PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Identifying Risk for Obesity in Early Childhood

Philip R. Nader, Marion O'Brien, Renate Houts, Robert Bradley, Jay Belsky, Robert Crosnoe, Sarah Friedman, Zuguo Mei, Elizabeth J. Susman and for the National Institute of Child Health and Human Development Early Child Care Research Network

Pediatrics 2006;118;e594-e601
DOI: 10.1542/peds.2005-2801

ARTICLE

Identifying Risk for Obesity in Early Childhood

Philip R. Nader, MD[a], Marion O'Brien, PhD[b], Renate Houts, PhD[c], Robert Bradley, PhD[d], Jay Belsky, PhD[e], Robert Crosnoe, PhD[f], Sarah Friedman, PhD[g], Zuguo Mei, MD[h], Elizabeth J. Susman, PhD[i]; for the National Institute of Child Health and Human Development Early Child Care Research Network

[a]Division of Community Pediatrics, University of California, San Diego, California; [b]Department of Human Development and Family Studies, University of North Carolina, Greensboro, North Carolina; [c]Statistics and Epidemiology, Research Triangle Institute, Research Triangle Park, North Carolina; [d]Center for Applied Studies in Education, University of Arkansas, Little Rock, Arkansas; [e]Institute for Study of Children, Families and Social Issues, Birkbeck University of London, London, United Kingdom; [f]Department of Sociology and Population Research Center, University of Texas, Austin, Texas; [g]National Institute of Child Health and Human Development, Bethesda, Maryland; [h]Division of Nutrition and Physical Activity, Centers for Disease Control and Prevention, Atlanta, Georgia; [i]Department of Biobehavioral Health, Pennsylvania State University, University Park, Pennsylvania

The authors have indicated they have no financial relationships relevant to this article to disclose.

ABSTRACT

OBJECTIVES. Our aim with this study was to assist clinicians by estimating the predictive value of earlier levels of BMI status on later risk of overweight and obesity during the middle childhood and early adolescent years.

METHODS. We present growth data from the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development, a longitudinal sample of 1042 healthy US children in 10 locations. Born in 1991, their growth reflects the secular trend of increasing overweight/obesity in the population. Height and weight of participating children in the study were measured at 7 time points. We examined odds ratios for overweight and obesity at age 12 years comparing the frequency with which children did versus did not reach specific BMI percentiles in the preschool- and elementary-age periods. To explore the question of whether and when earlier BMI was predictive of weight status at age 12 years, we used logistic regression to obtain the predicted probabilities of being overweight or obese (BMI ≥85%) at 12 years old on the basis of earlier BMI.

RESULTS. Persistence of obesity is apparent for both the preschool and elementary school period. Children who were ever overweight (>85th percentile), that is, ≥1 time at ages 24, 36, or 54 months during the preschool period were >5 times as likely to be overweight at age 12 years than those who were below the 85th percentile for BMI at all 3 of the preschool ages. During the elementary school period, ages 7, 9, and 11 years, the more times a child was overweight, the greater the odds of being overweight at age 12 years relative to a child who was never overweight. Sixty percent of children who were overweight at any time during the preschool period and 80% of children who were overweight at any time during the elementary period were overweight at age 12 years. Follow-up calculations showed that 2 in 5 children whose BMIs were ≥50th percentile by age 3 years were overweight at age 12 years. No children who were <50th percentile for BMI

www.pediatrics.org/cgi/doi/10.1542/peds.2005-2801

doi:10.1542/peds.2005-2801

This report does not represent a recommendation of either the National Institute of Child Health and Human Development or the Centers for Disease Control.

Key Words
BMI, childhood obesity, longitudinal growth

Abbreviations
CDC—Centers for Disease Control and Prevention
NICHD—National Institute of Child Health and Human Development
OR—odds ratio
CI—confidence interval

Accepted for publication Feb 10, 2006

Address correspondence to Philip R. Nader, MD, National Institute of Child Health and Human Development Early Child Care and Youth Development Research Network, CDB, CRMC, NICHD, 6100 Executive Blvd, Suite 4B05, Rockville, MD 20852. E-mail: pnader@ucsd.edu

at all points during elementary school were overweight at age 12 years. Children who have higher range BMIs earlier, but not at the 85th percentile, are also more likely to be overweight at age 12 years. Even at time points before and including age 9 years, children whose BMIs are between the 75th and 85th percentile have an ~40% to 50% chance of being overweight at age 12 years. Children at 54 months old whose BMIs are between the 50th and 75th percentile are 4 times more likely to be overweight at age 12 years than their contemporaries who are <50th percentile, and those whose BMIs are between the 75th and 85th percentile are >6 times more likely to be overweight at age 12 years than those <50th percentile.

CONCLUSIONS. The data from this study indicate that children with BMIs >85th percentile, as well as with BMIs in the high reference range are more likely than children whose BMI is <50th percentile to continue to gain weight and reach overweight status by adolescence. Pediatricians can be confident in counseling parents to begin to address the at-risk child's eating and activity patterns rather than delaying in hopes that overweight and the patterns that support it will resolve themselves in due course. Identifying children at risk for adolescent obesity provides physicians with an opportunity for earlier intervention with the goal of limiting the progression of abnormal weight gain that results in the development of obesity-related morbidity.

