

Age at menarche and age at first sexual intercourse: a prospective cohort study

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Abbreviations: AAM: age at menarche; CI: confidence interval; FSI: first sexual intercourse; HR: hazard ratio; IQR: interquartile range.

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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 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.

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Contributors' Statement

Jennifer L. Marino: Dr. Marino contributed to the conception and design of the study, contributed to the analysis and interpretation of data, drafted the manuscript jointly with Prof. Hickey, and approved the final manuscript as submitted.

S. Rachel Skinner: A/Prof. Skinner contributed to the conception and design of the study, contributed to the acquisition of the data, contributed to the interpretation of data, critically reviewed the manuscript and approved the final manuscript as submitted.

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Jeffrey Cannon: Mr. Cannon analyzed the data, contributed to the interpretation of data, critically reviewed the manuscript and approved the final manuscript as submitted.

Martha Hickey: Prof. Hickey conceived and designed the study, contributed to the acquisition of the data, drafted the manuscript jointly with Dr. Marino, and approved the final manuscript as submitted.

ABSTRACT

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

Methods: AAM was collected from 554 girls from the WA (Raine) Pregnancy Cohort Study, prospectively from age 10 or retrospectively at age 14-16 years. Age at FSI was collected at ages 17 and 20. Cox regression models describe the likelihood of FSI by age and years since menarche for younger (<12y) and older (\geq 14y) AAM relative to average AAM (12-13y).

Results: Median AAM was 12.8 years. By age 16-17, 275 (49.6%) and by age 20-21, 429 (77.4%) girls reported FSI. Girls with younger AAM and girls with average AAM were equally likely to have FSI by age 16 (aHR 0.90, 95% CI 0.60-1.35). FSI by age 16 was less likely in girls with older AAM compared to 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, IQR 4.4-8.5 years vs. 3.7 years, IQR 2.4-5.3 years). Those with younger AAM were less likely to report FSI than those with average AAM <4 years of menarche (0-2 years HR 0.04, 95% CI 0.01-0.32; 2-4 years HR 0.37, 95% CI 0.24-0.57).

Conclusions: Younger AAM was not a risk factor for younger age at FSI in this large birth cohort.

BACKGROUND

Age at menarche (AAM) marks the onset of reproductive capability and is a commonly utilized milestone for pubertal development. Factors regulating AAM are not well understood, but in developed countries, around half of the variation in AAM is thought to be genetic^{1, 2}. Other mediating factors include birth and childhood body size³⁻⁶, adiposity^{3, 7}, and growth⁸⁻¹⁰, race/ethnicity¹¹⁻¹³, socioeconomic position¹³⁻¹⁷, family relationships and structure^{11, 16, 18, 19}, 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 intercourse²⁴, inconsistent contraceptive use²⁵, and multiple partners²⁶, and with a variety of negative outcomes, including partner violence²⁷, lower educational attainment^{28, 29}, unintended pregnancy³⁰, adolescent pregnancy or birth^{31, 32}, and sexually transmitted infection³³⁻³⁵. If girls with younger AAM are at risk of 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}, so 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}, have reported only baseline data³⁵, or have used analytic methods which represent the probability of FSI at a particular age (e.g. logistic regression) rather than the time to FSI (e.g. hazard models)^{46, 48}, losing the longitudinal or temporal aspect of the study design. Prospective longitudinal designs have several advantages including the increased accuracy of reporting of timing since the date

are captured close to the time of the event^{49, 50}, and the use of use of statistical approaches, such as survival and hazard models, that measure changes within each subject over time, in addition to the difference between groups⁵¹. Hazard models do not require selecting a cut-off age (e.g. "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 of a shorter interval to FSI.

METHODS

PARTICIPANTS

The Western Australian Pregnancy Cohort (Raine) Study is a prospective cohort study of 2,868 live births (1,405 female, 1,463 male) from 2,900 pregnancies followed since 1989. Complete details of the cohort and initial recruitment procedures are published elsewhere⁵². 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 one, two, three, five, eight, ten, 14, 17, and 20 years with extensive clinical and questionnaire data 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 enrolment 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 two menstrual periods to be returned 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 (e.g. 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).

