Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature:

_____ _____

Larissa Aimee Cruz Date

Association Between Early and Late Timing of Menarche and Early Childhood Adversity Experienced at Years 3 and 5

By

Larissa Aimee Cruz
Masters in Public Health

Department of Epidemiology

_____

Shakira Suglia, ScD
Committee Chair

Association Between Early and Late Timing of Menarche and Early Childhood Adversity Experienced at Years 3 and 5

By

Larissa Aimee Cruz

Bachelor of Science
University of Texas at Austin
2016

Thesis Committee Chair: Shakira Suglia, ScD

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Epidemiology
2020

Abstract

Association Between Early and Late Timing of Menarche and Early Childhood Adversity Experienced at Years 3 and 5

By Larissa Aimee Cruz

Background: Exposure to early childhood adversities has been associated across a range of short- and long-term health outcomes. One such outcome that remains to be understood is pubertal timing and specifically onset of menarche. Mixed results have made it difficult to conclude which adversities and the degree of exposure strong enough to influences pubertal maturation and consequently timing of menarche.

Methods: The data utilized were from the Fragile Families and Child Wellbeing Study. Child adversity measures were collected during years 3 and 5 from mother or parent/caregiver surveys. Adversities assessed include, child physical and emotional abuse, child neglect, parental interpersonal violence, paternal incarceration, maternal substance use, maternal depression, housing instability, and food insecurity. Age of first menstruation was self-reported at year 15. Demographic information was collected at baseline and body mass index measures were recorded at age 9. Polytomous regression analysis were conducted to determine whether there was evidence of an association between cumulative adversity or individual adversities and irregular timing of menarche, either late or early.

Results: There was no association between cumulative adversity and early (odds ratio [OR]:1.06 [95% confidence interval [CI]: 0.96-1.18]) or late menarche (OR: .97 [95%CI: 0.85-1.11]). IPV was the only adversity construct significantly associated with early timing of menarche (OR: 1.56 [95%CI: 1.11-2.19], p = .01). Adversities measuring parental relationships and wellbeing, paternal incarceration, maternal substance use, and maternal depression, had the highest associations with timing of menarche, although not statistically significant. Remaining individual adversities were found to not be significantly associated with timing of menarche.

Conclusions: There is evidence a potential pattern between parental measures and timing of menarche. These measures had the higher measures of association and has been documented in the literature. Further analyses utilizing larger samples and more precise measures are needed to improve understanding of this association and the pathway linked between this type of child adversity and puberty measure.

Association Between Early and Late Timing of Menarche and Early Childhood Adversity Experienced at Years 3 and 5

By

Larissa Aimee Cruz

Bachelor of Science
University of Texas at Austin
2016

Thesis Committee Chair: Shakira Suglia, ScD

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Epidemiology
2020

Association Between Early and Late Timing of Menarche and Early Childhood Adversity Experienced at Years 3 and 5

Puberty can be defined as a set of intricate physiological processes for reproductive maturation beginning with adrenarche stimulating the adrenal glands around ages 6 to 8 and proceeding to gonadarche marked by gonadotropin-releasing hormone (GnRH) release around the ages of 9 and 10 among girls.[1] Among individuals with a female body, menarche is a clear marker that puberty has advanced to the latter phases of gonadarche.[1] Over the past century, initiation of pubertal maturation has shifted to earlier years and age of menarche has declined in high-income countries.[2] Etiologic causes remain debated, and public health concerns of increased morbidity and mortality risks, such as poor cardio-metabolic health outcomes and behavioral disorders, have been raised with this population shift towards earlier pubertal timing.[2-4]

Although not an etiologic cause, race and ethnicity have been associated with early puberty and menarche, with several studies citing African American girls to be at a higher risk for early onset of puberty.[5-7] In a study conducted by Freedman and colleagues utilizing data from the Bogalusa Heart study, on average, black girls underwent menarche about 2 to 3 months earlier than white girls.[5] Utilizing data from the third National Health and Nutrition Examination Survey (NHANES III), Chumlea and colleagues found average age of menarche among non-Hispanic black and Mexican American girls to be earlier than non-Hispanic white girls, with significant statistical differences in ages when 10%, 25%, and 50% of girls had reached menarche (2003). At the time half of girls had reached menarche, the average age for non-Hispanic white girls was 12.55 years whereas the age for non-Hispanic black girls was 12.06 and 12.25 for Mexican Americans girls.[8] Despite accounting for biological factors, such as weight or body mass index (BMI), there remains unexplained differences in markers of pubertal maturation, including breast growth, tanner stage, and age of menarche, across race/ethnicities.[5,9-11] Lower socioeconomic (SES) levels have also been associated with earlier menarche, it is hypothesized that SES functions as a proxy for underlying factors associated with early pubertal timing, such as chronic stress or obesity status.[12,13]

Childhood Adversity and Development

In 1998, the ACE study documented a dose-response relationship between adverse childhood experiences and increased risk for disease in adulthood was published.[14] Research has advanced our understanding of the scope of these adversities and magnitude of associated health risks. Life history theory has been central in understanding these relationships, as it explains the body's tradeoffs in response to environments compromising development, such as nutritional deficiencies and excess.[1] Further supported by the Adaptive Calibration Model, an individuals' response to stress can be described as varying due to "the result of conditional adaptation- the evolved ability of an organism to modify its developmental trajectory (and the resulting phenotype) to match the local conditions of the social and physical environment."[15] While research has been able to show how physical stressors affect pubertal development, understanding psychosocial stressors has been more complex.

