Published in final edited form as:

Ann Epidemiol. 2012 October ; 22(10): 731–737. doi:10.1016/j.annepidem.2012.08.005.

A Prospective Study of Childhood Social Hardships and Age at Menarche

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Abstract

Purpose—To determine the role of type, timing, and cumulative childhood hardships on age at menarche in a prospective cohort study.

Methods—Longitudinal analysis of 4,524 female participants of the National Child Development Study cohort (1958 – 2003). Six types of childhood hardships were identified with a factor analysis methodology: financial, family dysfunction, caregiver low interest in education, lack of supportive caregiving, neglectful environment, and family structure disruption. Paternal absence/low involvement in childhood was an a priori hardship. Retrospective reports of abuse in childhood were explored in relation to age at menarche, also. Generalized logit regression analyses explored the impact of type, timing, and cumulative hardships on age at menarche (11, 12–13, 14 years).

Results—Cumulative childhood hardships were associated with a graded increase in risk for later menarche with adjusted OR [AOR] of 1.37 (95%CI: 1.10, 1.70), 1.50 (95%CI: 1.18, 1.91), and 1.58 (95%CI: 1.29, 1.92) among those with 2, 3, and 4 adversities, respectively. More than 2 hardships in early life had the strongest association with late menarche (AOR=2.32, 95%CI: 1.12, 4.80). Sexual abuse was most strongly associated with early menarche (AOR=2.60, 95%CI: 1.40, 4.81).

Conclusion—Cumulative childhood hardships increased risk for later age at menarche. Child abuse was associated with both early and late menarche, although associations varied by type of abuse. Critical period of exposure, type, and chronicity of hardships demonstrate varying degrees of influence on age at menarche.

Keywords

adversity; birth cohort; child abuse; hardship; life course; menarche; socioeconomic status

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Introduction

Age at menarche denotes onset of the female reproductive lifespan and is a marker of health trajectory and chronic illness risk. While later age at menarche is associated with depression,¹ fractures² and low bone mineral density;³ earlier age at menarche is associated with cardiovascular and metabolic dysfunction,^{4,5} breast cancer risk,⁶ depression,⁷ all cause mortality,⁸ and health risk behaviors.⁹

The average age at menarche declined over the 20th and early 21st century.^{10–13} This trend has largely been credited to improvements in population health and nutrition.¹³ Populations characterized by greater gains in socioeconomic^{14,15} or social conditions experienced the greatest relative change in age at menarche.¹⁶ Malnutrition¹⁷ and food insecurity¹⁸ are associated with delayed menarche, while accelerated weight gain¹⁹ and elevated body composition of fat²⁰ have been linked to earlier age at menarche.

In general, higher socioeconomic position,²¹ parental education,^{14,22} income, and occupational class²² have been associated with earlier menarche; while, poverty,¹⁷ adult illiteracy level,²³ and impoverished or underprivileged regions^{24,25} have been associated with later menarche. However, these associations have varied over time¹⁴ and by place.²⁶ While poverty has been consistently associated with delayed sexual maturation in developing countries,^{17,27} the majority of contemporary studies among US cohorts have found that lower socioeconomic status (SES) is associated with earlier menarche and pubertal development,^{26–28} a finding replicated in several international cohorts.²⁹

Psychosocial stressors have been associated with both early and late onset menarche.^{16,30–32} Delayed onset of menarche has been associated with war and post-war periods in past and recent decades;³³ however, the relative contribution of psychosocial stress versus material hardships induced by war on menarchal timing is unknown. Early age at menarche is associated with familial conflict,³¹ alterations in family structure,³⁴ stressful home circumstances,^{35–37} paternal absence in childhood,³⁸ and attachment relationships.^{30,39,40} Child maltreatment has been associated with precocious sexual maturation.^{41,42} Of the six studies that have explored the impact of child abuse on menarcheal age, sexual abuse has been more strongly and consistently associated with early menarche, while physical abuse has had a weakly positive association.^{40,42–47}

Boyce and Ellis's theory of stress reactivity, biological sensitivity to context,⁴⁸ reconciles 'stress suppression theory,' which posits that excessive activation of the stress response system can suppress the hypothalamic-pituitary-gonadal (HPG) axis and inhibit pubertal development, and 'psychosocial acceleration theory,' which suggests that low or unpredictable resources or low parental investment accelerate reproductive maturation.¹⁶ Their theory of stress reactivity posits that there is a curvilinear, U-shaped association between adversities in early life and reactivity to stress. Social stressors and supports may accelerate or suppress the HPG axis by influencing the biological stress responses to early adversities.

