Relation of Age at Menarche to Race, Time Period, and Anthropometric Dimensions: The Bogalusa Heart Study

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ABSTRACT. ***Objective.*** **To assess secular trends in menarcheal age between 1973 and 1994 and to determine whether childhood levels of height, weight, and skinfold thicknesses can account for racial (white/black) differences in menarcheal age.**

Methods. **Data from 7 cross-sectional examinations of school-aged children, with menarcheal age obtained through interviews, were used for both cross-sectional (11 218 observations) and longitudinal (*n* = 2058) analyses. In the latter analyses, the baseline examination was performed between ages 5.0 and 9.9 years, and the mean follow-up was 6 years.**

Results. **Black girls experienced menarche, on average, 3 months earlier than did white girls (12.3 vs 12.6 years), and during the 20-year study period, the median menarcheal age decreased by approximately 9.5 months among black girls versus approximately 2 months among white girls. As compared with 5- to 9-year-old white girls, black girls were taller and weighed more, characteristics that were predictive of a relatively early (before age 11.0 years) menarche. However, even after adjustment for weight, height, and other characteristics, the rate of early menarche remained 1.4-fold higher among black girls than among white girls.**

Conclusions. **Additional study of the determinants of menarcheal age is needed, as the timing of pubertal maturation may influence the risk of various diseases in adulthood.** ***Pediatrics*** **2002;110(4). URL: http://www.pediatrics.org/cgi/content/full/110/4/e43;** ***menarche, obesity, blacks, height, secular trend.***

ABBREVIATIONS. BMI, body mass index; RR, rate ratio.

Black girls in the United States undergo sexual development at younger ages than do white girls.[1–5] In a study of 17 000 girls, for example, mean menarcheal ages were 12.2 years (blacks) and 12.9 years (whites),[4] a racial difference consistent with those that have been observed in the development of breast and pubic hair.[2,3] The timing of these events may influence the risk of various diseases in adulthood, and an early menarche has been associated with an increased risk for breast cancer,[6] obesity,[7–9] and spontaneous abortion.[10]

The reasons for these racial differences in menarcheal age are uncertain, but several characteristics, such as obesity,[11–14] height,[3,8,13–15] and skeletal maturation,[16–18] are known to influence sexual development. Furthermore, the dramatic decrease in menarcheal age between the mid-1800s and the mid-1900s[19] may be related to the changes in childhood heights and weights that occurred during this period as a result of improved nutritional status. As compared with similarly aged white girls, black girls are more advanced skeletally (after age 9 years),[20] are taller,[3,21] and are heavier.[3] It is uncertain, however, whether these characteristics account for the earlier sexual development of black girls in the United States.

The objectives of the current study were to examine changes in the menarcheal ages of girls between 1973 and 1994 and to determine whether differences between black and white girls are attributable to weight, height, or skinfold thicknesses. These associations are examined in the Bogalusa Heart Study,[22] a long-term study of cardiovascular disease risk factors among children and adults.

METHODS

Sample

Bogalusa (Louisiana), a semirural community of approximately 40 000 people, is 70 miles northeast of New Orleans. Seven cross-sectional studies of schoolchildren, with participation rates >80%, were conducted in ward 4 of Washington Parish between 1973–1974 and 1992–1994.[21] Protocols were approved by appropriate institutional review boards, and informed consent was obtained from all participants.

With the exception of the first study, in which the upper age range was 14 years, each examination targeted all 5- to 17-year-old schoolchildren in Bogalusa. This panel design resulted in multiple examinations for many participants, allowing for both cross-sectional and longitudinal analyses. A 6-year-old examined in 1976, for example, could have been reexamined in studies conducted in 1978, 1981, 1984, and 1987.

The current study consists of both cross-sectional and longitudinal analyses. The cross-sectional sample includes all 5- to 17-year-old girls who were examined between 1973 and 1994 and consists of 11 590 examinations conducted among 5552 different girls. We excluded 307 examinations because menarcheal status (for girls who were in the third grade and above) was unknown and 65 examinations because a postmenarcheal girl did not provide information on menarcheal age, resulting in a sample of 11 218 observations.