Assessing the relationship between child adversities and pubertal timing can be assessed by considering its cumulative effect on health or the impact each individual adversity may have on timing. Although variation does persist, studies assessing cumulative childhood adversities and timing of menarche have found an association with earlier onset, although there has been limited racially/ethnically diverse studies.[6,16,17] As there is already a large gap in understanding racial/ethnic differences in timing of menarche, this underrepresentation limits our understanding of adversity and pubertal maturation.[18]

Improving our understanding of how these social-economic factors influence observed associations with pubertal maturation may explain the variability found in studies which in spite of examining similar individual adversity, arrive at different conclusions. For example, some studies suggest father absence during early childhood is associated with earlier pubertal development and timing of menarche,[1] although another study found paternal absence and early menarche to only be associated with the high-income group and not hold among the low-income group.[19] Understanding which factors and the direction of its effect on timing of menarche will assist in furthering our knowledge on the etiology of pubertal maturation and important contextual factors. In this study we examine the potential association between cumulative and

individual adversities with timing of menarche among a diverse cohort from the Fragile Families and Child Wellbeing Study (FFCWS).

Methods

Data Source

The analytical sample was selected from the FFCWS cohort of parents and their children. The FFCWS participants were selected via a random sample of all US cities with 200, 000 or more people and were enrolled in the study beginning at the focal child's birth.[20] A key aim of the cohort was to collect more data on children of unwed parents (n=983 in subsample) which influenced the study design and forms of data collection, thus the overrepresentation of single-parent households.[20] Baseline sample size was 4700 families, consisting of 3600 unwed couples and 110 married couples. Mothers completed the baseline interview at delivery and have completed follow-up surveys when child was 1, 3, 5, and 9 years of age. Primary parent/caregiver also completed an additional survey at years 3, 5, and 9. At the year 15 interview wave, focal child and the main parent/caregiver completed the survey.

The FFCWS subsample utilized for analysis was restricted to girls with relevant data at years 3, 5, 9, and 15 (n = 2341). Participants missing menstruation data due to not participating in data collection at year 15, missing record, refusing, or not knowing age they begun menstruating were removed from sample (n =703). Individuals missing data on all adversity measures at both years 3 and 5 were also excluded from the sample (n = 41). Since adversity constructs were assessed individually, missing observations for child physical and emotional abuse and neglect were also dropped (n = 156). 173 additional observations were dropped due to missing information on either BMI, race/ethnicity, and receipt of public assistance, resulting in a final analytical sample size of 1268. Demographic information on maternal race/ethnicity, marriage/cohabitating status, and public assistance were collected at baseline. BMI, based on measured height and weight, was calculated. BMI at year 9 was utilized due to the number of missing BMI data at year 5 (n = 729). Public assistance was dichotomized as having received public assistance or not at baseline. Race and ethnicity was categorized into non-Hispanic white, non-Hispanic black, Hispanic/Latina, and other race/ethnicity.

Measures

Age of menstruation. Age of menstruation was participant reported at year 15 in years and months. Menstruation was trichotomized into early (≤ 11 years) , average (11.1 – 13.9 years) and late (≥ 14 years) onset as classified by previous studies.[16,17] Individuals reporting they had not started menstruating at age 15 were classified as late onset.

Adversity measures. Similar to previously established methodology, eight items were considered for adversity exposure: reports of maternal drug or alcohol use, interpersonal violence (IPV) between mother figure and father/current partner, paternal incarceration, food insecurity, housing instability, and maternal depression at either years 3 and 5.[21] Data informing adversity measures were collected at year 3 and 5 collection points utilizing the Mothers' Three-Year Follow-Up Survey and Mothers' Five-Year Follow-Up Survey and the Parent/Caregiver Questionnaires assessed at years 3 and 5.[22-25] At year 15, participants identifying as female were asked if they had begun menstruating and if so, to report the year and month of first menstruation.

