Secondary Sexual Characteristics and Menses in Young Girls Seen in Office Practice: A Study from the Pediatric Research in Office Settings Network

Article *in* PEDIATRICS · May 1997

DOI: 10.1542/peds.99.4.505 · Source: PubMed

7 authors, including:

Marcia E Herman-Giddens
University of North Carolina at Chapel Hill
67 PUBLICATIONS **5,726** CITATIONS

SEE PROFILE

Richard Wasserman
Larner College of Medicine University of Vermont
151 PUBLICATIONS **9,450** CITATIONS

SEE PROFILE

Gary G. Koch
University of North Carolina at Chapel Hill
462 PUBLICATIONS **114,024** CITATIONS

SEE PROFILE

Secondary Sexual Characteristics and Menses in Young Girls Seen in Office Practice: A Study from the Pediatric Research in Office Settings Network

Marcia E. Herman-Giddens, Eric J. Slora, Richard C. Wasserman, Carlos J. Bourdony, Manju V. Bhapkar, Gary G. Koch and Cynthia M. Hasemeier

Pediatrics 1997;99;505-512
DOI: 10.1542/peds.99.4.505

PEDIATRICS

APR 1997
VOL. 99
NO. 4

Secondary Sexual Characteristics and Menses in Young Girls Seen in Office Practice: A Study from the Pediatric Research in Office Settings Network

Marcia E. Herman-Giddens, PA, DrPH*; Eric J. Slora, PhD‡; Richard C. Wasserman, MD, MPH§‡; Carlos J. Bourdony, MD‖; Manju V. Bhapkar, MS¶; Gary G. Koch, PhD¶; and Cynthia M. Hasemeier, BS‡

ABSTRACT. *Objective.* **To determine the current prevalence and mean ages of onset of pubertal characteristics in young girls seen in pediatric practices in the United States.**

Methods. **A cross-sectional study was conducted by 225 clinicians in pediatric practices belonging to Pediatric Research in Office Settings, a practice-based research network. After standardized training in the assessment of pubertal maturation, practitioners rated the level of sexual maturation on girls 3 through 12 years who were undergoing complete physical examinations.**

Results. **Data were analyzed for 17 077 girls, of whom 9.6% were African-American and 90.4% white. At age 3, 3% of African-American girls and 1% of white girls showed breast and/or pubic hair development, with proportions increasing to 27.2% and 6.7%, respectively, at 7 years of age. At age 8, 48.3% of African-American girls and 14.7% of white girls had begun development. At every age for each characteristic, African-American girls were more advanced than white girls. The mean ages of onset of breast development for African-American and white girls were 8.87 years (SD, 1.93) and 9.96 years (SD, 1.82), respectively; and for pubic hair development, 8.78 years (SD, 2.00) and 10.51 years (SD, 1.67), respectively. Menses occurred at 12.16 years (SD, 1.21) in African-American girls and 12.88 years (SD, 1.20) of age in white girls.**

Conclusions. **These data suggest that girls seen in a sample of pediatric practices from across the United States are developing pubertal characteristics at younger ages than currently used norms. Practitioners may need to revise their criteria for referral of girls with precocious puberty, with attention to racial differences.** *Pediatrics* **1997;99:505–512;** ***puberty, secondary sexual characteristics, growth and development, precocious puberty, menses, menstruation, adrenarche, thelarche.***

ABBREVIATIONS. US, United States; AAP, American Academy of Pediatrics; PROS, Pediatric Research in Office Settings; HANES, Health and Nutrition Examination Survey.

The development of secondary sexual characteristics in girls is a significant event, signaling the onset of physiological and psychological changes of profound importance to the individual, family, and society. Studies from around the world have shown that the age of onset of pubertal changes can vary with race and ethnicity, environmental conditions, geographical location, and nutrition.[1]

Up-to-date, geographically relevant standards for the assessment of the onset of pubertal changes in girls are necessary for several reasons. Appropriate standards are required for practitioners to make clinical judgments on patients for whom growth and developmental problems are a concern. In addition, normative prevalence data on the pubertal characteristics of young girls at various ages are essential for the provision of appropriate anticipatory guidance and patient education. Finally, assessment of secular changes from one generation to the next is impossible without such information.

Despite the need for these data, the onset and prevalence of secondary sexual characteristics in

From the *Department of Maternal and Child Health, School of Public Health and the Office of Chief Medical Examiner, University of North Carolina, Chapel Hill, North Carolina; ‡Pediatric Research in Office Settings, Department of Research, American Academy of Pediatrics, Elk Grove Village, Illinois; the §Department of Pediatrics, University of Vermont College of Medicine, Burlington, Vermont; the ‖Department of Pediatrics, University of Puerto Rico School of Medicine, San Juan, Puerto Rico; and the ¶Department of Biostatistics, School of Public Health, University of North Carolina, Chapel Hill, North Carolina.
Received for publication Jan 23, 1996; accepted May 6, 1996.
Reprint requests to (M.E.H.-G.) Office of the Chief Medical Examiner, CB#7580, University of North Carolina, Chapel Hill, NC 27599–7580.

young girls have not been studied adequately.[2,3] Specifically, no large-scale studies on sexual maturation have been published on racially diverse groups of girls from the United States (US) younger than 12 years of age (Table 1).[4] In the larger US studies of development, some girls had already begun puberty at the time of entry into the studies, causing an upward bias to prevalence figures and calculations of the age of onset of the secondary sexual characteristics.[9,10] Other US studies cannot be used to provide normative data due to the dated nature of the study,[5,6] small sample size,[4–6,8] racial limitations,[5,6,8,10] or late age at entry in the study.[5,6,8–10] One recent study on Mexican-American girls 10 to 17 years of age concluded that pubertal events in that population occurred a few months later than in other populations, but noted that appropriate comparative data were lacking.[10]

Because nationally representative pubertal data for US girls are lacking, clinicians have relied largely on Marshall and Tanner's classic studies on variations of pubertal changes in girls,[4,9] despite previously described problems with such use of their studies.[4,11,12] To establish the current prevalence and mean ages of onset of pubertal characteristics in young girls seen in US practice settings and to establish a baseline for future trend studies, the American Academy of Pediatrics (AAP) Pediatric Research in Office Settings (PROS) network undertook this cross-sectional investigation. The goal of the study was to describe the prevalence of secondary sexual characteristics and the occurrence of menses in American girls aged 3 through 12 years to provide pubertal data relevant to girls seen in pediatric office practice. Although it was recognized that a study of girls drawn from practice would not represent a population-based sample, it was believed that findings from such a study would provide more relevant norms for US girls than currently exist.