THE PREVALENCE OF childhood obesity has nearly tripled since the 1970s and is recognized as a serious public health concern. Obesity persists from childhood to adolescence and into adulthood and is a leading cause of health problems.[1–6] Adult diseases related to obesity are now becoming more prevalent among youth.[7–9] In addition to long-term physical health risks, overweight and obese children and adolescents face significant mental health and psychosocial morbidities,[10,11] and these are linked to concurrent health problems.[12,13] The growing economic impact of obesity is also a concern.[14] Thus, research into overweight in childhood, with a focus on prevention, has a high priority.

Pediatricians and other health care providers seeing children are currently faced with a dilemma. Although the short- and long-range detrimental outcomes of overweight in children and adolescents are evident, no clear criteria exist for identifying who or when a child may be at risk for later obesity. Thus, physicians have neither firm guidelines to determine when and in what circumstances a given weight and height for age and weight and height for gender warrants preventive or remedial intervention, nor can they be certain that the results of intervention in the form of improved BMI (weight in relation to height, age, and gender) has actually reduced later risk.[4,15] As a result, pediatricians may be inclined not to pursue growth indicators of obesity or overweight status, at least in part because anecdotal experience and uncertainty regarding effectiveness may suggest that watchful waiting is a more prudent course of action.[16] It is increasingly important to examine longitudinal growth data to identify early stages in the pathway to obesity to understand when to apply successful and cost-effective clinical and population-based interventions as they are developed. In this report, we seek clues as to the patterns of growth in early childhood that place children at risk for later overweight and obesity. The findings presented here are based on longitudinal growth data collected on the same children growing up during the era when obesity and overweight have been on the rise.

Few longitudinal studies on US children exist from which to estimate the predictive value of earlier levels of BMI status on later risk of overweight during the middle childhood and early adolescent years. It is critical to identify early BMI predictors of later obesity to identify those at risk for overweight and the potential deleterious health consequences of overweight. The well-known Centers for Disease Control and Prevention (CDC) cross-sectional data tracking BMI from birth through adolescence were deliberately based on information collected before the emergence of the "obesity epidemic," (ie, data collected before 1980) to highlight the incidence of increasing overweight/obesity.[14] Standards of practice now reflect Institute of Medicine definitions of "overweight" (ie, BMI percentile for age and gender from the 85th to 95th percentile) and "obese" (ie, BMI ≥95th percentile for age and gender).[17–19] However, a recent report[20] indicated that merely being in the upper half of the normal weight range (up to the 84th percentile) was a good predictor of becoming overweight or hypertensive as a young adult, suggesting that levels of BMI <85th percentile may hold clinical or preventive significance.

Many studies suggest a strong relationship between weight status in childhood and eventual adult obesity,[5,6,8,20–22] but many are based on cross-sectional data or have relatively long periods of time between measurements. It is clear from previous studies that obesity in adolescence is highly predictive of obesity in adulthood. Therefore, an important next step is to identify those children at greatest risk of obesity in adolescence to intervene before chronic overweight is established. The goal of the present study is to begin the process of developing guidelines for preventive intervention by examining the relation of BMI percentiles in early and middle childhood to overweight and obesity in adolescence.

This study presents growth data from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development, a longitudinal sample of healthy US children in 10 locations.[23] This sample is particularly appropriate for an examination of growth. Because these children were born in 1991, their growth reflects the secular trend of increasing overweight/obesity in the population. Second, the sample has been followed over an extended period of time, yet measurements were collected fairly frequently. Height and weight of participating children in the study were measured at 7 time points: 24, 36, and 54 months and 7, 9, 11, and 12 years. Our aim with this study was to assist clinicians in identifying children, on the basis of growth of BMI, for whom intervention to control weight gain may be indicated by determining the risk of overweight and obesity at age 12 years on the basis of BMI status at earlier ages.

METHODS

Sample

Participants for the study were recruited in 1991 from designated hospitals at 10 data collection sites: Little Rock, AR; Irvine, CA; Lawrence, KS; Boston, MA; Philadelphia and Pittsburgh, PA; Charlottesville, VA; Seattle, WA; Hickory and Morganton, NC; and Madison, WI. A total of 1364 families with healthy newborns were enrolled. Multiple births and infants who remained in the hospital >7 days or had known medical complications were excluded. Recruitment and selection procedures are described in detail in several publications[23] and on the study Web site (http://secc.rti.org). Of the initial pool of 3015 eligible mothers contacted at 2 weeks for participation, 1364 (45%) completed the 1-month home visit and became study participants. These 1364 families were very similar to the eligible hospital sample on major demographic characteristics (years of maternal education, ethnicity, and presence of partner in home). The resulting sample was diverse, including 24% ethnic minority children, 11% mothers who had not completed high school, and 14% single-parent mothers. Mothers had an average of 14.4 years of education, and 51.7% of the children were boys (percentages not mutually exclusive). Eligibility requirements specified that mothers be ≥18 years of age, be English speaking, plan to be in the geographic area for the next 3 years, and not have known or acknowledged substance abuse and that infants not be hospitalized at birth for >7 days and not have any obvious disabilities. This had the effect of screening out very low birth weight, severely premature, or sick infants from the study.