Maternal drug and alcohol use. Mothers were asked whether in the past 12 months they had utilized tranquilizers, inhalants, marijuana, cocaine, LSD or other hallucinogens, and heroin and whether substance use or drinking interfered with their work at school, job or home.[22,23] Respondents were also asked how often in the past 12 months they had consumed four or more drinks in one day. Respondents answering "yes" to any of the aforementioned questions or drinking five or more drinks in one day were classified as using drugs and alcohol.[21]

IPV. If mother reported to be in a relationship with child's father or a current partner at year 3, mothers were asked whether they had been seriously hurt in a fight with the child's father or current partner since the last interview and how frequently the partner in question exhibited the following behaviors: slapping or kicking respondent, hitting respondent with a first or object that could hurt respondent, or attempting to have sex or sexual things respondent did not want to do.[22] Mothers answering "yes" to the first question or "often" and "sometimes" to the subsequent questions were categorized as experiencing IPV.[21]

At year 5, mothers were also asked whether they had been in a physical fight with respective partner in front of the child and how often respective partner threw something or pushed, grabbed, or shoved respondent.[23] Mothers answering "often" or "sometimes" to any of the questions were categorized as experiencing IPV. In addition, mothers were asked or had been seriously hurt in a fight with respective partner since the last interview or last two years. Mothers answering "yes" to the first question or "often" and "sometimes" to the subsequent questions were categorized as experiencing IPV.[21]

Paternal incarceration. Girls with mothers reporting child's father was currently in jail/prison at year 3 or 5 were classified as experiencing paternal incarceration.

Food insecurity. At year 3 and 5, mothers were asked whether in the past 12 months they or their child had been hungry but did not eat because they could not afford enough food, they had received any free food or meals due to not having enough money.[22,23] Respondents answering "yes" to any question were classified as experiencing food insecurity.[21,26]

Housing instability. Housing instability was identified if the respondent reported: not paying full amount of rent or mortgage, being evicted from home or apartment for not paying rent or mortgage, moving in with other people because of financial problems, and staying at a shelter, abandoned building, automobile or any other place not meant for regular housing even for one night in the past 12 months.[21]

Maternal mental health. Maternal depression was assessed at both years 3 and 5 utilizing a Composite International Diagnostic Interview Short Form (CIDI-SF) consistent with the Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition.[27,28] If mothers met the conservative depression criteria or reported taking antidepressants, mothers were classified as experiencing depression.

Child physical and emotional abuse and neglect. Child adversity was measured at years 3 and 5 utilizing the Conflict Tactics Scale: Parent Child Version (CTS) validated in a previous study.[29] Utilizing previously established methodology, ten CTS items were selected to assess child physical and emotional abuse. [30-32] Parents or caregivers were asked how frequently they shook child, hit child with a hard object, shouted at child, spanked child with hand, swore or cursed at child, threatened to spank or hit child but did not, told child they were going to be sent away or kicked out of house, slapped child, pinched child, and

called child dumb or lazy in the past 12 months. Respondents answered "once," "twice," "3-5 times," "6-10 times," "11-20 times," "more than 20 times," "yes but not in past year," and "never happened," and were given midpoint values (i.e., 4 = "3-5 times"; 8 = "6-10 times"; 15 = "11-20 times", etc.) for summation.[31,33,34] Girls scoring in the top 10th percentile during either year 3 or 5 were dichotomized as exposed to physical and emotional abuse.[33,34]

Utilizing the same methodology to construct the physical and emotional abuse construct, five CTS items were selected to assess neglect. These items surveyed how frequently in the past 12 months parents or caregivers had problems taking care of child due to being under the influence, left child alone when there should have been an adult present, were focused on their problems and consequently were unable to express love to child, were not able to get child food or a doctor or hospital when needed. As explained previously, girls in the 10th percentile were then classified as experiencing neglect.

Cumulative Adversity. As explained above, the following adversities were coded dichotomously as exposed equal to 1 versus nonexposed equal to 0: child physical and emotional abuse, child neglect, paternal incarceration, housing instability, food insecurity, maternal mental health, maternal drug and alcohol use, and IPV. The number of adversities experienced were then summed and divided by the number of adversities measured for that observation. For example, if an individual experienced 3 adversities, but only had data on six adversities, then their weighted sum would be determined by estimating 3/6. Since there was a total of eight possible items on the scale, this weighted sum would then be multiplied by eight to arrive at the final adversity score. Upon review, there were 41 observations missing information across all eight constructs and were consequently dropped. 156 observations were missing reports on 2 constructs, childhood physical and emotional abuse, and neglect, thus their weighted sum was adjusted for this six-item scale.

Categorization of adversity was determined by analyzing the distribution of scores. The 50% to 75% quartile range spanned from a score of 1 to 2 were thus categorized as low adversity, scoring a 3 or above was consequently classified as high adversity. The grouping of adversities is based on theories that

increased quantity and severity of adversities results in an adaptive developmental response fit to these groupings of intensity.[15,35]

Data Analysis

Frequency analyses were run to determine the distribution of demographic, covariate factors and the outcome of interest among the entire sample and by timing of menstruation, as reported in Table 1. Demographic measures include average age of menstruation, BMI at age 9, race/ethnicity distribution, mother-father marital status, and public assistance. The distribution of individuals across cumulative and individual adversities were also recorded.

