Race, Sex, and Socioeconomic Disparities in Overweight and Obesity Development Among Previously Healthy-Weight Children

Culminating Experience: Northwestern University Masters of Public Health

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Abstract

Objective

Some young healthy-weight (HW) toddlers and preschoolers develop overweight/obesity (OW/OB) in later childhood. Our study aims to identify demographic risk factors for OW/OB incidence in 8-10-year[y]-old children with HW history between ages 2-5y.

Methods

This retrospective longitudinal cohort study used data from the electronic medical record at an urban tertiary children's hospital. 2-5-year-olds born between 10/2007-05/2011 were included if they (1) had an outpatient visit with anthropometric data at 2-5y and 8-10y & (2) had HW from ages 2-5y. Predictor variables were sex, race/ethnicity, language, insurance & zip code. Main outcome was body mass index (BMI) percentile (%ile) category at 8-10y, determined by the highest %ile reached: HW (5-84%ile), OW (85-94%ile), mild-moderate OB (95-98%ile), severe OB (≥99%ile). Statistical analyses included descriptive frequencies and multinomial logistic regression.

Results

Of 7043 initially HW patients, 1070 (15%) developed OW and 863 (12%) developed OB by 8-10y. Severe OB risk factors were African-American race (OR 4.66; 2.45-8.67), Hispanic ethnicity (OR 2.99; 1.61-5.55) & public insurance (OR 3.69; 2.19- 6.24). Female sex was protective (OR 0.54; 0.36-0.79).

Conclusion

One-quarter of previously HW young children developed OW/OB by age 8-10y; African-American, Hispanic, male and publicly insured children have the highest risk of developing severe OB. While factors associated with OW/OB in this cohort are familiar, these findings suggest that clinicians should direct specific attention to young HW patients with these risks to prevent excessive BMI increase.

Introduction:

Obesity (OB) is the most common chronic disease of childhood, affecting 18.5% of children and adolescents in the United States and placing them at risk for significant morbidity and mortality throughout the lifespan.[1–4] Early onset of overweight (OW) and OB is a particular public health concern, as young children 2-5 years of age with OW/OB are likely to maintain an elevated body mass index (BMI) throughout childhood and adulthood. For example, Nader et al showed that preschoolers with OW at 24, 36, or 54 months were five times more likely to have OW at 12 years than preschoolers of healthy weight.[5] Gerserik et al found that among children who were obese at 3 years of age, 90% had OW/OB in adolescence.[6] Early obesity is often maintained in adulthood as well.[7,8] Modeling by Ward's group suggested that a 2-year-old with severe obesity had a 75% likelihood of having obesity by age 35 years .[9] Thus, not only is early childhood is a critical developmental window for OB onset, it is also an important predictor for future obesity status.

While it is well established that young children with obesity are at high risk for future OB, little is known about factors that predispose young children of healthy weight to OW/OB later in childhood. Age itself is a known risk factor for OB; in 2015-2016, only 13.9% of children 2-5 years of age had OB, compared to 18.4% of children 6-11 years of age.[1] Early identification and management of obesity risk factors in this young healthy weight population are crucial components of preventing or attenuating future risk of obesity.

The objective of this study was to identify risk factors for the development of OW/OB by age 8-10 years in children who were of healthy weight from age 2-5 years. Understanding populations at risk for developing OB will be an essential first step towards designing targeted prevention efforts.

Methods

Study Design

This was a retrospective cohort study following children with an initially healthy BMI between ages 2-5 years to identify risk factors associated with progression to OW/OB between ages 8-10 years. Data was collected from the electronic medical record (EMR) of an urban tertiary children's hospital's outpatient sites for children born between October 2007 and May 2011. The study population was children who (1) had a persistently healthy body mass index (BMI), defined as BMI between 5-84th percentile (%ile), from ages 2-5 years, and (2) had an outpatient visit at a community-based primary care site and/or a subspecialty clinic at two time points: 2-5 years of age and 8-10 years of age. Anthropometric data from urgent care or convenient care were excluded since the weights recorded during these encounters may be atypical in the setting of an acute illness. Visit data were excluded if anthropometric data were missing. This study was approved by the Institutional Review Board at the Ann & Robert H. Lurie Children's Hospital.

