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High Body Mass Index in Infancy May Predict Severe Obesity in Early Childhood

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Abstract

Objective—To characterize growth trajectories of children who develop severe obesity by age 6 years and identify clinical thresholds for detection of high-risk children before the onset of obesity.

Study design—Two lean (body mass index [BMI] 5th to 75th percentile) and 2 severely obese (BMI 99th percentile) groups were selected from populations treated at pediatric referral and primary care clinics. A population-based cohort was used to validate the utility of identified risk thresholds. Repeated-measures mixed modeling and logistic regression were used for analysis.

Results—A total of 783 participants of normal weight and 480 participants with severe obesity were included in the initial study. BMI differed significantly between the severely obese and normal-weight cohorts by age 4 months ($P < .001$), at 1 year before the median age at onset of obesity. A cutoff of the World Health Organization (WHO) 85th percentile for BMI at 6, 12, and 18 months was a strong predictor of severe obesity by age 6 years (sensitivity, 51%–95%; specificity, 95%). This BMI threshold was validated in a second independent cohort ($n = 2649$), with a sensitivity of 33%–77% and a specificity of 74%–87%. A BMI 85th percentile in infancy increases the risk of severe obesity by age 6 years by 2.5-fold and the risk of clinical obesity by age 6 years by 3-fold.

Conclusions—BMI trajectories in children who develop severe obesity by age 6 years differ from those in children who remain at normal weight by age 4–6 months, before the onset of obesity. Infants with a WHO BMI 85th percentile are at increased risk for developing severe obesity by age 6 years.

Pediatric obesity is a major health concern in the US, even for young children. Once obesity is established, it is often persistent,^{1,2} and increases the likelihood of lifelong health issues. Children who were overweight by kindergarten have been found to have a 4-fold greater risk of progressing to obesity by adolescence.³ In the Bogalusa Heart Study, in all children with a body mass index (BMI) 99th percentile, obesity persisted into adulthood.⁴ Furthermore, obesity can lead to metabolic abnormalities before age 5 years,⁵ and severe obesity in childhood carries short-, medium-, and longer-term cardiovascular risks that exceed those of their less-obese peers.⁶ All of these factors suggest an elevated lifetime risk of cardiometabolic disease in children with severe obesity, with a proportion of these children at risk for requiring bariatric surgery as early as adolescence.⁷ Therefore, proper early identification and intervention for young children with obesity is critical.

Despite these compelling concerns about early childhood obesity, pediatricians have no clinical guidance for identifying young children at risk, given the lack of accepted standards for identifying clinically significant weight gain,⁸ or even clinical obesity,⁹ in children aged <2 years. In addition, there has been little study of growth trajectories in children who ultimately develop severe obesity to facilitate early identification and intervention. In the present study, we used a nested case-control design with prospectively collected growth data to characterize growth patterns of children with severe obesity (BMI 99th percentile) by age 6 years to identify whether these children experience a critical period of deviation from normal growth, characterize that growth relative to growth in normally developing children, and detect thresholds for identifying children at elevated risk of developing severe obesity in early childhood. We then validated these thresholds for clinical utility using an independent cohort from another institution.

Methods

We selected 4 initial study populations, including 2 groups with severe obesity and 2 groups of normal weight status, described below. We adopted this extreme phenotype approach to ensure maximal discriminatory value with minimal noise when identifying thresholds for severe obesity risk. We tested these thresholds in an independent validation cohort with children of any weight status, also described below. We obtained data on date of birth, birth weight, date of visit, sex, and self-reported race and ethnicity from the electronic health record (EHR) and/or pediatrician records. Insurance status was obtained for all cohorts except the cohort from the Young Child Clinic (YCC). The initial study was conducted with approval from the Cincinnati Children's Hospital Medical Center (CCHMC) Institutional Review Board. The validation study was approved by the Colorado Multiple Institution Review Board, and a Health Insurance Portability and Accountability Act and consent waiver was granted.

Pediatric Primary Care Center

Two of the 4 initial study populations were drawn from the same clinical population. The Pediatric Primary Care Center (PPCC) at CCHMC offers primary care to a low-income, predominantly Medicaid-covered population of children from birth through adolescence. For the case group, designated PPCC, obese (PPCC-OB), children with a Centers for Disease Control (CDC) BMI 99th percentile at any time between age 2 and 5.99 years seen in the PPCC between January 2008 and January 2014 were identified from the EHR. The EHR automatically calculates and records the CDC BMI percentiles for all encounters in which height and weight are measured. The 99th percentile was chosen to define those with severe obesity, because there was no way to identify the 120th percentile of the 95th percentile using EHR data.