Polytomous regression was conducted to assess the association between early timing of menarche and cumulative measures of adversity in addition to assessing the association between late timing of menarche and cumulative and individual measures of adversity. Additional models were run to assess the association between early or late timing of menarche and the individual adversity constructs, child emotional and physical abuse, child neglect, paternal incarceration, IPV, maternal substance use, housing instability, and food insecurity. Each model adjusted for the following known confounders based on *a priori* criteria: public assistance, BMI at age 9, and race/ethnicity.[7,9,12,18]

Results

As presented in Table 1, the final sample size comprised of 1268 girls, 31 (2.4%) of which had not yet started menstruating at year 15. After trichotomizing menarche, 291 (23.0%) girls were identified as experiencing early menstruation and 150 (11.8%) girls as experiencing late menstruation. The sample was racially/ethnically diverse, with 51% being African-American, 24% being Hispanic/Latina, and 3% identifying as other race/ethnicity (Table 1). Among the girls who had begun menstruating, Hispanic/Latinx girls experienced menstruation earliest at a mean age 12.05 years of age followed by non-Hispanic black girls at 12.10 years of age (Table 1). Non-Hispanic white girls had the latest mean age of at 12.39 years of age. Across the entire sample, 22.5% of mothers reported being married or cohabitating with the child's father at birth. Most experienced at least one adverse experience, with 36% reporting no adversity.

Cumulative Adversity

Cumulative adversity in this analysis encompassed all events: child physical and emotional abuse, child neglect, IPV, paternal incarceration, maternal substance use, maternal depression, housing insecurity, and food insecurity. In fully adjusted models, for each unit increase in experiencing any of the aforementioned adversities, the odds of experiencing either early (odds ratio [OR]:1.06 [95% confidence interval [CI]: 0.96-1.18]) or late menarche (OR: .97 [95%CI: 0.85-1.11]) was nearly the same as the odds of those reaching menarche at an average age (Table 2). When cumulative adversities were grouped into no adversities (zero events), low number of adversities (one to two events), and high number of adversities (more than three events), the odds of early menarche among those who have experienced a high number of adversities was 1.24 times the odds of those experiencing no adversities [95%CI: 0.83-1.84]. There was no association between cumulative adversities and greater odds of late menarche among both the low adversity group (OR: 0.91 [95%CI: 0.62-1.33]) and high adversity group (OR:0.88 [95%CI: 0.52-1.49]).

Individual Adversities

Each adversity that comprised the overall adversity scale was assessed and results presented in Table 3. All assessments of child maltreatment (child physical and emotional abuse, and neglect) were not found to be associated with timing of menarche. Food insecurity and housing instability were also not found to be associated with timing of menarche.

Parental factors were associated with higher odds of experiencing early age of menarche. IPV was associated with a 1.22 greater odds of late menarche [95%CI: 0.78-1.91] and was significantly associated with early menarche (OR: 1.56 [95%CI: 1.11-2.19], p = .01). Although not statistically significant, odds of either early menarche (OR:1.40 [95%CI: 1.11-1.29]) or late menarche (OR 1.32 [95%CI: 0.72-2.40]) were higher among individuals with an incarcerated father figure. Maternal depression and maternal substance use were found to have similar effects on timing of early menarche (OR: 1.24 [95% CI: 0.91-1.69], OR:

1.16 [95%CI: 0.80-1.69] respectively) and late menarche (OR: .86 [95%CI:0.56-1.32], OR: .86 [95%CI: 0.52-1.44] respectively).

Discussion

Overall Cumulative Adversity

Overall, there was a null association between cumulative adversities and timing of menarche. There have been mixed results in the association between adversity and timing of menarche, where some studies have found an association between cumulative childhood hardships and early menarche,[36,37] while others found an association with late menarche[17] or no association at all.[16] Although grouping these adversities seems intuitive from theories hypothesizing the increased quantity of adversity has stronger effects, in relation to age of menstruation it appears the nature and adversity itself plays a stronger and more important role.

A recent study has provided evidence that adversities with a threatening rather than deficient nature, such as physical abuse versus physical neglect or witnessing domestic violence versus food insecurity, are associated with earlier age at menarche.[36] The age at which adversities are assessed is also an important consideration and likely explains findings relating adversity with late menarche. Although Boynton-Jarrett and Harville, for example, found an association between cumulative number of adversities and late menarche, childhood hardships were assessed at 7 and 11 years old which may not have detected early adversities that may have occurred during the adrenarche and gonadarche stages of pubertal development.