Data Collection

The following variables were collected for each patient visit: medical record number, date of birth, date of visit, clinic code and name, provider, sex, insurance, zip code, preferred language, race, ethnicity, weight, and height. BMI as well as %iles and z-scores for height, weight and BMI were calculated based on the Centers for Disease Control and Prevention (CDC)'s 2000 growth charts using anthropometric calculators from the CDC, British Columbia Children's Hospital, and the Canadian Pediatric Endocrine Group.[10–12] Patients with biologically

implausible weight, height, or BMI z-scores were excluded, defined per the CDC as height-z <-5 or >4, weight-z < -5 or > 8 and BMI-z <-4 or >8.[13]

Outcome Variable

The main outcome measure was the BMI %ile category at 8-10 years, determined by the highest BMI %ile reached during that age range: underweight, healthy weight, overweight (85-94%ile), mild-moderate obesity (95-98%ile), and severe obesity (≥99%ile). BMI of ≥99%ile has previously been identified as a threshold for severe obesity due to increased risk of medical complications.[14] Change in BMI %ile from first visit at age 2-5 years to last visit at age 8-10 years was also calculated.

Predictor Variables

The predictor variables were sex, insurance, zip code, preferred language, and race/ethnicity recorded at the patient's first visit. Zip codes were categorized as Chicago, non-Chicago Cook County, and non-Cook County. If a zip code covered both Chicago and a non-Chicago city, it was coded as Chicago. For race/ethnicity, any patient who marked "declined" for race was coded as unknown, even if they had marked another race category. If Hispanic was selected, the patient was coded as Hispanic, even if other race options were selected as well. Due to low numbers, the other category combined Native Hawaiian / Pacific Islander, American Indian/Alaskan Native, multiracial, and other.

Statistical Analysis

All analyses were conducted in SPSS version 25. We performed multivariable multinomial logistic regression to examine the combined effects of sex, insurance, preferred

language, zip code, and race/ethnicity on BMI %ile category at 8-10 years. The two-tailed significance level was set as 0.05.

Sensitivity Analysis

Several rounds of sensitivity analyses were performed. (1) The BMI outcome category was divided between BMI 95-96 %ile and ≥ 97 %ile, instead of BMI 95-98 %ile and ≥ 99 %ile. (2) We looked at a subset of patients who had BMI persistently less than the 75 %ile from age 2-5 years to see if patients who were not within 10 %ile points of an overweight diagnosis had an attenuated growth pattern later. (3) We examined a subset of children who were exclusively seen in subspecialty clinics, without any primary care visits, to see if there was a unique growth pattern in subspecialty clinic patients.

Results

Study Inclusion

A flow diagram of study inclusion is shown in Figure 1. 13,576 patients born between October 2007 and March 2011 had an outpatient visit to our hospital between ages 2-5 years and/or ages 8-10 years. Of these patients, 5,696 did not have a visit at both time points of interest, and 889 had a BMI outside of the healthy range from the 2-5 year age period. An additional 107 patients were excluded because their height-z, weight-z and/or BMI-z scores were biologically implausible. 17 were excluded because their only data points came from an urgent or convenient care setting. Four patients had a BMI in the 8-10 year range that oscillated between underweight and overweight; they were determined to be wheelchair bound upon chart review, so they were excluded due to inaccurate measurements. The final study population was

7,043 patients who attended 57,336 outpatient visits, 11.1% (6347) of which occurred in a primary care setting.

Sample Characteristics

Demographic characteristics of the patient population are shown in Table 1. 55% were male, 52% Caucasian, 11% African American, 27% Hispanic, 5% Asian, 89% English-speaking, 41% publicly-insured, and 43% urban Chicago residents. Of these initially healthy weight patients, 1070 (15%) developed overweight and 863 (12%) developed obesity by 8-10 years, with 741 (10%) developing mild-moderate obesity and 122 (2%) developing severe obesity. Asian (n = 68) and Hispanic children (n = 343) had the highest incidence of overweight at 18%, compared to 16% among African-American children (n = 128) and 13% of Caucasian children (n = 480). Hispanic children also had the highest incidence of mild-moderate obesity, at 17% (n = 325), compared to 13% (n = 107) among African-American children and 7% (n = 251) among Caucasian children. Among African-American children, 5% (n = 40) developed severe obesity, compared to 3% (n = 52) of Hispanic children and 1% (n = 22) of Caucasian children.

Odds Ratios for Overweight, Mild-Moderate Obesity and Severe Obesity

Table 2 shows multinomial logistic regression results for overweight, mild-moderate obesity and severe obesity at age 8-10 years as a function of sex, language, race/ethnicity, zip code and insurance. Spanish-speaking patients were significantly more likely to develop overweight compared to English-speaking patients (OR 1.33; 95% Confidence Interval 1.04-1.70). Asian race increased risk of developing overweight compared to Caucasian race (OR 1.45; 1.09-1.94). Patients on public insurance were significantly more likely to develop overweight (OR 1.43; 1.20-1.70) by age 8-10 years compared to patients with private insurance.