METHODS

Overview

This cross-sectional study was conducted in practices participating in the AAP's practice-based research network (PROS) established in 1986 to study pediatric primary care problems in practice settings. Practices were recruited by volunteer pediatricians (chapter coordinators; see Appendix) from AAP chapters throughout the country. At the time of the study, the network consisted of 632 self-selected clinicians (pediatricians, nurse practitioners, and physician assistants) in 155 practices located in 34 states and the Commonwealth of Puerto Rico. The 65 practices that participated in the study are listed in the Appendix.

The age, gender, practice arrangement, and subspecialty distributions of PROS pediatricians were compared with a randomly selected sample of 1611 AAP members who responded to an AAP Periodic Survey of Fellows in 1992. PROS pediatricians, when compared with respondents identifying direct patient care as their primary professional activity, were similar in age (56.7% younger than 45 vs 58.2%, χ^2 = .31, NS), gender (40.4% female vs 36.6%, χ^2 = 2.1, NS), and practice arrangement (27.1% solo or two-person practice vs 28.5%, χ^2=.13, NS).

Study Design and Sample

Data were collected from July 1992 through September 1993. Subjects were girls 3 through 12 years old who were being seen for a health supervision (well-child) visit or for a problem (eg, abdominal pain, fatigue) that according to office routine would require a complete physical examination. The study was approved by the Institutional Review Board of the AAP. Informed consent for the assessment phase of the study was not required because identifying information was known only to the practice where the subjects were seen and participating practitioners included only those network clinicians whose normal practice during complete physical examinations included examination of the breast, pubic, and axillary areas. All PROS practices are required to inform their patients of the practice's participation in a research network.

Completeness of subject enrollment was determined through daily logs. Participating clinicians were asked to keep a record of all 3- through 12-year-old girls who were seen for a complete physical examination during the data collection period, and whether or not they were enrolled as subjects. Analysis of these logs indicated that 99.4% of eligible subjects were enrolled in the study. A sticker was placed on each study subject's chart to assure that no girl was enrolled in the study more than once.

Procedures

To assure the accuracy of puberty ratings, participating clinicians were trained in the assessment of pubertal characteristics using training materials (comprising text and photographs by the authors) prepared for the study by two of the authors (M.E.H-G., C.J.B.). The sexual maturity staging criteria and definitions used in the study were the five stages of breast and pubic hair development determined by visual inspection as described by Marshall and Tanner (Tanner staging).[7,13] Before participating in the study, clinicians were required to take a 12-item photo test of sexual maturity staging. Test subjects were of varied racial and ethnic groups. To be eligible to collect data for the study, clinicians had to score 87.5% or higher on the test. Of 276 clinicians completing the validity training and testing, 260 passed. Clinicians who failed the test were dropped from the study. In all, 225 clinicians from 65 practices collected data.

To assess the inter-rater reliability of sexual maturity stage

TABLE 1. Selected Studies on Pubertal Events in Girls

Authors	Type of Study	Subjects	Age Range (yr)	Race	Mean Age (yr)* of Stage II Breast/ Pubic Hair	Mean Age (yr) of Onset of Menses	Year
Reynolds and Wines[5]†‡	Longitudinal	49	8–18	White	10.8/11.0	12.9	1948
Nicholson and Hanley[6]*‡	Longitudinal	70–97	8–18	Not stated	10.6/11.6	12.8	1953
Marshall and Tanner[7]	Mixed Longitudinal	192	8 up	White	11.2/11.7	13.5	1969
Lee[8]†‡	Longitudinal	18	8.6–17.8	White	11.2/11.9	13.3	1980
Harlan[9]†‡	Cross-sectional	2688	12–17	Mixed		12.8 White 12.5 Af.-Am.	1980
Villarreal[10]†‡	Cross-sectional	699	10–17	Mexican-American	11.0/11.3		1989
Herman-Giddens and MacMillan[4]†‡	Cross-sectional	525	3–10	Mixed			1991

* Health and Nutrition Examination Survey.
† Age at onset of characteristic.
‡ US studies.

ratings between clinicians, practitioners from 13 randomly selected practices participated in the inter-rater reliability phase of the study. Two clinicians from each practice independently recorded the Tanner stages of breast and pubic hair, and sexual maturity stage of axillary hair development on three to five consecutive girls ages 7 through 12 who met the requirements for study inclusion, for a total of 57 comparisons. Because examination by two clinicians was considered a departure from normal practice, informed consent was obtained from the subject's parent or guardian, and assent was obtained from the subject. Kappa statistics were calculated to assess inter-rater reliability in assigning pubertal stages.[14] Kappa statistics (agreement corrected for chance) were .86 for breast development, .93 for pubic hair development, and .81 for axillary hair development.

Study data were collected using a one-page, two-sided standardized form for each enrolled subject. The form elicited information on the girl's age, height, weight, race, ethnicity, payment status, reason for visit, chronic illness and medication history, presence or absence of menses, and stages of development of breast, pubic hair, and axillary hair. Children of stated mixed race were classified as "other." Because axillary hair stages are not described by Marshall and Tanner,[7] we designated the following stages for this study: stage 1–no hair; stage 2–sparse, either curly or straight; and stage 3–mature, adult type. The data collection form contained drawings with the stage number to be circled and verbal anchors that corresponded to each of the sexual maturity stages to enhance accuracy in assignment of the stages. A copy of the form is available on request. Heights and weights were collected only to the nearest centimeter or .5 inch and .5 kilogram or pound, respectively, due to the difficulty of calibrating the measuring instruments in multiple offices.

Data Analyses

The main quantities of interest were the proportions of girls at a given age with secondary sexual characteristics and menses and the mean ages of onset for each characteristic. Proportions are presented for the entire samples of African-American and white girls without regard to weight or other factors that might affect puberty to present overall prevalence data. For each racial and age group, the prevalence was calculated as the proportion with any development at stage 2 or greater. The association between race and pubertal stage was assessed with adjustment for age by the Cochran-Mantel-Haenszel test.[15] Consistency of the association at each age was confirmed by the nonsignificance of the Breslow-Day test. Estimates for mean ages of entry into a stage were calculated by probit analysis, a technique that provides estimates for mean and SD from cross-sectional data for proportions with a characteristic at different ages.[16] Probit analysis has the capability for obtaining these estimates from data for which only a portion of subjects have achieved the characteristic being studied. Data on menses were collected by the status quo method[1] (subject is asked whether or not she is menstruating and her precise age), and mean ages for onset also were calculated by probit analysis. In the probit analysis for menses a 5-year-old white girl with reported menses was excluded as not compatible with the probit model because all other girls with menses were at least 8 years old. All analyses were carried out with PC-SAS.[17]

RESULTS

Sample

Clinicians completed data collection sheets on 18 549 girls. For 976 (5.3%), the race, ethnicity, birth dates, or all pubertal values were missing from the form, or the girls were out of the age range of the study. These girls were deleted from the study. Because races other than African-American or white constituted only 2.8% of the study population, these cases were deleted from further analyses as well. The 17 077 remaining girls, of whom 90.4% were white and 9.6% were African-American, comprised the study sample. The sample demographics are described in Table 2. Girls of Hispanic ethnicity occurred in both African-American and white groups.

