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## Tracking and variability in childhood levels of BMI: The Bogalusa Heart Study

David S Freedman, PhD<sup>a</sup>, Hannah G Lawman, PhD<sup>b</sup>, Deborah A Galuska, PhD<sup>a</sup>, Alyson B Goodman, MD, MPH, and Gerald S Berenson, MD<sup>c</sup>

<sup>a</sup>Division of Nutrition, Physical Activity and Obesity, Centers for Disease Control and Prevention, Atlanta, GA

<sup>b</sup>Division of Chronic Disease Prevention, Philadelphia Department of Public Health, New Orleans, LA

<sup>c</sup>Division of Cardiology, LSU Health New Orleans Medical Center, New Orleans, LA

### Abstract

**Objective**—Although the tracking of BMI levels from childhood to adulthood has been examined, there is little information on the within-person variability of BMI.

**Methods**—We used longitudinal data from 11,591 schoolchildren, 3096 of whom were reexamined as adults, to explore the tracking and variability of BMI levels. We focus on changes in age-adjusted levels of BMI.

**Results**—There was strong tracking of BMI levels. The correlation of adjusted BMI levels was  $r=0.88$  and 78% of children with severe obesity at one examination had severe obesity at the next examination (mean interval, 2.7 years). Further, an increase in adjusted BMI from  $+5 \text{ kg/m}^2$  (above the median) to  $+10$  increased the risk for adult BMI  $\geq 40$  by 2.7-fold. However, BMI levels among children and adolescents were variable. Over a 9- to 15-month interval, the SD of adjusted BMI change was  $0.9 \text{ kg/m}^2$  and 0.7% of children had an absolute change  $\geq 3.5$ . This variability was associated with the interval between examinations and with the initial BMI.

**Conclusions**—Despite the high degree of tracking of BMI, annual changes of  $3.5 \text{ kg/m}^2$  or more are plausible. Knowledge of this variability is important when following a child over time.

### Introduction

Despite information on the tracking of BMI levels from childhood to adulthood (1–4), there is relatively little information on the within-person variability of BMI changes in childhood

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Address correspondence to, David S Freedman: CDC F-77, 4770 Buford Highway, Atlanta GA 30341 - 3724; phone: 770-488-6016, fax: 815-572-8152; [dxfl@cdc.gov](mailto:dxfl@cdc.gov).

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(5–7). Further, although there are recommendations from Centers for Disease Control and Prevention (CDC) (8) concerning the identification of implausible BMI values at a single examination, few studies have examined the distribution of BMI changes over time (9).

BMI z-scores derived from the 2000 CDC growth charts (10) are widely used in analyses to adjust for sex and age. However, these z-scores are known to be inaccurate for very high BMIs and to have an upper bound of about 3 SDs at most ages (11–14). These limitations have led to the use of 120% of the 95<sup>th</sup> percentile of BMI in the classification of severe obesity (15). Further, because change in BMI<sub>z</sub> is inversely associated with the initial BMI<sub>z</sub> level (16), it has been suggested that longitudinal analyses should focus on changes in BMI rather than BMI<sub>z</sub> (17, 18).

There is, however, little information on the persistence of severe obesity or on the distribution of BMI changes during childhood. The objectives of the current analyses of children and adults in the Bogalusa Heart Study are to (1) examine the variability of BMI levels over time, and (2) examine the prediction of severe obesity in adulthood (BMI ≥ 40) from BMI levels in childhood. We focus on BMI values that are adjusted for sex and age, and we examine the consistency of changes in BMI with those for the arm circumference and triceps skinfold. We use data from 11,591 2- to 17-year-olds who were examined at least 2 times between 1973 and 1994; 3096 children were re-examined as adults.

## Methods

### Study Sample

The Bogalusa Heart Study (19) examines the natural history of risk factors for cardiovascular disease in a biracial community (Ward 4 of Washington Parish, Louisiana). All procedures were in accordance with the ethical standards of the institutions, and approval was obtained from the relevant committees on human subjects.