African-American children were almost twice as likely to develop mild-moderate obesity by age 8-10 than their Caucasian peers (OR 1.70; 1.28 - 2.25), and Hispanic children were over twice as likely (OR 2.17; 1.71 - 2.75) to develop mild-moderate obesity. Children with public insurance had 1.6 times higher odds of developing mild-moderate obesity compared to children with private insurance (OR 1.61; 1.31 - 1.98). Female sex was protective against development of mild-moderate obesity (OR 0.76; 0.65 - 0.89).

African-American children were almost five times as likely to develop severe obesity by age 8-10 than their Caucasian peers (OR 4.66; 2.45 - 8.67), and Hispanic children were nearly three times as likely (OR 2.99; 1.61 - 5.55). Children with public insurance had almost four times higher odds of developing severe obesity compared to children with private insurance (OR 3.69; 2.19 - 6.24). Female sex was protective against development of severe obesity (OR 0.54; 0.36 - 0.79).

Odds Ratios for Increase of ≥25 BMI Percentile Points

Table 3 shows the results of multinomial logistic regression for an increase in BMI %ile of 25 %ile points or more from age 2-5 years to 8-10 years. This indicates that the patient crossed at least one %ile line on the standard CDC growth chart. Females were less likely than males to have an increase in BMI %ile of at least 25 %ile points (OR 0.84; 0.75 - 0.94). African-American children were more likely to cross at least one %ile line compared to their Caucasian peers (OR 1.62; 1.32 - 1.98), as were Asian (OR 1.54; 1.19 – 1.99) and Hispanic children (OR 1.50; 1.26 - 1.78). Public insurance increased risk of gaining at least 25 %ile points compared to children with public insurance (OR 1.26; 1.09 - 1.47). Finally, children who were not from Cook County were less likely to cross at least one %ile line compared to their peers from Chicago (OR 0.83; 0.72 - 0.95).

Sensitivity Analyses

Risk factors for development of obesity with BMI between 95 - 96 %ile were public insurance (OR 1.39; 1.04 – 1.87) and Hispanic ethnicity (OR 1.75; 1.23 – 2.47). Public insurance (OR 2.12; 1.66 – 2.70), African-American race (OR 2.64; 1.93 – 3.62) and Hispanic ethnicity (OR 2.65; 1.99 – 3.52) all increased risk of developing obesity with BMI ≥ 97 %, while female sex was protective (OR 0.63; 0.53 – 0.77).

Sensitivity analysis on a subset of patients (n =4359) who had BMI persistently less than the 75 %ile from age 2-5 years showed that 454 (10%) developed overweight, 271 (6%) developed mild-moderate obesity, and 38 (1%) developed severe obesity (results not shown). Risk factors for overweight in this cohort were Hispanic ethnicity (OR 1.65; 1.21-2.24) and Asian race (OR 1.79; 1.20 - 2.66), while female sex was protective (OR 0.67; 0.55 - 0.82) (Table 4). Risk factors for development of obesity with BMI between 95 - 96 %ile were Hispanic ethnicity (OR 2.02; 1.17 - 3.51) and public insurance (OR 1.73; 1.08 - 2.78), and female sex was protective (OR 0.64; 0.43 - 0.94). For obesity with BMI ≥ 97 %ile, risk factors were African-American race (OR 2.77; 1.66 - 4.61), Hispanic ethnicity (OR 3.37; 2.15 - 5.27) and public insurance (OR 1.78; 1.22 - 2.61).

Finally, we analyzed a subset of children who were exclusively seen in subspecialty clinics, without a single primary care visit (n = 6370). The results showed the same risk factors for OW/OB as the whole cohort. Risk factors for development of overweight included public insurance (OR 1.44; 1.20 - 1.73), Asian (OR 1.51; 1.12 - 2.04), and Spanish speaking (OR 1.38; 1.06 - 1.81), while female sex was protective (OR 0.86; 0.74 - 0.99). Increased risk of obesity was associated with public insurance (OR 1.81; 1.48 - 2.23), African American (OR 1.84; 1.37 - 2.47), Hispanic (OR 2.13; 1.67 - 2.71). Female sex was again protective (OR 0.70; 0.59 - 0.82).