TABLE 2. Demographic and Clinical Characteristics of Study Subjects by Race

Characteristic	Afr.-Am. (%) (N = 1638)	White (%) (N = 15 439)	Total (%) (N = 17 077)
Race	9.59	90.41	100.00
Hispanic	3.25	3.75	3.71
Payment status			
Medicaid	44.65	9.24	12.63
Other	55.35	90.16	87.37
Type of visit			
Well-child care	94.48	95.87	95.74
Other	5.52	4.13	4.26
Chronic disease			
Asthma	6.62	2.53	2.92
Other	6.19	3.41	3.67
Asthma and other	0.43	0.12	0.15
Chronic medications			
Glucocorticoids	0.56	0.27	0.30
Other	4.82	2.60	2.81
Glucocorticoids and other	0.31	0.09	0.11

The final sample distribution by age and race is shown in Table 3.

Secondary Sexual Characteristics and Menses

Figures 1, 2, and 3 show the prevalence of breast, pubic hair, and axillary hair development, respectively, at sexual maturity stage 2 or greater by age and race. Even at the youngest study age of 3, a small proportion of girls showed breast or pubic hair development, with the proportions increasing incrementally with age. Figure 4 shows the prevalence of breast and/or pubic hair development at stage 2 or greater, that is of interest in assessing what proportion of girls of a given age are developing one or more secondary sexual characteristics (ie, any sign of pubertal development). At age 7, 27.2% of African-American girls and 6.7% of white girls had evidence of breast and/or pubic hair development with the proportions increasing to 48.3% and 14.7% respectively, by age 8. At age 8, 16.8% of African-American girls and 1.8% of white girls also had axillary hair. For each characteristic, African-American girls were more advanced than white girls of the same age. Prevalences by age and race with 95% confidence intervals are shown in Table 4. Confidence intervals were calculated in a manner typically used for odds ratios, with the focus being the logarithm of odds for

TABLE 3. Age and Race Distribution of the Final Study Group

Age (yr)	Af.-Am. (%)	White (%)	Total (%)
3	290 (17.7)	2280 (14.8)	2570 (15.1)
4	290 (17.7)	2533 (16.4)	2823 (16.5)
5	209 (12.8)	2411 (15.6)	2620 (15.3)
6	126 (7.7)	1506 (9.8)	1632 (9.6)
7	136 (8.3)	1128 (7.3)	1264 (7.4)
8	143 (8.7)	1334 (8.6)	1477 (8.7)
9	115 (7.0)	1067 (6.9)	1182 (6.9)
10	112 (6.8)	1153 (7.5)	1265 (7.4)
11	126 (7.7)	1104 (7.2)	1230 (7.2)
12	91 (5.6)	923 (6.0)	1014 (5.9)
Total	1638 (9.6%)	15 439 (90.4%)	17 077

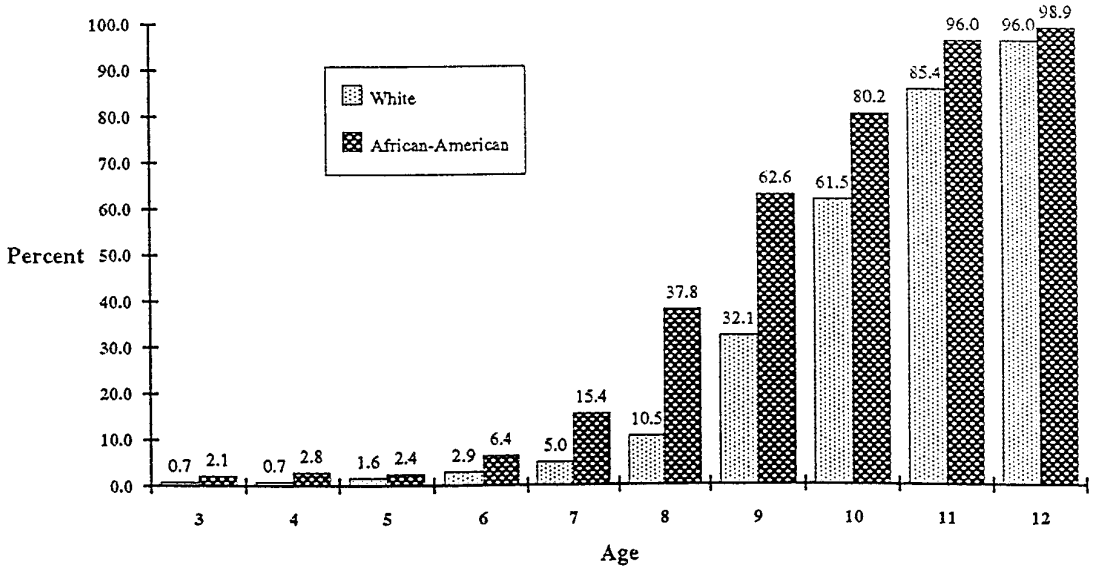

Fig 1. Prevalence of breast development at Tanner stage 2 or greater by age and race (Cochran-Mantel-Haenszel $\chi^2 = 168.6$, df = 1, $P < .001$; Breslow-Day $\chi^2 = 10.7$, df = 9, $P = .300$).

