on the immigrant advantage, but our study shows this at a more granular level in that it was most pronounced among Dominicans, South Americans, and Puerto Ricans and, and to a less degree, among Central Americans and Mexicans. This early immigrant advantage among Latino children could potentially translate into protective effects documented among immigrant adults for metabolic diseases.[10,46,47] However, prevalence of obesity by POB among Latino adults revealed the highest prevalence among Puerto Ricans and the lowest among South Americans.[48]

This suggests that the early immigrant advantage observed in children may not confer the same benefits into adulthood for all Latinos, and a robust line of sociological research suggests the importance of understanding the social and economic factors that create segmented patterns of experiences by POB.[28,49,50] The potential for obesity risk to follow similar segmented patterns by POB should be explored in future studies using longitudinal designs and move beyond proxy measures like POB since this is merely a proxy for the complex acculturation process these children are likely experiencing.

Indeed, acculturation, or the process in which immigrants begin to espouse the norms, beliefs, and behaviors of the dominant group, is likely shaping obesity risk

Table 3. Crude and Adjusted Models for the Association between Place of Birth and BMI Percentile, 2006/07–2016/17

	Crude			Adjusted		
		95% CI			95% CI	
POB	b	Lower	Upper	b[a]	Lower	Upper
NYC	**−1.10**	−1.17	−1.02	**−0.67**	−0.75	−0.59
South America	**−4.10**	−4.29	−3.92	**−3.21**	−3.40	−3.02
Central America	**−3.31**	−3.56	−3.06	**−2.73**	−2.98	−2.48
Dominican Republic	**−3.79**	−3.90	−3.67	**−3.67**	−3.79	−3.56
Puerto Rico	**−3.32**	−3.60	−3.04	**−3.15**	−3.44	−2.87
Mexico	**−2.12**	−2.40	−1.86	**−1.23**	−1.49	−0.97
United States, non-NYC						

Boldface indicates statistical significance ($p < 0.05$).

Beta estimates generated on three-level repeated measures mixed models using SAS PROC GLIMMIX.

[a]Adjusted models included sex, baseline age at time of BMI measurement (continuous variable), household poverty status (binary variable), home area poverty (categorical variable), linguistic isolation (categorical variable), and time (an integer value increasing from 0 to 10 corresponding to the number of repeated observations or years that each child was observed in the dataset) as covariates.

CI, confidence interval; non-NYC, not New York City; US, United States.

through proximate mechanism such as diet, and more distal mechanisms such as stress. Key time points for intervention warrant further investigation but would require at least a measure of length of stay in the United States among immigrant children, although previous studies among adults suggest that BMI of immigrants begins to converge with their US-born counterparts after 10 years in the country.[51,52]

The literature has failed to address the heterogeneity in obesity risk among Latino children of different national or cultural origin. For example, previous surveillance data from the NYC DOHMH showed that the obesity prevalence among all Latino NYC public high school students was 17% among male and 14% among female students, masking the risk and advantage among some subgroups.

Table 4. Models for the Association between Place of Birth and BMI Percentile Across Sex, 2006/07–2016/17

	Girls						Boys					
	Crude			Adjusted			Crude			Adjusted		
		95% CI			95% CI			95% CI			95% CI	
POB	B	Lower	Upper	b[a]	Lower	Upper	b	Lower	Upper	b[a]	Lower	Upper
NYC	**−0.91**	−1.02	−0.81	**−0.71**	−0.82	−0.60	**−1.30**	−1.39	−1.17	**−0.69**	−0.80	−0.58
South America	**−3.90**	−4.16	−3.65	**−3.24**	−3.51	−2.98	**−4.30**	−4.57	−4.57	**−3.19**	−3.46	−2.92
Central America	**−2.29**	−2.66	−1.93	**−1.94**	−2.30	−1.58	**−4.27**	−4.62	−4.62	**−3.39**	−3.73	−3.04
Dominican Republic	**−3.17**	−3.32	−3.01	**−3.42**	−3.58	−3.26	**−4.65**	−4.56	−4.56	**−3.94**	−4.11	−3.78
Puerto Rico	**−2.00**	−2.39	−1.61	**−2.16**	−2.56	−1.78	**−4.64**	−5.05	−5.05	**−4.18**	−4.59	−3.78
Mexico	**−1.82**	−2.19	−1.46	**−1.39**	−1.75	−1.02	**−2.41**	−2.78	−2.78	**−1.08**	−1.46	−0.70
United States, non-NYC												

Boldface indicates statistical significance ($p < 0.05$).

Beta estimates generated on three-level repeated measures mixed models using SAS PROC GLIMMIX.