Discussion

In this large urban, community-based clinic cohort, over one-quarter of previously healthy weight toddlers and preschool-age children developed OW/OB by age 8-10 years. Concerningly, strong racial, ethnic, socioeconomic, and sex disparities existed in the development of OB, in particular with African-American children who were almost five times as likely to go from healthy weight to having severe OB in just a 3-8 year span.

While the demographic factors associated with incidence of childhood OW/OB in this cohort are familiar, this study is novel in its focus on the incidence of OW/OB among toddlers and preschool-aged children with previously healthy weight. Most other studies in young children have focused on BMI persistence in young children who have already developed OW/OB.

Differential BMI outcomes rooted at least partially in race/ethnic, sex, and socioeconomic disparities are established in the first decade of life even in children with history of healthy weight during their early years. We found that among children with HW at age 2-5 years, African-American, Hispanic and Asian children, males, and those with public insurance were significantly more likely to have an increase of at least 25 %ile points in their BMI by age 8-10 years, regardless of whether they developed OW/OB. Though these children would still be classified under the HW category, this rapid gain in BMI %ile points is still an abnormal and concerning growth pattern. Isong and colleagues identified disparate growth trajectories in racial/ethnic minority children in the first five years of life. Notably, they found that Hispanic boys and American-Indian boys had significantly higher BMIs than their white peers by 24 months, and persistently higher BMIs through the kindergarten years.[15] They also found that African-American and Asian children have lower birth weights than white children, but African

American girls have steeper growth trajectories than Asian girls, leading to higher BMIs than their white and Asian peers by kindergarten. These disparate growth trajectories support the findings of our study by highlighting children who are at risk for continued excess BMI gain later in childhood because of disparate growth trajectories, even if they remain HW in early life.

Our findings suggest that HW children in high risk demographic groups, namely African-American, Hispanic, Asian, male, or publicly insured, should receive particular focus for counseling on behavioral risk factors to reduce risk of future OB. While development of childhood obesity is multifactorial, based on both modifiable and nonmodifiable factors, physicians can focus on addressing modifiable behavioral risk factors among high-risk children, such as dietary factors, physical activity and sedentary behaviors.[16,17] Early identification and management of these behavioral risk factors could attenuate the risk of future excess BMI among HW children. These children are at high risk for developing not just OB, but severe OB, and prevention efforts should be started as soon as possible, even when they have HW. Primary care interventions for children with OW/OB tend to result in BMI maintenance rather than a return to healthy BMI,[18] which highlights the importance of primary OB prevention rather than attempting to reduce BMI after children have already developed OB.

Additionally, Spanish speaking children in our cohort were more likely to develop OW than their Caucasian peers, though Hispanic ethnicity was not significantly associated with increased risk of OW. Spanish language preference has been associated with OB.[19] Among Hispanic children, those from Central and South America who spoke Spanish at home have been shown to be almost three times more likely to have OB than their Hispanic peers who speak English at home.[20] One study of Hispanic children with OW found that when Spanish-speaking families are seen by a non-Spanish speaking provider, growth charts were used less frequently,

an interpreter was used only in 25% of the visits, and weight management plans were not culturally sensitive.[21] Our study adds to these findings by furthering evidence that Spanish language preference independently increases the risk of developing excess BMI, possibly due to cultural influences more prevalent in Spanish-speaking households than other Hispanic families or the effects of language barriers in clinical settings. Special focus should be given to reduce language barriers and provide culturally sensitive counseling for Spanish-speaking patients in effort to reduce their risk of future excess BMI.

One surprising finding in our study was that Asian children had a higher risk of developing OW than Caucasian children and were more likely to experience an increase of ≥25 BMI %ile points. Numerous studies have found that rates of OW/OB tend to be lower in Asian children in the United States compared to Hispanic and African-American children, and lower or comparable to the prevalence of obesity among Caucasian children.[1,22] However, certain Asian sub-groups have been found to have higher risk of OW/OB compared to other Asian peers, including South Asian children and Vietnamese-American children.[23–25] Our data did not enable us to differentiate between Asian sub-groups, but it is possible that our cohort could have been composed of some higher risk Asian sub-groups, leading to the higher risk of OW seen here.

Our study had several limitations. Our cohort was based on outpatient visits to a single tertiary care center in an urban setting, and patients visiting our center likely have greater medical complexity than the general healthy pediatric population, so our findings may not be generalizable to other settings. Additionally, we could not control for medical status or complexity when analyzing the data, so it is possible that some patients increased BMI due to weight-altering conditions or medications, though this would have minimal effect on our data

since primary weight gain is by far the most common reason for excessive weight gain in this age group.

