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Racial differences in crossing major growth percentiles in infancy

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Abstract

Background/aims—We examined associations of ever crossing upwards ≥2 (vs <2) major weight-for-length (WFL) percentiles in the first 24 months with obesity at 5 years among white and black children.

Methods—We included 10 979 white and 1245 black children from the Linked CENTURY Study with percentile crossing data in all four 6-month periods in the first 24 months and obesity (age-specific and sex-specific body mass index ≥95th percentile) at 5 years. We used adjusted logistic regression models and stratified by race.

Results—64% of children crossed upwards ≥2 major WFL percentiles in the first 2 years. Among white children, 12% were obese vs 7% for <2 crossings, while among black children the frequencies were 23% vs 9%. Black children (adjusted OR 2.94, 2.04 to 4.23) who had ever crossed upwards ≥2 major WFL percentiles had a higher odds of obesity at age 5 than white children (adjusted OR 1.89, 1.64 to 2.18) (interaction p=0.02).

Conclusions—Our results suggest that rapid weight gain in infancy is more deleterious among black than white children for later obesity.

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Contributors SSH conceptualised and designed the study, participated in data collection and interpretation of the results, drafted the initial manuscript. SRL-S participated in data collection, analysis and interpretation, critically reviewed and revised the manuscript. MWG participated in data interpretation, critically reviewed and revised the manuscript. EMT conceptualised and designed the study, participated in data interpretation, critically reviewed and revised the manuscript. All authors approved the final manuscript. SRL-S had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Competing interests None declared.

Ethics approval The Institutional Review Boards at Boston College and Harvard Pilgrim Health Care reviewed this study and considered it exempt.

Data sharing statement No data from the Linked Collecting Electronic Nutrition Trajectory Data Using e-Records of Youth Study are publicly available.

INTRODUCTION

Rapid weight gain during infancy and early childhood appears to raise the risk for later obesity. Woo Baidal *et al* recently found that 45/46 studies reported an association between higher infancy weight or weight gain during the first 1000 days of life and overweight (including obesity) in children aged <18 years.[1] While the definition of weight gain varied across studies, relationships were consistent regardless of the type of measurement and growth chart used.

Until recently, clinicians in the USA routinely used the Centers for Disease Control and Prevention (CDC) growth charts to monitor young children's growth during well-child visits by collecting repeated measurements of weight and length or height. The CDC growth charts include major percentile lines indicating the 5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles for age and sex.[2] Taveras *et al* found that upward crossing of ≥2 (vs <2) major weight-for-length (WFL) percentiles in the first 24 months of life was associated with obesity at ages 5 and 10 years.[3] Among the four 6-month intervals in those first 24 months, upward crossing of ≥2 major WFL percentiles during the first 6 months was associated with the highest prevalence of later obesity.

While black (11.3%) and Hispanic (16.7%) children aged 2–5 years are more likely to be obese than white (3.5%) children,[4] little is known of how the association between rapid weight gain and later obesity may differ by race/ethnicity, a variable often poorly measured in clinical databases. We used the Linked Collecting Electronic Nutrition Trajectory Data Using e-Records of Youth (CENTURY) Study, created by linkage of clinical and public health data sources, to examine associations of ever crossing upwards ≥2 (vs <2) major WFL percentiles in the first 24 months of life with obesity at age 5 years among white and black children.

METHODS

The Linked CENTURY Study is a longitudinal clinical database of well-child visits for 200 343 singleton children through age 18 years linked to each child's Massachusetts birth certificate (74.2% of participants in the original CENTURY Study were linked).[5] While the original CENTURY Study contained children's clinical growth data, race/ethnicity was missing for 36% of participants, and linkage with birth certificates provided most of those missing data. From each birth certificate we extracted data on maternal race, self-reported in the categories white, black, Asian/Pacific Islander, American Indian and other, which was available for 98.7% of the participants.[5] For this analysis, we restricted the study population to white and black participants. We also obtained birth weight, marital status and maternal education from the birth certificate.