After 13 years of study, 1042 (76.4%) of the children have been retained in the sample. For some of the analyses reported here, the sample was limited to the 555 children for whom all 7 of the BMI measurement points were complete between ages 2 and 12 years. This subsample with complete data was composed of 54.2% girls and 20.7% minorities. Mothers had a mean of 14.5 years (SD: 2.4) of education at the time of the child's birth. Family income was indexed by an income/needs ratio, calculated as total family income divided by the poverty level for that family's size; at age 12, 20.7% of the families were low income (income/needs ratios of <2.0), 48.0% were middle income (2.0–5.0), and 31.3% were high income (>5.0). This sample was more likely to be female (χ^2 [1, N = 1364] = 13.1; $P < .0003$), white (χ^2 [1, N = 1364] = 5.5; $P < .02$), and to have mothers with more education (t [1254] = −3.9; $P < .0001$), than those who were missing ≥1 BMI measurement (n = 809). There was no difference between those in/out of the complete sample in risk of obesity at age 12 years.

Measurement of Height and Weight

Standardized procedures were used to measure height and weight at 24, 36, and 54 months and at 7, 9, 11, and 12 years. Height was measured with children standing with shoes off, feet together, and their backs to a calibrated 7-foot measuring stick fastened to a wall. Children were asked to stand straight and tall while a research assistant lowered a level T-square to rest on the top of the child's head to read the height value. Height was measured to the nearest 0.125 in (0.32 cm) and recorded 2 times. If the first 2 height measures differed by >0.25 in (0.64 cm), 2 more height measurements were taken. Weight was measured using a physician's 2-beam scale. Scales were calibrated monthly using certified calibration weights. Weight was measured with children in minimal clothing (ie, no shoes, no outer layers of clothing, and no other items that could add weight such as belts, keys, or watches). As with height, weight was measured twice, each time to the nearest 0.25 lb (0.1 kg). If the 2 weight measurements differed by >4 oz, 2 more measurements were taken.

BMI was calculated by converting height from inches to meters and weight from pounds to kilograms and then dividing weight by height squared. Because of sample size, in most of our analyses we use the overweight category of ≥85th percentile. We also conducted some analyses using the obese category of over the 95th percentile; in all cases, the results were similar.

Quality-Assurance Checks

Quality-assurance checks used by the CDC to determine the acceptability/reliability of height and weight data were applied to the data from the NICHD data set. Following criteria used in the Pediatric Nutrition Surveillance System (PedNSS) study (www.cdc.gov/pednss/pop-ups/biv_pednss.htm), heights that corresponded with the 2000 CDC height-for-age z scores that were less than −5 or >3, weights that corresponded with the 2000 CDC weight-for-age z scores that were less than −5 or >5, and BMIs that corresponded with the 2000 BMI-for-age z scores that were less than −4 or >5 were deleted as biologically implausible. In addition, logically implausible values, such as children becoming shorter over time, were also deleted. All in all, the data were extremely clean; only 27 biologically implausible values and 26 logically implausible values of >6800 height or weight measurements had to be excluded from the analysis.

Statistical Methods

Calculation of odds ratios (ORs) of being overweight at age 12 years based on various levels of BMI at previous ages was conducted. Logistic regressions were used to determine the risk of becoming overweight or obese at age 12 from the number of times a child was overweight during the preschool and school age periods. Finally, the impact of being in a specific range of BMI percentiles across the preschool and school age periods on eventual overweight status at age 12 years was determined.

RESULTS

The mean weight, height, and BMI of boys and girls in the NICHD study cohort, including all of those on whom any data are available, are shown in Table 1 along with the percentage of children whose BMIs were between the CDC 85th and 95th percentiles and above the 95th percentile. Gender did not differentiate between obese and nonobese at age 12 in this sample. When examined separately, white versus nonwhite and maternal education are both related to the presence of obesity at age 12 years. When examined together, only maternal education is associated with obesity at age 12 years.

Our first set of analyses examined ORs for overweight and obese at age 12 years based on the frequency with which children attained versus did not attain specific BMI levels in the preschool and elementary age periods. For these analyses, only those children with complete data at all 7 time points ($n = 555$) were included. Initially, children's weight status at each age was defined as normal (BMI percentile <85) versus overweight and obese (BMI percentile ≥85). The number of times a child was over the 85th percentile during the preschool period (from 0 to 3 times at 24, 36, and 54 months) and elementary school period (from 0 to 3 times at 7, 9, and 11 years) was then calculated. A logistic regression was run, using weight status at age 12 years as the dependent variable and the number of times overweight during each earlier period as the independent variable. ORs were calculated, comparing the likelihood of being overweight in children who experienced 1, 2, or 3 earlier overweight periods to children who experienced no earlier overweight periods. We also calculated the ORs comparing the likelihood of being overweight at age 12 years in children who were overweight at any of the time points within each age period to children who experienced no overweight periods. To determine whether a lower threshold of BMI suggests later risk, ORs were also calculated using a BMI ≥50% in the preschool and elementary school periods. ORs were calculated separately by gender ($N = 254$ boys and 301 girls). Because the total number of children from ethnic minority families was only 113, we could not conduct separate analyses by ethnicity.