The intent of this study is to investigate the independent and cumulative impact of multiple types of childhood adversities (including maltreatment, family conflict, and poverty) on timing of menarche in a prospective cohort of British girls born in 1958. We hypothesized that children exposed to higher cumulative adversities would have altered timing of menarche—earlier or later age at onset. Existing studies are limited by retrospective exposure assessment, and failure to account for multiple types of adversities. Uniquely, this cohort also offers an opportunity to investigate the association between psychosocial stressors and timing of menarche within a post-war period.

Methods

Sample

Study participants are enrolled in the National Child Development Study, a prospective cohort study of 17,638 British children born during 1 week in March 1958 in England, Scotland, and Wales (originally the Perinatal Mortality Survey birth cohort). Respondents were contacted at multiple time points in childhood (ages 7, 11, 16) and adulthood (ages 23, 33, and 42). In total, 91.5% of the target sample participated at age 11 and 87% at age 16.⁴⁹ Our sample is restricted to female participants with a reported age at menarche or stated that menstruation had not yet started at the 16-year follow up (N=4,524).

Measures

Assessment of the Outcome—At the 16 year follow-up survey part of the medical examination included a report of pubertal development, including age at menarche. It was up to the examiner whether the parent stayed in the room for this exam, so the age was reported by either the participant or the parent. Data was captured via self-report as a categorical variable (<11, 11, 12, 13, 14, 15 years, unsure, has not commenced). We created a categorical variables for onset of menarche: early menarche 11 years of age, average age of menarche 12–13 years, and late menarche 14 years of age.

Assessment of the Exposure—Childhood hardships were measured through a variety of modalities during the study. A Local Authority Health visitor interviewed the parents (usually the mothers) at ages 7, 11, and 16. The health visitor completed an assessment of the social environment, which included a list of questions about social services the family had required, as well as a question: “under which categories would you list the difficulties of this family”, which included a list of responses such as “alcoholism”, “mental illness or neurosis”, “housing”, and “financial”. The Educational Questionnaire was completed by the head teacher and class teacher at the child’s school, and provided information about the child’s eligibility for services, adjustment, and appearance of neglect. A Local Authority Medical Officer carried out the medical examination and consulted records.

We performed an exploratory factor analysis in order to categorize the types of hardships, as we have previously described.⁵⁰ Using the maximum likelihood method followed by the oblique (promax) rotation all items with factor loadings > 0.45 were assigned to the factor for which they had the greatest loading. A six factor solution was chosen due to parsimony and consistency with theoretically pre-determined latent constructs of types of hardships. Our method yielded the following factors: (1) financial, (2) caregiver low interest in education, (3) family dysfunction, (4) lack of supportive caregiving, (5) neglectful environment, (6) family structure disruption (see Table 1 for details). For items measured more than once, participants were categorized as having experienced if it was reported at any time point. We summed the number of hardships in each factor in order to create scales for each factor. Within each factor, number of different types of hardships within that factor was considered to be a proxy for severity of that hardship type. A priori, an additional factor was created to assess lack of paternal involvement: single mother, father dead, spent time in foster care, father had limited role in upbringing, father not interested in educational progress. Paternal investment theory suggests that pubertal timing is sensitive to the quality of paternal investment, and this may independently influence maturation¹⁶. The association between lack of paternal involvement and age at menarche was assessed independently.

An indicator of the number of cumulative hardships was created by summing the total number of hardships (based on the 6 factors, see Table 1) irrespective of number within each type or timing. The final category was created by collapsing the upper categories to maintain

a reasonable sample size. We also categorized exposure within each factor by timing of when the hardship was reported (early (birth or age 7), late (age 11 yrs only) or both time periods in order to capture both timing and chronicity. A final indicator was created to capture both the severity and timing of hardship exposures.

At the 45-year interview, participants were also interviewed about their childhood experience of physical, sexual or verbal abuse, neglect, and parental alcoholism or mental health issues. Ultimately, 2915 women (64%) of the women with age at menarche completed this interview.

