Age at Menarche and Age at First Sexual Intercourse: A Prospective Cohort Study

WHAT’S KNOWN ON THIS SUBJECT: Young age at first sexual intercourse (FSI) is related to risk-taking behaviors and negative outcomes. Previous studies using a cohort or cross-sectional design have concluded that younger age at menarche (AAM) is related to younger age at FSI.

WHAT THIS STUDY ADDS: This large birth cohort study is the first to address the temporal relationship between AAM and FSI. We found that younger AAM does not confer higher risk of early FSI, whether in terms of calendar age or time since menarche.

abstract

OBJECTIVE: Younger age at menarche (AAM) may put girls at risk for earlier first sexual intercourse (FSI). Young age at FSI has far-reaching negative outcomes. We describe the longitudinal relationship between AAM and FSI in a large prospective birth cohort.

METHODS: AAM was collected from 554 girls from the Western Australia (Raine) Pregnancy Cohort Study, prospectively from age 10 or retrospectively at age 14. Age at FSI was collected at ages 17 and 20. Cox regression models describe likelihood of FSI by age and years since menarche. Younger age at menarche (AAM) may put girls at risk for earlier first sexual intercourse (FSI). Young age at FSI has far-reaching negative outcomes. We describe the longitudinal relationship between AAM and FSI in a large prospective birth cohort.

RESULTS: Girls with younger AAM and average AAM were equally likely to have FSI by age 16 (adjusted hazard ratio [aHR]: 0.90 [95% confidence interval (CI): 0.60–1.35]). FSI by age 16 was less likely among girls with older AAM than those with average AAM (aHR: 0.35 [95% CI: 0.17–0.72]). Girls with younger AAM had a longer median interval between menarche and FSI than girls with average AAM (5.0 years [interquartile range: 4.4–8.5 years] vs 3.7 years [interquartile range: 2.4–5.3 years]). Those with younger AAM were less likely to report FSI within 4 years of menarche than those with average AAM (0–2 years aHR: 0.04 [95% CI: 0.01–0.31]; 2–4 years aHR: 0.36 [95% CI: 0.23–0.55]). By age 20, 429 girls (77.4%) reported FSI.

CONCLUSIONS: Younger AAM was not a risk factor for younger age at FSI in this cohort. Pediatrics 2013;132:1028–1036

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KEY WORDS
puberty, reproductive behavior, risk-taking behavior, sexual behavior, Raine Study

ABBREVIATIONS
AAM—age at menarche
aHR—adjust hazard ratio
CI—confidence interval
FSI—first sexual intercourse
HR—hazard ratio
IQR—interquartile range

Dr Marino contributed to the conception and design of the study, contributed to the analysis and interpretation of data, and drafted the manuscript jointly with Dr Hickey; Dr Skinner contributed to the conception and design of the study, contributed to the acquisition and interpretation of data, and critically reviewed the manuscript; Dr Rosenthal contributed to the conception and design of the study, contributed to the acquisition and interpretation of data, and critically reviewed the manuscript; Dr Doherty contributed to the conception and design of the study, contributed to the acquisition and interpretation of data, and critically reviewed the manuscript; Mr Cannon analyzed the data, contributed to the interpretation of data, and critically reviewed the manuscript; Dr Cooper Robbins contributed to the acquisition of data and critically reviewed the manuscript; Mr Cannon analyzed the data, contributed to the interpretation of data, and critically reviewed the manuscript; and Dr Hickey conceived and designed the study, contributed to the acquisition of the data, and drafted the manuscript jointly with Dr Marino. All authors approved the final manuscript as submitted.

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Age at menarche (AAM) marks the onset of reproductive capability and is a commonly used milestone for pubertal development. Factors regulating AAM are not well understood, but in developed countries, about one-half of the variation in AAM is thought to be genetic.\(^1,2\) Other mediating factors include birth and childhood body size,\(^3–6\) adiposity,\(^7,7\) growth,\(^8–10\) race/ethnicity,\(^11–13\) socioeconomic position,\(^15–17\) family relationships and structure,\(^11,16,18,19\) and exposure to childhood adversity and trauma.\(^20,21\) Younger AAM has widely been proposed as a risk factor for early first sexual intercourse (FSI).\(^22,23\)