Familial Factors

There was a significant association between IPV and early timing of menarche, and although not significant, associations between paternal incarceration and maternal wellness factors were found to be higher in comparison to the other factors assessed. These findings are aligned with findings documenting an association between family dysfunction and early menarche timing [1,38] and quality parental investment with lower rates of early adrenarche.[39] Paternal absence has been found to be associated with earlier pubertal and menarche timing.[19,40-42] Maternal psychosocial stress has also been associated with earlier pubertal and menarche timing.[10,39] The findings found in this study support the notion interpersonal relationships can

have harmful or protective effect on preexisting risks. In another study examining timing of menarche and adversity for example, maternal unmarried status was found to be a risk factor for earlier menarche among white and Hispanic girls, but was not the case for black girls in the study.[13] It was hypothesized additional factors, such as strong family support and connection, may have mitigated the harmful effects of adversity on timing of menarche.[13]

Child Maltreatment

Child Physical and Emotional Abuse. Child physical and emotional abuse was also not significantly associated with timing of menarche. This finding is in contrast with studies having found an association with physical and emotional abuse and early menarche and pubertal development.[43] As this null associations has been observed in other studies, it is hypothesized child physical and emotional abuse may not be particularly strong dimension of child maltreatment associated with early menarche and rather sexual abuse may explain more of the association with early menarche.[16,43,44] In studies where sexual abuse was measured, there was a more significant and stronger association with early menarche.[44,45] Due to lack of availability on data on sexual abuse at years 3 and 5, sexual abuse was not assessed in this analysis.

Child Neglect. In this sample, neglectful experiences and events were found to not be associated with late timing of menarche. Previous studies have demonstrated events with a deprivation nature, such as neglecting child physical and emotional needs, has been associated late timing of menarche.[6] This falls into line with the life history theory postulating that in the presence of an environment without sufficient energetic resources, pubertal development will be delayed until successful reproductive outcomes become more probable.[1] However, an important distinction between the evolutionary theory of deficiency and the contemporary context of a deficient environment can imply very different environments. Theories basing the association between neglect and late timing of puberty are often rooted in the bioenergetics of factors associated with pubertal timing, such as nutrition, however, in contemporary life what falls into category as neglect may not necessarily imply there is an energetic deficiency.[1,12] Furthermore, low SES in high-income countries may actually be associated with a higher energic intake due to the quality of available foods and alter its predicted association with early menarche.[9]

Strengths & Limitations

Some of the key strengths of this study include being able to assess timing of adversities at an earlier age. This allows for one to account for the potential influence it may have on the actual beginning of the pubertal stages of adrenarche and gonadarche. Along the same lines, assessing BMI at an earlier age eliminates the concern that increased adiposity later on in the timeline is what speeds up the process.

Some of the limitations of this study include the limited sample size recorded for some adversities, such as child physical and emotional abuse it is also possible the sample did not have sufficient power to detect its effect due to the lower number of individuals classified as experiencing physical and/or emotional abuse (6%) and neglect (5%). Further, as sexual abuse was only documented at year 5 by inquiring if Child Protective Services had been concerned about sexual abuse, there was not a stronger measure to assess sexual abuse at years 3 and 5, which has been associated with earlier timing of menarche. Similarly, most measures were reported by the mother or caregiver of the child and it is difficult to know whether they responded honestly, especially in the context of some of the more difficult questions.

Conclusion

The associations observed in the analyses warrant further investigation on the role of adult relationships during early childhood. While negative parental factors, such as IPV, were significantly associated with early odds of menarche, it is not evident whether the inverse is true and supportive relationships can serve a protective role on timing of menarche. Although there may be environmental factors and psychosocial stressors increasing girls' risk for earlier pubertal timing, there may be set of positive factors that may have a protective effect against these outcomes. Understanding how these associations differ when analyzed by race and ethnicity may not only uncover populations at most risk, but may also assist in developing relevant and effective public health interventions by also being aware of the protective factors and resources associated with the populations.[7,13,46,47] Although the analyses did not have the statistical power to observe the associations of adversity and timing of menarche by race and ethnicity, studies have indicated pubertal trends vary significantly by race and ethnicity, making this a pressing next

step.[48] Considering dimensions of family support and healthy relationships, especially in a culturally sensitive context, may assist our understanding in the observed associations of this analysis and elucidate the risk and protective factors associated with pubertal development.

Table 1. Demographic characteristics and distribution of adversities in analytical sample and by timing of menarche,[a] the Fragile Families and Wellbeing Study (*n* = 1268)