The most significant strength of our study is the large sample size of over 7,000 patients, which was also ethnically diverse with 48% racial/ethnic minority patients. Additionally, we performed several sensitivity analyses that supported the robustness of our findings. Our findings were replicable even among children who had a BMI persistently less than the 75th percentile from 2-5 years. This suggests that our findings were not simply due to healthy weight children in our cohort with a BMI near the overweight threshold developing OW/OB during our follow-up period. Instead, our findings suggest a rapid increase in BMI among these children during the follow-up period. Results from analysis of children who had exclusively been seen at subspecialty clinics also showed the same associations as analysis of the entire cohort, demonstrating robustness across subgroups of patients.

Our study highlights the importance of identifying patients in demographic groups at increased risk of future obesity, even if they are of HW. Special attention and counseling about obesity prevention should be directed towards young HW Hispanic, African-American, male and low-income preschool and toddler aged children since they are at risk of developing severe obesity in the short term. Behavioral and nutritional risk factors should be addressed early and often in order to attenuate the risk of future development of excess BMI.

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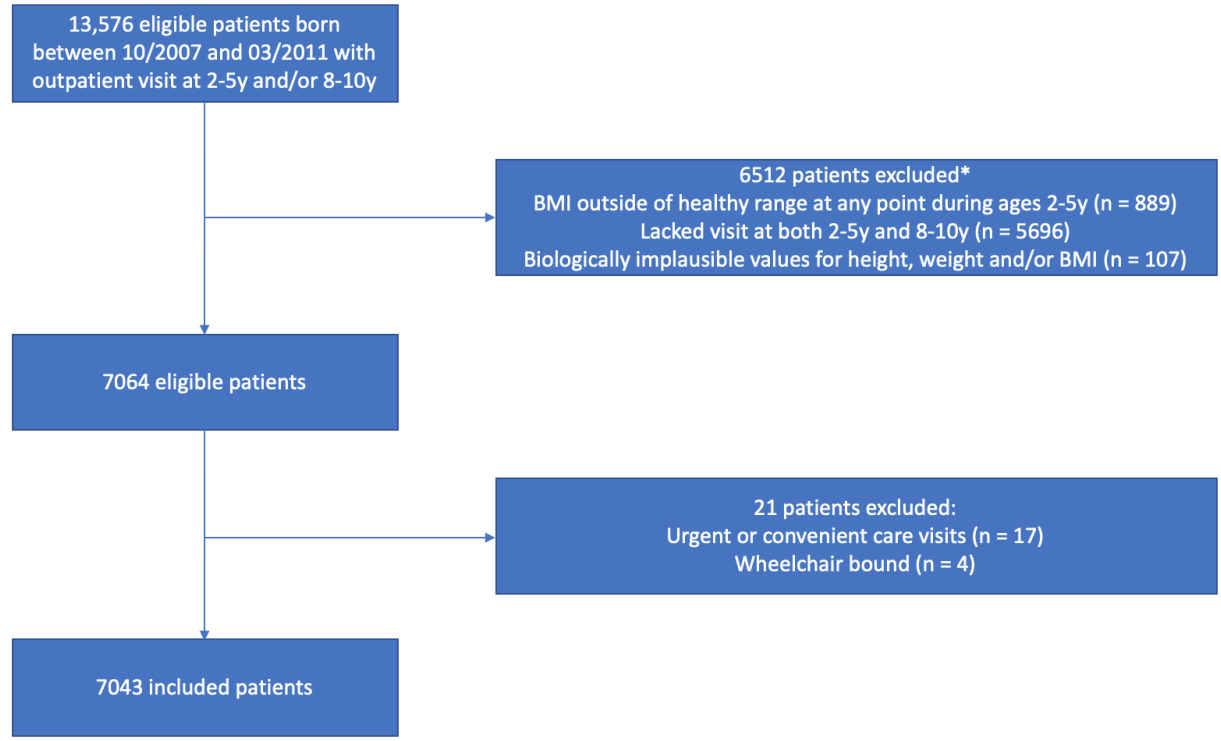
Figure 1: Flow Diagram for Subject Selection



*Sum of patients excluded for each category is greater than total number of patients excluded because some patients met multiple exclusion criteria

Table 1: Demographic Characteristics of Study Participants and BMI Category at Age 8-10 years