[a]Adjusted models included baseline age at time of BMI measurement (continuous variable), household poverty status (binary variable), home area poverty (categorical variable), linguistic isolation (categorical variable), and time (an integer value increasing from 0 to 10 corresponding to the number of repeated observations or years that each child was observed in the dataset) as covariates.

CI, confidence interval; non-NYC, not New York City; US, United States.

This might explain why a recent study using data with grades K-8 showed that the decrease in obesity in terms of both absolute and relative prevalence remained smaller among Latino children than white children.[20]

Combining Latino children into one large category obscures relevant differences for understanding risk in excess weight and obesity in this growing segment of the population. Although research and practitioners have a growing recognition of differing health patterns and profiles among the various Latino groups, to date, there are almost no data on obesity of subgroups such as Dominicans, who constitute the fifth largest Latino group in the United States.[53] An exception is the Hispanic Community Children's Health Study/Study of Latino Youth, although prevalence of obesity was stratified by those of Mexican background vs. non-Mexican background.[18]

Further understanding of obesity risk among Latino children will likely require an exploration of other broad social determinants of health that might explain some of the patterns observed in this dataset. This study accounted for neighborhood-level sociodemographic and cultural factors as covariates, including area poverty derived from the proportion of residents receiving food assistance, as well as the proportion of residents speaking only Spanish in the home as a proxy for linguistic isolation. Others have pointed to a wider array of neighborhood and social factors that may be critical in obesity prevention throughout the life course,[14] and factors that may be particularly important for Latino communities such as strategies that focus more on behavior change.[54]

Contextualizing these factors within a theoretical framework will be important to move beyond documenting differences; rather, we need to move into the next phase of research to explore the risk and resilience mechanisms that are shaped by complex sociocultural and SES factors.[55,56]

This study has some limitations. First, the results do not include private, charter, and special education schools, which constitute around 18%, 10%, and 2% of elementary and middle school children, respectively, in NYC, since these children do not participate in NYC Fitnessgram. Second, not all NYC public school children participate in Fitnessgram every year, although since 2010, schools have been incentivized to collect data from a minimum of 85% of students who do not have a testing waiver. The majority of observations in this study came from younger children in elementary and middle school (60%), indicating that high school children disproportionately missed the NYC Fitnessgram assessment.

However, the size and heterogeneity of the complete sample, and the ability to stratify analyses based on key demographic factors while maintaining statistical power, are strengths. We also ran sensitivity analyses restricting the sample to elementary-aged students estimates and found estimates that were consistent with those reported for all grades, with the exception of a smaller magnitude of association for youth born in South America and Central America (Supplementary Table S2). Third, US-born and NYC-born children may live in households that are still deeply connected to countries throughout Latin America and this dataset does not allow for this exploration. Fourth, this dataset does not allow for a disaggregation of Central and South Americans.

Conclusions

The NYC public school system is the largest in the country, serving 1.1 million children and representing all countries in Latin America.[57] Findings presented in this study highlight important disparities by POB and sex after controlling for individual- and neighborhood-level factors. Future research should also examine other sociocultural factors such as neighborhood composition and intergenerational patterns of acculturation that may be working in tandem with our indicator of POB to exacerbate obesity *risk and/or resiliency* among Latino children.

Disclaimer

The content is solely the responsibility of the authors and does not represent the official views of NIDDK/NIH.

Authors' Contributions

Overall integrity of the work from inception to publication: K.R.F., S.E.D., T.T.-K.H., K.J.K., and E.M.D'A. Design, acquisition of data, or analysis and interpretation of data: K.R.F., S.E.D., and E.M.D'A. Preparation and review of the article for important intellectual content: K.R.F., S.E.D., T.T.-K.H., and E.M.D'A. Final approval of the version to be published: K.R.F., S.E.D., T.T.-K.H., K.J.K., and E.M.D'A.

Acknowledgments

K.R.F. is grateful to her colleagues at the CUNY's Faculty Fellowship Publication Program (FFPP) (Dr. Anna Manukyan, Dr. Sandra Maldonado, Dr. Mabel Korie, Dr. Tatiana Emmanouil, and Dr. Mara Schvarzstein) for their thoughtful review of this article, as well as that of Dr. William Carr, FFPP mentor.

Funding Information

K.R.F. received salary support from grant 1R21DK114630-01A1 from the National Institute of Diabetes and Digestive and Kidney Diseases of the National Institutes of Health (NIDDK/NIH).

Author Disclosure Statement

No competing financial interests exist.

Supplementary Material

Supplementary Table S1
Supplementary Table S2
Supplementary Figure S1
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Supplementary Figure S3

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