	Average Menarche (*n* = 827)	Early Menarche (*n* = 291)	Late Menarche (*n* = 150)	Total Sample, (*n* = 1268)
	n %	n %	n %	n %
Timing of menarche, y				
Average				827, 65.2
Early				291, 23.0
Late				150, 11.8
Age of menarche,[b] mean (sd), y	12.49 (.71)	10.30 (.77)	14.32 (.40)	12.15 (1.35)
Age of menarche by race/ethnicity[c]				
White, single race				12.39 (1.20)
African-American, single race				12.10 (1.40)
Hispanic/Latinx				12.05 (1.37)
Other race/ethnicity				12.22 (1.29)
BMI,[d] mean (sd), kg/m^2	19.48 (4.31)	20.80 (4.49)	18.50 (4.34)	19.65 (4.19)
Race/ethnicity, parent-reported[e]				
White, single race	191, 23.1	50, 17.2	40, 26.7	281, 22.2
African-American, single race	409, 49.5	160, 55.0	77, 51.3	646, 51.0
Hispanic/Latinx	204, 24.7	72, 24.7	27,18.0	303, 23.9
Other race/ethnicity	23, 2.8	9, 3.1	6, 4.0	38, 3.0
Mother-Father married/ cohabitating[e]	189, 22.9	58, 19.9	38, 25.3	285, 22.5
Receiving public assistance[e]	286, 34.6	110, 37.8	90, 40.0	456, 35.7
Cumulative adversity				
No adversity (0 events)	305, 36.9	100, 34.5	57, 38.0	462, 36.4
Low adversity (1 -2 events)	387, 46.8	137, 47.1	69, 46.0	593, 46.8
High adversity (3+ events)	135, 16.3	54, 18.6	24, 16.0	213, 16.8
Individual adversity constructs				
Child physical/emotional abuse	44, 5.3	15, 5.2	11, 7.3	70, 5.5
Child neglect	43, 5.2	16, 5.5	7, 4.7	66, 5.2
Paternal incarceration	61, 7.4	29, 10.0	15, 10.0	105, 8.3
IPV	130, 15.7	64, 22.0	29, 19.3	223, 17.6
Maternal substance abuse	121, 15.6	47, 16.2	20, 13.3	188, 14.8
Maternal depression	188, 22.7	76, 26.1	31, 20.7	295, 23.4
Housing insecurity	274, 33.1	87, 29.9	44, 29.3	405, 31.9
Food insecurity	160, 19.4	53, 18.2	26, 17.3	239, 18.9

[a] Average Menarche, 11.1 - 13.9 Yrs., Early Menarche, ≤ 11.0 Yrs. Late Menarche, ≥ 14 Yrs.

[b] *n* =1237, 31 reported not having menstruated at time of interview at age 15 and were categorized as late menarche

[c] At year 15, 13 individuals had not begun menstruating among white participants, 13 among African-American participants, and 5 among Hispanic/Latinx participants

[d] Measured at age 9

[e] Recorded at baseline

Table 2. Polytomous regression models of early and late timing of menarche[a] by cumulative adversity measures, FFWS (*n* = 1268)

Cumulative Adversities[b]	Menarche			
	Early (*n* = 291) v. Average (*n* = 827)		Late (*n* = 150) v. Average (*n* = 827)	
	OR (CI)	*p*	OR (CI)	*p*
Model 1: Low and high measures				
No adversity (0 events)	1.00, Reference		1.00, Reference	
Low adversity (1-2 events)	1.10 (0.82, 1.50)	*.53*	0.91 (0.62, 1.33)	*.62*
High adversity (3+ events)	1.24 (.83, 1.84)	*.30*	.88 (.52,1.49)	*.63*
Model 2: Continuous measure[c]	1.06 (.96, 1.18)	*.25*	.97 (.85, 1.11)	*.67*

[a] Average menarche: 11.1 - 13.9 years (reference), early menarche: ≤ 11.0 years, late menarche: ≥ 14 years.
[b] Adjusted for race/ethnicity, receipt of public assistance, and BMI at age 9.
[c] Adversity was measured continuously using an eight-item scale, maximum number of items experienced was 6.

Table 3. Polytomous regression models of early and late timing of menarche[a] by individual adversity measures, FFWS (*n* = 1268)

Individual Adversities[b]	Menarche			
	Early (*n* = 291) v. Average (*n* = 827)		Late (*n* = 150) v. Average (*n* = 827)	
	OR (CI)	*p*	OR (CI)	*p*
Model 3: Child abuse	.95 (0.52, 1.74)	*.87*	1.38 (0.69, 2.75)	*.37*
Model 4: Child neglect	1.12 (.62, 2.03)	*.70*	.85 (.37, 2.93)	*.70*
Model 5: Paternal incarceration	1.40 (.88, 2.25)	*.16*	1.32 (.72, 2.40)	*.37*
Model 6: IPV	1.56 (1.11, 2.19)	*.01*	1.22 (0.78, 1.91)	*.39*
Model 7: Maternal substance use	1.16 (.80, 1.69)	*.42*	.86 (.52, 1.44)	*.57*
Model 8: Maternal depression	1.24 (.91, 1.69)	*.18*	.86 (.58, 1.32)	*.49*
Model 9: Housing insecurity	.83 (.62, 1.11)	*.20*	.84 (.57, 1.23)	*.37*
Model 10: Food insecurity	.92 (.65, 1.31)	*.65*	.83 (.52, 1.32)	*.43*

[a] Average menarche: 11.1 - 13.9 years (reference), early menarche: ≤ 11.0 years, late menarche: ≥ 14 years.
[b] Adjusted for race/ethnicity, receipt of public assistance, and BMI at age 9.