FIRST SEXUAL INTERCOURSE DATA

Self-reported data on age at first (vaginal) sexual intercourse (FSI) were collected at age 17 years using a confidential questionnaire derived from the National Survey of Secondary School Students, HIV/AIDS and Sexual Health, 2002⁵³. At the 17-year-follow-up, 607 girls (43.2% of the original cohort) provided information regarding sexual activity. For those that were not yet sexually active by age 17, FSI data were obtained at age 20 years.

The interval between AAM and a reproductive endpoint, also referred to as gynecologic age⁵⁴, 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 considered the effect of AAM on that interval.

COVARIATES

Ethnicity^{14, 22, 42, 55}, socioeconomic status^{15, 44, 56}, family structure^{11, 55, 57}, and birth size^{3, 11, 15}⁵⁸ 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 to construct an a priori adjusted model. As 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, sex, nulliparity, and gestational age) and absence of biological father at 10 years.

STATISTICAL ANALYSIS

Continuous data were summarized by means and standard deviations (SD) or medians, interquartile ranges (IQR) and minimum and maximum values, and categorical data were summarized by frequency distributions. We examined the effects of younger, average, and older AAM (see above) on calendar age at FSI and duration between menarche and FSI. Univariate comparisons between groups were conducted using one-way ANOVA or Kruskal-Wallis tests for continuous outcomes and chi-square 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 which does not require a specific cut-off 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 rate ratios, HR) that are constant across time in comparing the predictor group to the reference group. The proportionate hazard assumption was assessed by inspection of plotted Kaplan-Meier survivor probabilities and,

where graphical findings were ambiguous, examination of Schoenfeld residuals⁵⁹. 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 using HR and 95% confidence intervals (CI). All hypothesis tests were two-sided and p-values<0.05 were considered statistically significant. SPSS version 18 (SPSS, IBM Corp., Chicago, IL) 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 three menstrual periods, while 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 (interquartile range 12.1-13.5 years, range 9.0-16.1 years). The distribution of AAM differed by ethnicity (Table 1).

AGE AT FIRST SEXUAL INTERCOURSE

At the age 17 follow-up, 275 girls (50.4%) 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 follow-up (77.4%).

The median age of FSI for the cohort was 16.0 years (95% CI 15.8-16.2 y) while the median ages at FSI among girls with younger, average, and older AAM were, respectively, 16 years (IQR 15-20 y, range 13-21 y), 17 years (IQR 15-18 y, range 13-20 y), and 17 years (IQR 16-18 y, range 14-19 y). The cumulative incidence of FSI by 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, around a quarter had FSI by age 15, but none of the girls in the older AAM group had FSI before age 14, and only 1 in 10 had FSI by age 15.

As is illustrated in Figure 1, the slope of incident FSI (absolute FSI risk) was not the same for the three groups across all ages (i.e. the curves cross, indicating that the absolute risk changed at different rates for the three groups, a violation of the proportionate hazards assumption underlying calculation of relative risks in standard Cox regression modeling). On closer examination, within three 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 and under, age 16 years, and 17 years and over (Table 4). Girls with younger AAM and girls with average AAM were equally likely to have FSI by age 15 (adjusted hazard ratio (aHR): 0.90, 95% confidence interval (CI): 0.60-1.35), and girls with older AAM were only a third as likely as girls with average AAM to experience FSI by age 15 (aHR 0.35, 95% CI 0.17-0.72). All three groups were equally likely to experience FSI at age 16 (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 half as likely to experience FSI between age 17 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 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 significantly affected the likelihood of FSI by calendar age in univariate or multivariate models (maternal tertiary v. 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 4).