For the control group, designated PPCC, normal weight (PPCC-NW), children seen in the PPCC during the same years with a BMI consistently between the 5th and the 75th percentiles from age 2 to 5.99 years were also identified by EHR data.

Young Child Clinic

A second population with severe obesity was drawn from CCHMC's Young Child Clinic (YCC), a tertiary referral clinic for the evaluation and treatment of early-onset severe obesity, among other disorders. Patients seen in the YCC for obesity with an initial visit at age 1–6 years between August 2008 and March 2013 were identified from EHR data and designated the YCC, obese (YCC-OB) group. Patients with a known endocrine abnormality or a genetic cause for obesity, or who were taking a medication that causes weight gain (eg, corticosteroids), were excluded.

Epidemiologic Cohort Study Group

A second normal-weight control group, designated the epidemiologic cohort, normal weight (EPI-NW), was chosen from a longitudinal epidemiologic study of growth and body composition consisting of 372 healthy Cincinnati children enrolled at age 3 years between March 2001 and August 2002. These children were assessed every 4 months up to age 7 years (a total of up to 13 study visits). Length/height and weight data were requested from the child's pediatrician for 9 ages: 2–4 weeks and 2, 4, 6, 9, 12, 15, 18, and 24 months. Children with available infant/toddler growth data whose BMI was consistently between the 5th and 75th percentiles from age 3 to 6 years were included in this analysis.

Validation Cohort

A validation cohort from the Child Health Clinic (CHC) at Children's Hospital Colorado was included to assess the clinical validity of the BMI thresholds identified from our initial study. The CHC is a metropolitan, hospital-based clinic offering primary care primarily to low-income families. Patients with weight and length or height measurements obtained during at least 1 visit to the CHC at age 6, 12, or 18 months and at least 1 visit between age 3 and 5.99 years were identified from EHR data. The visit closest to the 6-, 12-, or 18-month milestone was selected for patients with multiple visits near a given milestone visit, and 1 visit was selected at random for patients with multiple visits between age 3 and 5.99 years.

Calculated Variables/Measurements

For measurements obtained at age 2 years, recumbent length measurements were assumed, with anthropometric percentiles calculated using 2005 WHO growth standards, as recommended by the CDC.¹⁰ For measurements obtained at age >2 years, standing height was assumed, with percentiles calculated using 2000 CDC growth standards.

Obesity was defined as WHO BMI 97.7th percentile in children aged 2 years¹⁰ and as CDC BMI 95th percentile in children aged >2 years. In the 2 obese cohorts (PPCC-OB and YCC-OB), the onset of obesity was identified as the exact age at the first visit at which criteria for obesity were met (for those aged 2 years) or at the first visit at which the criteria for obesity were met following at least 1 visit at which these criteria were not met (for those aged >2 years). Children aged >2 years without a visit at which the criteria for obesity were not met excluded from the analysis.

Statistical Analyses

All analyses were conducted using SAS version 9.3 (SAS Institute, Cary, North Carolina). EHR data outliers were identified and removed from the analysis when length/height was flagged as biologically implausible (<-5 or $>+5$ SD; $<1\%$ observations were excluded). Owing to the large sample sizes, we believed that additional data cleaning (eg, identifying large changes from visit to visit, aberrant but not biologically implausible values) would have a minimal impact on estimates of means and SDs. Moreover, most such errors would result in misclassification of truly normal-weight individuals as having severe obesity (eg, mismeasured shorter height or length), minimizing differences between groups for all other longitudinal data points. Thus, we did not perform any further data cleaning.

Growth trajectories for BMI and weight-for-length (WFL) percentiles were evaluated using longitudinal mixed modeling, adjusting for sex and accounting for multiple measurements per person, with least squares means estimated for each month of age. Comparisons were conducted between the normal-weight groups (PPCC-NW vs EPI-NW), between the obese groups (PPCC-OB vs YCC-OB), and between the combined normal-weight groups (PPCC-NW + EPI-NW) vs the combined obese groups (PPCC-OB + YCC-OB), using an interaction term of age by group, with a Bonferroni-corrected P value $<.002$ considered significant (eg, 25 monthly pairwise comparisons).