Works Cited

1. Ellis BJ. Timing of pubertal maturation in girls: an integrated life history approach. *Psychological Bulletin*. 2004;130(6):920-958.
2. Bellis MA, Downing J, Ashton JR. Adults at 12? trends in puberty and their public health consequences. *J Epidemiol Community Health*. 2006;60(11):910-911.
3. Bleil M. Mechanisms explaining effects of pubertal timing on adulthood cardio-metabolic health. *Menopause*. 2016;23(11):1165-1167.
4. Golub MS, Collman GW, Foster PMD, et al. Public health implications of altered puberty timing. *Pediatrics*. 2008;121(Supplement 3):S218.
5. Freedman DS, Khan LK, Serdula MK, Dietz WH, Srinivasan SR, Berenson GS. Relation of age at menarche to race, time period, and anthropometric dimensions: the Bogalusa Heart Study. *Pediatrics*. 2002;110(4):e43.
6. Allsworth JE, Weitzen S, Boardman LA. Early age at menarche and allostatic load: data from the third national health and nutrition examination survey. *Ann Epidemiol*. 2005;15(6):438-444.
7. Deardorff J, Fyfe M, Ekwaru JP, Kushi LH, Greenspan LC, Yen IH. Does neighborhood environment influence girls' pubertal onset? findings from a cohort study. *BMC Pediatr*. 2012;12:27-27.
8. Chumlea WC, Schubert CM, Roche AF, et al. Age at menarche and racial comparisons in US girls. *Pediatrics*. 2003;111(1):110.
9. Lee JM, Appugliese D, Kaciroti N, Corwyn RF, Bradley RH, Lumeng JC. Weight status in young girls and the onset of puberty. *Pediatrics*. 2007;119(3):e624.
10. Kelly Y, Zilanawala A, Sacker A, Hiatt R, Viner R. Early puberty in 11-year-old girls: Millennium Cohort Study findings. *Arch Dis Child*. 2017;102(3):232-237.
11. Kaplowitz PB, Slora EJ, Wasserman RC, Pedlow SE, Herman-Giddens ME. Earlier onset of puberty in girls: relation to increased body mass index and race. *Pediatrics*. 2001;108(2):347.
12. James-Todd T, Tehranifar P, Rich-Edwards J, Titievsky L, Terry MB. The impact of socioeconomic status across early life on age at menarche among a racially diverse population of girls. *Ann Epidemiol*. 2010;20(11):836-842.
13. Deardorff J, Abrams B, Ekwaru JP, Rehkopf DH. Socioeconomic status and age at menarche: an examination of multiple indicators in an ethnically diverse cohort. *Ann Epidemiol*. 2014;24(10):727-733.
14. Felitti VJ, Anda RF, Nordenberg D, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: the Adverse Childhood Experiences (ACE) Study. *American J Prev Med*. 1998;14(4):245-258.
15. Del Giudice M, Ellis BJ, Shirtcliff EA. The Adaptive Calibration Model of stress responsivity. *Neurosci Biobehav Rev*. 2011;35(7):1562-1592.
16. Li L, Denholm R, Power C. Child maltreatment and household dysfunction: associations with pubertal development in a British birth cohort. *International J Epidemiol*. 2014;43(4):1163-1173.
17. Boynton-Jarrett R, Harville EW. A prospective study of childhood social hardships and age at menarche. *Ann of Epidemiol*. 2012;22(10):731-737.
18. Cronholm PF, Forke CM, Wade R, et al. Adverse childhood experiences: expanding the concept of adversity. *Am J Prev Med*. 2015;49(3):354-361.
19. Deardorff J, Ekwaru JP, Kushi LH, et al. Father absence, body mass index, and pubertal timing in girls: differential effects by family income and ethnicity. *J Adolesc Health*. 2011;48(5):441-447.
20. Reichman NE, Teitler JO, Garfinkel I, McLanahan SS. Fragile Families: sample and design. *Children Youth Services Rev*. 2001;23(4):303-326.
21. Suglia SF, Duarte CS, Chambers EC, Boynton-Jarrett R. Cumulative social risk and obesity in early childhood. *Pediatrics*. 2012;129(5):e1173.