INTERVAL BETWEEN MENARCHE AND FIRST SEXUAL INTERCOURSE

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 y, range 0.5-9.0 y), 5.0 years for girls with younger AAM (IQR 4.4-8.5 y, range 1.2-10.8 y), and 2.5 years for girls with older AAM (IQR 1.4-3.9, range 0.0-5.7 y). Cumulative incidence of FSI for each year since menarche for the three groups of AAM are shown in Table 3. Only one girl with younger AAM experienced FSI within two years of menarche, in contrast with the 17% of girls with average AAM and over 40% of girls with older AAM.

As with FSI by calendar age, the rate curves for FSI were not parallel across the three AAM groups for the years since menarche (Figure 2). Examination of Schoenfeld residuals confirmed this more subtle departure from proportionality ($p < 0.001$) so relative rates of FSI were estimated over those intervals for which hazards were proportionate: < 2 years since menarche, 2-4 years since menarche, and > 4 years since menarche (Table 4). For the first two years after menarche, girls with younger AAM were much less likely, and girls with older AAM much more likely, to commence sexual activity compared to girls with average AAM (younger aHR 0.04, 95% CI 0.01-0.31; older AAM aHR 3.46, 95% CI 2.25-5.31). For the subsequent two years, girls with younger AAM were still less likely to experience FSI than girls with average AAM (aHR 0.36, 95% CI 0.23-0.55), but girls with older AAM no longer differed (aHR 1.38, 95% CI 0.87-2.17). Of the potential confounders, as with calendar age, only maternal education and father's absence at age 10 significantly affected the likelihood of FSI by time since menarche (maternal tertiary v. high school education HR 0.52, 95% CI 0.37-0.74, aHR 0.54, 95% CI 0.38-0.77; absent father HR 1.40, 95% CI 1.14-1.72, aHR 1.33, 95% CI 1.07-1.64). Adjustment for potential

confounders did not substantially change risk estimates (Table 4).

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 four 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 was true even when accounting for early life growth, socioeconomic variables and father absence at puberty. This may have implications for the life history theories which presuppose that adversity leads to earlier puberty (including menarche) and then earlier reproduction^{36, 60}. In clinical practice, younger AAM alone does not appear to put girls at risk of 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 (12.9y, N=9683²⁷; Penrith birth cohort 12.6y, N=156⁶¹), the UK (12.9 y, N=3938⁶²), Canada (12.7 y, N=1403⁶³, and the United States (12 y, N=262⁶⁴). The cohort median age of FSI (16 y) is comparable to a representative sample of Australians⁶⁵, and to current measures in the UK⁶⁶, but older than that in the US (15.0-15.3 y)⁶⁷. Nearly a quarter of participants had still not initiated sexual intercourse by age 20 or 21. It is unlikely that age of FSI was reported erroneously, as these data were collected using a standardized written instrument that has previously been used successfully⁵³.

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 by AAM category in empirically derived age groups rather than at a specific cut-off age, and which accounts for loss to follow-up prior to 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 to 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 (CHDS cohort)⁴⁸ (N=497) the Dunedin cohort study^{44, 46, 69} (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 CHDS and 17 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 16⁷⁰; however, they used a composite measure of pubertal timing including 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 one other study has examined the relationship between AAM and the interval between menarche and FSI. Segal and Stohs⁷¹ report that, amongst 44 twin pairs, AAM was inversely related to interval between menarche and FSI, consistent with our findings.

CONCLUSIONS

This is the first large birth cohort study to prospectively report the relationship between AAM and first sexual intercourse using longitudinal analyses. Younger age at reproductive maturity (AAM) did not predict younger age at FSI. Further, 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 progression⁷². Recent international data strongly suggest earlier onset and faster tempo of puberty in some populations, without an overall population reduction in the AAM⁷³⁻⁷⁵. Greater understanding of factors regulating the onset and tempo of puberty are likely to further inform how sexual behavior, reproductive and emotional development are interlinked.

