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Exploring the Relationship Between Timing of Menarche and Eating Disorder Symptoms in Black and White Adolescent Girls

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Abstract: Objective: This study examined the relationship between timing of sexual maturation and eating disorders symptoms in adolescent girls. Method: Data were collected over 10 years for a cohort of 1,213 Black girls and 1,166 White girls who were either 9 or 10 years old at study entry. Annually, girls’ height and weight were measured and, biannually, girls completed self-report measures of eating disorders symptoms. Results: Early-onset menarche is a risk factor for the development of body image and dieting concerns, but the effect of timing is due to the impact of early and late maturation on body weight. Discussion: Findings underscore the importance of adiposity as a risk factor for poor mental health. © 2001 by John Wiley & Sons, Inc. Int J Eat Disord 30: 421–433, 2001.

Key words: sexual maturation; adolescent girls; early-onset menarche

INTRODUCTION

Sexual maturation is one of the most salient developmental milestones of adolescence, with profound physical and psychological consequences. Although puberty is a normal developmental process, individual patterns of sexual maturation vary considerably (Marshall & Tanner, 1969). Experts have suggested that differences in timing of sexual maturation may explain, in part, why some girls develop adjustment problems and behavioral disorders during adolescence (for review, see Graber, Petersen, & Brooks-Gunn, 1996).

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According to the stage termination hypothesis, early maturation puts girls at risk because early-maturing girls have to confront developmental tasks for which they are unprepared psychologically (Petersen & Taylor, 1980; Striegel-Moore, 1993). As a result, early-developing girls experience more stress and interpersonal conflict than on-time or late-developing girls and this stress or conflict, in turn, may contribute to the development of psychological symptoms. Moreover, early timing is associated with physical differences. For example, early-developing girls have been found to be shorter and relatively heavier (weight for height) than on-time or late-developing girls (Garn, Labelle, Rosenberg, & Hawthorne, 1986). These physical effects of early sexual maturation have been hypothesized to play a central role in the development of body image concerns and disordered eating (Killen et al., 1992, 1994; Smolak, Levine, & Gralen, 1993).

Some developmental theorists have proposed that any deviation from normative timing would place girls at risk, because both early- and late-maturing girls are “out of step” with their peer group (Petersen & Taylor, 1980). Most studies of the relationship between timing of sexual maturation and girl’s psychological adjustment have focused on the impact of early maturation rather than on the consequences of both early and late maturation. This study provides a comprehensive examination of the impact of timing of sexual maturation (early, mid, late) on eating disorder symptoms.

Because previous research studied White girls almost exclusively, little is known about the role of timing of sexual maturation in the development of eating disorder symptoms in girls from other populations. The present study extends previous investigations by including a large sample of Black girls. A recent study found that Black girls experience menarche at a younger age than their White peers (Herman-Giddens et al., 1997). Therefore, the present report utilized ethnicity specific cut points for describing the onset of sexual maturation.

METHODS

Participants

As described in detail (National Heart, Lung and Blood Institute, Growth and Health Study Research, Group, 1992), the National Heart Lung and Blood Institute (NHLBI) Growth and Health Study (NGHS) is a collaborative cohort study with data collection conducted annually at three clinical centers (or, if the girl could not travel to the center, at the girl’s home). The University of California at Berkeley and Cincinnati Children’s Hospital recruited participants from public and parochial schools; Westat, Inc. (Rockville, MD) recruited girls from a large health maintenance organization and from several local Girl Scout troops. Eligibility criteria for the study required that girls were either 9 or 10 years old, declared themselves as either non-Hispanic White or Black and that they had ethnically concordant parents.

A total of 2,379 girls enrolled in the study, including 1,213 Black girls and 1,166 White girls. Due to variable annual participation rates, sample size varied from year to year, with retention rates in Years 2 and 3 (96%), declining participation rates in Years 4–6 (from 91% to 78%), and increasing participation rates in Years 7–10 (81%–89%).
Instruments and Procedure

Demographic Information
At study entry, parents or guardians provided information about their educational attainment. For all statistical analyses, highest parental education (parental education) was collapsed into three categories (high school or less, less than 4 years of college, 4 or more years of college). The parents or guardians of the Black girls reported lower educational attainment compared with the parents or guardians of the White girls (NHLBI Growth and Health Study Research Group, 1992).

Timing of Sexual Maturation and Physical Measurements
During annual assessment sessions, trained and certified female health examiners took height and weight measurements. Body mass index (BMI) was calculated by dividing weight (in kilograms) by height (in squared meters). Health examiners obtained information annually (until Year 7) about menstrual status and date of onset of first menses. Age of menarche was used as the index of timing of sexual maturation for several reasons. Eighty percent of the 10-year-old Black girls already were pubertal at study entry. Studies have shown that onset of pubertal maturation and age of menarche are correlated significantly (Marshall & Tanner, 1969; Taranger, Engstrom, Lichtenstein, & Svennberg-Redegren, 1976) and that self-reported measurement of onset of menses is more reliable than self-reported measurement of onset of pubertal maturation (Brooks-Gunn & Warren, 1989; Brooks-Gunn, Warren, Rosso, & Gargiulo, 1987; Herman-Giddens et al., 1977). In the present study, timing was defined by ethnicity-specific quintiles: Early-maturing and late-maturing girls fell below or exceeded the 20th and 80th percentile, respectively, of their ethnic group in the NGHS.