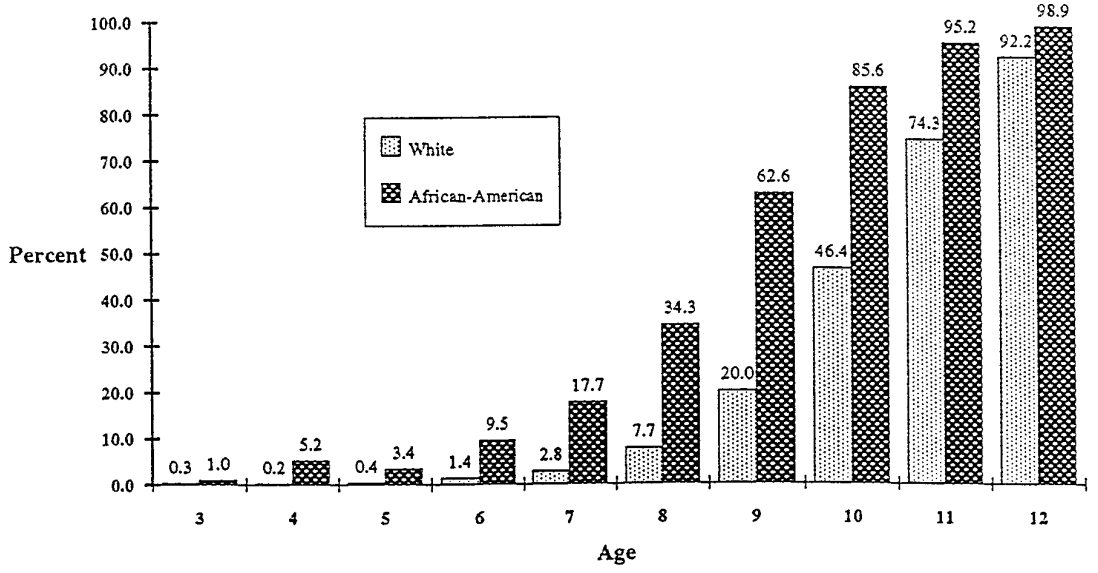

Fig 2. Prevalence of pubic hair development at Tanner stage 2 or greater by age and race (Cochran-Mantel-Haenszel $\chi^2 = 408.0$, df = 1, $P < .001$; Breslow-Day $\chi^2 = 7.8$, df = 9, $P = .552$).

the characteristic or not, and with counts having .5 added to improve statistical behavior.[14]

Figure 5 presents the prevalence of menarche by age and race. At age 11, 27.9% of African-American girls and 13.4% of white girls had begun menses; at age 12, 62.1% of African-American girls and 35.2% of the white girls had begun menses.

Mean heights and weights of study girls controlling for age were compared using the paired *t* test statistic ($P < .001$) with a national sample of race-specific data from the first and second national Health and Nutrition Examination Surveys (HANES).[18] In general, the girls in our study were taller and heavier than the HANES sample, especially as age increased. Study girls who had one or more secondary sexual characteristics were larger and heavier than sexually immature girls.

Mean Ages of Onset of Development of Pubertal Characteristics

Mean ages for attainment of Tanner stage 2 and stage 3 for breast and pubic hair, and for menarche are shown in Table 5 along with the SD of the ages of onset and the standard error of the estimated mean. The mean age for onset of breast development was 8.87 years for African-American girls and 9.96 years for white girls. The mean age for the onset of pubic hair development was 8.78 years for African-American girls and 10.51 years for white girls. Mean age of onset of stage 2 axillary hair was 10.08 (SD, 2.01) and 11.80 (SD, 1.93) years for African-American and white girls, respectively. The difference in ages of onset between African-American and white girls were significant ($P < .001$) for all characteristics, both with and without controlling for height and weight.

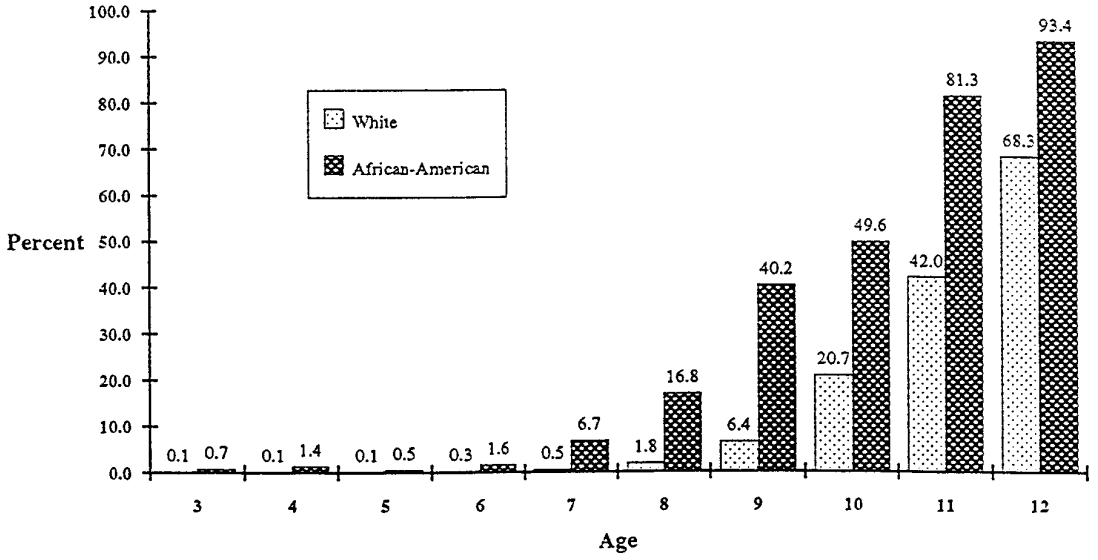

Fig 3. Prevalence of axillary hair development at stage 2 or greater by age and race (Cochran-Mantel-Haenszel $\chi^2 = 329.1$, df = 1, $P < .001$; Breslow-Day $\chi^2 = 16.5$, df = 9, $P = .057$).