Covariates—Maternal age at menarche was assessed at the age 11 follow-up using a categorical response (<11, 11, 12, 13, 14, >14). Birth weight was abstracted from on medical records obtained at birth. Mother's smoking during pregnancy was based on self-report at birth. BMI at age 11 was calculated from height and weight measured at the 11-year follow-up.

Statistical Analysis

All analyses used multivariable generalized logit regression models to estimate risk ratios (OR) while controlling for covariates associated with age at menarche. The SAS PROC LOGISTIC procedure with the glogit link (SAS Institute, 1991) was used. A 3-level outcome variable was used: menarche 11 years to menarche, 12–13 years, and menarche 14 years. Model #1 was unadjusted and Model#2 controlled for the following covariates: birth weight, maternal smoking during pregnancy (non-smoker/any smoking); BMI at age 11 years (continuous); and mother's age at menses (categorized as above). Multiple imputation, using SAS 9.1's PROC MI and PROC MIANALYZE, was used to impute missing values for confounders; data were missing for 7% of the study population for mother's smoking, 8.5% for mother's birth weight, 19% for mother's age at menarche, and 18% for BMI at age 11.

We also ran analyses that mutually adjusted for the different types of hardship: one that included only the six factors listed above, and a second model that also incorporated reports of sexual, physical, and verbal abuse.

The 41 year survey has been approved by the North Thames Multi-Centre Research Ethics Committee and the current analysis was approved by the Institutional Review Boards of Tulane University and Boston University School of Medicine.

Results

Of the 4524 participants, the majority (58%) reported menarche between ages 12–13 years, while 15% experienced menarche younger than age 12 (n=695), and 27% reported onset of menarche at or after age 14 years (n=1217). Table 2 presents the distribution of age at menarche by childhood hardships. Financial, caregiver low interest in education, lack of supportive caregiving, violence/mental health issues, neglectful environment and cumulative hardships were significantly associated with age at menarche (*p trend* <0.05). Table 3 presents the distribution of age at menarche by retrospective report of child abuse and adversities. Sexual abuse, verbal abuse, physical punishment, humiliation, witnessing abuse, conflict in the home, and maternal drinking were associated with age at menarche (*p* <0.03).

Childhood Hardships and Late Menarche

As presented in Table 4, for 2 or more forms of the associated hardship the adjusted ORs [AOR] for late menarche were 1.80 (95%CI: 1.37, 2.35) for financial hardships, 1.52 for

caregiver low interest in education (95%CI: 1.25, 1.85), 1.28 for lack of supportive caregiving (95%CI: 1.04, 1.57), 1.76 for violence/mental health (95%CI: 1.41, 2.20), and 1.25 for lack of paternal involvement (95%CI: 1.02, 1.52) relative to those without the respective exposures. We found a graded association between the cumulative number of hardship types and risk for late menarche (p-trend <0.01): adjusted ORs for late menarche for 2, 3, and 4 or more hardships were 1.37 (95%CI: 1.10, 1.70), 1.50 (95%CI: 1.18, 1.91), and 1.58 (95%CI: 1.29, 1.92), respectively.

Table 5 presents the association between retrospective report of child abuse and age at menarche. Verbal abuse, physical punishment, humiliation, witnessing abuse, family conflict, and maternal alcohol abuse were associated with adjusted ORs of 1.58 (95%CI: 1.18, 2.12), 1.75 (95%CI: 1.18, 2.58), 1.53 (95%CI: 1.13, 2.07), 1.49 (95%CI: 1.08, 2.07), 1.71 (95%CI: 1.35, 2.16), and 1.50 (95%CI: 1.04, 2.17) for menarche 14 years, respectively.

Childhood Hardships and Early Menarche

As shown in Table 4, there was no significant association between individual hardships and early menarche, or cumulative childhood hardships and menarche 11 years. As presented in Table 5, retrospective report of sexual abuse was associated with an AOR of 2.60 (95%CI: 1.40, 4.81) for menarche 11 years, mother having 'nervous troubles' was associated with an AOR of 1.37 (95%CI: 1.07, 1.76), father drinking was associated with an AOR of 1.41 (1.02, 1.96).

