

## Original Study

## Age of Menarche in a Longitudinal US Cohort

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## A B S T R A C T

**Study Objective:** Menarche is a critical milestone in a woman's life, and historically has been determined using several approaches. The goals of this study were to: (1) determine age at menarche from multiple reports of parents and adolescent participants in a prospective study; (2) examine factors affecting age at menarche; and (3) determine correlates of menarche and pubertal tempo.

**Design:** Longitudinal observational study.

**Setting:** Three sites of the Breast Cancer and the Environment Research Program.

**Participants:** Girls enrolled at 6-8 years of age.

**Interventions and Main Outcome Measures:** Parental and participant reported age of menarche, and tempo of puberty.

**Results:** There were 946 girls who were assigned an age of menarche. The correlation between parent and participant reports was high (Spearman  $R = 0.799$ ,  $P < .001$ ), and the difference was insignificant. Median age at menarche overall was 12.25 years. Compared with black participants, Hispanic girls were more likely to have menarche earlier, whereas white and Asian girls were more likely to have menarche later. Age of menarche was highly correlated with age of breast development (Spearman  $R = 0.547$ ;  $P < .001$ ), and inversely with body mass index (Spearman  $R = -0.403$ ;  $P < .001$ ). Tempo (interval of age of breast development to menarche) was slower in those with earlier breast development.

**Conclusion:** Parental and adolescent reports of menarche are highly correlated. Earlier breast maturation was associated with slower tempo through puberty. Body mass index had a greater effect on age at menarche than did race and ethnicity.

**Key Words:** Menarche, Puberty, Pubertal tempo, Breast development

## Introduction

Menarche is a critical milestone in a woman's life, from sociocultural as well as medical perspectives. Age at menarche has been extensively studied and identified as a risk factor for many health outcomes in adolescence and adulthood, because relative timing of maturation affects engagement in risky behaviors during adolescence,<sup>1,2</sup> breast cancer risk,<sup>3</sup> and all-cause mortality. Accurate assignment of menarcheal age is critical for epidemiologic studies. In epidemiologic analyses, it common to assign age at menarche from a single recalled date or age with a precision of approximately one-half year.<sup>4</sup>

The Breast Cancer and the Environment Research Program puberty cohort was established to examine factors that influence onset of pubertal maturation, in recognition of puberty as a window of susceptibility for development of breast cancer.

The goals of this current study were to: (1) determine age at menarche from multiple reports of parents and adolescent participants in a prospective study; (2) examine factors related to age at menarche; and (3) determine correlates of menarche and pubertal tempo.

## Materials and Methods

## Study Population

The puberty studies of the Breast Cancer and the Environment Research Program are 3 prospective cohorts of 1257 young girls, enrolled at 6-8 years of age, 2004 to 2007, and followed up at least annually through 2014. Study sites were at Mount Sinai Medical Center in East Harlem, New York (NY), Cincinnati Children's Hospital Medical Center (OH), and Kaiser Permanente of Northern California (CA). The main goal of the puberty studies was to investigate the role of the environment on pubertal development.<sup>5</sup> Information was collected in the preferred language (English/Spanish) of the parent/guardian. Before data collection, informed consent was obtained from all parents/guardians and assent was obtained from the girl.

The authors indicate no conflicts of interest.