Medical assistants measured length or height and weight according to the written protocol of the department of paediatrics at Harvard Vanguard Medical Associates (currently Atrius Health). More details on the measurements are available else-where.[5] We used height and weight measurements to calculate age-specific and sex-specific WFL percentiles for children <24.0 months and body mass index (BMI) percentiles for children aged 2–18 years based on

the CDC growth charts from 2000.[2] The main exposure was ever crossing upwards ≥2 major WFL percentiles (ie, rise in BMI) during any of the four 6-month intervals (±30 days) in the first 24 months of life (1–6, 6–12, 12–18, 18–24). We used the CDC's predefined major percentile lines (5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles).

In a validation study among 160 children aged 0 through 23 months conducted at one of the participating health centres, the usual clinical paper-and-pencil method systematically overestimated children's length compared with a reference method using a recumbent length measuring board.[6] This bias did not depend meaningfully on the age or sex of the child. Thus, we used a regression correction factor to adjust for this systematic overestimation: ((0.953×length measured by paper-and-pencil method)+1.8 cm).[6] The main outcome was obesity at age 5 years defined as a BMI ≥95th percentile for age and sex.[2]

We included 12 224 children, including 10 979 white and 1245 black children, who had data on percentile crossing in all four 6-month periods in the first 24 months of life and BMI data at age 5 years (mean (SD) was 5.25 years (0.33); range=5.00–5.99 years). We used logistic regression models to examine the association of ever crossing upwards ≥2 (vs <2) major WFL percentiles during any of the four intervals in the first 24 months of life with obesity at age 5 years. We adjusted all models for sex, age, birth weight, marital status, maternal education and 5-year time period at outcome, and stratified by race. We conducted all analyses using SAS V.9.3.

RESULTS

Table 1 shows that 6974 (64%) white children and 797 (64%) black children crossed upwards ≥2 major WFL percentiles in the first 2 years. Among white children, 837 (12%) of them were obese compared with 277 (7%) for those who crossed <2 major WFL percentiles. Among black children, 186 (23%) were obese who crossed ≥2 major WFL percentiles compared with 42 (9%) who crossed <2. Black children (adjusted OR 2.94, 95% CI 2.04 to 4.23) who had ever crossed upwards ≥2 major WFL percentiles (vs <2) had a higher odds of obesity at age 5 than white children (adjusted OR 1.89, 1.64 to 2.18). A significant interaction (p=0.02) indicated that the association varied by children's race/ethnicity, such that black children had a stronger association between crossed upwards ≥2 major WFL percentiles (vs <2) and obesity at age 5 than white children.

Figure 1 illustrates the prevalence of obesity at age 5 associated with crossing upwards ≥2 major WFL percentiles during each of the four 6-month periods in the first 24 months, according to the category of starting WFL percentile at the start of each interval. For white children, crossing upwards ≥2 major WFL percentiles in the first 6 months was associated with the highest prevalence of obesity at age 5 years, except for those who started at the 75 to <90th percentile. For black children, crossing upwards ≥2 major WFL percentiles in the first 6 months was associated with the highest prevalence of obesity at age 5 years only for those who started at the <25th percentile.

DISCUSSION

We found that rapid weight gain in infancy conferred a higher odds of obesity at age 5 among black than white children. Our findings expand on those of Taveras *et al*, who reported that crossed upwards ≥2 major WFL percentiles increased obesity at ages 5 and 10 years, but these authors could not explore racial/ethnic differences due to missing information.[3] We also found increasing trends of obesity across 5-year time periods, consistent with the existing literature.