Timing of Hardships and Menarche

In Table 6 we report results for age of menarche analyzed by timing of hardship (early childhood, late childhood or both periods). Financial hardship experienced in early or late childhood significantly increased risk for late menarche, adjusted OR were 2.05 (95%CI: 1.02, 4.15) and 1.32 (95%CI: 1.11, 1.56), respectively.. Exposure to caregiver low interest in education in early, late and both early and late childhood increased risk for late menarche, AOR were 1.39 (95%CI: 1.09, 1.78), 1.25 (95%CI: 1.00, 1.57), and 1.72 (95%CI: 1.28, 2.32). In addition, violence/mental health issues in early, late, and both early and late childhood were significantly associated with increased risk for late menarche, AORs were 1.25 (95%CI: 1.03, 1.53), 1.29 (95%CI: 1.01, 1.64), and 1.74 (95%CI: 1.38, 2.18), respectively. Finally, in a variable accounting for both chronicity and frequency of exposures, those with >2 hardships in early childhood had the highest risk for late menarche (AOR 2.32, 95%CI: 1.12, 4.80), as did those with >2 types of hardship exposures in both early childhood and late childhood/adolescence (AOR=1.72; 95%CI: 1.14, 2.60). Exposure to >2 types of hardship in both early childhood and late childhood/adolescence was also associated with late menarche (AOR=2.08; 95%CI: 1.47, 2.96). Early menarche was not significantly associated with the timing of hardships.

When the models were mutually adjusted for the other hardships, violence/mental health issues were associated with both early menarche (AOR for 2 or more, 1.83, 95%CI: 1.18–2.85) and later menarche (AOR for 2 or more, 1.67, 95%CI: 1.16–2.41). In the mutually adjusted model, household tension (AOR 1.57, 95%CI: 1.12–2.19) and lack of parental interest in education (AOR for 2 or more, 1.32, 95%CI: 0.99–1.77) were associated with later menarche. Sexual abuse had a borderline significant association with early menarche (AOR 1.97; 95%CI: 0.86, 4.50), as did lack of supportive caregiving (AOR for 2 or more, 1.32, 95%CI: 0.95–1.84) in mutually adjusted models. Finally, in sub-analyses stratified by maternal age at menarche (>12 vs. ≤12 years) we found no evidence of effect modification.

Discussion

We found a graded association between cumulative social hardships in childhood and risk for late menarche. Different types of hardships appeared to have a stronger impact on risk for late menarche, including financial hardships, caregiver low interest in education, and neglectful home environment. In general, chronic exposure to hardships during childhood conferred a greater risk for late onset menarche, but these associations varied by type and timing of exposure. Family violence/mental health issues were associated with an increased risk for both early and late menarche in models mutually adjusted for other hardships. Childhood sexual abuse was most strongly associated with risk for early menarche. Retrospective reports of verbal abuse, family conflict, maternal drinking, excessive physical punishment, and witnessing abuse were associated with risk for late menarche.

Our findings both confirm and deviate from those in prior studies and therefore extend current understanding of social determinants of pubertal timing. The majority of contemporary studies have highlighted the impact of psychosocial stressors associated with familial disruption (paternal absence) and dysfunction (parental conflict) on risk for earlier timing of menarche.⁴⁰ After adjustment for other factors, we did find an increased risk of earlier age at menarche with retrospectively reported sexual abuse, maternal 'nervous troubles', and paternal drinking problems. However, a variable expressing lack of paternal involvement was a predictor of later age at menarche, rather than early, which deviates from previous literature that supports an association between paternal absence and earlier menarche^{16,36}.

Mounting research evidence supports the role of childhood adversities on reproductive lifespan.^{11,21,26,40} While our findings support the hypothesis that cumulative social stressors are associated with altered menarcheal timing, they also suggest that different types and periods of exposure to social adversities may impact timing of menarche differently. It is plausible the psychosocial stress associated with specific forms of child maltreatment may accelerate onset of menarche through chronic elevation of HPA and HPG axes,⁵¹ while socioeconomic deprivation and environmental neglect may be associated with nutritional deprivation, increased energy expenditure, and slow sexual maturation.