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Table 1. Demographic profile of study participants stratified by age at menarche (AAM). Percentages within each group may not add to 100% due to missing data.

Characteristic	Average AAM (12-13y) N=353 (%)	Younger AAM (<12y) N=123 (%)	Older AAM (≥14y) N=78 (%)	Total N=554 (%)	<i>p</i>
Maternal ethnicity					
Caucasian	316 (89.5)	100 (81.3)	71 (91.0)	487 (87.9)	0.01
Non-Caucasian*	29 (8.2)	21 (17.7)	5 (6.4)	55 (9.9)	
Maternal age at birth					
<25 years	94 (26.6)	38 (30.9)	24 (30.8)	156 (28.2)	0.87
25-35 years	206 (58.4)	69 (56.1)	43 (55.1)	318 (57.4)	
>35 years	53 (15.0)	16 (13.0)	11 (14.1)	80 (14.4)	
Family income at pregnancy					
<\$12,000	58 (16.4)	21 (17.1)	17 (21.8)	96 (17.3)	0.555
\$12000-\$35,999	158 (44.7)	61 (49.6)	33 (42.3)	252 (45.5)	
≥\$36,000	116 (15.0)	33 (26.8)	22 (28.2)	171 (30.9)	
Maternal education					
<High school	85 (24.1)	37 (30.0)	14 (17.9)	151 (27.3)	0.44
High school	60 (17.0)	15 (12.2)	14 (17.9)	99 (17.9)	
Trade	133 (37.7)	51 (41.5)	34 (43.6)	236 (41.6)	
Tertiary	52 (14.7)	14 (11.4)	11 (14.1)	80 (14.4)	
EBW					
Mean (SD)	1.01 (0.13)	1.01 (0.12)	1.01 (0.17)	1.01 (0.13)	0.850
Father absence at 10-year follow-up					
Not living with family	103 (30.3)	37 (30.6)	20 (26.0)	160 (29.7)	0.736

*Aboriginal: 5 (0.9%); Polynesian 5 (0.9%); Vietnamese 1 (0.2%); Chinese 22 (4.0%); Indian 14 (2.5%); Other 8 (1.4%); SES = social economic status; Income at pregnancy was recorded during 1989-1992 \$AUD. EBW = expected birth weight ratio reflecting birth size for gestational age.

Table 2. Estimated cumulative incidence of sexual intercourse for each year of age, by age at menarche (AAM)

Age	Average AAM (12-13y)			Earlier AAM (<12y)			Later AAM (≥14y)		
	N. Risk	N. SI	% (95% CI)	N. Risk	N. SI	% (95% CI)	N. Risk	N. SI	% (95% CI)
13	353	5	1.4 (0.2-2.6)	123	3	2.4 (0.0-5.2)	79	0	-
14	348	31	10.2 (7.0-13.4)	120	14	13.8 (7.7-19.9)	78	1	1.3 (0.0-3.8)
15	317	65	28.6 (23.9-33.3)	106	14	25.2 (17.5-32.9)	77	7	10.3 (3.5-17.0)
16	252	75	49.9 (44.6-55.1)	92	38	56.1 (47.3-64.9)	70	24	41.0 (30.1-51.9)
17	165	48	64.4 (59.4-69.5)	48	5	60.7 (51.9-69.4)	42	11	56.5 (45.2-67.7)
18	103	34	76.2 (71.5-80.9)	37	9	70.2 (61.7-78.8)	28	12	75.1 (64.9-85.4)
19	68	24	84.6 (80.5-88.7)	28	2	72.4 (63.9-80.8)	16	3	79.8 (70.2-89.4)
20	18	1	85.4 (81.3-89.6)	14	2	76.3 (67.5-85.1)	8	0	-
21	2	1	92.7 (82.4-100)	12	0	-	1	0	-

N risk = number of adolescents that have not previously debuted in sexual intercourse; N SI = number of adolescents debuting in sexual intercourse

Table 3. Estimated cumulative incidence of sexual intercourse for each year since menarche, by age at menarche (AAM)