We created the Linked CENTURY Study by linking each child's clinical record and birth certificate.[5] Information from the birth certificate can help enhance clinical databases by filling in missing child race/ethnicity information and capturing information not routinely collected, such as maternal education.[5] Despite near-complete race/ethnicity data in our analyses, we were able to include only white and black children because sample sizes for other racial/ethnic groups were too small. While the birth certificate captures the mother's race/ethnicity and not the child's, in our dataset there was a 91% agreement between mothers' and children's race/ethnicity.

Our study highlights the advantages of linking clinical and population-based databases to identify racial differences in risk factors for obesity. Since clinicians routinely use growth charts to monitor children's growth during well-child visits, our findings provide further support[3] that counting the number of major percentiles a child crosses may have clinical utility for identifying those at higher risk for later obesity.[4] Further research to ascertain the underlying causes of rapid weight gain during infancy,[1] and the extent to which those causes also differ by race/ethnicity (ie, infant feeding or sleep patterns), is critical for the development of evidence-based policies and programmes to address the obesity epidemic in the USA.

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What is already known on this topic?

- Taveras *et al*[3] found that upward crossing of ≥2 (vs <2) major weight-for-length percentiles in the first 24 months was associated with later obesity.
- There is little known of how the association between rapid weight gain and later obesity may differ by race/ethnicity.

What this study adds?

Rapid weight gain in infancy conferred a higher odds of obesity at age 5 among black than white children.

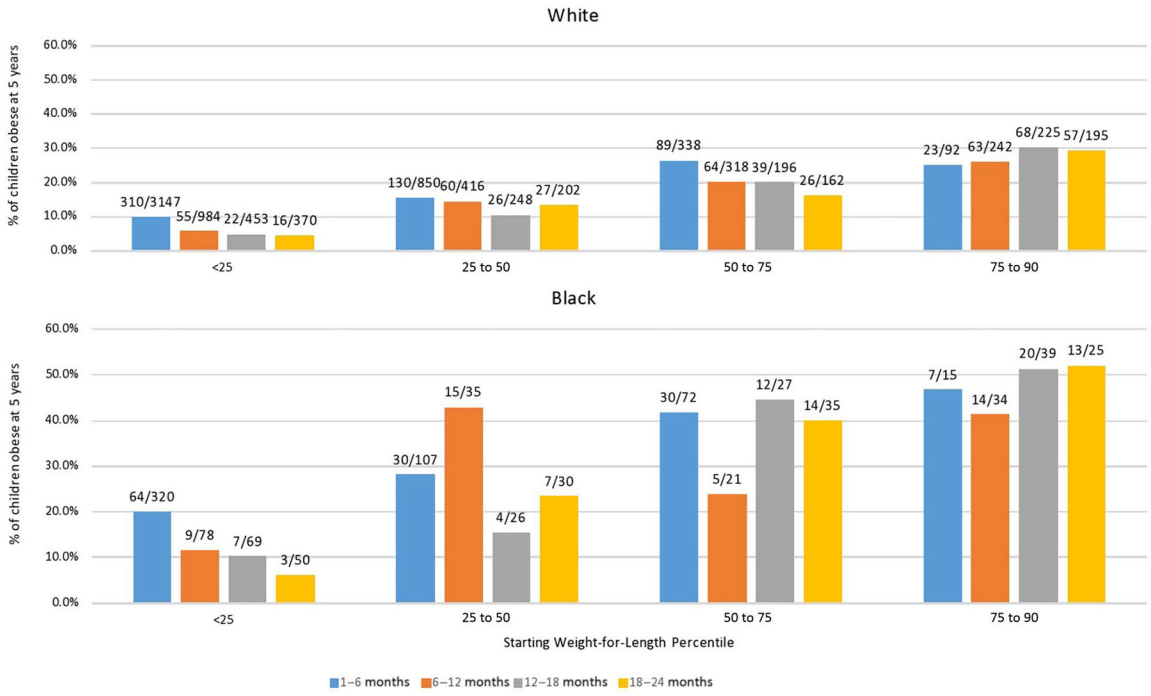

Figure 1.