Limitations

Our analysis has several limitations. First, we model BMI at age 11 years as a covariate in our model, but BMI could be an intermediate variable. BMI trajectory has been associated with childhood hardships including poverty, and has also been associated with pubertal timing.^{52–54} Next, age of menarche was reported by either female participant or her mother. It is plausible that less engaged or neglectful parents may also be more likely to inaccurately report age at menarche. However, if a reporting bias were present it would most likely lead to underestimation of the association between hardships and age at menarche. Many hardships were assessed through multiple informants and prior to the assessment of age at menarche. It seems unlikely that timing of menarche would affect recall of child abuse, which was assessed via retrospective survey administered in adulthood. Next, we lack prospective measures of several forms of child maltreatment, including child physical and sexual abuse. Although we have a prospective measure of child neglect, there is a chance that we could misattribute findings to other unmeasured, but correlated factors. We lack information on timing of the abuse, and it may be that girls who reach menarche earlier are more likely to be targets of sexual abuse. However, an earlier study exploring multiple forms of adversities, including child abuse, low SES, and family conflict found that they preceded early menarche.⁴⁰ However, our analysis is strengthened by the prospective measurement of childhood hardships, and triangulation of assessment of these hardships by multiple informants, including teacher, social visitor, parent, and the adolescent participant.

While the use of multiple informants may provide a more accurate view of the pattern of adversity exposure,⁵⁵ it may also introduce misclassification in the case of conflicting reports. In addition, we are strengthened by assessment of maternal age at menarche. Prior studies exploring multiple psychosocial stressors have found weak associations between psychosocial stressor and menarche when controlling for maternal menarche.⁵⁶

Food rationing in post-war Britain occurred over a 14-year period (1940–1954). Plausibly, maternal health and fitness was adversely affected prior to pregnancy due to food rationing, or due to the stress and general deprivation associated with WWII. Alternatively, nutritional content of the diets of children may have been influenced by parental experience of the food rationing. We have no measures of nutritional content or dietary intake, factors that are associated with both pubertal timing and childhood hardships, so we are unable to evaluate these pathways. Epidemiologic data has largely supported an association between socioeconomic and nutritional conditions, and secular changes in these factors, and pubertal timing;²⁶ therefore, a cautionary note on our findings is that they should be considered with respect to nutritional and socioeconomic conditions in Britain in the mid 20th century. Future studies should explore more thoroughly the potential roles of individual diet and BMI trajectory, with respect to the larger nutritional and socioeconomic context.

Conclusion

In conclusion our findings demonstrate an association between cumulative social hardships in childhood and an increased likelihood of later menarche in this cohort of British women born in 1958. More subtle findings include evidence that critical periods of exposure, types of hardships, and chronicity demonstrate varying degrees of influence on age at menarche. Sexual abuse in childhood, and several forms of child adversity paternal drinking problems and maternal anxiety was associated with risk for early menarche. These findings reflect the complexity of the relation between type and timing of social adversity and menarcheal timing, in addition to cumulative effects. A more thorough understanding of the relative impact of childhood hardships on age at menarche may help inform the design of public health interventions to improve the health of women over the life course.

Acknowledgments

Sources of Financial Support: William T Grant Foundation, Boston University Building Interdisciplinary Research Careers in Women's Health K12 HD043444 NIH Office of Women's Health Research and the Charles Hood Foundation. Dr. Harville was supported by Grant Number K12HD043451 from the National Institute of Child Health And Human Development. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Child Health And Human Development or the National Institutes of Health

The authors would like to acknowledge the study participants.

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Table 1

Description of Childhood Social Hardship Factors

Factor	Items	Reported by	Time period assessed
Financial hardship	Unemployment	Parent	Birth, age 7 and 11
	Eligible for free school lunches	Parent, school	Age 11
	Sharing a bed	Parent	Age 11 Age 11
Caregiver low interest in education	Contact with the criminal justice system	Parent	
	Lack of interest in child's education	School	Age 7 and 11
	Hope child would leave school at the minimum age	Parent	Age 11
Indicators of family dysfunction	Family problems with tension	Health visitor	Age 7
	Alcoholism, or other problems	Health visitor	Age 7
Lack of supportive caregiving	Parents' not reading to the child	Parent	Age 7
	Father not taking an active role in the child's upbringing.	Parent	Age 7 and 11
Neglectful environment	Physical neglect	Teacher	Age 7 and 11
	Maladjustment	Teacher	Age 7 and 11
	Mental subnormality in family	Health visitor	Age 7
	Experienced Bullying	Parent	Age 7 and 11
	Contact with social services	School, Parent	Age 7 and 11
Family structure disruption	Foster care	Parent	Age 7 and 11
	Divorced parents	Parent, child	Age 7, 11, adult report
	Single mother at birth	Parent	Birth
	Parent dead	Parent, child, health visitor	Age 7, 11, adult report