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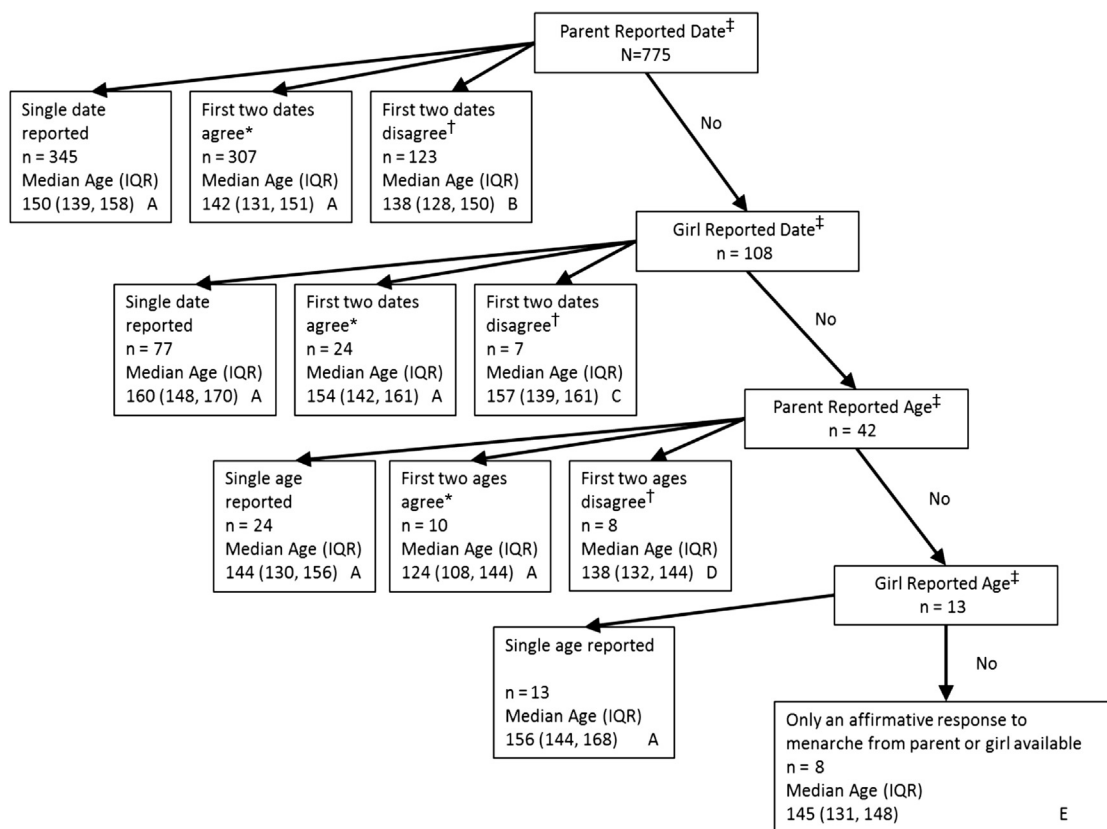
E-mail address: frank.biro@cchmc.org (F.M. Biro).

The study protocols were approved by each site's institutional review board.

#### Age at Menarche Ascertainment

Beginning in the second year (NY and CA, ages 7–9 years) or third year (OH, ages 8–10 years) of follow-up interviews, parents or legal guardians provided information annually on their daughter's first menstrual period. The parent was asked whether the girl had had her first menstrual period and, if she had, the month and year (or age, if no date was given). Information availability differed according to study site, because of the combination of early loss to follow-up (NY and OH had most of the loss by the first follow-up visit) and the later administration of menarche-related questions (first follow-up visit in NY/CA and second year of follow-up in OH). Beginning in the sixth year of follow-up, the girls at all sites were also asked whether they had had a period and in what month and year (or age). Girls who had been asked at least once about menarche, and had complete demographic data, were included (N = 1088), as others were lost to follow-up before menarche questions were asked.

The age at menarche assignment algorithm used for this investigation is illustrated in Figure 1 for 946 girls who had complete demographic data and reported having reached menarche. Because parental/guardian menarche-related information was available on most of the girls and, in most cases, this information was provided closer in time to the menarche event, parent information was used as the primary source of information for age at menarche assignment; parent-provided information was used for assigning age at menarche for 822 girls (parent reported date [n = 775] or age [n = 42] or an affirmative answer without age or date [n = 5]). Girls' dates or ages were used for 124 assignments. As many as 8 parental reports and 5 self-reports were available for each girl. We used an actual reported value rather than an average of multiple reports. Because misinformation potentially increases with longer intervals between the event and report, the first 2 reports were chosen as the primary information for assignment of age at menarche. We considered dates to be more precise ( $\pm 1$  month) than age ( $\pm 3$ –6 months), and preferentially used dates if available; for example, a girl's report of a date superseded a parental age report (Fig. 1). When reported dates were used for assignment of age at menarche and the



**Fig. 1.** Flow chart of the age at menarche assignment algorithm for 946 girls with an ascertained age; ages reported in months. Median and IQR were computed from the survival distribution using SAS Proc PHREG (SAS Institute, Inc) with an additional strata statement adjusting for site. A, First reported date/age was used to determine age at menarche; B, The first girl-reported date was used as a tie-breaker. If the first girl-reported date was within 6 months of the first parent-reported date, then first parent-reported date was used. If the first girl-reported date was within 6 months of the second parent-reported date, then the second parent-reported date was used. If there was no agreement among all dates, the first parent-reported date was used; C, The third girl-reported date was used as a tie-breaker. If the third girl-reported date was within 6 months of the first girl-reported date, then the first girl-reported date was used. If the third girl-reported date was within 6 months of the second girl-reported date, then the second girl-reported date was used. If there was no agreement among all dates, the first girl-reported date was used; D, Third parent-reported age was used as a tie-breaker. If the third parent-reported age was within 6 months of the first parent-reported age, then the first parent-reported age was used. If the third parent-reported age was within 6 months of the second parent-reported age, the second parent-reported age was used. If there was no agreement among all ages, the first parent-reported age was used; E, Age at menarche was computed as 9 months before first affirmative response to menarche. IQR, interquartile range. \* Agree = difference within 6 months; † Disagree = difference  $\geq 6$  months; ‡ At least 1 report.

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