Seven cross-sectional studies of school-children were conducted from 1973-1974 through 1992-1994, and on average, each of these studies examined about 3500 children. Pre-school schoolchildren (n=714) were also examined in 1973. Overall, there were 27,232 examinations from 11,665 children in these studies. Eight studies of adults were conducted from 1982 through 2008 (20).

Among the schoolchildren, we excluded 342 examinations. These exclusions included 95 records with missing data for weight or height, 23 records in which a girl reported being pregnant, 41 records in which sex was coded inconsistently across examinations, 20 records for which the body size measurements were considered to be implausible (8), 81 records in which whom height decreased by more than 1 inch, 13 records in which BMI levels differed substantially from levels of both arm circumference and triceps skinfold thickness), and 69 records in which there were inconsistencies in the date of birth. These exclusions resulted in a sample of 26,890 records from 11,591 children.

For the longitudinal analyses of BMI levels throughout childhood, we also excluded 229 examinations that occurred within 9 months or more than 7 years after the previous

examination resulting in a sample of 11,591 children. Of these children, 6828 were examined multiple times: 2536 were examined 2 times, 1802 were examined 3 times, 1412 were examined 4 times, and 1078 were examined 5 to 7 times.

Of the 11,591 children, 3106 were re-examined in adulthood. We excluded 10 children who had a final adult age that was within 5 years of their mean childhood age, resulting in a sample of 3096 children who were followed to adulthood.

### Body Size Measures and BMI Metrics

Height was measured to the nearest 0.1 cm and weight to the nearest 0.1 kg; BMI was calculated as  $\text{kg}/\text{m}^2$ . Arm circumference was measured to the nearest cm with a non-stretchable tape, and the triceps skinfold thickness was measured to the nearest mm using Lange Skinfold Calipers (19pp127–47).

Obesity is defined as a BMI  $\geq 95^{\text{th}}$  age-specific percentile of the CDC growth charts for each sex. Because of the inaccuracies of the CDC z-scores and percentiles among heavier children (11, 15), severe obesity is defined as a BMI  $\geq 120\%$  of the  $95^{\text{th}}$  percentile ( $\% \text{BMI}_{p95}$ ). We consider children who have a  $\% \text{BMI}_{p95}$  between 100 and 119 to have ‘moderate obesity’. A child with a  $\% \text{BMI}_{p95}$  of 100 has a BMI that is at the CDC 95th percentile.

Although changes in BMI z-scores, which are derived from the L (transformation for normality), M (median) and S (dispersion) parameters (12, 21), have frequently been used to standardize BMI levels for sex and age, the compression of very high z-scores into a narrow range limits the usefulness of this metric for very high BMIs (14, 22). BMIz values approach an upper bound that varies by sex and age so that among children with very high BMIs, large BMI differences can correspond to only small differences in BMIz.

Because of these limitations, we accounted for the difference in BMI by sex and age by subtracting the median BMI in the CDC growth charts (for each sex and age) from a child’s BMI. We refer to this metric, which has been used in previous longitudinal analyses (17), as ‘adjusted BMI’. The current study focuses on changes (in units of  $\text{kg}/\text{m}^2$ ) in adjusted BMI. We also examine the annualized change in this metric.

### Statistical Methods

All analyses were performed in R (23). Levels of various characteristics of the sample are presented and because multiple examinations from the same children are not independent, we used generalized estimating equations (24) to assess the statistical significance of differences across BMI categories.

We then examined the tracking and within-person variability of adjusted BMI levels between consecutive examinations. In general, a child with N measurements would contribute N-1 pairs of consecutive measurements to the longitudinal analysis. For example, a child who was examined at ages 6, 9, and 12 y of age would contribute 2 pairs of measurements: the change in adjusted BMI between ages 6 and 9 y, and the change in adjusted BMI between 9 and 12 y. There were 15,070 pairs of examinations for these analyses. The tracking of

adjusted BMI levels among these children was examined using cross-classifications of initial and final BMI categories, Spearman correlations, and intraclass correlations coefficients.