Table 2

Distribution of Early and Late Age at Menarche by Childhood Hardships

	Menarche 11 years		Menarche 14 years		Menarche 12–13 years		p (chi-square)
	N	%	N	%	N	%	
Financial hardship							<0.01
0	530	77.8	843	25.2	1971	76.8	
1	111	16.3	235	29.4	453	17.7	
2+	40	5.9	112	38.2	141	5.5	<0.01
No interest in education							
0	496	74.4	795	25.0	1895	75.0	
1	76	11.4	143	28.2	289	11.4	0.73
2+	95	14.2	224	33.9	342	13.5	
Family dysfunction*							
0	567	93.7	972	93.3	2154	93.5	0.05
1+	38	6.3	70	6.7	150	6.5	
Lack of supportive caregiving							
0	424	64.6	685	60.0	1580	63.7	<0.01
1	135	20.6	272	23.8	568	22.9	
2+	97	14.8	184	16.1	334	13.5	
Violence/mental health issues							0.31
0	444	64.6	664	56.7	1638	64.6	
1	159	23.5	330	28.2	662	26.1	
2+	74	10.9	178	15.2	236	9.3	0.05
Issues of family structure*							
0	596	86.9	1063	88.4	2269	87.7	<0.01
1+	90	13.1	139	11.6	319	12.3	
Lack of paternal involvement							
0	371	54.2	595	49.8	1387	53.8	<0.01
1	198	28.9	390	32.6	792	30.7	
2+	116	16.9	211	17.6	400	15.5	
Overall							<0.01
0	225	32.8	327	27.2	866	33.4	

	Menarche		11 years		Menarche		14 years		Menarche 12–13 years		p (chi-square)
	N	%	N	%	N	%	N	%	N	%	
1	140	20.4	229	19.0	586	22.6					
2	121	17.6	204	17.0	390	15.1					
3	75	10.9	152	12.6	271	10.5					
4+	125	18.2	291	24.2	477	18.4					

Table 3

Distribution of Early and Late Age at Menarche by Child Abuse

	Menarche 11 years		Menarche 14 years		Menarche 12-13 years		p (chi-square)
	N	%	N	%	N	%	
Sexual abuse	17	3.9	22	1.8	31	3.1	0.02
Physical abuse	29	6.6	52	5.6	97	7.3	0.28
Verbal abuse	40	9.1	87	12.2	138	8.1	<0.01
Neglected	10	2.3	28	4.0	52	3.0	0.27
Received too much physical punishment	19	4.4	48	6.8	72	4.2	0.02
Suffered humiliation, ridicule, etc.	42	17.0	79	32.0	126	7.4	0.01
Witnessed physical/sexual abuse	31	7.1	67	9.3	107	6.2	0.02
A lot of conflict/tension in home	69	15.5	149	20.6	230	13.2	<0.01
Mother nervous troubles	113	25.5	165	22.9	358	20.7	0.07
Father nervous troubles	51	12.0	90	12.8	187	11.0	0.43
Mother problems with drinking	19	4.3	53	7.4	86	5.0	0.03
Father problems with drinking	58	13.6	86	12.2	180	10.6	0.16

Table 4

Multivariate Generalized Logit Regression Models of Early and Late Age at Menarche by Number of Hardships