Exploring the mediators of young age at FSI is of clinical and social significance. Younger age at FSI is associated with sexual risk-taking behaviors, including unprotected intercourse,\(^24\) inconsistent contraceptive use,\(^25\) and multiple partners,\(^26\) and with a variety of negative outcomes, including partner violence,\(^27\) lower educational attainment,\(^28,29\) unintended pregnancy,\(^30\) adolescent pregnancy or birth,\(^31,32\) and sexually transmitted infection.\(^33–35\) If girls with younger AAM are at risk for younger age at FSI, they may be a target for educational or other preventive interventions. Current life history theories are based on the assumption that early adversity leads to younger reproduction via younger reproductive capacity and drive.\(^36,37\) Therefore, the time elapsed between menarche and FSI (gynecologic age at FSI) is also of interest.

Most of the data supporting the association between a younger AAM and earlier onset of sexual activity are cross-sectional.\(^16,23,38–45\) Even the rare prospective cohort studies of this topic have ascertained ages of menarche or prospective cohort studies of this topic cross-sectional.\(^16,23,38\) Earlier onset of sexual activity are associated with a younger AAM and a variety of negative outcomes, including unprotected intercourse,\(^24\) inconsistent contraceptive use,\(^25\) and multiple partners,\(^26\) and with a variety of negative outcomes, including partner violence,\(^27\) lower educational attainment,\(^28,29\) unintended pregnancy,\(^30\) adolescent pregnancy or birth,\(^31,32\) and sexually transmitted infection.\(^33–35\) If girls with younger AAM are at risk for younger age at FSI, they may be a target for educational or other preventive interventions. Current life history theories are based on the assumption that early adversity leads to younger reproduction via younger reproductive capacity and drive.\(^36,37\) Therefore, the time elapsed between menarche and FSI (gynecologic age at FSI) is also of interest.

Most of the data supporting the association between a younger AAM and earlier onset of sexual activity are cross-sectional.\(^16,23,38–45\) Even the rare prospective cohort studies of this topic have ascertained ages of menarche or sexual intercourse retrospectively.\(^46,47\) They have reported only baseline data,\(^35\) or have used analytic methods that represent the probability of FSI at a particular age (eg, logistic regression) rather than the time to FSI (eg, hazard models).\(^46,48\) Thus losing the longitudinal or temporal aspect of the study design. Prospective longitudinal designs have several advantages, including the increased accuracy of reporting of timing because the dates are captured close to the time of the event\(^49,50\) and the use of statistical approaches, such as survival and hazard models, that measure changes within each subject over time, in addition to the difference between groups.\(^51\) Hazard models do not require selecting a cutoff age (eg, “early” or “normal” age at FSI).

This is the first study to use a large prospective birth cohort to examine closely the temporal relationship between contemporaneously measured AAM and age at FSI. We also report the duration between AAM and FSI to determine whether younger AAM puts girls at risk for a shorter interval to FSI.

**METHODS**

**Participants**

The Western Australian Pregnancy Cohort (Raine) Study is a prospective cohort study of 2868 live births (1405 female, 1463 male) from 2900 pregnancies followed up since 1989. Complete details of the cohort and initial recruitment procedures have been published elsewhere.\(^52\) In brief, the cohort was recruited from a tertiary maternity hospital in Western Australia and followed up at 18 and 34 weeks’ gestation with clinical examinations and questionnaire data collection. Children and their families were then followed up at the ages of 1, 2, 3, 5, 8, 10, 14, 17, and 20 years. Extensive clinical and questionnaire data were collected. After the baseline data collection, families were not required to have participated in the previous wave to participate subsequently. Of the birth cohort, 624 girls (44.4%) participated in the 17-year follow-up, and 607 provided valid sexual activity data.

Informed consent was obtained at the time of enrollment in the study and at each follow-up. Study protocols were approved by the human ethics committees at King Edward Memorial Hospital and Princess Margaret Hospital for Children in Perth, Western Australia.

**Date of Menarche**

Families of girls participating in the 10-year follow-up were given a diary asking the date of menarche and the next 2 menstrual periods; the families were asked to return the diaries by mail (prospective ascertainment). If the menstrual diary had not been returned by the 14-year follow-up, mothers and girls received a telephone reminder. If the girl had already experienced menarche at that time, information was collected on the date of menarche, including the source of information (eg, diary, calendar, memory of a coinciding event such as a party or school holiday). Where recall included only the month and year, the day was coded as the fifteenth of the month. For analyses, AAM was classified into younger (<12 years old), average (12–13 years old), and older (≥14 years old).