Because an objective was to describe the tracking of severe obesity among children, we focus on the prediction of severe (class 3) obesity (BMI  $\geq 40$ ) in analyses that followed children into adulthood. For children who were examined multiple times, we used the mean adjusted BMI in these analyses. Logistic regression models were used to estimate the probability of class 3 obesity according to adult age, race-sex group, and mean levels of adjusted BMI and childhood age. The relative risk associated with an increase of mean adjusted BMI (1) from 0 to +5 kg/m<sup>2</sup> and (2) from +5 to +10 kg/m<sup>2</sup> was estimated in Poisson regression models (25, 26).

## Results

Table 1 shows levels of various characteristics according to BMI status in the 26,890 examinations. Children had moderate obesity (%BMI<sub>p95</sub> of 100 to 119) at about 7% of these examinations and severe obesity (%BMI<sub>p95</sub>  $\geq 120$ ) at about 2% of these examinations. As compared with examinations in which BMI was below the 85th percentile, children at examinations in which they had severe obesity were older (mean difference, 10 months), occurred in later years of the study (1985 vs. 1981), were more likely be black (45% vs. 38%), and had a 14.3 kg/m<sup>2</sup> higher mean adjusted BMI. As assessed in generalized estimating equations that account for the multiple examinations from some children, all of these comparisons were statistically significant at the 0.001 level.

We then assessed the cross-classification of BMI status among the 15,070 pairs of examinations (Table 2) among children. The correlation between consecutive levels of adjusted BMI was  $r=0.88$  and 78% of the 243 subjects who had severe obesity at the initial examination were severely obese at reexamination. (The intraclass correlation coefficient for levels of adjusted BMI was 0.85). Both the positive predictive value and specificity of severe obesity were high, but its sensitivity was only moderate. About 50% ( $n = 26 + 162$ ) of the children with severe obesity at the 2<sup>nd</sup> examination did not have severe obesity at the previous examination.

Table 3 shows the variability of changes in adjusted BMI. The overall SD was 1.9 kg/m<sup>2</sup> with 99% of the children having an adjusted BMI change between  $-4.4$  and  $+8.5$ . Although there was little difference in the variability of the changes in adjusted BMI by sex or race, the SD increased by more than 3-fold (from 0.9 to 3.2) as the interval between examinations increased, decreased with the age of the child, and increased with the initial BMI level. Additional analyses (not shown) indicated that this variability was more strongly related to the interval between examinations than to the child's age.

Among the 2721 children who were re-examined within 9 to 15 months, 99% of the changes in adjusted BMI change were between  $-3.0$  and  $+3.4$  kg/m<sup>2</sup> and only 19 (0.7%) had an absolute change of  $\geq 3.5$ . (Of these 19 children, 14 had an initial BMI that was  $\geq 5$  kg/m<sup>2</sup> above the median and 8 had obesity at the initial examination.) Further, among these 2721

children, the largest decrease in adjusted BMI was  $-9.3 \text{ kg/m}^2$  and the largest increase was  $14.2 \text{ kg/m}^2$  (data not shown).

An examination of the annualized change in adjusted BMI (Table 4), calculated by dividing adjusted BMI change by the interval between examinations, indicated that the overall annualized SD was  $0.7 \text{ kg/m}^2$ . In contrast to analyses in Table 3 that did not account for the time between examinations, the only substantial difference in the variability of the annualized change was across categories of initial BMI. The SDs of the annualized adjusted changes ranged from  $0.6 \text{ kg/m}^2$  (non-obese) to  $1.4$  (severe obesity).

We then examined the cross-classification of levels of childhood %BMI<sub>p95</sub> and adult BMI categories among 3096 subjects who were re-examined as adults (Table 5). The mean follow-up interval was 21 years. Of the 55 children who had had a mean %BMI<sub>p95</sub>  $\geq 120$ , 69% had an adult BMI  $\geq 40$  and only 2 had an adult BMI  $< 30$ . Despite this high positive predictive value, the sensitivity of childhood BMI was low. Of the 233 adults with a BMI  $\geq 40$ , 128 (55%) had had a mean adjusted BMI in childhood that was below the 95<sup>th</sup> percentile.