OR (unadjusted)				OR (adjusted for mother's smoking, birthweight, BMI at age 11, and mother's age at menses)				
Age at menarche		11	14	Age at menarche		11	14	
OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	
Financial hardship								
0								
1	0.91	(0.73, 1.15)	1.21	(1.02, 1.45)	0.92	(0.73, 1.16)	1.20	(1.00, 1.44)
2+	1.06	(0.73, 1.52)	1.86	(1.43, 2.41)	1.14	(0.79, 1.66)	1.80	(1.37, 2.35)
No interest in education								
0								
1	1.01	(0.77, 1.32)	1.18	(0.95, 1.47)	0.97	(0.73, 1.29)	1.20	(0.96, 1.50)
2+	1.06	(0.83, 1.36)	1.56	(1.29, 1.88)	1.05	(0.81, 1.36)	1.52	(1.25, 1.85)
Family dysfunction								
0								
1+	0.96	(0.67, 1.39)	1.04	(0.77, 1.39)	0.96	(0.66, 1.40)	1.05	(0.77, 1.42)
Lack of supportive caregiving								
0								
1	0.89	(0.71, 1.10)	1.11	(0.93, 1.31)	0.86	(0.69, 1.08)	1.11	(0.93, 1.32)
2+	1.08	(0.84, 1.39)	1.27	(1.04, 1.55)	1.06	(0.82, 1.37)	1.28	(1.04, 1.57)
Violence/mental health issues								
0								
1	0.89	(0.72, 1.09)	1.23	(1.05, 1.44)	0.90	(0.73, 1.10)	1.21	(1.03, 1.43)
2+	1.16	(0.87, 1.53)	1.86	(1.50, 2.31)	1.21	(0.91, 1.63)	1.76	(1.41, 2.20)
Issues of family structure								
0								
1+	1.07	(0.84, 1.38)	0.93	(0.75, 1.15)	1.10	(0.85, 1.43)	0.92	(0.74, 1.14)
Lack of paternal involvement								
0								
1	0.94	(0.77, 1.14)	1.15	(0.98, 1.34)	0.94	(0.77, 1.15)	1.12	(0.96, 1.32)
2+	1.08	(0.86, 1.37)	1.23	(1.01, 1.49)	1.04	(0.81, 1.32)	1.25	(1.02, 1.52)
Overall								

	OR (unadjusted)			OR (adjusted for mother's smoking, birthweight, BMI at age 11, and mother's age at menses)					
	Age at menarche 11			Age at menarche 14			Age at menarche 11		
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR
0									
1	0.92	(0.73, 1.16)	1.04	(0.85, 1.26)	0.95	(0.74, 1.20)	1.02	(0.83, 1.25)	
2	1.19	(0.93, 1.54)	1.39	(1.12, 1.71)	1.20	(0.93, 1.55)	1.37	(1.10, 1.70)	
3	1.07	(0.79, 1.43)	1.49	(1.17, 1.88)	1.01	(0.75, 1.37)	1.50	(1.18, 1.91)	
4+	1.01	(0.79, 1.29)	1.62	(1.33, 1.29)	1.03	(0.80, 1.32)	1.58	(1.29, 1.92)	

Table 5
Multivariate Log-Poisson Regression Models of Early and Late Age at Menarche by Child Abuse

	unadjusted			adjusted for mother's smoking, birthweight, BMI at age 11, and mother's age at menses					
	menarche 11 years		menarche 14 years		menarche 11 years		menarche 14 years		
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	
Sexual abuse	2.20	(1.21, 4.01)	1.73	(1.00, 3.01)	2.60	(1.40, 4.81)	1.57	(0.89, 2.77)	
Physical abuse	1.19	(0.77, 1.82)	1.32	(0.93, 1.87)	1.29	(0.84, 2.01)	1.26	(0.88, 1.80)	
Verbal abuse	1.14	(0.79, 1.64)	1.58	(1.19, 2.10)	1.13	(0.77, 1.65)	1.58	(1.18, 2.12)	
Neglected	0.76	(0.38, 1.50)	1.32	(0.83, 2.11)	0.74	(0.37, 1.51)	1.28	(0.79, 2.08)	
Received too much physical punishment	1.04	(0.62, 1.74)	1.66	(1.14, 2.41)	0.88	(0.51, 1.52)	1.75	(1.18, 2.58)	
Suffered humiliation, ridicule, etc.	1.34	(0.93, 1.94)	1.58	(1.17, 2.12)	1.33	(0.91, 1.95)	1.53	(1.13, 2.07)	
Witnessed physical/sexual abuse	1.16	(0.76, 1.75)	1.55	(1.13, 2.13)	1.29	(0.84, 1.97)	1.49	(1.08, 2.07)	
A lot of conflict/tension in home	1.21	(0.91, 1.62)	1.71	(1.36, 2.14)	1.21	(0.90, 1.64)	1.71	(1.35, 2.16)	
Mother nervous troubles	1.31	(1.03, 1.67)	1.14	(0.93, 1.41)	1.37	(1.07, 1.76)	1.10	(0.89, 1.36)	
Father nervous troubles	1.11	(0.80, 1.54)	1.19	(0.91, 1.55)	1.16	(0.82, 1.63)	1.15	(0.88, 1.52)	
Mother problems with drinking	0.86	(0.52, 1.42)	1.52	(1.07, 2.17)	0.83	(0.49, 1.40)	1.50	(1.04, 2.17)	
Father problems with drinking	1.33	(0.97, 1.83)	1.18	(0.90, 1.55)	1.41	(1.02, 1.96)	1.13	(0.85, 1.50)	