The 3132 girls who were examined 2 or more times were considered eligible for the longitudinal analyses. Because we were interested in the relation of various childhood characteristics to menarcheal age, we restricted these analyses to 2058 girls who had an initial (baseline) examination before age 10 years, along with a

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subsequent (follow-up) examination after age 10 years. For girls in this cohort who had participated in >1 examination before age 10 years, we used data from the first examination. For those who participated in >1 follow-up examination, we used data from the first examination after menarche. Of the girls in this cohort, 524 (25%) reported being premenarcheal at all follow-up examinations, and data from the final examination were used to increase the length of follow-up.

The 2058 girls in this cohort had a mean (range) age at baseline of 7.2 years (5.0–9.9) and at follow-up of 13.4 years (10.0–17.9). There were various combinations of baseline and follow-up examinations in this cohort, but the largest numbers of girls were followed from 1987–1988 to 1992–1994 (n = 378) and from 1973–1974 to 1978–1979 (n = 252).

General Examinations

The examination procedures used in the Bogalusa Heart Study have been described.[22] Weight was measured to the nearest 0.1 kg using a balance beam scale, and height was measured to the nearest 0.1 cm with a manual height board. The body mass index (BMI; kg/m^2) was used as an index of relative weight. Levels of weight, height, and BMI were converted into sex- and age-specific percentiles (P) and z scores based on national US data collected between 1963 and 1994.[23]

The triceps skinfold thickness was measured 3 times in succession with Lange skinfold calipers, and the mean value is included in the analyses. The subscapular skinfold thickness was not measured until 1978 to 1979 (the third of 7 examinations), and levels are available for approximately 50% of the girls in the longitudinal analyses.

Menarcheal History

As previously described,[24] information on menarcheal age was obtained through interview by a registered nurse. Girls in the third grade and above were asked whether they had ever had a menstrual period, and, when necessary, the term "menstrual period" was explained. Postmenarcheal girls were then asked to identify the year (and in some examinations, the month) of their first period. Probing questions such as, "Do you remember what grade you were in when you started having periods?" were used to help the respondent remember the date.

Because most postmenarcheal girls provided the year but not the month of menarche, we assumed that all girls experienced menarche at the midpoint (July 1) of the specified year. Age at menarche was then calculated by dividing the number of days between birth and July 1 of the reported year by 365.25.

Statistical Analyses

Unless stated otherwise, menarcheal age is treated as a continuous variable in all analyses, with an age of 11 years, for example, representing exactly 11.0 years rather than all ages between 11 years and 11.9 years. The cumulative distribution of menarcheal age in the cross-sectional sample was examined using lowess (locally weighted scatterplot smoother), a robust smoothing technique that uses the data to determine the shape of the relation[25]; the neighborhood width was 25%. The median menarcheal age and the proportion of girls who experienced menarche by age 11 years were estimated by using logistic regression to model the proportion of postmenarcheal girls as a function of age (the "status quo" method[26]).

Various analyses were then performed in the longitudinal sample to determine whether black/white differences in various childhood characteristics (eg, height) could explain the earlier menarche of black girls. Mean levels of various characteristics were contrasted between black and white girls, and because some data were censored (524 of 2058 girls in this cohort had not undergone menarche by their final examination), the median age at menarche and the proportions of postmenarcheal girls at various ages were obtained using the Kaplan-Meir (product-limit) method.[27] The statistical significance of the racial difference in menarcheal age was assessed with the log-rank test.