**FSI Data**

Self-reported data on age at FSI (vaginal) were collected at age 17 years by using a confidential questionnaire derived from the National Survey of Secondary School Students, HIV/AIDS and Sexual Health, 2002.\(^53\) At the age 17-year follow-up, 607 girls (43.2% of the original cohort) provided information regarding sexual activity for those who were not yet sexually active by age 17 years, FSI data were obtained at age 20 years.

The interval between AAM and a reproductive end point, also referred to as gynecologic age,\(^54\) can provide further insight regarding temporal relationships with respect to reproductive maturity. We calculated the interval...
between AAM and age at FSI for each girl, and we considered the effect of AAM on that interval.

**Covariates**

Ethnicity, socioeconomic status, family structure, and birth size are thought to be associated with both AAM and age at FSI but are unlikely to mediate the relationship. Key variables reflecting these constructs were selected from the data collected at baseline and at age 10 years to construct an a priori–adjusted model. Because maternal age at pregnancy was expected to correlate closely with education of both parents, and education reflects socioeconomic advantage, maternal education was prioritized for the adjusted model. The model included maternal ethnicity, education, and family income at baseline, expected birth weight ratio (observed birth weight over median birth weight appropriate for maternal height, gender, nulliparity, and gestational age), and absence of biological father at 10 years.

**Statistical Analysis**

Continuous data were summarized by using means ± standard deviations or medians, interquartile ranges (IQRs), and minimum and maximum values; categorical data were summarized by using frequency distributions. We examined the effects of younger, average, and older AAM (as noted earlier) on calendar age at FSI and duration between menarche and FSI. Univariate comparisons between groups were conducted by using 1-way analysis of variance or Kruskal-Wallis tests for continuous outcomes and \( \chi^2 \) tests for categorical outcomes. Kaplan-Meier survival probabilities were used to estimate the cumulative incidence of calendar and gynecologic age at FSI.

Survival analysis (event history analysis) methods allow examination of the full range of timing for FSI; it does not require a specific cutoff age for early, average, or late age at FSI as is required for logistic regression methods. For some survival methods, the assumption of proportional hazards is required; namely, that the absolute risk (hazard) for each group of the predictor of interest (in this case, earlier, average, and later AAM) changes at the same rate across study time, yielding summary relative risks (hazard ratios [HRs]) that are constant across time in comparing the predictor group with the reference group. The proportional hazard assumption was assessed by inspection of plotted Kaplan-Meier survivor probabilities and, where graphical findings were ambiguous, examination of Schoenfeld residuals. Where the Kaplan-Meier curves are parallel for all predictor groups, the proportional hazard assumption is upheld. Where the assumption was violated, extended Cox regression models were used to investigate the time-dependent effects of AAM: separate relative risk estimates were generated for those time intervals over which the risk estimate could be shown to be constant. The effects of AAM were summarized by using HRs and 95% confidence intervals (CIs).

All hypothesis tests were 2-sided, and \( P \) values < .05 were considered statistically significant. SPSS version 18 (IBM SPSS Statistics, IBM Corporation, Armonk, NY) software was used for data analysis.

**RESULTS**

**Age at Menarche**

Of 607 girls participating in the 17-year follow-up, 384 (63.3%) returned the menstrual diary indicating the date of their first 3 menstrual periods; 145 (23.9%) retrospectively reported date of menarche to the closest day or month and 25 (4.1%) to the closest year; totaling 554 complete AAM records. The median AAM was 12.8 years (IQR: 12.1–13.5 years; range: 9.0–16.1 years). The distribution of AAM differed according to ethnicity (Table 1).

**Age at FSI**

At the follow-up at age 17 years, 275 girls (49.6%) had initiated sexual intercourse. Of the remaining 279 girls, 233 (83.5%) participated in the 20-year follow-up, of whom 154 (66.1%) had initiated intercourse. Thus, a total of 429 girls had engaged in FSI by the age 20-year follow-up (77.4%).