The combined normal-weight and obese groups were also used to identify optimal risk thresholds. Logistic regression analysis was conducted at specific ages corresponding to typical clinical visit timing (eg, 6, 12, and 18 months). Sex-specific models were evaluated, but sex differences in estimates were found to be minimal, and thus sex-combined models are presented. BMI and WFL percentile thresholds for high specificity (specificity 95%) prediction of later severe obesity were evaluated for sensitivity, specificity, and consistency by age.

The BMI and WFL percentile high-specificity thresholds identified using the initial cohorts were tested in the validation analysis. BMI and WFL percentiles were calculated as for the initial cohorts, and each visit was classified as either meeting/exceeding or not meeting the age-specific BMI and WFL thresholds identified previously. The outcome of severe early-

onset obesity was evaluated at the childhood visit using the CDC's 99th percentile, although sensitivity analyses were conducted using 120% of the 95th percentile BMI threshold. In addition, weight status was classified at the childhood visit as normal weight (BMI <85th percentile), overweight (BMI 85th percentile to <95th percentile), and obese (BMI ≥95th percentile). Results were evaluated using contingency tables and unadjusted logistic regression models. The sensitivity, specificity, positive predictive value, negative predictive value, and relative risk for severe and nonsevere (BMI 95th percentile) obesity, as well as the combined category of overweight/obese (BMI ≥85th percentile) were calculated using the BMI or WFL 85th percentile infant risk threshold, which represents an approximation of the high-specificity BMI or WFL threshold, but with greater clinical utility.

Results

Table I presents the demographic and clinical characteristics of the initial patient population, including 480 children with severe obesity and 783 children of normal weight status. Figure, A presents the BMI of the 4 cohorts between birth and age 6 years (72 months). The PPCC-NW and EPI-NW cohorts followed nearly the same trajectory in infancy, with a peak BMI at around age 6–9 months and remaining lean throughout, as expected. No growth differences were noted between the 2 normal-weight cohorts at any point, despite differing racial and socioeconomic profiles.

The BMI values of the PPCC-OB and the YCC-OB cohorts begin to diverge significantly from those of the normal-weight cohorts at age 4 months (all obese vs. all normal weight; $P = .001$) (Figure, B). Similar separation occurred for BMI percentile ($P < .001$ separation beginning at age 2 months) and WFL percentile ($P < .001$ separation beginning at age 1 month; data not shown). In the second year of life, the BMI values for the 2 groups with severe obesity began to differ significantly from each other ($P = .001$ at age 19, 20, 23, and 24 months), with the YCC-OB cohort (tertiary referral population) exhibiting a more severe phenotype.

Clinical Thresholds for Identifying Risk of Severe Obesity

We next evaluated whether BMI percentile and/or WFL percentile could be used to identify patients at high risk for severe obesity before obesity onset. High-specificity thresholds for BMI percentile and WFL percentile are presented in Table II. We chose to focus on high-specificity cutoffs (vs high-sensitivity cutoffs) to minimize false-positive results while enabling identification of patients at the highest risk. BMI and WFL percentile models outperformed weight-for-age percentile for later severe obesity, for all ages studied. For BMI percentile, all of the high-specificity threshold values correspond to approximately the 85th percentile on the WHO BMI growth charts, and WFL percentile high-specificity thresholds also correspond to the 85th percentile on the WHO WFL chart.

Validation

Table III (available at www.jpeds.com) presents demographic and clinical characteristics of the validation cohort. This population was roughly similar to other included cohorts except for a higher proportion of Hispanic patients (53%). The prevalence of BMI ≥99th percentile

was 4.5%, and that of BMI 120% of the 95th percentile was 1.6%. Both BMI 85th percentile and WFL 85th percentile at age 6, 12, or 18 months were sensitive and highly specific for severe obesity in early childhood (Table IV). The specificity is somewhat lower than that seen in our initial cohorts, as would be expected when applying thresholds to a general population. Table V demonstrates that being in the 85th percentile for BMI at age 6, 12, or 18 months imparts between a 2.44-fold (95% CI, 1.92–3.10) and a 2.92-fold (95% CI, 2.46–3.48) increased risk of severe obesity by age 6 years, depending on the age at infant assessment. Furthermore, BMI 85th percentile increases the risk of any abnormal weight status, with 54% of such children being either overweight or obese by age 6 years.