Mean levels of various characteristics were examined according to menarcheal age, and Cox proportional hazards models were used to examine predictors of early (<11.0 years) menarche. Of the 2058 girls, 240 underwent menarche by age 11 years, 1294 girls reported menarche after age 11 years, and 438 were premenarcheal at a follow-up examination after age 11 years. The 86 girls who were premenarcheal at an examination between the ages of 10 and 11 years were considered to be censored in these analyses. Age of menarche (before 11 years) was the dependent variable in these proportional hazards analyses, and we controlled for the year of follow-up examination (with indicator variables) and baseline age. A hazard rate ratio (RR) >1 would indicate that the specified characteristic is predictive of early menarche.

RESULTS

Figure 1 shows the cumulative distribution of menarche by age among white and black girls in the

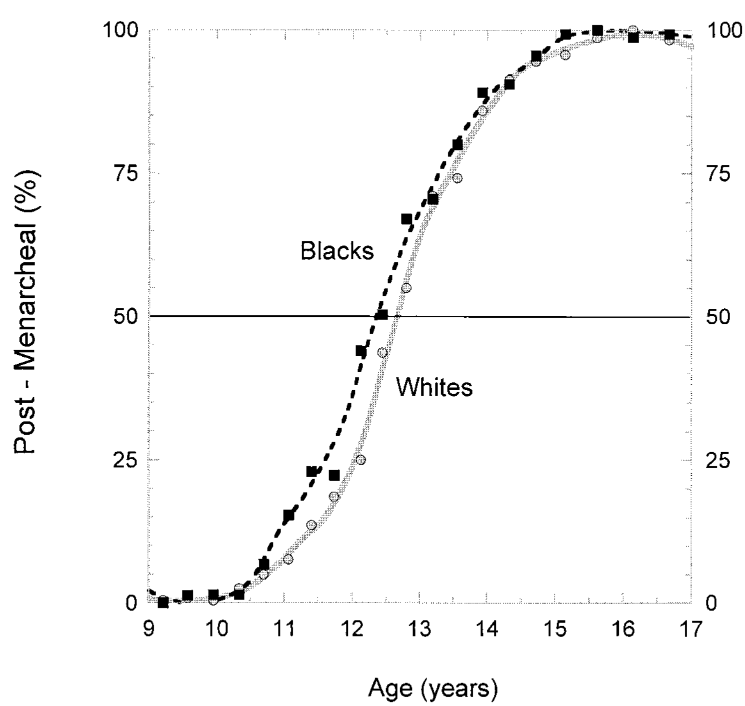

Fig 1. Lowess curves showing the proportion of black girls (black curve) and white girls (gray curve) who had experienced menarche at various ages. Curves were based on cross-sectional data collected between 1973 and 1994. The proportions of postmenarcheal girls within various age groups (each of which included approximately 375 girls) are also shown.

cross-sectional (1973–1994) sample; the curves represent smoothed (lowess) estimates, and the points represent the proportion of postmenarcheal girls within age intervals of approximately 0.5 years. On the basis of the smoothed curves, the median menarcheal age (ie, the age at which 50% of girls had undergone menarche) was approximately 3 months lower among black girls than among white girls. Furthermore, the racial difference was most evident in the proportion of girls who underwent a relatively early menarche. Between the ages of 10.5 and 10.9 years, for example, 4.6% of white girls versus 8.0% of black girls reported having undergone menarche. As estimated in logistic regression models, median menarcheal ages were 12.73 years (whites) and 12.45 years (blacks).

Cross-sectional analyses within each examination (Table 1) indicated that the median menarcheal age of black girls decreased substantially during the 20-year study period, from 12.9 years (1973–1974) to 12.1 years (1992–1994). In contrast, secular trends among white girls were smaller (and less consistent), with the median menarcheal age initially increasing from 12.7 years (1973–1974) to 12.9 years (1976–1977 through 1981–1982). The median menarcheal age of white girls subsequently decreased to 12.5 years, resulting in a 2-month difference between 1973–1974 and 1992/1994. Similar trends were also seen in the proportion of girls who underwent menarche by age 11.0 years, with a larger increase occurring among black girls (5% to 17%) than among white girls (7% to 10%). There was no racial difference in BMI levels among 7- to 10.9-year-old girls, but black girls were 2 to 3 cm taller, on average, in each examination.