Results are shown in Table 2. The table indicates the ORs and 95% confidence intervals (CIs) for the sample as a whole and for boys and girls separately. All of the reported ORs are significant at $P < .05$, as indicated by 1.0 not being included in the CI. No significant gender differences were found. Across the entire sample, persistence of obesity is apparent for both the preschool and elementary school period. Children who were ever overweight (ie, ≥1 time) during the preschool period were >5 times as likely to be overweight at age 12 than those who were <85th percentile for BMI at all 3 of the preschool ages. During the elementary school period, the more times a child was overweight, the greater the

TABLE 1 Mean Weight, Height, and BMI of Boys and Girls in the NICHD Study of Early Child Care and Youth Development and Percentages in CDC Categories of Overweight and Obesity

Age	Weight, kg			Height, cm			BMI				
	N	Mean	SD	N	Mean	SD	N	Mean	SD	85%–95%	>95%
Boys											
24 mo	530	13.0	1.5	508	87.4	3.1	491	17.0	1.4	11	7
36 mo	555	14.9	1.7	558	95.8	3.5	546	16.3	1.3	12	6
54 mo	517	18.7	2.6	515	107.3	4.3	513	16.1	1.5	15	9
7 y	499	25.8	5.5	496	123.0	5.4	493	16.9	2.7	15	13
9 y	463	34.4	9.3	463	135.3	6.2	458	18.6	3.9	14	19
11 y	465	44.0	13.6	467	146.4	7.0	464	20.3	5.0	14	22
12 y	445	49.0	15.1	445	152.0	7.5	439	20.9	5.2	14	21
Girls											
24 mo	535	12.4	1.4	510	86.4	3.2	500	16.5	1.3	9	4
36 mo	546	14.5	1.7	549	94.8	3.5	541	16.1	1.3	13	6
54 mo	522	18.2	2.7	522	106.6	4.3	518	16.0	1.6	15	9
7 y	499	25.0	4.7	498	122.0	5.3	497	16.7	2.4	12	10
9 y	478	33.4	8.4	478	134.7	6.1	473	18.2	3.5	14	14
11 y	455	43.6	12.0	457	147.6	7.3	449	19.7	4.2	15	15
12 y	465	49.6	13.4	462	153.9	7.2	460	20.7	4.6	17	15

TABLE 2 **ORs of Having an Age-12 BMI ≥85% as a Function of the Number of Times With BMI ≥50% or 85% in the Preschool (24–54 Months) or Elementary (7–11 Years) Periods**

Variable	Total (n = 555), OR (95% CI)	Boys (n = 254), OR (95% CI)	Girls (n = 301), OR (95% CI)
Preschool			
BMI ≥ 85% 1 vs 0	6.5 (3.8–10.9)	5.9 (2.8–12.4)	7.0 (3.3–14.6)
BMI ≥ 85% 2 vs 0	5.5 (2.7–11.1)	4.1 (1.6–10.9)	7.5 (2.6–21.3)
BMI ≥ 85% 3 vs 0	5.4 (2.9–9.9)	6.5 (2.5–16.6)	4.7 (2.1–10.6)
BMI ≥ 85% ≥1 vs 0	5.9 (3.9–8.8)	5.6 (3.1–9.9)	6.2 (3.6–10.7)
BMI ≥ 50% 1 vs 0	4.5 (2.1–9.6)	4.4 (1.5–12.9)	4.6 (1.6–13.1)
BMI ≥ 50% 2 vs 0	8.2 (4.0–17.1)	8.8 (3.0–25.7)	8.0 (2.9–21.9)
BMI ≥ 50% 3 vs 0	7.4 (3.9–14.1)	5.9 (2.3–14.8)	9.0 (3.6–22.2)
BMI ≥ 50% ≥1 vs 0	6.9 (3.7–12.8)	6.0 (2.5–14.7)	7.7 (3.2–18.4)
Elementary school			
BMI ≥ 85% 1 vs 0	25.9 (12.0–55.9)	29.5 (7.5–115.9)	34.1 (12.1–96.1)
BMI ≥ 85% 2 vs 0	159.9 (57.3–445.6)	306.1 (57.6–1626.5)	115.2 (29.0–456.9)
BMI ≥ 85% 3 vs 0	374.0 (145.3–962.7)	837.8 (163.9–4281.7)	235.2 (70.8–781.8)
BMI ≥ 85% ≥1 vs 0	106.9 (55.7–205.4)	165.1 (48.2–564.8)	99.6 (43.4–228.6)

odds of being overweight at age 12 years relative to a child who was never overweight (ie, 1 time = 25 times more likely, 2 times = 159 times more likely, and 3 times = 374 times more likely). Follow-up calculations showed that 60% of children who were overweight at any time during the preschool period and 80% of children who were overweight at any time during the elementary period were overweight at age 12. These results suggest that any time a child reaches the 85th percentile for BMI may be an appropriate time for intervention. Interestingly, the analyses using BMI ≥50% indicated a sixfold increase in the likelihood of later overweight among preschoolers who reached the 50th percentile when compared with children who never reached the BMI 50th percentile during that period. Follow-up calculations showed that 2 in 5 children whose BMIs were ≥50th percentile by age 3 years were overweight at age 12 years. No children who were <50th percentile for BMI at all points during elementary school were overweight at age 12 years; thus, ORs could not be calculated for the elementary school period.