Discussion

In this study characterizing the growth trajectories of young children with severe obesity compared with normal-weight controls, we demonstrate that BMI and WFL values in children who develop severe obesity begin to deviate from those in children who remain at normal weight at as early as age 4–6 months, and can be detected using simple clinical BMI or WFL thresholds. At the time of this deviation, BMI is not typically in the obese range, allowing for identification of this high-risk group before the onset of obesity. Furthermore, a BMI and WFL cutoff of the 85th percentile in the first 18 months of life is a highly-specific threshold for the risk of severe obesity by age 6 years. Thus, this study demonstrates that infancy may be a critical period in the development of severe obesity in early childhood, and that BMI or WFL percentile (WHO) is a valid obesity risk metric in infancy.

Currently only limited data are available on early growth patterns of children with severe obesity. One study found that rapid increases in WFL during the first 6 months of life were associated with increased risk of obesity at age 3 years,¹¹ but the authors did not assess BMI in their infants. Our study confirms the findings of a previous small-scale study that also identified BMI as an early tool for differentiating children at risk for severe obesity from those with normal growth,¹² with differences in BMI evident by age 2–6 months. In addition, another recent study also found BMI and WFL >85th percentile during infancy to be useful for identifying children at risk for obesity by age 2 years,¹³ bolstering our present findings.

Currently, there is no clinical obesity definition for children aged <2 years using either a WFL or a BMI standard.¹⁴ The CDC has not published BMI growth charts for children aged <2 years,¹⁵ and an expert panel on WHO growth standards did not comment on the clinical use of the BMI charts before age 2 years, calling for additional research on the health implications of BMI in this age group.¹⁰ The present study provides evidence that the clinical use of BMI or WFL percentiles for evaluating infants and toddlers aged <2 years can effectively differentiate infants at higher risk vs lower risk for severe obesity. Although BMI percentile and WFL percentile yielded comparable results in identifying high-risk infants, we argue that monitoring BMI percentile may be more clinically relevant, because this value can be tracked over time and is already routinely used in children aged >2 years.

Several logistical considerations must be addressed. First, WHO BMI growth charts must be readily accessible for physicians to ensure their use, but current EHR systems might not

implement these charts. Second, the frequency of typical well-child visits during infancy is an important consideration in the timely identification of at-risk children. Regular visits during infancy quickly become less frequent, with only 4 visits recommended between age 12 and 36 months (at 12, 18, 24, and 36 months). This critical period is when the onset of obesity occurs, and the transition to obesity may easily be missed at the 24-month visit. The present study provides a method for identifying at-risk children during the first year of life, before the onset of obesity, when well-child visits are more frequent and during the period of transition to primarily solid food.

In this study, we specifically characterized and compared growth trajectories of very young children with severe obesity with healthy controls, using unbiased, prospective, preobesity growth measurements. Some limitations of this study must be acknowledged, however. Although intermediate levels of over-weight or obesity were not included in our original analysis, the validation of our findings in a second population cohort of children suggests that the thresholds that we imposed are useful clinically for identifying not only those at risk for severe obesity in early childhood, but also those with less severe obesity. Flegal et al¹⁶ found that using 120% of the 95th percentile of BMI for age allows for more accurate definition of severe obesity compared with the calculated 99th percentile; however, this newer definition of severe obesity was not available for clinical use in the EHR data, so data were captured using the calculated 99th percentile. In this age range, the calculated 99th percentile is generally lower than the 120% of the 95th percentile threshold,¹⁶ and thus the definition used here is inclusive of many children who would not meet the newer definition of severe obesity, reducing potential differences between the obese and normal-weight groups. However, use of the calculated 99th percentile is consistent with the available clinical data in many health systems, enhancing the clinical utility of our findings.

A myriad of in utero and early-life factors can contribute to the development of severe obesity. Although it may be useful to consider early exposures in refining risk prediction in infants, such information must be clinically available. Unfortunately, we did not have access to these data in our study population and so cannot speak to the underlying reasons for growth pattern divergence. Finally, in this study we were unable to determine whether growth patterns of children with severe obesity in early childhood are similar to or different from those seen in individuals who develop severe obesity later in life.