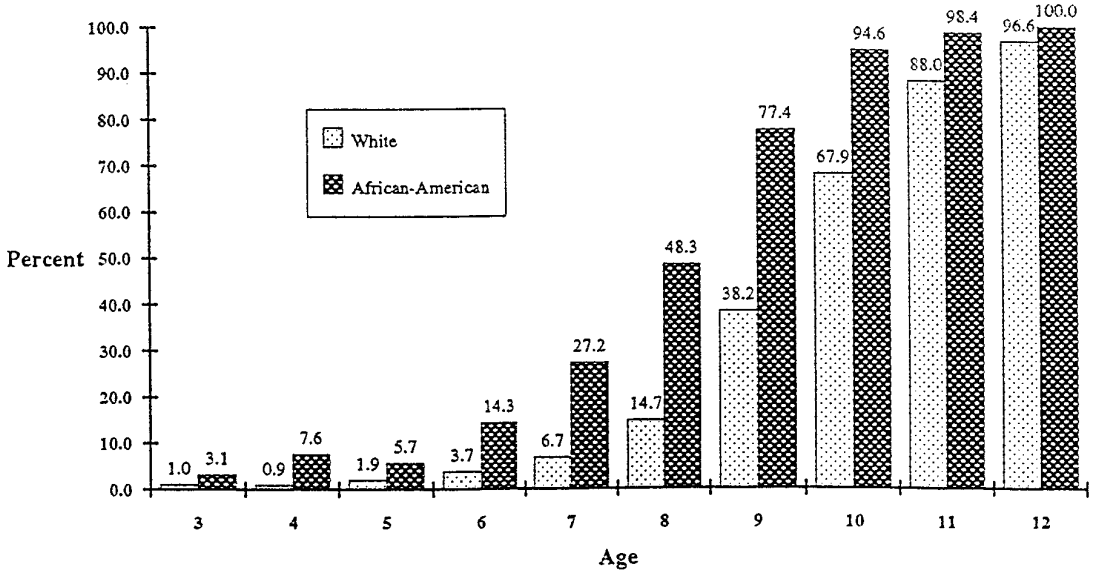

Fig 4. Prevalence of breast and/or pubic hair development at Tanner stage 2 or greater by age and race (Cochran-Mantel-Haenszel $\chi^2 = 354.8$, df = 1, $P < .001$; Breslow-Day $\chi^2 = 10.0$, df = 9, $P = .354$).

African-American girls began menses on the average at 12.16 years. White girls were almost three-fourths of a year older, beginning at 12.88 years.

DISCUSSION

Our cross-sectional study found that girls seen in pediatric office practices are developing pubertal characteristics at younger ages than suggested in standard pediatric textbooks[19,20] and in earlier US studies.[5,6,8,9] We found that on average, African-American girls begin puberty between 8 and 9 years of age and white girls by 10 years of age. We have presented our data in prevalence graphs, as well as by mean ages of attainment of pubertal characteristics, to allow visual appreciation of the proportion of girls experiencing development at given ages with its inherent social, psychological, and physical significance.

Due to methodological differences, late age at entry, or small sample sizes in earlier studies,[5,6,8] there are no adequate US data to assess changes over time in the age of pubertal onset. With these limitations in mind, however, white girls in our study appear to be developing 6 months to 1 year sooner than girls in these earlier studies. Some populations of girls outside of North America have been noted previously to begin breast development earlier than Marshall and Tanner's British population.[1,21–25]

Comparisons of the onset of menses are more reliable than those which require assessment of physical characteristics. The status quo method[1] allows application of a probit analysis, yielding estimates for the mean and variance for the population. We found the mean age of onset of menses to be 12.88 years in white girls and 12.16 in African-Americans. Therefore, it appears that age of onset of menses in

TABLE 4. Percentages of Girls With Secondary Sexual Characteristics at Sexual Maturity Stage 2 or Greater by Age and Race*

Age (yr)	Breast Development		Pubic Hair		Axillary Hair	
	Af.-Am.	White	Af.-Am.	White	Af.-Am.	White
3	2.07 (1.03–4.74)	0.70 (0.45–1.17)	1.03 (0.42–3.38)	0.26 (0.13–0.61)	0.70 (0.25–2.98)	0.09 (0.03–0.38)
4	2.77 (1.50–5.64)	0.67 (0.43–1.10)	5.19 (3.27–8.61)	0.24 (0.12–0.55)	1.40 (0.62–3.89)	0.12 (0.05–0.40)
5	2.40 (1.15–5.93)	1.54 (1.13–2.21)	3.37 (1.76–7.16)	0.42 (0.24–0.80)	0.50 (0.15–3.60)	0.08 (0.03–0.36)
6	6.35 (3.45–12.58)	2.93 (2.22–3.95)	9.52 (5.74–16.37)	1.40 (0.94–2.18)	1.64 (0.59–6.77)	0.27 (0.12–0.76)
7	15.44 (10.51–22.78)	4.97 (3.88–6.45)	17.65 (12.33–25.21)	2.75 (1.98–3.93)	6.67 (3.74–12.68)	0.54 (0.27–1.26)
8	37.76 (30.31–46.03)	10.50 (9.00–12.30)	34.27 (27.08–42.49)	7.67 (6.38–9.25)	16.79 (11.64–24.24)	1.75 (1.19–2.66)
9	62.61 (53.37–70.82)	32.11 (29.39–35.00)	62.61 (53.37–70.82)	20.04 (17.77–22.58)	40.18 (31.64–49.54)	6.43 (5.13–8.14)
10	80.18 (71.47–86.33)	61.51 (58.66–64.27)	85.59 (77.44–90.71)	46.43 (43.56–49.32)	49.55 (40.41–58.72)	20.69 (18.46–23.17)
11	96.03 (90.39–98.11)	85.36 (83.12–87.30)	95.24 (89.38–97.61)	74.27 (71.58–76.75)	81.30 (73.19–87.02)	41.96 (39.05–44.95)
12	98.90 (92.32–99.67)	95.97 (94.44–97.03)	98.90 (92.32–99.67)	92.15 (90.17–93.68)	93.41 (85.56–96.69)	68.25 (65.09–71.22)

* Followed by 95% confidence intervals in parentheses.

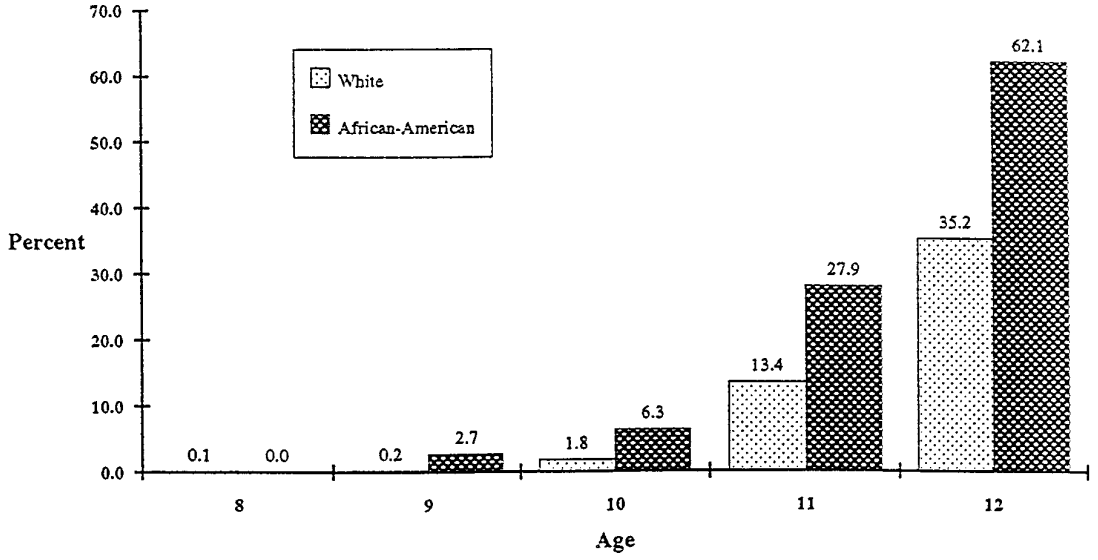

Fig 5. Prevalence of menses by age and race (Cochran-Mantel-Haenszel $\chi^2 = 55.4$, df = 1, $P < .001$; Breslow-Day $\chi^2 = 4.9$, df = 4, $P = .295$).

white girls in the US has remained stable over the last 45 years. (See Table 1 and discussions by Tanner,[26] Zacharias and Wurtman,[27] and Wyshak and Frisch[28]).