Figure 1 shows the predicted probabilities, based on logistic regression, of an adult BMI  $\geq 40$  according to race, sex, and mean, adjusted childhood BMI. (Adult age and the mean childhood age were also included as covariates.) At a mean adjusted BMI of  $+10 \text{ kg/m}^2$  and a mean childhood age of 12, the probabilities of severe obesity at age 32 y ranged from 37% (white males) to 64% (black females). As assessed in Poisson regression models, an increase in the mean adjusted BMI from  $+0$  to  $+5 \text{ kg/m}^2$  was associated with a 7.1-fold increase in the risk of an adult BMI  $\geq 40$ . However, as compared with children who had a mean adjusted BMI of  $+5$ , those with a mean adjusted BMI of  $+10$  had a 2.7-fold increased risk for class 3 obesity.

## Discussion

The current results show that although high BMI levels are likely to persist into adulthood, there is a large amount of within-person variability in BMI levels among children. Although the intraclass correlation coefficient among adjusted BMI levels was 0.85 and the Spearman correlation between consecutive levels was  $r = 0.88$ , about 1% of the absolute changes over 9- to 15-months were greater than  $+3.5 \text{ kg/m}^2$ . The within-person variability was most strongly related to the number of years between examinations and the initial BMI level. Despite this variability, during a 22-year (mean) follow-up, adjusted BMI levels among children were strongly associated with an adult BMI  $\geq 40$ . As compared with children who had a BMI at the median of the CDC growth charts, those who had a mean adjusted BMI of  $+5$  had a 7.1-fold increased risk for an adult BMI  $\geq 40$ . Our results concerning the tracking of BMI, along with the high positive predictive value but only moderate sensitivity, are consistent with those of others (1–4).

Although there is some guidance on the identification of implausible BMIs at a single examination (8, 27), few studies have provided information on the distribution of longitudinal BMI changes among children and adolescents (5–7). This is, in part, because of

the large sample needed to quantify the distribution of these changes within categories of sex, age, initial BMI and interval between examinations (28, 29). Velocity growth charts for longitudinal changes in the weight and height (length) have been constructed for infants (30, 31), but not for children and teens. Although the probability of a specific BMI change can also be examined using conditional gain charts (32, 33), this method requires the use of BMIz and this limits its usefulness for children who have very high BMIs.

The few studies that have examined longitudinal changes in BMI among schoolchildren have emphasized the substantial variability of the observed changes (5–7). For example, Brannsether et al. (7) reported that the 90th percentile of annual BMI changes among Norwegian children varied from +1.1 to +2.5 kg/m<sup>2</sup> across sex-age groups. Further, the distribution of BMIz changes had heavy tails, with 6% of the changes being greater than 2 SDs. Other investigators have focused on BMI changes thought to be errors but have provided little justification for the criteria used to identify these values. For example, Kim et al (34) excluded 1-year z-score changes of more than 3 SDs (about 4% of the sample), while an analysis from the Early Childhood Longitudinal Study (35) excluded the smallest and largest 1% of BMI changes. Other studies have had pediatric endocrinologists review cases that were flagged according to various criteria (e.g. more than a 15% change in BMI change over 1 year) (3).

Our results add to the literature by showing the distribution of BMI changes in a carefully measured, diverse sample. This information may be useful when deciding if a large BMI change is plausible or may have resulted from a transcription error. Because the variability of BMI changes was strongly influenced by the time interval between examinations, the changes that we observed over a 9- to 15-month interval may be of most interest. Among these 2721 children, the correlation between consecutive levels of adjusted BMI was  $r = 0.95$  and the SD of adjusted BMI change was 0.9 kg/m<sup>2</sup>. However, 0.7% of these children had an adjusted BMI change of more than 3.5 kg/m<sup>2</sup>. It is possible that BMI changes of this magnitude should be assessed for potential transcription errors.

Over longer periods, however, the variability of BMI is much greater. Among the examinations that were separated by 5 y, for example, the SD of BMI change was about three times larger (3.2 kg/m<sup>2</sup>) and about 2.5% of the adjusted BMI changes were greater than 10 kg/m<sup>2</sup>. Although it is possible that the greater variability of BMI levels among older children could have contributed to this increased variability in adjusted BMI change, the annual rate of change differed only slightly according to the interval between examinations.