22. The Fragile Families and Child Wellbeing Study. Mothers' Three-Year Follow-Up Survey; Public Use Version. In: Center for Research on Child Wellbeing, Princeton University Population Center, Columbia University; 2013.
23. The Fragile Families and Child Wellbeing Study. Mothers' Five-Year Follow-Up Survey; Public Use Version. In: Center for Research on Child Wellbeing at Princeton University Social Indicatory Survey Center at Columbia University; 2013.
24. The Fragile Families and Child Wellbeing Study. In home longitudinal study of pre-school aged children, parent questionaire year 3. In: Princeton University; 2002.
25. The Fragile Families and Child Wellbeing Study. In home longitudinal study of pre-school aged children, parent questionaire year 5. In: Princeton University.
26. Schroeder A, Slopen N, Mittal M. Accumulation, timing, and duration of early childhood adversity and behavior problems at age 9. *J Clin Child Adolesc Psychol*. 2018:1-14.
27. The Fragile Families and Child Wellbeing Study. User Guide for the Fragile Families and Child Wellbeing Study Public Data, Year 3. In: Princeton University; 2018:1-111.
28. Association AP. *Diagnostic and statistical manual of mental disorders, Fourth Edition*. Washington, DC: American Psychiatric Association; 1994.
29. Straus MA, Hamby SL, Finkelhor D, Moore DW, Runyan D. Identification of child maltreatment with the parent-child conflict tactics scales: development and psychometric data for a national sample of american parents. *Child Abuse Negl*. 1998;22(4):249-270.
30. McKenzie C, Silverberg J. Association of adverse childhood experiences with childhood atopic dermatitis in the United States. *Dermatitis*. 2020;31(2):147-152.
31. Paul E, Ortin A. Psychopathological mechanisms of early neglect and abuse on suicidal ideation and self-harm in middle childhood. *Eur Child Adolesc Psychiatry*. 2019;28(10):1311-1319.
32. Jimenez ME, Wade R, Jr., Schwartz-Soicher O, Lin Y, Reichman NE. Adverse Childhood Experiences and ADHD diagnosis at age 9 years in a national urban sample. *Acad Pediatr*. 2017;17(4):356-361.
33. Hunt TKA, Slack KS, Berger LM. Adverse childhood experiences and behavioral problems in middle childhood. *Child Abuse Negl*. 2017;67:391-402.
34. Reichman NE, Corman H, Noonan K, Jiménez ME. Infant health and future childhood adversity. *Matern Child Health J*. 2018;22(3):318-326.
35. Blair C, Raver CC. Child development in the context of adversity: experiential canalization of brain and behavior. *Am Psychol*. 2012;67(4):309-318.
36. Colich NL, Platt JM, Keyes KM, Sumner JA, Allen NB, McLaughlin KA. Earlier age at menarche as a transdiagnostic mechanism linking childhood trauma with multiple forms of psychopathology in adolescent girls. *Psychol Med*. 2019:1-9.
37. Buzney CD, DeCaro JA. Explanatory models of female pubertal timing: discordances between cultural models of maturation and the recollection and interpretation of personal developmental experiences. *Cult Med Psychiatry*. 2012;36(4):601-620.
38. Graberc JA, Brooks-Gunn J, Warren MP. the antecedents of menarcheal age: heredity, family environment, and stressful life events. *Child Dev*. 1995;66(2):346-359.
39. Ellis BJ, Essex MJ. Family environments, adrenarche, and sexual maturation: a longitudinal test of a life history model. *Child Dev*. 2007;78(6):1799-1817.
40. Bleil ME, Adler NE, Appelhans BM, Gregorich SE, Sternfeld B, Cedars MI. Childhood adversity and pubertal timing: understanding the origins of adulthood cardiovascular risk. *Biol Psychol*. 2013;93(1):213-219.
41. Bogaert AF. Age at puberty and father absence in a national probability sample. *J Adoles*. 2005;28(4):541-546.
42. Ellis BJ, Garber J. Psychosocial antecedents of variation in girls' pubertal timing: maternal depression, stepfather presence, and marital and family stress. *Child Dev*. 2000;71(2):485-501.

43. Mendle J, Leve LD, Van Ryzin M, Natsuaki MN, Ge X. Associations between early life stress, child maltreatment, and pubertal development among girls in foster care. *J Res Adolesc*. 2011;21(4):871-880.
44. Mendle J, Ryan RM, McKone KM. Early childhood maltreatment and pubertal development: replication in a population-based sample. *J Res Adolesc*. 2016;26(3):595-602.
45. Negriff S, Blankson AN, Trickett PK. Pubertal timing and tempo: associations with childhood maltreatment. *J Res Adolesc*. 2015;25(2):201-213.
46. Crandall A, Miller JR, Cheung A, et al. ACEs and counter-ACEs: how positive and negative childhood experiences influence adult health. *Child Abuse Negl*. 2019;96:104089.
47. Lavoie J, Pereira LC, Talwar V. Children's physical resilience outcomes: meta-analysis of vulnerability and protective factors. *J Pediatr Nurs*. 2016;31(6):701-711.
48. Bleil ME, Booth-LaForce C, Benner AD. Race disparities in pubertal timing: implications for cardiovascular disease risk among African American women. *Popul Res Policy Rev*. 2017;36(5):717-738.