Subsequent analyses were based on the longitudinal sample of 2508 5- to 9.9-year-old girls who were followed for (mean) 6 years. Various characteristics of this cohort are shown in Table 2. The mean baseline age among both black and white girls was 7.2 years (range: 5.0–9.9 years), and the mean age at follow-up was 13.4 years (range: 10.0–17.9 years). At follow-up, 70% of white girls and 82% of black girls had undergone menarche, with median ages of 12.6 years (whites) and 12.3 years (blacks; $P < .001$ for racial difference). Approximately 10% of white girls versus 15% of black girls in this cohort had undergone menarche before age 11 years.

Several of the anthropometric dimensions also differed between white and black girls. As assessed by age-specific z scores, black girls were substantially heavier (0.2 standard deviations) and taller (0.4 standard deviations) than white girls ($P < .001$ for each difference). (Mean levels of weight and height were also higher among black girls than among white girls, but the 0.5-kg weight difference was not statistically significant.) The differences in both weight and height resulted in similar BMI levels between the 2 groups, but white girls had thicker skinfolds (triceps and subscapular) than did black girls ($P < .01$).

Mean baseline (ages 5.0–9.9 years) levels of several characteristics, within categories of subsequent menarcheal age, are shown in Table 3. Of the 240 girls who reported having undergone menarche before age 11.0 years, for example, 50% were black, and mean childhood levels of height and weight were 124 cm and 27.0 kg, respectively. In contrast, girls who underwent menarche after age 13.0 years were, on average, 4 cm shorter (mean: 120 cm) and weighed 3.8 kg less (mean: 23.2 kg) in childhood. Correlations between menarcheal age and the anthropometric dimensions (final column) ranged from −0.20 (triceps skinfold thickness) to −0.28 (weight) and were fairly similar among black and white girls.

Predictors of early (<11.0 years) menarche were then examined in proportional hazards models (Table 4). The rate of early menarche was higher (RR = 1.56) among black girls than among white girls and was associated with all anthropometric dimensions considered separately. (Initial age and the year of follow-up examination were included in all models.) For facilitating comparisons of characteristics measured on different scales (eg, kg/m^2 vs log mm), the estimated RRs are also shown for girls at the 75th percentile versus 25th percentile of each anthropometric dimension (second column). On the basis of these comparisons, the rate of early menarche among girls at the 75th percentile of weight was almost 2-fold (RR = 1.95) higher than among girls at the 25th percentile, and similar RRs

TABLE 1. Median Age of Menarche, the Proportion of Girls Who Underwent Menarche by Age 11 Years, and Mean Levels of BMI and Triceps Skinfold Thickness, by Race and Examination Among Girls in the Cross-Sectional Sample*

Examination Years	N	Median Age† of Menarche		Menarche (%) Before Age 11.0 Years		BMI‡ (kg/m^2)		Height‡ (cm)	
		Whites§	Blacks§	Whites	Blacks	Whites	Blacks	Whites	Blacks
Overall	9158	12.7 (12.6–12.8)	12.5 (12.4–12.6)	7%	11%	17.5	17.5	132	135
1973–1974	1398	12.7 (12.6–12.9)	12.9 (12.7–13.1)	7%	5%	16.8	16.7	132	134
1976–1977	1561	12.9 (12.7–13.1)	12.6 (12.4–12.8)	5%	7%	16.9	17.3	132	135
1978–1979	1319	12.9 (12.8–13.1)	12.8 (12.6–13.0)	6%	6%	17.1	17.6	131	135
1981–1982	1197	12.9 (12.7–13.0)	12.4 (12.4–12.6)	6%	11%	17.4	17.5	133	135
1984–1985	1239	12.6 (12.4–12.7)	12.1 (11.8–12.3)	8%	21%	17.6	17.3	133	135
1987–1988	1214	12.6 (12.4–12.8)	12.2 (11.9–12.4)	11%	14%	18.1	17.6	133	135
1992–1994	1230	12.5 (12.4–12.8)	12.1 (11.9–12.3)	10%	17%	18.7	18.7	134	137

* Analyses were restricted to 9158 girls between the ages of 7.0 and 16.9 years.