				Underweight		Healthy Weight		Overweight		Mild-Moderate Obesity (95th - 98th BMI percentile)		Severe Obesity (≥ 99th BMI percentile)	
		Total Study Population (N = 7043)	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Sex	Male	3380	55.1%	190	4.9%	2561	66.0%	605	15.6%	442	11.4%	82	2.1%
	Female	3163	44.9%	151	4.8%	2208	69.8%	465	14.7%	299	9.5%	40	1.3%
Race/Ethnicity	Caucasian	3644	51.7%	191	5.2%	2700	74.1%	480	13.2%	251	6.9%	22	0.6%
	African-American	806	11.4%	31	3.8%	500	62.0%	128	15.9%	107	13.3%	40	5.0%
	Hispanic	1908	27.1%	72	3.8%	1116	58.5%	343	18.0%	325	17.0%	52	2.7%
	Asian	377	5.4%	30	8.0%	252	66.8%	68	18.0%	25	6.6%	2	0.5%
	Other	280	4.0%	15	5.4%	184	65.7%	47	16.8%	28	10.0%	6	2.1%
	Unknown	28	0.4%	2	7.1%	17	60.7%	4	14.3%	5	17.9%	0	0.0%
Insurance	Public	2865	40.7%	118	4.1%	1702	59.4%	516	18.0%	433	15.1%	96	3.4%
	Private	4163	59.1%	223	5.4%	3057	73.4%	551	13.2%	306	7.4%	26	0.6%
	Other/Self-Pay	15	0.2%	0	0.0%	10	66.7%	3	20.0%	2	13.3%	0	0.0%
Language	English	6242	88.6%	309	5.0%	4323	69.3%	909	14.6%	596	9.5%	105	1.7%
	Spanish	717	10.2%	28	3.9%	388	54.1%	150	20.9%	134	18.7%	17	2.4%
	Other	84	1.2%	4	4.8%	58	69.0%	11	13.1%	11	13.1%	0	0.0%
Zip Code	Chicago	3037	43.1%	135	4.4%	1952	64.3%	497	16.4%	384	12.6%	69	2.3%
	Non-Chicago Cook County	1428	20.3%	61	4.3%	1008	70.6%	215	15.1%	125	8.8%	19	1.3%
	Other	2578	36.6%	145	5.6%	1809	70.2%	358	13.9%	232	9.0%	34	1.3%

Table 2: Logistic Regression Model for Overweight and Obesity as a Function of Sex, Race/Ethnicity, Insurance, Language, Zip Code

	Overweight (85th - 94th BMI percentile)			Mild-Moderate Obesity (95th - 98th BMI percentile)			Severe Obesity (≥ 99th BMI percentile)		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Sex									
Male	-	-	-	-	-	-	-	-	-
Female	0.87	0.76 - 1.00	0.05	0.76	0.65 - 0.89	0.00	0.54	0.36 - 0.79	0.00
Race/Ethnicity									
Caucasian	-	-	-	-	-	-	-	-	-
African-American	1.14	0.89 - 1.46	0.30	1.70	1.28 - 2.25	0.00	4.66	2.45 - 8.67	0.00
Hispanic	1.22	0.98 - 1.51	0.07	2.17	1.71 - 2.75	0.00	2.99	1.61 - 5.55	0.00
Asian	1.45	1.09 - 1.94	0.01	0.95	0.61 - 1.48	0.83	0.84	0.20 - 3.64	0.82
Other	1.31	0.93 - 1.84	0.12	1.4	0.91 - 2. 14	0.12	2.99	1.17 - 7.62	0.02
Unknown	1.33	0.45 - 3.98	0.61	3.19	1.17 - 8.74	0.02	0.00	0.00 - 0.00	N/A
Insurance									
Private	-	-	-	-	-	-	-	-	-
Public	1.43	1.20 - 1.70	0.00	1.61	1.31 - 1.98	0.00	3.69	2.19 - 6.24	0.00
Other/Self-Pay	1.62	0.44 - 5.95	0.47	1.68	0.36 - 7.78	0.51	0.00	0.00 - 0.00	N/A
Language									
English	-	-	-	-	-	-	-	-	-
Spanish	1.33	1.04 - 1.70	0.03	1.18	0.91 - 1.52	0.21	0.72	0.40 - 1.30	0.27
Other	0.66	0.34 - 1.28	0.22	1.26	0.64 - 2.47	0.51	0.00	0.00 – N/A	1.00
Zip Code									
Chicago	-	-	-	-	-	-	-	-	-
Non-Chicago Cook County	1.01	0.84 - 1.21	0.93	0.93	0.74 - 1.16	0.5	1.06	0.62 - 1.80	0.84
Non-Cook County	0.94	0.80 - 1.10	0.44	0.97	0.81 - 1.18	0.77	1.12	0.71 - 1.74	0.63