Our use of adjusted BMI levels in the current study separates the within-person variability from the age-related increases in BMI. Although this metric does not account for differences in the dispersion of BMI levels with age, the relatively short interval between examinations (2.7 years), may have reduced the effects of differences in dispersion. It should be realized, however, that other BMI metrics can account for differences in both the median (M) and dispersion (S) of BMI levels. For example, the L parameter in the LMS transformation (21) can be set to 0 or 1, and in the latter case, the LMS transformation becomes  $(\text{BMI} - M)/(M \times S)$ . This metric avoids the compression of very high BMIs into a narrow range of z-scores. Further, it can be used to adjust for the differences in the median and dispersion of BMI

levels by sex and age when multiplied by reference values of M and S. The reference values could be chosen to be those at age 20 y or at the mean age of the sample (36).

A strength of the current study is that we were able to verify the BMI values with those for arm circumference and triceps skinfold thickness. An examination of BMIs levels among the 9 children who were examined three or more times and who showed the largest changes in adjusted BMI indicated that all were consistent with changes in arm circumference. Although there were differences between some of the BMI changes and changes in the triceps skinfold thickness, this may reflect the difficulties in accurately measuring skinfolds (37, 38).

At least three limitations of the current study should be considered. For the current analyses, we excluded values thought to be erroneous, but it is likely that errors remained which may have influenced our estimates of BMI variability. For example, one boy in our analyses had adjusted BMI values of +5.6 (age 5 y), +10.5 (7 y), +1.2 (11 y) and +14.2 (16 y). Although both the arm circumference and triceps skinfold of this child showed similar patterns, it is possible that the low value at age 11 y reflected an acute condition or that an incorrect identification number was assigned at that examination. It should also be realized that data for these analyses were collected in a period (1973 through 1994) in which the prevalence of obesity was relatively low (9% in Bogalusa vs. 18.5% in NHANES 2015-16 (39)). Because the variability of adjusted BMI change increases at higher BMIs, our results may underestimate the current variability of BMI values over time. Finally, it should be realized that many of the children contributed more than 1 observation in several of the analyses focused on longitudinal change. As these changes are not independent, we were unable to assess the statistical significance of differences across categories.

In conclusion, these results show although BMI levels track strongly throughout childhood and adolescence and are predictive of high adult BMIs, many children exhibit large changes in BMI as they age. The magnitude of these changes increases with the time between examinations and is greater among children with severe obesity than among other children. Over a period of 9 to 15 months, we found that about 0.7% of children had an absolute change in adjusted BMI of more than 3.5 kg/m<sup>2</sup>. However, among children with severe obesity, adjusted BMI changes of more than 10 kg/m<sup>2</sup> may be observed over longer periods. These results may provide some guidance concerning the magnitudes of BMI changes among children that might be expected.

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## Abbreviations

<b>BMI</b>	body mass index
<b>CDC</b>	Centers for Disease Control and Prevention
<b>NHANES</b>	National Health and Nutrition Examination Survey