The most reliable earlier data on the onset of menses in African-American girls are in MacMahon's analysis of HANES cycles II (1963–1965) and III (1966–1970) findings.[29] African-American girls in this population began menses at 12.52 years. African-American girls in our study were 12.16 years. If the age of menses onset for African-American girls has in fact decreased, it may be due to African-Americans now coming closer to achieving optimal nutritional and health status, as age of menarche may be more sensitive to nutritional and chronic infection status than development of the secondary characteristics.[1,30]

Our study found African-American girls entering puberty approximately 1 to 1.5 years earlier than white girls and beginning menses approximately 8.5 months earlier. We have no explanation for the discrepancy in timing sequence between the African-American and white girls for either the onset of puberty and subsequent menses or appearance and spacing of the secondary sexual characteristics. Neither can we explain the earlier development among African-American girls in general.

A number of studies in the US have noted earlier development and larger prepubertal size among African-American girls.[4,9,29–32] Harlan et al,[9] in their analysis of the HANES cycle III (1966–1970), found that the differences between African-American and white girls' development necessitated separate tables, as did Herman-Giddens and MacMillan[4] in 1991. Several studies of girls in the 1970s and 1980s, assessing the relationship between sexual maturity, blood pressure, and lipids levels, found African-American girls taller, heavier, and maturing earlier than white girls of the same age.[33–36]

Several methodological issues need to be considered in interpreting these data. The subjects were being seen for visits requiring complete physical examinations in largely suburban practices in a practice-based research network. Neither the practices nor the girls in the study were selected randomly to represent a statistical sample. If these girls differ systematically from girls in the general population, the results could be questioned. However, the large number of study subjects and the lack of a plausible reason why girls in the general population should

TABLE 5. Mean Age of Transition to Sexual Maturity Stages 2 and 3 and Menarche

	Mean (yr)*	SD	SE
Breast		Tanner Stage 2	
White	9.96	1.82	0.032
Afr.-Am.	8.87	1.93	0.093
Breast		Tanner Stage 3	
White	11.30	1.42	0.032
Afr.-Am.	10.19	1.42	0.084
Pubic Hair		Tanner Stage 2	
White	10.51	1.67	0.032
Afr.-Am.	8.78	2.00	0.094
Pubic Hair		Tanner Stage 3	
White	11.53	1.21	0.029
Afr.-Am.	10.35	1.63	0.093
Any development†		Tanner Stage 2	
White	9.71	1.87	0.031
Afr.-Am.	8.11	2.02	0.091
Any development†		Tanner Stage 3	
White	11.14	1.42	0.030
Afr.-Am.	9.85	1.59	0.088
Menarche			
White	12.88	1.20	0.061
Afr.-Am.	12.16	1.21	0.118

Abbreviations: SD, standard deviation; SE, standard error.
* $P < 0.001$ for the comparisons between African-American and white girls for each stage of development of breast, pubic hair, and menses.
† Denotes the appearance of either breast or pubic hair or both.

differ biologically from girls attending the study practices decreases this likelihood. Alternately, it is conceivable that a selection bias was operating such that younger girls with evidence of development were more likely to be brought in for physical examinations because their parents were concerned, and that this could account for the earlier onset of pubertal changes in our sample. If so, this bias might also be expected to be operating among parents of 12-year-old girls with no development, leading to a decrease in the prevalence of secondary sexual characteristics in that age group. However, no such decrease is apparent in our findings. Also, such a bias would in no way invalidate our findings of a difference between African-American girls and white girls. In any case, our findings (drawn from office practice) are highly relevant for the large numbers of girls seen in office practices, and these data provide more relevant norms for US girls than currently exist elsewhere.

The girls in our study are taller and heavier than girls in the HANES sample, especially as age increases. Because much of the HANES data are approximately 20 years old, it may be that girls in general are larger now. The National Growth and Health Study found a similar increase in the height and weight of 9- and 10-year-old African-American and white girls when compared to HANES data.[32]

Another consideration concerns the etiology of pubertal changes occurring in girls in the study. No data were collected on endocrine evaluations that the early developers in the study may have received; therefore, we do not know if some of these girls had pathologic conditions affecting their development.

Tiwary[37] suggested that hair products containing estrogen or placenta may be related to some of the increased prevalence of early puberty in African-American girls. The possibility that the increasing use of certain plastics and insecticides that degrade into substances that have estrogen-related physiological effects on living things[38–40] should be investigated in relation to the earlier onset of puberty.

The findings of this study need to be confirmed in other research including a nationally representative sample such as HANES. Until such studies are done, our data offer the best information about young girls in the US. These studies should also inquire into the existence of earlier or later pubertal development in young boys.

In conclusion, the prevalence of one or more secondary sexual characteristics in girls younger than 8 years of age found in this study is substantially higher than the commonly used figure of 1%.[41] More appropriate standards for defining precocious and delayed puberty may need to be developed, taking into account racial differences. This study strongly suggests that earlier puberty is a real phenomenon, and this has important clinical, educational, and social implications. The timing and content of sex education programs in schools may need revision. The etiology and effects of earlier pubertal maturation in young girls, including any possible relationship to breast cancer prevalence, requires further study. Finally, the consequences of otherwise immature children needing to cope with bodies that are maturing earlier need to be investigated.