The median age of FSI for the cohort was 16.0 years (95% CI: 15.8–16.2 years), whereas the median ages at FSI among girls with younger, average, and older AAM were, respectively, 16 years (IQR: 15–20 years; range: 13–21 years), 17 years (IQR: 15–18 years; range: 13–20 years), and 17 years (IQR: 16–18 years; range: 14–19 years). The cumulative incidence of FSI according to age (Table 2) is the proportion of the group who have experienced FSI by the end of each year of age. Among girls with younger and average AAM, approximately one-quarter had FSI by age 15 years, but none of the girls in the older AAM group had FSI before age 14 years, and only 1 in 10 had FSI by age 15 years.

As illustrated in Fig 1, the slope of incident FSI (absolute FSI risk) was not the same for the 3 groups across all ages; that is, the curves cross, indicating that the absolute risk changed at different rates for the 3 groups, a violation of the proportionate hazards assumption underlying calculation of relative risks in standard Cox regression modeling. On closer examination, within the 3 time intervals, the incidence curves were parallel. Consequently, we estimated the relative risks of FSI over those intervals of age for which hazards were proportionate: ≤ 15 years of age, age 16 years, and ≥ 17 years (Table 3). Girls with younger AAM and girls with average AAM were equally likely to have...
TABLE 1  Demographic Profile of Study Participants Stratified According to AAM

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Average AAM: 12–13 y (n = 353)</th>
<th>Younger AAM: &lt;12 y (n = 123)</th>
<th>Older AAM: ≥14 y (n = 78)</th>
<th>Total (N = 554)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal ethnicity</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>White</td>
<td>316 (89.5)</td>
<td>100 (81.5)</td>
<td>71 (91.0)</td>
<td>487 (87.9)</td>
<td>.01</td>
</tr>
<tr>
<td>Non-white*</td>
<td>29 (8.2)</td>
<td>21 (17.7)</td>
<td>5 (6.4)</td>
<td>55 (9.9)</td>
<td></td>
</tr>
<tr>
<td>Maternal age at birth, y</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>&lt;25</td>
<td>94 (26.8)</td>
<td>38 (30.9)</td>
<td>24 (50.8)</td>
<td>156 (28.2)</td>
<td>.87</td>
</tr>
<tr>
<td>25–35</td>
<td>206 (58.4)</td>
<td>69 (56.1)</td>
<td>43 (55.1)</td>
<td>318 (57.4)</td>
<td></td>
</tr>
<tr>
<td>≥35</td>
<td>53 (15.0)</td>
<td>16 (13.0)</td>
<td>11 (14.1)</td>
<td>80 (14.4)</td>
<td></td>
</tr>
<tr>
<td>Family income at pregnancy, $b</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;12 000</td>
<td>58 (16.4)</td>
<td>21 (17.1)</td>
<td>17 (21.8)</td>
<td>96 (17.3)</td>
<td>.555</td>
</tr>
<tr>
<td>12 000–35 999</td>
<td>158 (44.7)</td>
<td>61 (49.6)</td>
<td>33 (42.3)</td>
<td>252 (45.5)</td>
<td></td>
</tr>
<tr>
<td>≥36 000</td>
<td>116 (32.6)</td>
<td>33 (26.8)</td>
<td>22 (28.2)</td>
<td>171 (30.9)</td>
<td></td>
</tr>
<tr>
<td>Maternal education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;-High school</td>
<td>85 (24.1)</td>
<td>37 (30.0)</td>
<td>14 (17.9)</td>
<td>151 (27.3)</td>
<td>.44</td>
</tr>
<tr>
<td>High school</td>
<td>90 (25.7)</td>
<td>15 (12.2)</td>
<td>14 (17.3)</td>
<td>99 (17.9)</td>
<td></td>
</tr>
<tr>
<td>Trade</td>
<td>135 (38.4)</td>
<td>51 (41.5)</td>
<td>34 (43.6)</td>
<td>238 (41.8)</td>
<td></td>
</tr>
<tr>
<td>Tertiary</td>
<td>52 (14.7)</td>
<td>14 (11.4)</td>
<td>11 (14.1)</td>
<td>80 (14.4)</td>
<td></td>
</tr>
<tr>
<td>EBW, mean ± SD</td>
<td>1.01 ± 0.13</td>
<td>1.01 ± 0.12</td>
<td>1.01 ± 0.17</td>
<td>1.01 ± 0.13</td>
<td>.850</td>
</tr>
<tr>
<td>Father absence at 10-y follow-up</td>
<td>103 (30.3)</td>
<td>37 (30.6)</td>
<td>20 (28.0)</td>
<td>160 (29.7)</td>
<td>.736</td>
</tr>
</tbody>
</table>

Percentages within each group may not add to 100% due to missing data. EBW, expected birth weight ratio reflecting birth size for gestational age.