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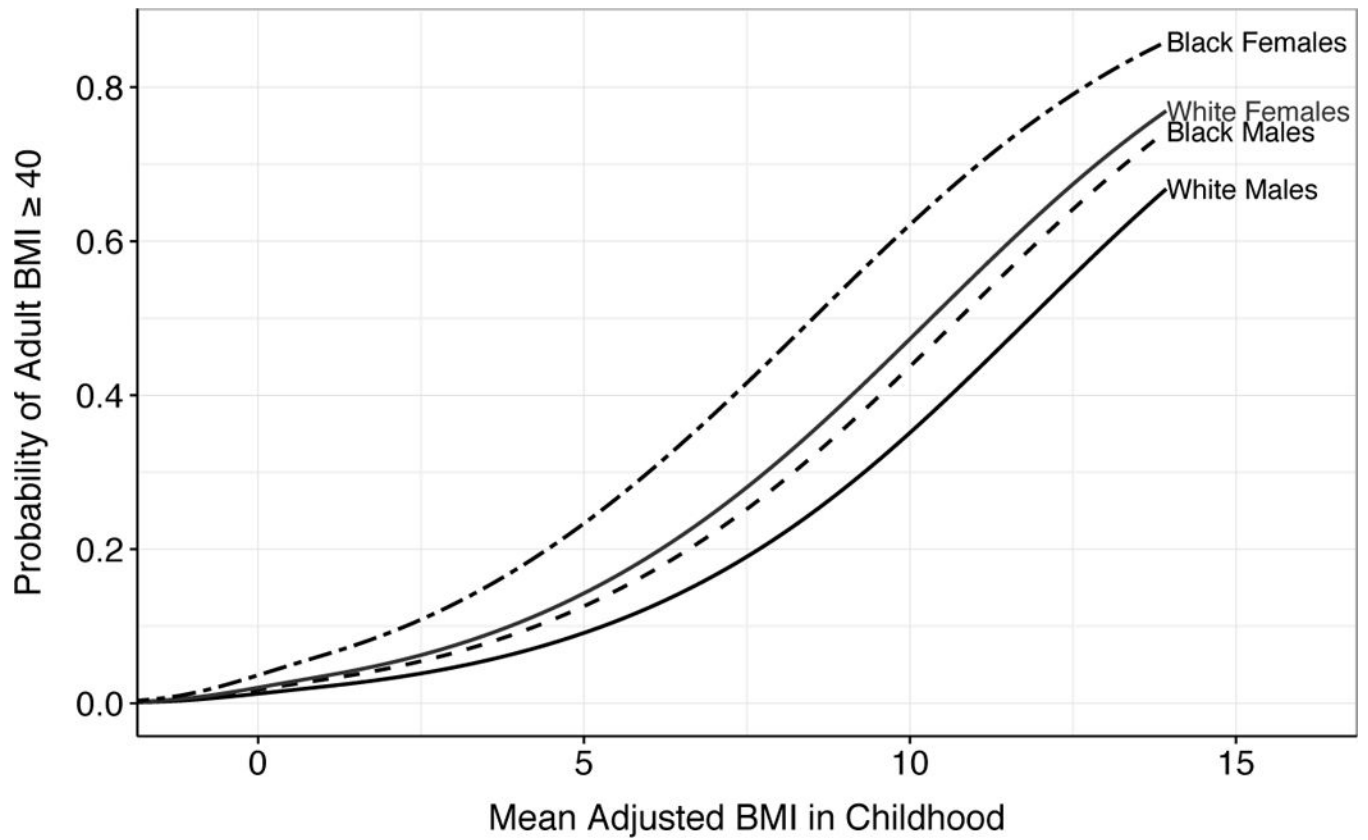
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**What is already known about this subject?**

1. The tracking of BMI levels over time is relatively high and many studies have reported correlation coefficients of  $r > 0.70$  between consecutive examinations.
2. There is, however, very little information on the within-child variability of BMI levels or on the persistence of severe obesity over time.

**What does your study add?**

1. The correlation of adjusted BMI levels was  $r = 0.88$  and 78% of children with severe obesity at one examination had severe obesity at the next examination.
2. Over approximately one year, the SD of adjusted BMI change was  $0.9 \text{ kg/m}^2$  and 0.7% of children had an absolute change  $> 3.5 \text{ kg/m}^2$ .
3. The extent of variability was related to the interval between examinations and to the initial BMI.



**Figure 1.** Predicted probabilities of adult BMI  $\geq 40$  kg/m<sup>2</sup> according to race-sex group and adjusted BMI in childhood. (Adjusted BMI was calculated by subtracting the CDC sex- and age-specific 50th percentile of BMI from a child's BMI). The probabilities were calculated for an adult age of 32 y.