APPENDIX

The PROS chapter coordinators and the Academy chapters they represented at the time of the study were as follows: *Arizona,* Joseph Piacentine, MD; *California 1,* Ross De Hovitz, MD; *Colorado,* David Kessel, MD; *Connecticut,* Frederick Berrien, MD; *Florida,* Lorne Katz, MD; *Georgia,* Edward Gotlieb, MD; *Illinois,* Emalee Flaherty, MD; *Indiana,* Virginia Wagner, MD; *Maryland,* Paul Bodnar, MD; *Massachusetts,* John Straus, MD; *Michigan,* Mary Lu Angelilli, MD; *New* Jersey, Harris Lilienfeld, MD; *New York 1,* Thomas McInerny; *New York 2,* Ivan Koota, MD; *North Carolina,* George Prince, MD and J. Gordon Still, MD, PhD; *Ohio,* James Davis, MD; *Pennsylvania,* Edward Rothstein, MD; *Puerto Rico,* Carlos Bourdony, MD; *Rhode Island,* Anthony Alario, MD; *South Carolina,* Robert Walker, MD; *Tennessee,* Charles Fish, MD; Uniformed Services West, Jose Pascual, MD; *Utah,* Gordon Glade, MD; *Vermont,* John Long, MD; *Virginia,* Harry Gewanter, MD; *Washington,* James Taylor, MD; *Wisconsin,* John Pascoe, MD; *Wyoming,* James Little, MD.

The pediatric practices or individual practitioners who participated in this study are listed here by AAP chapter: *Arizona,* Mesa Pediatrics Professional Assoc (Mesa), *California 1,* Robert L. Black, MD (Monterey); *Colorado,* Arvada Pediatric Associates, PC (Arvada); *Connecticut,* Children's Medical Group, (Bloomfield), St Francis Ped Primary Care Ctr, (Hartford); *Florida,* Sawgrass Pediatrics, PA (Coral Springs); *Georgia,* The Pediatric Center, (Stone Mountain); *Illinois,* Emalee Flaherty, MD (Chicago); *Indiana,* Claudia Somes, MD (Indianapolis); *Maryland,* Steven Caplan, MD (Baltimore), Children's Medical Practice (Baltimore), Chesapeake Physicians, PA (Baltimore), Valley Pediatric Associates, PA (Owings Mills), Ralph Brown, MD (Baltimore, MD), Clinical Associates Pediatrics' (Towson), Greenspring Pediatric Associates (Baltimore), Drs Kramer, Andorsky & Finkelstein (Owings Mills), Children's Medical Group (Cumberland); *Massachusetts,* The Fallon Clinic (Worcester), Weston Pediatric Physicians, PC (Weston); *Michigan,* Children's Health Care of Port Huron, PC (Port Huron), Pediatric Assoc of Farmington, PC (Farmington), General Pediat-

ric Services, Children's Hospital of Michigan (Detroit); *New Jersey,* Denville Pediatrics (Denville), Kids Care Pediatrics (Cardiff), Delaware Valley Ped Assoc, PA (Lawrenceville); *New York 1,* Amherst Pediatric Associates, PC (Williamsville), Panorama Pediatric Group (Rochester) Pediatric Associates (Camillus), Elmwood Pediatric Group (Rochester); *New York 2,* Kuritzkes, Koota, Grijnsztein, Resmovits–Partners (Corona); *North Carolina,* Fleming, Edwards, Goldman, Carr, & Lehan (Raleigh), Michael Grode, MD, PA (Charlotte), Gastonia Children's Clinic PA (Gastonia), Duke General Pediatric Group (Durham); *Ohio,* John DiTraglia, MD (Portsmouth), Oxford Pediatrics & Adolescents (Oxford), Bryan Medical Group (Bryan); *Pennsylvania,* Leonard Leibowitz, MD (Monroeville), Mindy Rosenblum, MD (Bala Cynwyd), Pediatric Care of York (York), Reading Pediatrics, Inc. (Wyomissing), Pennridge Pediatric Associates (Sellersville), Schuylkill Pediatrics (Pottsville), Delaware Valley Medical Associates (Philadelphia); *Puerto Rico,* Felisa Santiago, MD (Paradise Hills); *Rhode Island,* Marvin Wasser, MD (Cranston), Harvard Community Health Plan (N.E.D.-Lincoln); *South Carolina,* Palmetto Ped & Adolescent Clinic (Columbia); *Tennessee,* Johnson City Pediatrics, PC (Johnson City); Uniformed Services West, Wilford Hall USAF Med Ctr-SGHPP, Department of Pediatrics (San Antonio); *Utah,* Granger Medical Center (West Valley City), Gordon Glade, MD (American Fork), Salt Lake Clinic–Sandy Office (Sandy); *Vermont,* H. Taylor Yates, Jr, MD (Saint Albans), Practitioners of Ped Medicine (South Burlington), University Pediatrics (Burlington); *Virginia,* Pediatric Assoc of Richmond, Inc. (Richmond), Eastern VA Med School, Children's Hospital of The King's Daughters (Norfolk); *Washington,* Children's Hospital Med Ctr (Seattle), Sand Point Pediatrics (Seattle); *Wisconsin,* Gundersen Clinic-Whitehall (Whitehall), Gundersen/Clinic Lutheran Medical Center (La Crosse), Beloit-Clinic SC (Beloit); *Wyoming,* Jackson Pediatrics, PC (Jackson).

ACKNOWLEDGMENTS

This study was supported by a grant from Genentech, Inc. and grant MCJ-177022 from the US Health Resources and Services Administration Maternal and Child Health Bureau. Much of this work was done while M.E.H-G. was with the Department of Pediatrics at Duke University. We are indebted to the participating PROS practitioners and their office staffs for their participation in the data collection, to PROS chapter coordinators for contributions to the design of the study and data collection materials, to members of the PROS Steering Committee (1990–1994) for support, advice, and manuscript review, to members of AAP Sections of Endocrinology and Adolescent Health for review of the study design, to the Office of Information Technology at the University of North Carolina for assistance with data quality control, to Gretchen Fleming, PhD for ongoing support for PROS activities, to James M. Tanner, MD, PhD, for overall assistance, to Thomas E. Frothingham, MD for bringing the study idea to the network's attention, and to Pamela L. Cunov and Jayne L. Flynn for manuscript preparation.