† Median age (and % of girls who experienced menarche by age 11 years) was estimated in cross-sectional analyses using logistic regression.

‡ Estimates of mean BMI and height are restricted to girls between the ages of 7.0 and 10.9 years and have been adjusted for the effects of age.

§ 95% confidence interval is shown in parentheses.

TABLE 2. Characteristics of the Longitudinal Cohort (n = 2058)

	Whites	Blacks
n	1253	805
Year of baseline examination	1979 ± 5	1979 ± 5
Year of follow-up examination	1985 ± 5	1985 ± 5
Initial age (y)	7.2 ± 1.3	7.2 ± 1.4
Follow-up age (y)	13.4 ± 1.7	13.4 ± 1.6
Menarcheal characteristics*		
Median age (y)	12.6‡	12.3‡
Before age 11.0 y (%)	10%	15%
Before age 12.0 y (%)	30%	43%
Before age 13.0 y (%)	64%	72%
Postmenarcheal at follow-up (%)	70%‡	82%‡
Baseline characteristics		
Weight (kg)	24.4 ± 7.2	24.9 ± 6.8
Height (cm)	121 ± 10‡	123 ± 10‡
BMI (kg/m^2)	16.4 ± 2.7	16.2 ± 2.4
Triceps skinfold (mm)	14 ± 5‡	12 ± 5‡
Subscapular skinfold (mm)†	8 ± 5‡	7 ± 4‡
Age-specific scores		
Weight	−0.1 ± 1.1‡	0.1 ± 1.0‡
Height	−0.2 ± 1.0‡	0.2 ± 0.9‡
BMI	0.1 ± 1.0	0.1 ± 1.0

* Estimates of median menarcheal age and proportions of girls who experienced menarche by specific ages are based on Kaplan-Meir (product-limit) estimates. The statistical significance of the racial difference in menarcheal age was assessed with the log-rank test.

† A total of 1007 (of the 2058) girls had a subscapular skinfold thickness measurement at baseline.

‡ $P < .01$.

were observed for height (1.83) and BMI (1.79). The RRs for the skinfold thicknesses were lower (1.4–1.5) but were also statistically significant.

We then examined whether the racial difference in the rate of early menarche could be attributed to differences in the anthropometric characteristics (Table 4). Controlling for height and either BMI (model 1) or weight (model 2) reduced the RR for race by approximately 25%, but the rate of early menarche remained significantly higher (RR = ~1.4) among black girls. White girls had thicker triceps skinfolds than did black girls, and at comparable levels of this skinfold and height (model 3), the rate of early menarche was 1.57-fold higher among black girls.

Figure 2 illustrates the relation of race, height, and BMI to menarcheal age. (Because of the strong intercorrelation between weight and height [$r = 0.76$], the model containing race, BMI, and height (model 2 in Table 4) was slightly more predictive of early menarche.) The curves represent the cumulative distribution of menarche among girls whose childhood levels of BMI and height both were above the median (upper curves) or both were below the median (lower curves).

The cumulative distribution of menarche by age varied greatly between the low/low and high/high groups, but in general, a slightly larger proportion of black girls than white girls had experienced menarche at each age. For example, at age 11.0 years, 4% (whites) versus 7.5% (blacks) of girls in the low/low group had undergone menarche. Among girls with high levels of both height and BMI, the racial difference tended to be more pronounced at older ages. For example, fairly similarly proportions of white (19%) and black (21%) girls in the high/high group had experienced menarche by age 11.0 years, but comparable proportions at age 12.0 years were 48% (whites) and 59% (blacks).