Table 3: Logistic regression model for increase in BMI percentile by at least 25 percentile points as a function of Sex, Race/Ethnicity, Insurance, Language, Zip Code

	Increase in BMI percentile by ≥ 25 percentile points		
	OR	**95% CI**	**p-value**
Sex			
Male	-	-	-
Female	0.84	0.75 - 0.94	0.00
Race/Ethnicity			
Caucasian	-	-	-
African-American	1.62	1.32 - 1.98	0.00
Hispanic	1.50	1.26 - 1.78	0.00
Asian	1.54	1.19 - 1.99	0.00
Other	1.24	0.92 - 1.67	0.15
Unknown	1.00	0.37- 2.71	1.00
Insurance			
Private	-	-	-
Public	1.26	1.09 - 1.47	0.00
Other/Self-Pay	1.64	0.48 - 5.63	0.44
Language			
English	-	-	-
Spanish	0.95	0.77 - 1.17	0.63
Other	1.15	0.69 - 1.93	0.59
Zip Code			
Chicago	-	-	-
Non-Chicago Cook County	0.91	0.78 - 1.07	0.25
Non-Cook County	0.83	0.72 - 0.95	0.01

Table 4: Sensitivity Analysis for Overweight and Obesity at age 8-10 years among Children with BMI persistently < 75th percentile at age 2-5 years

	Overweight (BMI percentile 85 - 94)			Obesity (BMI percentile 95 - 96)			Obesity (BMI percentile ≥ 97)		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Sex									
Male	-	-	-	-	-	-	-	-	-
Female	0.67	0.55 - 0.82	0.00	0.64	0.43 - 0.94	0.02	0.58	0.43 - 0.79	0.00
Race/Ethnicity									
Caucasian	-	-	-	-	-	-	-	-	-
African-American	1.28	0.89 - 1.86	0.19	1.21	0.61 - 2.41	0.59	2.77	1.66 - 4.61	0.00
Hispanic	1.65	1.21 - 2.24	0.00	2.02	1.17 - 3.51	0.01	3.37	2.15- 5.27	0.00
Asian	1.79	1.20 - 2.66	0.00	0.77	0.27 - 2.21	0.63	1.08	0.45 - 2.57	0.87
Other	1.37	0.82 - 2.27	0.23	1.43	0.55 - 3.71	0.46	1.53	0.64 - 3.66	0.34
Unknown	1.68	0.37 - 7.67	0.5	3.83	0.48 - 30.49	0.21	3.20	0.40 - 25.44	0.27
Insurance									
Private	-	-	-	-	-	-	-	-	-
Public	1.21	0.94 - 1.56	0.15	1.73	1.08 - 2.78	0.02	1.78	1.22 - 2.61	0.00
Other/Self-Pay	0.00	0.00 – N/A	1.00	0.00	0.00 - 0.00	N/A	4.28	0.49 - 37.40	0.19
Language									
English	-	-	-	-	-	-	-	-	-
Spanish	1.22	0.84 - 1.75	0.30	0.89	0.47 - 1.67	0.71	1.07	0.68 - 1.68	0.77
Other	0.83	0.32 - 2.18	0.71	1.50	0.34 - 6.67	0.59	0.97	0.22 - 4.24	0.97
Zip Code									
Chicago	-	-	-	-	-	-	-	-	-
Non-Chicago Cook County	0.97	0.74 - 1.29	0.85	1.28	0.78 - 2.11	0.32	1.02	0.66 - 1.58	0.92
Non-Cook County	1.02	0.81 - 1.30	0.85	0.93	0.58 - 1.48	0.75	1.26	0.89 - 1.79	0.19

References

1. Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of Obesity Among Adults and Youth: United States, 2015-2016. *NCHS Data Brief*. 2017;(288):1-8.

2. Kumar S, Kelly AS. Review of Childhood Obesity: From Epidemiology, Etiology, and Comorbidities to Clinical Assessment and Treatment. *Mayo Clin Proc*. 2017;92(2):251-265.

3. Juonala M, Magnussen CG, Berenson GS, et al. Childhood adiposity, adult adiposity, and cardiovascular risk factors. *N Engl J Med*. 2011;365(20):1876-1885.

4. Daniels SR. Complications of obesity in children and adolescents. *Int J Obes* . 2009;33 Suppl 1:S60-S65.

5. Nader PR, O'Brien M, Houts R, et al. Identifying risk for obesity in early childhood. *Pediatrics*. 2006;118(3):e594-e601.