* Aboriginal: 5 (0.9%); Polynesian: 5 (0.9%); Vietnamese: 1 (0.2%); Chinese: 22 (4.0%); Indian: 14 (2.5%); other: 8 (1.4%).

§ Income at pregnancy was recorded during 1989–1992 in Australian dollars.

FSI by age 15 years (adjusted HR [aHR]: 0.90 [95% CI: 0.60–1.35]), and girls with older AAM were only one-third as likely as girls with average AAM to experience FSI by age 15 years (aHR: 0.35 [95% CI: 0.17–0.72]). All 3 groups were equally likely to experience FSI at age 16 years (younger AAM aHR: 1.35 [95% CI: 0.91–2.00]; older AAM aHR: 1.18 [95% CI: 0.74–1.87]). Girls with younger AAM were only one-half as likely to experience FSI between age 17 years and the end of follow-up as girls with average AAM (aHR: 0.50 [95% CI: 0.30–0.82]), and girls with older AAM and girls with average AAM were equally likely to have FSI between age 17 years and the end of follow-up (aHR: 0.97 [95% CI: 0.63–1.49]). Of the potential confounders, only maternal education and father’s absence at age 10 years significantly affected the likelihood of FSI by calendar age in univariate or multivariate models (maternal tertiary versus high school education, HR: 0.58 [95% CI: 0.41–0.83]; aHR: 0.59 [95% CI: 0.42–0.84]; absent father, HR: 1.44 [95% CI: 1.17–1.78]; aHR: 1.40 [95% CI: 1.13–1.72]). Adjustment for potential confounders did not substantially change risk estimates (Table 3).

**Table 2: Estimated Cumulative Incidence of FSI for Each Year of Age According to AAM (N = 554)**

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>Average AAM (12–13 y)</th>
<th>Earlier AAM (&lt;12 y)</th>
<th>Later AAM (≥14 y)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Risk</td>
<td>N</td>
<td>% (95% CI)</td>
</tr>
<tr>
<td>13</td>
<td>353</td>
<td>5</td>
<td>1.4 (0.2–2.6)</td>
</tr>
<tr>
<td>14</td>
<td>348</td>
<td>31</td>
<td>10.2 (7.0–13.4)</td>
</tr>
<tr>
<td>15</td>
<td>317</td>
<td>65</td>
<td>28.6 (23.9–33.3)</td>
</tr>
<tr>
<td>16</td>
<td>252</td>
<td>75</td>
<td>49.9 (44.6–55.1)</td>
</tr>
<tr>
<td>17</td>
<td>165</td>
<td>48</td>
<td>64.4 (59.4–69.5)</td>
</tr>
<tr>
<td>18</td>
<td>103</td>
<td>34</td>
<td>76.2 (71.5–80.9)</td>
</tr>
<tr>
<td>19</td>
<td>68</td>
<td>24</td>
<td>84.6 (80.5–88.7)</td>
</tr>
<tr>
<td>20</td>
<td>18</td>
<td>1</td>
<td>85.4 (81.3–89.6)</td>
</tr>
<tr>
<td>21</td>
<td>2</td>
<td>1</td>
<td>92.7 (84.2–100)</td>
</tr>
</tbody>
</table>

*a Risk, number of adolescents who have not previously debuted in sexual intercourse; NSI, number of adolescents debuting in sexual intercourse.

**Interval Between Menarche and FSI**

No girls had FSI before menarche. The mean interval between menarche and FSI was 3.7 years for girls with average AAM (IQR: 2.4–5.3 years; range: 0.5–9.0 years), 5.0 years for girls with younger AAM (IQR: 4.4–8.5 years; range: 1.2–10.8 years), and 2.5 years for girls with older AAM (IQR: 1.4–3.9 years; range: 0.0–5.7 years). Cumulative incidence of FSI for each year since menarche for the 3 groups of AAM are shown in Table 4. Only 1 girl with younger AAM experienced FSI within 2 years of menarche, in contrast with 17% of girls with average AAM and >40% of girls with older AAM.