DISCUSSION

Our results indicate that, on average, black girls undergo menarche approximately 2 to 3 months earlier than do white girls. In addition, between 1973 and 1994, the median menarcheal age of black girls decreased markedly (~9.5 months), but white girls showed a smaller and somewhat inconsistent secular decrease. As compared with 5- to 9-year-old white girls, similarly aged black girls were taller and weighed more, characteristics that were predictive of menarche before age 11.0 years. However, even after statistical adjustment for these anthropometric dimensions, the rate of early menarche remained approximately 1.4-fold higher ($P < .01$) among black girls.

Racial differences in the median menarcheal age, which were 12.45 years (blacks) and 12.73 years (whites) in our cross-sectional analyses, have been reported by other investigators. Three studies conducted in the early 1990s, for example, found that black girls underwent menarche approximately 0.7 years earlier than white girls, with median estimates ranging from 12.0 years to 12.2 years among black girls and from 12.7 years to 12.9 years among white girls.[4,13,14] In contrast, a substantially smaller racial difference in menarcheal age was reported in the 1960s (12.5 years for black girls vs 12.8 years for white girls),[1] and we found little difference between the menarcheal ages of black and white girls in 1973–1974.

The average menarcheal age decreased by approximately 4 years between the mid-1800s and the mid-1900s.[19] Although it has been suggested that this age has remained stable in recent decades,[28,29] we found a substantial decrease among black (but not white) girls between 1973 and 1994. A similar interaction, with the median menarcheal age showing a larger decrease among black girls (0.7 years) than among white girls (0.1 years), was also observed in national US data between 1963–1970 and 1988–1994.[30] It should be realized, however, that the current analyses are based on data from a single community and that menarcheal ages (and racial differences) could vary by location. For example, the Health Examination Survey (1963–1970) found that black girls generally experienced menarche earlier than white girls but that there was no racial difference in the South.[1] The observed secular trends among black girls in Bogalusa may be related to various programs aimed at improving nutritional status, such as the National School Lunch Program and the Federal Food Stamp Act. Consistent with the secular trends that we observed in menarcheal age, black 9- to 12-year-old girls in Bogalusa showed a larger increase in height between 1973 and 1994 than did white girls.[21]

The numerous changes that occur in the years preceding menarche, which is a relatively late event in puberty, make it difficult to determine which (if any) factor is causative.[31] The timing of menarche,

TABLE 3. Childhood Levels of Various Characteristics in the Longitudinal Cohort According to Subsequent Age at Menarche

	Age at Menarche (Y)				Premenarcheal* at Follow-up	Correlation With Menarcheal Age†
	<11.0	11.0–11.9	12.0–12.9	≥13.0		
Overall						
N	240	427	480	472	439	
Race (% black)	50%	48%	38%	38%	26%	
Height (cm)	124‡	123	122	120	121	−0.25§
Weight (kg)	27.0	25.9	24.4	23.2	23.9	−0.28§
BMI (kg/m²)	17.3	16.7	16.2	15.8	16.1	−0.24§
Triceps skinfold (mm)	15	14	14	13	13	−0.20§
White girls						
N	119	221	296	291	326	
Height (cm)	123	122	121	120	120	−0.20§
Weight (kg)	27.3	25.7	24.2	23.5	23.6	−0.24§
BMI (kg/m²)	17.5	16.8	16.3	16.0	16.1	−0.23§
Triceps skinfold (mm)	16	15	14	14	14	−0.20§
Black girls						
N	121	206	184	181	113	
Height (cm)	125	124	123	121	122	−0.26§
Weight (kg)	26.7	26.2	24.6	22.9	24.5	−0.32§
BMI (kg/m²)	16.9	16.6	16.1	15.5	16.1	−0.24§
Triceps skinfold (mm)	13	13	12	11	11	−0.19§

* Consists of premenarcheal girls whose final examination was the ages of 10 y and 12.9 y. The 85 girls who were older than 13 y at follow-up and who reported being premenarcheal were included in the "menarche ≥ 13.0 y" category.
† Spearman correlation coefficient adjusted for race and baseline age; premenarcheal girls have been excluded from these analyses.
‡ Mean levels of height, weight, BMI, and triceps skinfold thickness have been adjusted (in linear regression models) for race (in the overall analyses) and baseline age.
§ $P < .001$.