Table 6
Multivariate Logistic Regression Models of Early and Late Age at Menarche by Timing of Hardships

	unadjusted			adjusted for mother's smoking, birthweight, BMI at age 11, and mother's age at menses		
	menarche 11 years			menarche 14 years		
	OR	95% CI	OR	OR	95% CI	OR
Financial hardship						
neither early nor late a						
early only	1.06	(0.39, 2.88)	2.11	1.20	(0.44, 3.29)	2.05
late only	0.93	(0.75, 1.15)	1.34	0.95	(0.76, 1.19)	1.32
early and late	1.44	(0.83, 2.49)	1.63	1.55	(0.88, 2.74)	1.55
No interest in education						
neither early nor late a						
early only	0.94	(0.68, 1.29)	1.39	0.91	(0.66, 1.26)	1.39
late only	1.16	(0.89, 1.51)	1.30	1.17	(0.89, 1.53)	1.25
early and late	1.03	(0.69, 1.53)	1.71	1.02	(0.67, 1.53)	1.72
Issues of family structure						
neither early nor late						
early only	0.95	(0.64, 1.41)	0.76	0.97	(0.64, 1.46)	0.74
late only	1.18	(0.76, 1.83)	1.14	1.29	(0.82, 2.03)	1.09
early and late	1.14	(0.76, 1.73)	0.97	1.13	(0.74, 1.73)	1.00
Violence/mental health issues						
neither early nor late						
early only	0.95	(0.75, 1.22)	1.30	1.00	(0.78, 1.29)	1.25
late only	1.05	(0.79, 1.41)	1.32	1.07	(0.79, 1.44)	1.29
early and late	1.06	(0.79, 1.44)	1.79	1.09	(0.80, 1.48)	1.74
Overall						
neither birth nor 7						
birth/7 only	0.96	(0.73, 1.27)	1.27	0.98	(0.73, 1.31)	1.25
11 only	1.10	(0.88, 1.38)	1.22	1.11	(0.88, 1.40)	1.19
both early and 11	1.02	(0.82, 1.27)	1.59	1.03	(0.81, 1.29)	1.56
neither						
early 1-2	0.96	(0.72, 1.28)	1.21	0.98	(0.73, 1.32)	1.19

	adjusted for mother's smoking, birthweight, BMI at age 11, and mother's age at menses					
	unadjusted			11 years		
	menarche	11 years	menarche	14 years	OR	95% CI
early >2	0.92	(0.31, 2.74)	2.33	(1.15, 4.70)	0.96	(0.31, 2.97)
late 1-2 only	1.13	(0.89, 1.43)	1.13	(0.93, 1.39)	1.13	(0.89, 1.44)
late >2 only	0.91	(0.51, 1.62)	1.81	(1.22, 2.70)	0.94	(0.52, 1.71)
early 1-2 and late 1-2	1.00	(0.76, 1.32)	1.49	(1.20, 1.85)	0.98	(0.74, 1.31)
early 1-2 and late >2	1.15	(0.76, 1.75)	1.49	(1.07, 2.08)	1.21	(0.79, 1.86)
early >2 and late 1-2	0.55	(0.27, 1.11)	1.44	(0.94, 2.21)	0.54	(0.26, 1.12)
both >2	1.28	(0.81, 2.02)	2.19	(1.56, 3.07)	1.36	(0.85, 2.18)
					2.08	(1.47, 2.96)