As with FSI according to calendar age, the rate curves for FSI were not parallel across the 3 AAM groups for the years since menarche (Fig 2). Examination of Schoenfeld residuals confirmed this more subtle departure from proportionality (P < .001); relative rates of FSI were therefore estimated over those intervals for which hazards were...
DISCUSSION

This is the first prospective study to document the relationship between AAM and both age at FSI and the interval between menarche and FSI. The most striking observation was that younger AAM did not predict younger age at FSI. In addition, within 4 years of menarche, girls with younger AAM were less likely than girls with average or older AAM to initiate sexual intercourse. Taken together, these data suggest that in this population, younger-than-average AAM does not confer an increased risk of earlier FSI or of shortened interval between menarche and FSI. This finding was true even when accounting for early life growth, socioeconomic variables, and father’s absence at puberty. This finding may have implications for the life history theories which presuppose that adversity leads to earlier puberty (including menarche) and then earlier reproduction. In clinical practice, younger AAM alone does not seem to put girls at risk for younger age at FSI and teenage pregnancy. Other factors such as psychosocial and cognitive development may provide better targets for interventions. The median AAM in our study (12.8 years) was similar to that reported in other recent population-based studies in Australia (12.9 years, N = 986327; Penrith birth cohort: 12.6 years, N = 15601), the United

![FIGURE 1](Image)

Cumulative incidence of FSI according to years of age among girls with earlier, average, and later AAM.

![TABLE 3](Image)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unadjusted Relative Risk of FSI</th>
<th>Adjusted* Relative Risk of FSI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Younger AAM (&lt;14 y)</td>
<td>Older AAM (≥14 y)</td>
</tr>
<tr>
<td></td>
<td>HR (95% CI)</td>
<td>P</td>
</tr>
<tr>
<td>Calendar age, y</td>
<td></td>
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</tr>
<tr>
<td>≤15</td>
<td>0.91 (0.61–1.36)</td>
<td>.632</td>
</tr>
<tr>
<td>16</td>
<td>1.39 (0.94–2.05)</td>
<td>.100</td>
</tr>
<tr>
<td>≥17</td>
<td>0.48 (0.29–0.79)</td>
<td>.004</td>
</tr>
<tr>
<td>Time since menarche, y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2</td>
<td>0.04 (0.01–0.32)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>2–4</td>
<td>0.37 (0.25–0.57)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>≥4</td>
<td>0.82 (0.59–1.15)</td>
<td>.250</td>
</tr>
</tbody>
</table>

Reference group was girls with average AAM.

* Adjusted for maternal ethnicity (white versus other) and education (<high school, high school, trade, or tertiary), family income at pregnancy (<$12 000, $12 000–35 000, ≥$36 000 [Australian dollars]), expected birth weight ratio, and absence of biological father at age 10 years.

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Nearly one-quarter of participants had still not initiated sexual intercourse by age 20 or 21 years. It is unlikely that age of FSI was reported erroneously because these data were collected by using a standardized written instrument that has previously been used successfully.

Compared with previous longitudinal studies, our study has a number of strengths. Ours is the first study to use hazard modeling, which permits calculation of FSI risk according to AAM category in empirically derived age groups rather than at a specific cutoff age and which accounts for loss to follow-up before the occurrence of the event of interest (addressing “right censoring”). Another difference is that studies categorizing AAM dichotomously may distort the relationship between AAM and age at FSI. The older a girl is at menarche, the lower her risk of commencing sexual intercourse at younger ages. Comparing a group of earlier-maturing girls versus a reference group that includes later-maturing girls (who delay FSI relative to the average) would overstate the likelihood of FSI for the earlier-maturing girls. More accurate categorization of AAM separates girls into groups with younger, average, and older ages at menarche.

Both the Christchurch Health and Development Study (N = 497) and the Dunedin cohort study (N = 477) found an association between AAM (continuously measured in months, or appropriately categorized) and earlier age at FSI. Our novel analytic approach may account for some of this disparity. Cohort effects are possible but unlikely (the Raine cohort was born 12 years after the Christchurch Health and Development Study cohort and 17 years after the Dunedin cohort). The Great Smoky Mountains longitudinal study (N = 630) found that early-maturing girls were more likely to engage in sexual intercourse before age 16 years; however, they used a composite measure of pubertal timing that included AAM and Tanner staging. The discrepancy between our finding and theirs is most likely accounted for partly by the difference in maturity markers and partly by their decision to include both “on-time” and late-maturing girls in the comparison group.