TABLE 4. Baseline Predictors of Early Menarche (< 11.0 Years)* in the Longitudinal Sample

	Hazard RRs	
	1-Unit Difference	75th Percentile Versus 25th Percentile†
Individual predictors‡		
Race (black vs white)	1.56¶ (1.2, 3.0)	–
Height *z* score	1.60¶ (1.4, 1.8)	1.83 (1.5, 2.2)
Weight *z* score	1.63¶ (1.4, 1.8)	1.95 (1.6, 2.3)
BMI *z* score	1.52¶ (1.3, 1.7)	1.79 (1.5, 2.1)
Log triceps skinfold	2.31¶ (1.6, 3.4)	1.48 (1.2, 1.8)
Log subscapular skinfold§	1.73‖ (1.2, 2.4)	1.38 (1.1, 1.7)
Joint predictors		
Model 1		
Race (black vs white)	1.43‖ (1.1, 1.8)	–
Height *z* score	1.37¶ (1.2, 1.6)	1.51 (1.2, 1.8)
BMI *z* score	1.37¶ (1.2, 1.6)	1.54 (1.3, 1.8)
Model 2		
Race (black vs white)	1.42‖ (1.1, 1.8)	–
Height *z* score	1.11 (0.9, 1.4)	1.15 (0.9, 1.5)
Weight *z* score	1.50¶ (1.3, 1.8)	1.75 (1.4, 2.2)
Model 3		
Race (black vs white)	1.57‖ (1.2, 2.1)	–
Height *z* score	1.43¶ (1.2, 2.1)	1.59 (1.3, 1.9)
Log triceps skinfold	2.02¶ (1.4, 3.0)	1.39 (1.2, 1.7)

* 240 (of the 2058) girls experienced menarche before age 11.0 y.
† RRs compare the rate of early menarche for girl at the 75th vs 25th percentile of each specified characteristic.
‡ All models control for baseline age and year of follow-up; levels of height, weight, and skinfold thicknesses were measured among 5.0- to 9.9-year-olds.
§ 1007 girls had a subscapular skinfold thickness measurement at baseline
‖ $P < .01$.
¶ $P < .001$.

however, is strongly correlated with the degree of skeletal maturation,[17,18,26] and height is a fairly accurate measure of bone growth and skeletal age in childhood.[32,33] The relation of childhood height to menarcheal age may, therefore, indicate that children with an advanced skeletal maturation (as indicated by height) tend also to have an advanced sexual development (as indicated by menarcheal age). A moderate ($r \sim 0.5$) correlation between bone age at age 8 years and menarcheal age has been reported,[34] and several studies have found childhood height to be inversely associated with subsequent menarcheal age.[3,8,13,15,35] Although childhood obesity is also predictive of early menarche,[11,12,36] there does not seem to be a "critical" body weight (or fatness).[33]

In agreement with the racial difference in height that we observed, the skeletal maturation of black 9- to 12-year-old girls is greater than that of white girls.[20] However, even at comparable levels of height, BMI, weight, and skinfold thicknesses, we found that black girls underwent menarche earlier than white girls. It is possible that a single childhood measurement does not entirely capture the relevant developmental information, and after age 9 years, the annual change in height is a stronger predictor of menarcheal age than is actual height.[35] Additional analyses of the 761 girls in the current study who had 2 premenarcheal examinations confirmed the importance of height change, but the racial difference in menarcheal age was independent of both childhood height and the rate of height increase (data not shown).