BMI trajectories in children who later developed severe obesity by age 6 years differ from those in children who remain at normal weight as early as age 4–6 months, approximately 12–18 months before the median age at onset of clinical obesity. BMI or WFL values exceeding the 85th percentile on the WHO growth charts at 6, 12, or 18 months are predictive of future obesity and thus should be identified. Future studies should focus on whether intervening in infants and toddlers meeting these cutoffs leads to better weight outcomes and reduced metabolic risk later in life.

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Glossary

BMI	Body mass index
CCHMC	Cincinnati Children's Hospital Medical Center
CDC	Centers for Disease Control
CHC	Children's Health Clinic at Children's Hospital Colorado
EHR	Electronic health record
EPI-NW	Epidemiologic cohort study, normal weight
PPCC	Pediatric Primary Care Center
PPCC-NW	Pediatric Primary Care Center, normal weight
PPCC-OB	Pediatric Primary Care Center, obese
WFL	Weight-for-length
WHO	World Health Organization
YCC	Young Child Clinic
YCC-OB	Young Child Clinic, obese

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Figure.

Attained BMI least squares mean $\pm$ SD by month of age and cohort: **A**, between birth and age 6 years; **B**, enlarged to show BMI between birth and age 2 years. *Statistically significant difference between adjacent lines ($P = .002$); statistical differences between lean and severely obese group between age 4 and 24 months (all $P = .001$) not shown. Solid circles indicate YCC-OB; open circles, PPCC-OB; solid triangles, PPCC-NW; open triangles, EPI-NW. The solid line without symbols represents the obesity threshold from the WHO and CDC growth charts for age <2 years and age >2 years, respectively.

Characteristics of the study population

Table 1.

Characteristics	Normal-weight cohorts		Severely obese cohorts	
	PPCC-NW	EPI-NW	PPCC-OB	YCC-OB
No.	647	136	365	115
Male sex, n (%)	325 (50)	72 (53)	194 (53)	49 (43)
Race (%)				
White	79 (12) ^a	104 (76) ^b	74 (20) ^c	69 (60) ^d
African-American	512 (79)	32 (24)	235 (62)	27 (23)
Other	56 (9)	0 (0)	56 (15)	19 (17)
Ethnicity, n (%)				
Non-Hispanic	628 (97) ^a	0 (0)	347 (95) ^a	96 (83) ^b
Hispanic	16(2)	0 (0)	17 (5)	19 (17)
Unknown	3 (<1)	136 (100)	1 (<1)	0 (0)
Health insurance, n (%)				
Public/Medicaid	559 (86) ^a	16 (12) ^b	315 (86) ^a	0 (0)
Private	52 (8)	90 (66)	24 (7)	0 (0)
Other/none	3 (<1)	2 (1)	1 (<1)	0 (0)
Unknown	34 (5)	28 (21)	25 (7)	115 (100)
Birth weight, kg, median (IQR)	2.91 (2.41–3.35) ^a , n = 178	3.21 (2.95–3.52) ^b , n = 134	3.21 (2.81–3.66) ^b , n = 161	3.48 (2.92–3.77) ^c , n = 96
Age at obesity onset, yr, median (IQR)	NA	NA	2.00 (1.24–3.11) ^a	1.39 (0.61–3.02) ^b

NA, not applicable.

Columns with differing superscripted letters differ significantly from one another ($P < .05$). Superscripts for categorical variables reflect pairwise chi-square tests across all categories, excluding unknown values. Superscripts for continuous variables represent pairwise Wilcoxon rank sum tests.

Table II.

Thresholds for detecting severe obesity in the initial cohorts

Ages	Model AUC	Threshold percentile	High-specificity threshold			85th percentile threshold				
			Sensitivity, n/N	%	Specificity, n/N (%)	Sensitivity, n/N (%)	Specificity, n/N (%)			
BMI percentile										
6 mo	0.851	83.1	23/47	(49)	110/115	(96)	22/47	(47)	110/115	(96)
12 mo	0.890	89.8	38/67	(57)	106/111	(95)	41/67	(61)	105/111	(95)
18 mo	0.970	83.4	49/55	(89)	84/88	(95)	47/55	(85)	85/93	(97)
WFL percentile										
6 mo	0.853	85.3	23/47	(49)	110/115	(96)	23/47	(49)	110/115	(96)
12 mo	0.889	84.9	40/67	(60)	106/111	(95)	40/67	(60)	106/111	(95)
18 mo	0.972	72.4	51/55	(93)	84/88	(95)	43/55	(78)	88/88	(100)
Weight-for-age percentile										
6 mo	0.776	86.6	50/98	(51)	152/160	(95)	50/98	(51)	146/160	(91)
12 mo	0.840	78.1	58/122	(48)	187/196	(95)	42/122	(34)	193/196	(98)
18 mo	0.902	86.6	78/123	(63)	162/170	(95)	81/123	(66)	161/170	(95)

AUC, area under the curve.