To explore in more detail the question of whether and when earlier BMI was predictive of weight status at age 12 years, we used logistic regression to obtain the predicted probabilities of being overweight/obese (BMI ≥85%) at 12 years old on the basis of earlier BMI. As before, children's weight status at age 12 years was defined as normal (BMI percentile <85%) or overweight/obese (BMI percentile ≥85%). At each age before 12 years, BMI was categorized into 20 equally spaced groups (ie, 0% to <5%, 5% to <10%, 10% to <15%, etc). Separate logistic regressions were conducted for each previous age using children's weight status at age 12 years as the outcome and the categorized BMI percentile rankings from the earlier age as predictors.[24] All of the children with data at 12 years old and the specific previous age to be analyzed were included in these regression analyses (24 months: n = 725; 36 months: n = 810; 54 months: n = 828; 7 years: n = 826; 9 years: n = 818; and 11 years: n = 833). Gender differences and interactions with gender were also tested, and none was significant.

The results are shown in Fig 1. Patterns for boys and girls were similar, and, therefore, only the graph for the total sample is shown. Again, as expected, tracking of overweight status becomes more evident as children age. In addition, the results indicate that children who have higher BMIs earlier are more likely to be overweight at age 12 years. Even at time points before and including age 9, children whose BMIs are between the 75th and 85th percentile have approximately a 40% to 50% chance of being overweight at age 12 years. Similar results were obtained when examining the subsample that had complete data across all of the time points and when the outcome was examined in terms of BMI >95% at age 12 years.

Following up on these analyses, we calculated the ORs of having a BMI ≥85% at age 12 years for children who fell within particular BMI categories (50% to <75%, 75% to <85%, 85% to <95%, and ≥95%) at each of the previous measurement points versus children who fell into lower BMI categories. These analyses included only those children with complete data (n = 555). Analyses examining gender differences and interactions with gender were conducted, and the patterns were similar; only data for the full sample are shown. Table 3 presents the results of these analyses with ORs. Each set of columns shows the ORs and 95% CIs of being overweight at age 12 years for children within a specific BMI category at each age versus children with lower BMIs. Thus, children at 54 months old whose BMIs are between the 50th and 75th percentile are 4 times more likely to be overweight at age 12 years than their contemporaries who are <50th percentile, and those whose BMIs are between the 75th and 85th percentile are >6 times more likely to be overweight at age 12 years than those <50th percentile. As expected, ORs are highest when the previous measurement is closest to the out-

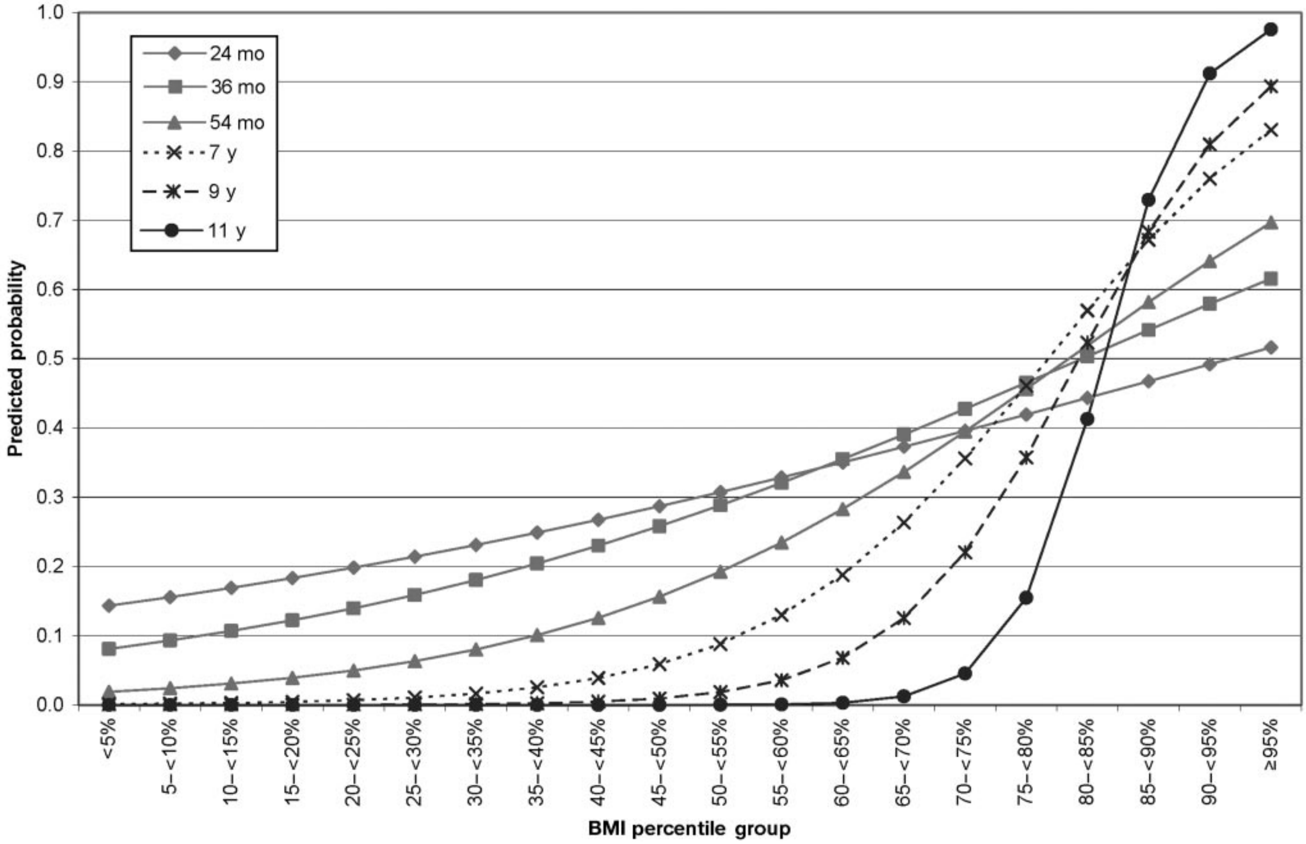

FIGURE 1
Predicted probabilities of age-12 BMI ≥85% as a function of 24-, 36-, 54-month or 7-, 9-, or 11-year BMIs.