In agreement with other results,[12,30] we found that childhood height, weight, and skinfold thicknesses were similarly related to menarcheal age among black and white girls. Because 9- to 12-year-old black girls have less body fat than do white girls,[37] it is possible that there are racial differences in other

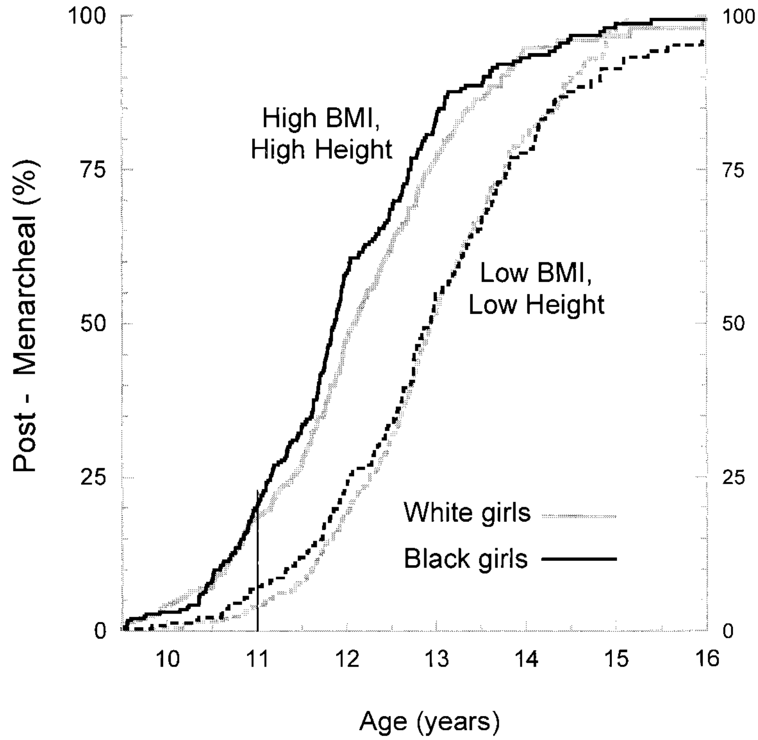

Fig 2. Proportions of girls in the longitudinal cohort who had experienced menarche by various ages, according to race, BMI, and height. The solid lines represent the proportion of girls who had (age-specific) baseline levels of both BMI and height above the median and were postmenarcheal at various ages; the dashed curves represent girls whose baseline levels of both BMI and height were below the median.

characteristics associated with the timing of menarche. For example, leptin levels are predictive of early menarche,[38] and levels are higher among black girls than white girls.[39] Racial differences may also exist in other characteristics that have been suggested to influence pubertal development, such as the secretion of hormones by the hypothalamus, anterior pituitary, and ovary[40]; social stress[41]; organic pollutants[42]; and hormone-containing hair products.[43]

The most important limitation of the current study may be our use of self-reported menarcheal age. Correlations between recalled and recorded menarcheal ages have generally been high ($r > 0.75$) over periods of up to 10 years,[44,45] with 60% of girls being able to recall the month and year of menarche over short periods.[46] Additional analyses (data not shown) of 1082 girls in Bogalusa who were examined 2 times after menarche suggested that the reproducibility of menarcheal age in the current study was somewhat lower ($r = 0.57$), possibly as a result of our lack of information on month of menarche. However, we found that the 2 reported menarcheal ages differed by 1 year or less among 84% of these girls, and this estimate was similar among white (85%) and black (83%) girls. In addition, the estimated racial difference in median menarcheal ages was almost identical in the cross-sectional (0.28 years) and longitudinal (0.32 years) analyses, suggesting that the latter were not strongly influenced by a misclassification bias.

The age of menarche may have important health implications in later life. For example, relatively early maturers (<11 years) have been found to be slightly shorter but up to 5.5 kg heavier in adulthood than are late maturers.[7,9,14] In addition, a relatively young age at menarche increases the risk for breast cancer.[6,47] Our findings indicate that a secular decrease in menarcheal age may still be occurring (particularly among black girls) and that various anthropometric dimensions cannot account for black/white differences in menarcheal age. Additional studies of the determinants of menarcheal age are needed, as well as possible explanations for the differences between black and white girls.

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