Only 1 other study has examined the relationship between AAM and the interval between menarche and FSI. Segal and Stohs report that, among 44 twin pairs, AAM was inversely related to

### Table 4: Estimated Cumulative Incidence of Sexual Intercourse for Each Year Since Menarche According to AAM (N = 554)

<table>
<thead>
<tr>
<th>Years</th>
<th>Average AAM (12–13 y)</th>
<th>Earlier AAM (&lt;12 y)</th>
<th>Later AAM (≥14 y)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>SI</td>
<td>% (95% CI)</td>
</tr>
<tr>
<td>&lt;1</td>
<td>353</td>
<td>10</td>
<td>2.8 (1.1–4.6)</td>
</tr>
<tr>
<td>1</td>
<td>343</td>
<td>50</td>
<td>17.0 (13.1–20.9)</td>
</tr>
<tr>
<td>2</td>
<td>293</td>
<td>82</td>
<td>40.2 (35.1–45.3)</td>
</tr>
<tr>
<td>3</td>
<td>203</td>
<td>53</td>
<td>55.8 (50.6–61.1)</td>
</tr>
<tr>
<td>4</td>
<td>139</td>
<td>45</td>
<td>70.1 (65.2–75.1)</td>
</tr>
<tr>
<td>5</td>
<td>87</td>
<td>29</td>
<td>80.1 (75.7–84.5)</td>
</tr>
<tr>
<td>6</td>
<td>48</td>
<td>14</td>
<td>85.9 (81.8–89.9)</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>1</td>
<td>87.7 (82.9–92.5)</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>0</td>
<td>92.5 (87.6–97.6)</td>
</tr>
<tr>
<td>9</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>10</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Risk, number of adolescents who have not previously debuted in sexual intercourse; N, number of adolescents debuting in sexual intercourse.

a Beyond study period.
b Zero events, no change to cumulative incidence.

Kingdom (12.9 years, N = 3938), Canada (12.7 years, N = 1403), and the United States (12 years, N = 2624). The cohort median age of FSI (16 years) is comparable to a representative sample of Australians and to current measures in the United Kingdom but older than that in the United States (15.0–15.3 years). Nearly one-quarter of participants had still not initiated sexual intercourse by age 20 or 21 years. It is unlikely that age of FSI was reported erroneously because these data were collected by using a standardized written instrument that has previously been used successfully.

Compared with previous longitudinal studies, our study has a number of strengths. Ours is the first study to use hazard modeling, which permits calculation of FSI risk according to AAM category in empirically derived age groups rather than at a specific cutoff age and which accounts for loss to follow-up before the occurrence of the event of interest (addressing “right censoring”). Another difference is that studies categorizing AAM dichotomously may distort the relationship between AAM and age at FSI. The older a girl is at menarche, the lower her risk of commencing sexual intercourse at younger ages. Comparing a group of earlier-maturing girls versus a reference group that includes later-maturing girls (who delay FSI relative to the average) would overstate the likelihood of FSI for the earlier-maturing girls. More accurate categorization of AAM separates girls into groups with younger, average, and older ages at menarche.

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**FIGURE 2**
Cumulative incidence of FSI according to years since menarche (gynecologic age) among girls with earlier, average, and later AAM.
interval between menarche and FSI, which is consistent with our findings.

CONCLUSIONS
This is the first large birth cohort study to prospectively report the relationship between AAM and first sexual intercourse by using longitudinal analyses. Younger age at reproductive maturity (AAM) did not predict younger age at menarche. Furthermore, we have shown that the interval between AAM and FSI is longer for girls with a younger AAM than those with an average or older AAM. These findings are of social and clinical significance. However, menarche is a relatively late event in pubertal progression. Recent international data strongly suggest earlier onset and faster tempo of puberty in some populations, without an overall population reduction in the AAM. Greater understanding of factors regulating the onset and tempo of puberty are likely to further inform how sexual behavior and reproductive development are interlinked.

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