**Table 1**

Descriptive characteristics according to BMI status for 26,890 examinations in the Bogalusa Heart Study

	<b>BMI &lt; 85 Percentile</b>	<b>Overweight (BMI Percentile: 85 to 94)</b>	<b>Moderate Obesity<sup>a</sup> (%BMIP95: 100 to 119)</b>	<b>Severe Obesity (%BMIP95: 120)</b>
N (examinations) <sup>b</sup>	21,332	3,158	1,797	603
Year of examination	1981 (1976, 1985) <sup>c</sup>	1983 (1977, 1988)	1984 (1977, 1988)	1985 (1979, 1993)
Age (y)	10.9 (7.8, 13.8)	11.2 (8.5, 13.9)	11.1 (8.6, 13.6)	11.7 (9.2, 14.2)
% Girls	49%	52%	49%	47%
% Blacks	38%	35%	35%	45%
BMI (kg/m <sup>2</sup> )	17.3 (15.4, 18.9)	22.0 (19.4, 24.4)	25.4 (22.6, 28.3)	31.9 (28.4, 35.3)
Adjusted BMI (kg/m <sup>2</sup> ) <sup>d</sup>	-0.3 (-1.4, 0.8)	4.3 (3.3, 5.3)	7.8 (6.3, 9.3)	14.0 (11.7, 15.7)
Arm Circumference (cm)	21.5 (18.5, 24.0)	25.9 (22.8, 29.0)	28.6 (25.5, 32.0)	33.3 (30.0, 37.0)
Triceps skinfold (mm)	12.3 (8.7, 15.0)	20.0 (16.0, 24.0)	25.3 (20.7, 29.7)	32.6 (27.3, 36.7)

<sup>a</sup> A child with a %BMIP95 of 100 has a BMI that is at the CDC 95th percentile.

<sup>b</sup> The examinations were from 11,591 children.

<sup>c</sup> Values of the continuous variables are mean (25<sup>th</sup> and 75<sup>th</sup> percentiles).

<sup>d</sup> Adjusted BMI is child's BMI minus the sex- and age-specific median in the CDC growth chart.

**Table 2**

Cross-classification of initial and subsequent BMI status

Initial Exam	Subsequent Exam			
	Overall	Non-obese <sup>a</sup>	Moderate Obesity <sup>a</sup>	Severe Obesity <sup>a</sup>
Non-obese	13,935	13,429 (96%) <sup>b</sup>	481 (4%)	26 (0.2%)
Moderate Obesity	892	226 (25%)	504 (56%)	162 (18%)
Severe Obesity	243	6 (2%)	47 (19%)	189 (78%)
Overall	15,070	13,661 (91%)	1032 (7%)	377 (3%)

<sup>a</sup>The 'non-obese' category consists of children with a BMI < 95th percentile (%BMI<sub>p95</sub> < 100). Moderate obesity represents a %BMI<sub>p95</sub> of 100 to 119, while severe obesity represents a %BMI<sub>p95</sub> ≥ 120.

<sup>b</sup>Values are the number of number of examination pairs (2 consecutive examinations). Values in parentheses are row percents.

**Table 3**

Variability of change in adjusted BMI

Category	N <sup>a</sup>	SD	Percentiles							Spearman Correlation <sup>b</sup>
			0.5	2.5	5.0	97.5	99.5	8.5		
Overall	15,070	1.9	-4.4	-2.4	0.8	5.4	8.5		0.88	
Sex										
Boys	7,635	1.8	-4.4	-2.3	0.7	5.1	8.0		0.88	
Girls	7,435	2.0	-4.5	-2.6	0.9	5.7	9.0		0.87	
Race <sup>c</sup>										
Whites	9,063	1.9	-4.5	-2.6	0.8	5.2	8.3		0.87	
Blacks	6,005	1.9	-4.0	-2.2	0.8	5.7	9.0		0.89	
Initial Age										
2 to 6	3,431	2.0	-2.2	-1.6	0.7	6.7	10.1		0.82	
7 to 9	4,397	1.9	-3.1	-1.8	0.8	5.8	9.0		0.88	
10 to 13	5,724	1.8	-4.8	-3.0	0.9	4.6	7.0		0.89	
14 to 17	1,518	1.5	-5.7	-3.4	0.7	3.1	4.5		0.92	
Interval Between Examinations										
0.75 to 1.25 y	2,721	0.9	-3.0	-1.7	0.5	2.3	3.4		0.95	
1.25 to 2.4 y	3,130	1.4	-4.7	-2.4	0.7	3.2	4.9		0.90	
2.5 to 3.4 y	6,642	1.8	-4.6	-2.7	0.9	5.0	6.8		0.87	
3.5 to 4.9 y	1,516	2.5	-4.0	-2.3	1.1	7.5	10.6		0.83	
5 to 6.9 y	1,061	3.2	-4.5	-2.8	1.5	10.1	12.8		0.76	
Initial BMI Category (%BMIp95)										
<100 <sup>th</sup>	13,936	1.7	-3.4	-2.2	0.7	4.7	7.7		0.85 <sup>d</sup>	
100 to 119	892	3.2	-7.2	-4.5	2.2	8.3	12.1		0.43 <sup>d</sup>	
120	242	3.7	-8.7	-5.9	2.7	9.0	13.0		0.50 <sup>d</sup>	