REFERENCES

1. Eveleth PB, Tanner JM. Sexual development. In: Eveleth PB, ed. *Worldwide Variation in Human Growth*. Cambridge, England: Cambridge University Press; 1990:161–175
2. Freni-Titulaer LW, Cordero JF, Haddock L, et al. Premature thelarche in Puerto Rico. A search for environmental factors. *Am J Dis Child*. 1986; 150:1263–1267
3. Herman-Giddens ME, Sandler AD, Friedman NE. Sexual precocity in girls: an association with sexual abuse? *Am J Dis Child*. 1988;142:431–433
4. Herman-Giddens ME, MacMillan JP. Prevalence of secondary sexual characteristics in a population of North Carolina girls ages 3 to 10. *Adolesc Pediatr Gynecol*. 1991;4:21–26
5. Reynolds EL, Wines JV. Individual differences in physical changes associated with adolescence in girls. *Am J Dis Child*. 1948;75:329–350
6. Nicholson AB, Hanley C. Indices of physiological maturity: derivation and interrelationships. *Child Dev*. 1953;24:3–38
7. Marshall WA, Tanner JM. Variations in the pattern of pubertal changes in girls. *Arch Dis Child*. 1969;44:291–303
8. Lee PA. Normal ages of pubertal events among American males and females. *J Adolesc Health Care*. 1980;1:26–29
9. Harlan WR, Harlan EA, Grillo CP. Secondary sex characteristics of girls 12 to 17 years of age: the U. S. Health Examination Survey. *J Pediatr*. 1980;96:1074–1078
10. Villarreal SF, Martorell R, Mendoza F. Sexual maturation of Mexican-American adolescents. *Am J Hum Biol*. 1989;1:87–95
11. Tanner JM, Davies PS. Clinical longitudinal standards for height and height velocity for North American children. *J Pediatr*. 1985;107:317–329
12. Burstein S, Rosenfield RL. Pubertal data for growth velocity charts. *J Pediatr*. 1986;109:564. Letter
13. Tanner JM. Physical growth and development. In: Forfar JO, Arneil GC, eds. *Textbook of Paediatrics*. 3rd ed. Edinburgh, Scotland: Churchill Livingston; 1984;1:292
14. Fleiss JL. *Statistical Methods for Rates and Proportions*, 2nd ed. New York, NY: John Wiley & Sons Inc; 1981:61–70
15. Mantel N, Haenszel W. Statistical aspects of the analysis of data from retrospective studies of disease. *J Natl Cancer Inst*. 1959;22:719–748
16. Finney DJ. Assay based on quantat responses. In: *Statistical Method in Biological Assay*. London, England: Charles Griffin and Company Limited; 1952;468–490
17. *SAS Language Guide for Personal Computers*. Release 6.08. Cary, NC: SAS Institute Inc; 1994
18. Frisancho AR. *Anthropometric Standards for the Assessment of Growth and Nutritional Status*. Ann Arbor, MI: The University of Michigan Press; 1990
19. Behrman RE, ed. *Nelson Textbook of Pediatrics*. 14th ed. Philadelphia, PA: WB Saunders Company; 1992:1407–1408
20. Rudolph AM, ed. *Rudolph's Pediatrics*. 19th ed. Norwalk, CT: Appleton & Lange; 1991:138
21. Dacou-Voutetakis C, Klontza D, Lagos P, et al. Age of pubertal stages including menarche in Greek girls. *Ann Hum Biol*. 1983;10:557–564
22. Belmaker E. Sexual maturation of Jerusalem schoolgirls and its association with socioeconomic factors and ethnic group. *Ann Hum Biol*. 1982;9:321–328
23. Lee MM, Chang MS, Chan MM. Sexual maturation of Chinese girls in Hong Kong. *Pediatrics*. 1963;32:389–398
24. Neyzi O, Hulya A, Orhon A. Sexual maturation in Turkish girls. *Ann Hum Biol*. 1975;2:49–59
25. Colli AS. Sexual maturation of adolescents in Sao Paulo. In: *The Health of Adolescents and Youths in the Americas*. Washington, DC: Pan American Health Organization, World Health Organization; 1985:234–242
26. Tanner JM. Age at onset of puberty and trend toward earlier development. In: Gardiner LI, ed. *Endocrine and Genetic Diseases of Childhood*. Philadelphia, PA: Saunders; 1969:51–55
27. Zacharias L, Wurtman RJ. Age at menarche. *N Engl J Med*. 1969;280: 868–875
28. Wyshak G, Frisch RE. Evidence for a secular trend in age of menarche. *N Engl J Med*. 1982;306:1033–1035
29. MacMahon B. *Age at Menarche: United States, 1973*. Rockville, MD: National Center for Health Statistics; DHEW publication (HRA) 74–1615, 1974
30. Lasha-Mierzejewsha T. Development and maturation of children and youngsters in Havana, Cuba. *Rev Cubana Pediatr*. 1967;39:385–447
31. Garn SM, Clark DC. Nutrition, growth, development, and maturation: findings from the ten-state nutrition survey of 1968–1970. *Pediatrics*. 1975;56:306–319
32. Campaigne BN, Morrison JA, Schumann BC, et al. Indexes of obesity and comparisons with previous national survey data in 9- and 10-year-old black and white girls: the National Heart, Lung, and Blood Institute Growth and Health Study. *J Pediatr*. 1994;124:675–680
33. Foster TA, Voors AW, Webber LS, Frerichs RR, Berenson GS, Anthropometric and maturation measurements of children, ages 5 to 14 years, in a biracial community—the Bogalusa Heart Study. *Am J Clin Nutr*. 1977;30:582–591
34. Freedman DS, Srinivasan SR, Webber LS, Burke GL, Berenson GS. African-American-white differences in serum lipoproteins during sexual maturation: the heart study. *J Chronic Dis*. 1987;40:309–318
35. The National Heart, Lung, and Blood Institute Growth and Health Study Research Group. Obesity and cardiovascular disease risk factors in African-American and white girls: the NHLBI growth and health study. *Am J Public Health*. 1992;82:1613–1620
36. Kozinetz CA. Sexual maturation and blood pressure levels of a biracial sample of girls. *Am J Dis Child*. 1991;145:142–147
37. Tiwary CM. Premature sexual development in children following the use of placenta and/or estrogen containing hair products. *Pediatr Res*. 1994;135:108A. Abstract.
38. Marshall E. Search for a killer: focus shifts from fat to hormones. *Science*. 1993;259:618–621
39. McKinney JD, Waller CL. Polychlorinated biphenyls as hormonally active structural analogues. *Environ Health Perspect*. 1994;102:290–297
40. Sharpe RM, Skappeback NE. Are oestrogens involved in falling sperm counts and disorders of the male reproductive tract? *Lancet*. 1993;341: 1392–1395
41. Bacon G, Spencer M, Hopwood N, et al. *A Practical Approach to Pediatric Endocrinology*. Chicago, IL: Year Book Medical Publishers; 1982:189

Secondary Sexual Characteristics and Menses in Young Girls Seen in Office Practice: A Study from the Pediatric Research in Office Settings Network

Marcia E. Herman-Giddens, Eric J. Slora, Richard C. Wasserman, Carlos J. Bourdony, Manju V. Bhapkar, Gary G. Koch and Cynthia M. Hasemeier

Pediatrics 1997;99;505-512
DOI: 10.1542/peds.99.4.505