6. Geserick M, Vogel M, Gausche R, et al. Acceleration of BMI in Early Childhood and Risk of Sustained Obesity. *N Engl J Med*. 2018;379(14):1303-1312.

7. Guo SS, Wu W, Chumlea WC, Roche AF. Predicting overweight and obesity in adulthood from body mass index values in childhood and adolescence. *Am J Clin Nutr*. 2002;76(3):653-658.

8. Gordon-Larsen P, Adair LS, Nelson MC, Popkin BM. Five-year obesity incidence in the transition period between adolescence and adulthood: the National Longitudinal Study of Adolescent Health. *Am J Clin Nutr*. 2004;80(3):569-575.

9. Ward ZJ, Long MW, Resch SC, Giles CM, Cradock AL, Gortmaker SL. Simulation of Growth Trajectories of Childhood Obesity into Adulthood. *N Engl J Med*. 2017;377(22):2145-2153.

10. Centers for Disease Control and Prevention. *BMI Percentile Calculator for Child and Teen*.; 2019. https://www.cdc.gov/healthyweight/bmi/calculator.html.

11. British Columbia Children's Hospital. *Anthropometric Calculator for Normal Children 0–20 Years of Age*.

12. Canadian Pediatric Endocrine Group. *CDC Anthropometric Z-Scores 0-20y*. https://apps.cpeg-gcep.net/quickZ_CDC/.

13. Freedman DS, Lawman HG, Skinner AC, McGuire LC, Allison DB, Ogden CL. Validity of the WHO cutoffs for biologically implausible values of weight, height, and BMI in children and adolescents in NHANES from 1999 through 2012. *Am J Clin Nutr*. 2015;102(5):1000-1006.

14. Barlow SE, Expert Committee. Expert committee recommendations regarding the

prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*. 2007;120 Suppl 4:S164-S192.

15. Isong IA, Richmond T, Avendaño M, Kawachi I. Racial/Ethnic Disparities: a Longitudinal Study of Growth Trajectories Among US Kindergarten Children. *J Racial Ethn Health Disparities*. 2018;5(4):875-884.

16. Chi DL, Luu M, Chu F. A scoping review of epidemiologic risk factors for pediatric obesity: Implications for future childhood obesity and dental caries prevention research. *J Public Health Dent*. 2017;77 Suppl 1:S8-S31.

17. O'Brien M, Nader PR, Houts RM, et al. The ecology of childhood overweight: a 12-year longitudinal analysis. *Int J Obes* . 2007;31(9):1469-1478.

18. Sim LA, Lebow J, Wang Z, Koball A, Murad MH. Brief Primary Care Obesity Interventions: A Meta-analysis. *Pediatrics*. 2016;138(4). doi:10.1542/peds.2016-0149

19. Messiah SE, Asfour L, Arheart KL, Selem SM, Uhlhorn SB, Natale R. Relationship between parent demographic characteristics, perinatal and early childhood behaviors, and body mass index among preschool-age children. *J Immigr Minor Health*. 2015;17(2):414-421.

20. Wojcicki JM, Schwartz N, Jiménez-Cruz A, Bacardi-Gascon M, Heyman MB. Acculturation, dietary practices and risk for childhood obesity in an ethnically heterogeneous population of Latino school children in the San Francisco bay area. *J Immigr Minor Health*. 2012;14(4):533-539.

21. Turer CB, Montaño S, Lin H, Hoang K, Flores G. Pediatricians' communication about weight with overweight Latino children and their parents. *Pediatrics*. 2014;134(5):892-899.

22. Skinner AC, Ravanbakht SN, Skelton JA, Perrin EM, Armstrong SC. Prevalence of Obesity and Severe Obesity in US Children, 1999-2016. *Pediatrics*. 2018;141(3). doi:10.1542/peds.2017-3459

23. Banerjee AT, Flora PK, Stone M, Faulkner G. Differences in the Prevalence of Overweight Between 10-12-Year-old South Asian and Non-South Asian Children in Toronto, Ontario: Findings from Project BEAT. *J Racial Ethn Health Disparities*. 2015;2(2):184-191.

24. Hudda MT, Nightingale CM, Donin AS, et al. Patterns of childhood body mass index (BMI), overweight and obesity in South Asian and black participants in the English National child measurement programme: Effect of applying BMI adjustments standardizing for ethnic differences in BMI-body fatness associations. *Int J Obes* . November 2017. doi:10.1038/ijo.2017.272

25. Jain A, Mitchell S, Chirumamilla R, et al. Prevalence of obesity among young Asian-American children. *Child Obes*. 2012;8(6):518-525.