Prevalence of obesity (defined as body mass index ≥95th percentile) at age 5 years among white and black children associated with crossing upwards 2 or more major weight-for-length percentile lines (Centers for Disease Control and Prevention 2000 growth charts) during each of four 6-month age intervals in the first 24 months of life, according to the category of starting weight-for-length percentile at the start of each interval. The denominators are the number of participants who crossed ≥2 major percentiles during the 6-month age interval. The numerators are the number of participants who were obese at 5 years among those who crossed ≥2 major percentiles. Children whose starting weight-for-length percentile was ≥90th were excluded because they could not cross upwards 2 major percentile lines.

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Table 1

Characteristics and adjusted odds of obesity at age 5 years among white and black children who had ever crossed upwards ≥2 vs <2 major weight-for-length percentiles in the first 24 months of life (N=12 224)

	White (N=10 979)			Black (N=1245)		
Characteristic	**N (column %)**	**N (row %) with obesity**	**OR (95% CI)**	**N (column %)**	**N (row %) with obesity**	**OR (95% CI)**
Number of major weight-for-length percentile crossings in the first 24 months						
<2 major weight-for-length percentiles	4 005 (36.5)	277 (6.9)	1.0	448 (36.0)	42 (9.4)	1.0
≥2 major weight-for-length percentiles	6 974 (63.5)	837 (12.0)	1.89 (1.64 to 2.18)	797 (64.0)	186 (23.3)	2.94 (2.04 to 4.23)
Sex						
Male	5 662 (51.6)	603 (10.7)	1.0	611 (49.1)	107 (17.5)	1.0
Female	5 317 (48.4)	511 (9.6)	0.99 (0.88 to 1.13)	634 (50.9)	121 (19.1)	1.31 (0.96 to 1.77)
5-Year time period at 5-year visit						
1985 to <1990	499 (4.5)	24 (4.8)	0.43 (0.28 to 0.66)	32 (2.6)	8 (25.0)	1.21 (0.50 to 2.94)
1990 to <1995	1940 (17.7)	129 (6.7)	0.56 (0.45 to 0.70)	138 (11.1)	18 (13.0)	0.43 (0.23 to 0.78)
1995 to <2000	2769 (25.2)	259 (9.4)	0.83 (0.69 to 0.99)	346 (27.8)	55 (15.9)	0.65 (0.44 to 0.97)
2000 to <2005	3184 (29.0)	397 (12.5)	1.08 (0.92 to 1.27)	365 (29.3)	62 (17.0)	0.68 (0.47 to 1.00)
2005 to 2008	2587 (23.6)	305 (11.8)	1.0	364 (29.2)	85 (23.4)	1.0
Marital status						
Married	10 409 (94.8)	1031 (9.9)	0.76 (0.59 to 0.97)	769 (61.8)	149 (19.4)	1.14 (0.83 to 1.58)
Not married	568 (5.2)	83 (14.6)	1.0	476 (38.2)	79 (16.6)	1.0
Maternal education						
≤12 years	2050 (18.7)	262 (12.8)	1.0	387 (31.3)	67 (17.3)	1.0
13–15 years	6098 (55.6)	628 (10.3)	0.82 (0.70 to 0.96)	703 (56.8)	134 (19.1)	1.06 (0.75 to 1.48)
16+ years	2814 (25.7)	222 (7.9)	0.67 (0.55 to 0.81)	147 (11.9)	23 (15.7)	0.76 (0.44 to 1.31)
	Mean (SD)			Mean (SD)		
Birth weight, kg	3.53 (0.50)	1114 (10.2)	1.71 (1.50 to 1.95)	3.32 (0.52)	228 (18.3)	2.04 (1.51 to 2.76)
Age at outcome, months	63.0 (4.0)	1114 (10.2)	1.00 (0.99 to 1.02)	63.4 (3.7)	228 (18.3)	0.99 (0.95 to 1.03)