TABLE 3 **ORs of Age-12 BMI ≥85% as a Function of Earlier BMI Categories (*N* = 555)**

Variable	BMI Percentile Category, OR (95% CI)			
	50% to <75%	75% to <85%	85% to <95%	≥95%
vs <50%				
24 mo	1.8 (1.1–2.7)[a]	1.8 (1.0–3.1)	2.4 (1.3–4.5)[a]	5.3 (2.1–13.4)[a]
36 mo	1.3 (0.8–2.1)	3.0 (1.7–5.4)[a]	4.0 (2.3–7.1)[a]	10.0 (3.8–26.7)[a]
54 mo	4.2 (2.3–7.6)[a]	6.0 (3.0–12.1)[a]	13.0 (6.7–25.2)[a]	47.5 (19.8–114.0)[a]
7 y	3.6 (1.7–7.7)[a]	10.3 (4.7–22.4)[a]	36.4 (16.0–82.6)[a]	337.4 (89.9–1266.7)[a]
9 y	8.3 (1.8–38.3)[a]	43.8 (10.1–190.5)[a]	283.1 (63.7–1257.7)[a]	2517.6 (412.9–15 351.4)[a]
vs <75%				
24 mo		1.0 (0.6–1.8)	1.4 (0.7–2.5)	3.0 (1.2–7.6)[a]
36 mo		2.3 (1.3–4.2)[a]	3.1 (1.7–5.6)[a]	7.7 (2.8–20.8)[a]
54 mo		1.4 (0.8–2.6)	3.1 (1.8–5.4)[a]	11.4 (5.2–25.3)[a]
7 y		2.8 (1.6–5.1)[a]	10.0 (5.2–19.2)[a]	92.8 (27.3–315.8)[a]
9 y		5.3 (2.4–11.4)[a]	33.9 (15.0–76.6)[a]	301.8 (81.7–1115.1)[a]
vs <85%				
24 mo			1.4 (0.7–2.8)	3.0 (1.1–8.2)[a]
36 mo			1.3 (0.7–2.6)	3.3 (1.2–9.5)[a]
54 mo			2.2 (1.1–4.2)[a]	7.9 (3.3–18.8)[a]
7 y			3.5 (1.8–7.0)[a]	32.8 (9.5–113.6)[a]
9 y			6.5 (3.2–13.1)[a]	57.5 (16.6–199.2)[a]
vs <95%				
24 mo				2.2 (0.8–6.1)
36 mo				2.5 (0.9–7.2)
54 mo				3.7 (1.6–8.5)[a]
7 y				9.3 (2.6–33.0)[a]
9 y				8.9 (2.5–31.6)[a]

[a] ORs that differ significantly from those for the comparison group.

come age of 12 years. Even for children between ages 3 and 7 years, however, later overweight is at least 3 to 10 times more likely for children in the 75th percentile than for those with BMIs <50th percentile.

DISCUSSION

For this sample of children who are growing up during a period of increasing obesity prevalence, it is clear that the longer a child remained in the lower range of normal BMI, the less likelihood there was that the child would become overweight by early adolescence. The more times a child entered a BMI category over the 85th percentile, the greater the likelihood that the child remained overweight. This first becomes evident during the preschool years and is reinforced and strengthened during the school-age years.

The data also suggest information regarding the level of BMI that might warrant clinical attention with regard to initiating preventive intervention efforts to reduce or control children's weight gain. On the basis of these contemporary longitudinal data, it seems that children ≥75th percentile for BMI at any previous age have a detectable increase in risk of being overweight according to CDC criteria by 12 years old. Furthermore, the data indicate that preschool age children whose BMIs are >50th percentile are considerably more likely than those who stay below this point to become overweight by age 12 years. These findings suggest that parents and health care providers may want to be even more vigilant than currently recommended in recognizing early signs of being on the path to overweight. Pediatricians will also have other data available to them, which were not accounted for in these analyses, such as growth patterns before 2 years old, ethnicity, parental and sibling weight status, and family and environmental factors that might be linked to child overweight. Discussion of these issues with parents in terms of healthy growth and prevention of eventual overweight, with avoidance of "labeling" a child, is important.