Table III.

Characteristics of the CHC validation cohort

Characteristics	Value
Number of patients	2679
Age at severe obesity evaluation, mo, median (IQR)	48.1 (39.5–55.8)
Male sex, n (%)	1385 (52)
Race, n (%)	
White	705 (26)
African-American	737 (28)
Asian	73 (3)
Multiple races	238 (9)
Other/unknown	926 (35)
Ethnicity, n (%)	
Non-Hispanic	1220 (46)
Hispanic	1433 (54)
Unknown	26 (1)
Health insurance, n (%)	
Public/Medicaid	2407 (90)
Private	252 (9)
Self-pay/none	11 (< 1)
Unknown	9 (<1)
BMI status in childhood	
BMI, kg/m ² , median (IQR)	15.9 (15.0–16.9)
BMI percentile, median (IQR)	62.4 (32.5–84.4)
Severe obesity (BMI 99th percentile), n (%)	121 (4.5)
Severe obesity (BMI 120% of 95th percentile), n (%)	43 (1.6)

Validation of BMI 85th percentile and WFL 85th percentile for identifying infants at increased risk for severe obesity (BMI 99th percentile) by age 6 years

Table IV.

Ages	Exceeding threshold, n (%)	Sensitivity, n/N (%)	Specificity, n/N (%)	PPV, n/N (%)	NPV, n/N (%)
BMI 85th percentile					
6 mo	273 (14)	30/92 (33)	1643/1886 (87)	30/273 (11.0)	1643/1705 (96)
12 mo	389 (23)	36/67 (54)	1248/1601 (78)	36/389 (9.3)	1248/1279 (98)
18 mo	331 (29)	43/56 (77)	809/1097 (74)	43/331 (13)	809/822 (98)
WFL 85th percentile					
6 mo	303 (15)	31/92 (34)	1607/1879 (86)	31/303 (10.2)	1607/1668 (96)
12 mo	259 (16)	27/67 (40)	1354/1586 (85)	27/259 (10.4)	1354/1394 (97)
18 mo	184 (16)	37/56 (66)	945/1092 (87)	37/184 (20.1)	945/964 (98)

NPV, negative predictive value; PPV, positive predictive value.

Thresholds applied to the full cohort (n = 2679), BMI 99th percentile definition of severe obesity applied in young childhood (overall prevalence = 4.5%).

Relative risk and prevalence of severe obesity, obesity, or overweight/obesity by age 6 years in infants meeting BMI and WFL percentile thresholds

Table V.

Ages	Severe obesity (BMI 99th percentile) Prevalence if threshold met/not met, %	RR (95% CI)	Obesity (BMI 95th percentile) Prevalence if threshold met/not met, %	RR (95% CI)	Overweight or obesity (BMI 85th percentile) Prevalence if threshold met/not met, %	RR (95% CI)
BMI 85th percentile						
6 mo	11/4	2.53 (1.84–3.47)	32/9	3.25 (2.62–4.04)	54/19	3.66 (2.95–4.54)
12 mo	9/2	2.44 (1.92–3.10)	29/7	2.93 (2.49–3.45)	54/15	3.70 (3.13–4.36)
18 mo	13/2	2.92 (2.46–3.48)	28/6	2.78 (2.36–3.27)	54/13	3.58 (3.02–4.24)
WFL 85th percentile						
6 mo	10/4	2.33 (1.71–3.16)	30/9	2.99 (2.43–3.68)	51/19	3.33 (2.73–4.07)
12 mo	10/3	2.75 (2.01–3.77)	33/8	3.57 (2.89–4.42)	58/18	4.34 (3.48–5.40)
18 mo	20/2	4.91 (3.86–6.24)	40/7	4.59 (3.61–5.82)	65/17	5.62 (4.28–7.39)

RR, relative risk.

Overall prevalence in this cohort: severe obesity, 4.5%; obesity, 12.0%; overweight or obesity, 24.3%.