Years	Average AAM (12-13y)			Earlier AAM (<12y)			Later AAM (≥14y)		
	N. Risk	N. SI	% (95% CI)	N. Risk	N. SI	% (95% CI)	N. Risk	N. SI	% (95% CI)
<1	353	10	2.8 (1.1-4.6)	123	0	-	78	10	12.8 (5.4-20.2)
1	343	50	17.0 (13.1-20.9)	123	1	0.8 (0.0-2.4)	67	23	42.7 (31.7-53.8)
2	293	82	40.2 (35.1-45.3)	122	15	13.0 (7.1-19.0)	41	13	60.9 (49.8-72.0)
3	203	53	55.8 (50.6-61.1)	107	11	22.0 (14.6-29.3)	25	9	75.0 (64.7-85.2)
4	139	45	70.1 (65.2-75.1)	96	34	49.6 (40.8-58.4)	14	3	80.3 (70.7-90.0)
5	87	29	80.1 (75.7-84.5)	58	13	60.9 (52.2-69.6)	6	0	-
6	48	14	85.9 (81.8-89.9)	40	8	68.7 (60.2-77.2)			
7	8	1	87.7 (82.9-92.5)	29	2	70.9 (62.4-79.3)			
8	1	0	-	19	2	73.9 (65.4-82.5)			
9				7	1	77.7 (67.7-87.6)			
10				1	0	-			

N risk = number of adolescents that have not previously debuted in sexual intercourse; N SI = number of adolescents debuting in sexual intercourse

Table 4. Relative risk of first sexual intercourse (FSI) for girls with younger and older ages at menarche (AAM) compared to girls with average AAM, for risk-stable intervals of years of age (calendar age) and years since menarche (gynecologic age).

	Unadjusted relative risk of FSI				Adjusted* relative risk of FSI			
	Younger AAM (<12 years)		Older AAM (≥14 years)		Younger AAM (<12 years)		Older AAM (≥14 years)	
	HR (95% CI)	p	HR (95% CI)	p	HR (95% CI)	p	HR (95% CI)	p
Calendar age								
≤15 years	0.91 (0.61-1.36)	0.632	0.34 (0.16-0.69)	0.003	0.90 (0.60-1.35)	0.620	0.35 (0.17-0.72)	0.004
16 years	1.39 (0.94-2.05)	0.100	1.15 (0.73-1.82)	0.546	1.35 (0.91-2.00)	0.136	1.18 (0.74-1.87)	0.486
≥17 years	0.48 (0.29-0.79)	0.004	0.92 (0.60-1.41)	0.707	0.50 (0.30-0.82)	0.007	0.97 (0.63-1.49)	0.884
Time since menarche								
<2 years	0.04 (0.01-0.32)	0.002	3.15 (2.06-4.82)	<0.001	0.04 (0.01-0.31)	0.002	3.46 (2.25-5.31)	<0.001
2-4 years	0.37 (0.25-0.57)	<0.001	1.22 (0.78-1.92)	0.387	0.36 (0.23-0.55)	<0.001	1.38 (0.87-2.17)	0.168
>4 years	0.82 (0.59-1.15)	0.250	0.49 (0.15-1.55)	0.225	0.80 (0.57-1.12)	0.191	0.56 (0.18-1.79)	0.330

Reference group was girls with average AAM.

*Adjusted for maternal ethnicity (Caucasian vs. Other) and education (<high school, high school, trade, tertiary), family income at pregnancy (<\$AUD 12K, \$AUD 12-35K, ≥\$AUD 36K), expected birth weight ratio and absence of biological father at age 10 years.

Figure legends (see figure file)

Figure 1. Cumulative incidence of first sexual intercourse by years of age among girls with earlier, average, and later ages at menarche.

Figure 2. Cumulative incidence of first sexual intercourse by years since menarche (gynecologic age) among girls with earlier, average, and later ages at menarche.