Although this report includes participants from many different locations around the United States, it is difficult to extrapolate these findings to the entire population of US children, given our relatively small sample size. Compared with the US total population, the NICHD Study of Early Child Care and Youth Development sample contains a higher percentage of economically well-off families and a lower percentage of nonwhites. Thus, our findings may underestimate the overall progression of overweight and obesity among US children. Some other limitations of the analyses presented here must be noted. We do not have measures of parental weight status, which would have allowed us to relate this variable to predicted outcomes.[5] Neither do we have an independent measure of body fat, such as skinfolds or waist circumference, across all of the periods of measurement. Nevertheless, we do have acceptably reliable measurement of a recognized surrogate indicator, BMI, measured repeatedly from age 2 years to early adolescence. In this report, we can provide only a description of the relation of BMI in early childhood to overweight status in early adolescence. The reasons that some children continue to gain weight and become obese, whereas others maintain healthy weights within the midrange of BMI, remain to be examined. Additional research to identify familial, psychosocial, and health-related correlates of weight status in childhood and adolescence is clearly needed.

Debate continues among pediatricians around several critical issues: the relationship of early weight gain to immediate demonstrable morbidity and to later manifestations of disease[25,26]; the lack of demonstrated effectiveness of clinical interventions with some evidence of effective population-based interventions; and the potential benefits and costs of routine screening.[27,28] Nevertheless, there is good evidence that absence of overweight is a positive health goal for most individuals and that efforts to reduce overweight need to begin in childhood.[8,16,19,29–31] A minimal intervention approach that promotes healthful eating and activity behaviors, both on an individual and population basis, seems logical, because the data from this study indicate that children with BMIs in the high reference range are more likely than children whose weight is below the 50th percentile to continue to gain weight and reach overweight status by adolescence. On the basis of the growth data reported here, it would seem that pediatricians can be confident in counseling parents to begin to address the at-risk child's eating and activity patterns, rather than delaying in hopes that overweight and the patterns that support it will resolve themselves in due course. Identifying children at risk for adolescent obesity provides physicians with an opportunity for earlier intervention with the goal of limiting the progression of abnormal weight gain that results in the development of obesity-related morbidity.

ACKNOWLEDGMENTS

This study is directed by a steering committee and supported by NICHD through a cooperative agreement (U10) that calls for a scientific collaboration between the grantees and NICHD staff.

Participating investigators, listed in alphabetical order, were: Cathryn Booth-LaForce (University of Washington); Alison Clarke-Stewart (University of California at Irvine); Martha Cox (University of North Carolina at Chapel Hill); Bonnie Knoke (Research Triangle Institute); Kathleen McCartney (Harvard University); Margaret T. Owen (University of Texas at Dallas); Ross Parke (University of California at Riverside); Robert Pianta (University of Virginia); Peter C. Scheidt (NICHD); Susan Spieker (University of Washington); Deborah Lowe Vandell (University of Wisconsin-Madison); and Marsha Weinraub (Temple University).

We thank the study coordinators at each site who supervised the data collection, the research assistants who collected the data, and especially the families who participated in the study. We also thank Kortnee Barnett-Walker for assistance with data analysis.