<sup>a</sup>Pairs of examinations. Adjusted BMI was calculated by subtracting the CDC 50<sup>th</sup> sex- and age-specific percentile of BMI from a child's BMI. Change in adjusted BMI represents the adjusted BMI at the 2nd examination minus the adjusted BMI at the first examination.

<sup>b</sup>Spearman correlation between consecutive values of adjusted BMI

<sup>c</sup>All children are non-Hispanic.

$\rho$  Correlations within categories of initial BMI should be interpreted with caution as the range of initial BMI values is restricted.

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**Table 4**

Variability of annualized change in adjusted BMI

Category	N <sup>a</sup>	SD	Percentiles				
			0.5	2.5	50	97.5	99.5
Overall	15,070	0.7	-2.2	-1.1	0.3	1.8	2.6
Sex							
Boys	7635	0.7	-1.9	-1.0	0.3	1.7	2.6
Girls	7435	0.7	-2.3	-1.1	0.4	1.8	2.6
Race							
Whites	9063	0.7	-2.2	-1.1	0.3	1.7	2.5
Blacks	6005	0.7	-1.9	-1.0	0.3	1.8	2.8
Initial Age							
2 to 6	3431	0.6	-0.9	-0.6	0.3	1.8	2.6
7 to 9	4397	0.6	-1.2	-0.7	0.3	1.8	2.5
10 to 13	5724	0.7	-2.3	-1.3	0.4	1.8	2.6
14 to 17	1518	0.9	-3.2	-2.1	0.4	1.6	2.9
Interval Between Examinations							
0.75 to 1.25 y	2,721	0.9	-3.0	-1.7	0.5	2.2	3.4
1.25 to 2.4 y	3,130	0.7	-2.4	-1.2	0.3	1.6	2.5
2.5 to 3.4 y	6,642	0.6	-1.6	-0.9	0.3	1.6	2.3
3.5 to 4.9 y	1,516	0.6	-0.9	-0.5	0.3	1.7	2.3
5 to 6.9 y	1,061	0.6	-0.9	-0.5	0.3	1.8	2.4
Initial BMI Category (%BMIp95)							
<100 <sup>th</sup>	13,936	0.6	-1.8	-1.0	0.3	1.6	2.4
100 to 119	892	1.2	-4.0	-2.2	0.9	2.5	3.7
120	243	1.4	-5.3	-2.6	1.1	2.8	3.3

<sup>a</sup>Pairs of examinations. The annualized change in adjusted BMI was by dividing the change in adjusted BMI by the number of years between the 2 examinations. Adjusted BMI is the child's BMI minus the CDC 50<sup>th</sup> sex- and age-specific percentile.



**Table 5**

Cross-classification of childhood and adult BMI status

Mean %BMIp95 in Childhood	Overall	Adult BMI (kg/m <sup>2</sup> ) <sup>a</sup>		
		< 30	30 – 39	40
< 100	2,866	2,045 (71%)	695 (24%)	128 (4%)
100 to 119	175	24 (14%)	82 (47%)	67 (39%)
120	55	2 (0.4%)	15 (27%)	38 (69%)
Overall	3,096	2,071	792	233

<sup>a</sup>BMI at last examination in adulthood

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