REFERENCES

1. Strauss RS, Pollack HA. Epidemic increase in childhood overweight, 1986–1998. *JAMA.* 2001;286:2845–2848
2. Ogden CL, Flegal KM, Carroll MD, Johnson CL. Prevalence and trends in overweight among US children and adolescents, 1999–2000. *JAMA.* 2002;288:1728–1732
3. Troiano RP, Flegal KM. Overweight children and adolescents: description, epidemiology, and demographics. *Pediatrics.* 1998; 10:497–504
4. US Preventive Services Task Force. Screening and intervention recommendations for overweight in children and adolescents: recommendation statement. *Pediatrics.* 2005;116:205–209
5. Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. *N Engl J Med.* 1997;337:869–873
6. Guo SS, Chumlea WC. Tracking of body mass index in children in relation to overweight in adulthood. *Am J Clin Nutr.* 1999; 70(suppl):145S–148S
7. Sinha R, Fisch G, Teague B, et al. Prevalence of impaired glucose tolerance among children and adolescence with marked obesity. *N Engl J Med.* 2002;346:802–810
8. Berenson GS. Obesity – a critical issue in preventive cardiology: the Bogalusa Heart Study. *Prev Cardiol.* 2005;8:234–241
9. Marcovecchio M, Mohn A, Chiarelli F. Type 2 diabetes mellitus in children and adolescents. *J Endocrinol Invest.* 2005;28: 853–863
10. Schwimmer JB, Burwinkle TM, Varni JW. Health-related quality of life in severely obese children and adolescents. *JAMA.* 2003;289:1813–1819
11. Zametkin AJ, Zoon CK, Klein HW, Munson S. Psychiatric aspects of child and adolescent obesity: a review of the past ten years. *J Am Acad Child Adolesc Psychiatry.* 2004;43:134–150
12. Needham B, Crosnoe R. Overweight and depression during adolescence. *J Adolesc Health.* 2004;36:48–55
13. Ross CE. Overweight and depression. *J Health Soc Behav.* 1994; 33:63–78
14. Wang G, Dietz WH. Economic burden of obesity in youths aged 6 to 17 years 1979–1999. *Pediatrics.* 2002;109(5). Available at: www.pediatrics.org/cgi/content/full/109/5/e81
15. US Preventive Services Task Force. Screening for overweight in children and adolescents: where is the evidence? A commentary by the Childhood Obesity Working Group. *Pediatrics.* 2005; 116:235–237
16. Barlow SE, Dietz WH. Management of childhood and adolescent obesity: summary and recommendations based on reports from pediatricians, pediatric nurse practitioners, and registered dietitians. *Pediatrics.* 2002;110:236–241
17. Kuczmarski RJ, Ogden CL, Guo SS, et al. 2000 CDC Growth Charts for the United States: methods and development. *Vital Health Stat 11.* 2002;(246):1–190
18. Centers for Disease Control and Prevention. *BMI for Children and Teens*. Atlanta, GA: Centers for Disease Control and Prevention; 2003. Available at: www.cdc.gov/nccdphp/dnpa/bmi/bmi-for-age.htm. Accessed January 20, 2006
19. Institute of Medicine. *Preventing Childhood Obesity: Health in the Balance*. Washington, DC: National Academies Press; 2005
20. Field AE, Cook NR, Gillman MW. Weight status in childhood as a predictor of becoming overweight or hypertensive in early adulthood. *Obes Res.* 2005;13:1:163–169
21. Must A, Naumova EN, Phillips SM, Blum M, Dawson-Hughes B, Rand WM. Childhood overweight and maturational timing in the development of adult overweight and fatness: the Newton Girls Study and its follow-up. *Pediatrics.* 2005;116:620–627
22. Viner RM, Cole TJ. Adult socioeconomic, educational, social, and psychological outcomes of childhood obesity: a national birth cohort study. *BMJ.* 2005;330:1354–1358
23. NICHD Early Child Care Research Network. Nonmaternal care and family factors in early development: an overview of the NICHD Study of Early Child Care. *J Appl Dev Psychol.* 2001;22: 457–492
24. Long J Scott. *Regression Models for Categorical and Limited Dependent Variables*. Thousand Oaks, CA: Sage Publications; 1997
25. Freedman DS, Dietz WH, Tang R, et al. The relationship of obesity throughout life to carotid intima-media thickness in adulthood: the Bogalusa Heart Study. *Int J Obes Relat Metab Disord.* 2004;28:159–166
26. Casey VA, Dwyer JT, Coleman KA, Valadian I. Body mass index from childhood to middle age: a 50-y follow up. *Am J Clin Nutr.* 1992;56:14–18
27. Task Force on Community Preventive Services. Zaza, S, Briss PA, Harris KW, eds. *The Guide to Community Preventive Services: What Works to Promote Health*. New York, NY: Oxford University Press; 2005. Available at: thecommunityguide.org/pubs/Book/Front-Matter.pdf. Accessed January 20, 2006
28. Teutsch SM, Briss PA. Spanning the boundary between clinics and communities to address overweight and obesity in children [commentary]. *Pediatrics.* 2005;116:240–241
29. Johnson DB, Gerstein, DE, Evans AE, Woodward-Lopez G. Preventing obesity: a life cycle perspective. *J Am Diet Assoc.* 2006;106:97–102
30. Flynn MA, McNeil DA, Maloff B, et al. Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with "best practice" recommendations. *Obes Rev.* 2006;7(suppl 1):7–66
31. Krebs NF, Jacobson MS; American Academy of Pediatrics, Committee on Nutrition. Prevention of pediatric overweight and obesity. *Pediatrics.* 2003;112:424–430

ERRATA

Nader PR, O'Brien M, Houts R, et al. Identifying Risk for Obesity in Early Childhood. PEDIATRICS 2006;118:e594–e601.

An error appears in the article by Nader et al, titled "Identifying Risk for Obesity in Early Childhood" published in the September 2006 issue of *Pediatrics Electronic Pages* (doi:10.1542/peds.2005-2801). In Table 1, "CDC" should be removed from the title.

doi:10.1542/peds.2006-2516

Flores G, Abreu M, Tomany-Korman SC. Why Are Latinos the Most Uninsured Racial/Ethnic Group of US Children? A Community-Based Study of Risk Factors for and Consequences of Being an Uninsured Latino Child. PEDIATRICS 2006;118:e730–e740.

An error appears in the article by Flores et al, titled "Why Are Latinos the Most Uninsured Racial/Ethnic Group of US Children? A Community-Based Study of Risk Factors for and Consequences of Being an Uninsured Latino Child" that was published in the September 2006 issue of *Pediatrics Electronic Pages* (doi:10.1542/peds.2005-2599). On page 1235 of the Electronic Pages section of the print edition, abstract e730, Objective, the first sentence "Latinos continue to be the most uninsured racial/ethnic group of US children, but not enough is known about the risk factors for and consequences of not being insured in Latino children." has been duplicated and should be removed. We regret the error.

doi:10.1542/peds.2006-2691

Kinane TB, Murphy J, Bass JL, Corwin MJ. Comparison of Respiratory Physiologic Features When Infants Are Placed in Car Safety Seats or Car Beds. PEDIATRICS 2006;118:522–527.

An error appears in the article by Kinane et al, titled "Comparison of Respiratory Physiologic Features When Infants Are Placed in Car Safety Seats or Car Beds" that was published in the August 2006 issue of *Pediatrics* (doi:10.1542/peds.2005-2712). On page 522, the Results section of the Abstract, line 4 reads: "The percentages of time with oxygen saturation of <95% were also similar for the 2 groups (car bed: 18.3%; car seat: 11.8%)." It should read: "The percentages of time with oxygen saturation of <95% were also similar for the 2 groups (car bed: 11.8%; car seat: 18.3%)."

doi:10.1542/peds.2006-2693