Eating Disorder Symptoms
The core eating disorder symptom scales of the Eating Disorder Inventory2 (EDI, Garner & Olmsted, 1984) were administered in study Years 3, 5, 7, 9, and 10: Body Dissatisfaction assessed dissatisfaction with fat-bearing body parts such as hips, waist, thighs; Drive for Thinness measured desire and attempts to control weight; and Bulimia assessed the tendency to engage in binge eating and purging.

Data Analysis
The association between timing of sexual maturation and maximum parental education was tested using a Mantel-Haenszel chi-square test (Landis, Heyman, & Koch, 1978). To explore the relationship between timing of sexual maturation and eating disorder

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1 Timing of menarche was not available for a small number of White girls (6.4%, n = 74) and Black girls (4.1%, n = 50) primarily due to attrition prior to menarche onset. Participants with known age at menarche did not differ at baseline from those for whom age at menarche was not determined in height, weight, or BMI. Not surprisingly, they did differ in the mean number of annual study visits completed (8.8 ± 1.8 vs. 4.6 ± 3.2 in White girls and 9.0 ± 1.5 vs. 4.8 ± 3.5 in Black girls).

2 During pilot testing, we found that some of the EDI items were too complex in wording for our young sample. In consultation with Dr. David Garner, the senior author of EDI, several items were simplified to improve cohesion.
symptoms (Body Dissatisfaction, Drive for Thinness, and Bulimia subscales), longitudinal regression models were fitted for each outcome using the generalized estimating equations (GEE) technique (Liang & Zeger, 1986). GEE regression models for longitudinal data use a two-step approach to fit models for data that include repeated measurements on the same individuals. At the first step, unbiased weighted least square estimates of the regression coefficients are obtained using working estimates of the within-individual correlations among observations. At the second step, the residuals from the resulting model are used to correct the estimated standard errors of the regression coefficients for any overestimates or underestimates that might arise from not using the true within-individual correlations in the first step. Separate models were fitted for Black and White girls. GEE models were fitted for each outcome adjusting for age alone, as well as for age, parental education, and age-specific BMI percentile. BMI percentile was used for adjustment under the assumption that effects of BMI on psychological outcomes would depend more closely on a child’s ranking relative to her peers than on her absolute BMI. Age was entered into these models as a categorical variable with girls grouped by age at last birthday. For each outcome, models were fitted to estimate the overall effect of timing of sexual maturation and to estimate age-specific differences by timing of sexual maturation (Age × Timing interactions). If the test for the Age × Timing interaction was not significant, only the average estimate of difference by timing across all ages was reported. The significance level was set at \( p < .01 \) due to the large number of tests. The figures present unadjusted age and ethnicity-specific means to facilitate comparisons with results reported in the literature.\(^3\)

**RESULTS**

**Timing of Sexual Maturation and Adiposity**

Mean age at menarche was 12.0 years \((SD = 1.2)\) in Black girls and 12.7 years \((SD = 1.2)\) in White girls. The 20th and 80th percentiles of menarche were 11.1 years and 13.5 years and 11.7 years and 13.6 years in Black and White girls, respectively. Using our ethnicity-specific definitions of timing, the mean age of menarche was 10.5 years \((SD = 0.6)\) in early-maturing Black girls \((n = 238)\) and 11.1 years \((SD = 0.5)\) in early-maturing White girls \((n = 200)\). Mid-onset Black girls \((n = 706)\) and White girls \((n = 668)\) started menses at mean ages of 12.0 years \((SD = 0.5)\) and 12.6 years \((SD = 0.5)\), respectively. In late-onset girls, the mean age of menarche was 13.7 years \((SD = 0.6)\) in Black girls \((n = 219)\) versus 14.4 years \((SD = 0.6)\) in White girls \((n = 224)\).

As shown in Tables 1 and 2, there were significant differences in BMI at every age among early, mid, and late-onset girls: Early-onset girls had the highest BMIs and late-onset girls had the lowest BMIs. In Black girls, the differences among early-onset, mid-onset, and late-onset girls did not vary significantly from year to year \((X^2 = 23.1, p = .28)\). Over ages 9–19 years, the mean difference in BMI between early-onset and mid-onset Black girls was \( 1.7 \pm 0.4 \) kg/m\(^2\) \((z = 3.97, p < .001)\) and the mean BMI difference between mid-onset and late-onset Black girls was \( 1.2 \pm 0.4 \) kg/m\(^2\) \((z = 2.97, p < .003)\). Among White girls, the magnitude of the differences by timing varied with age \((X^2 = 91.6, p < .001)\) and was largest at ages 12–14 years.

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\(^3\) Adjusted means are available upon request.
Table 1. Mean body mass index (BMI) by timing of sexual maturation and age at last birthday in Black girls

<table>
<thead>
<tr>
<th>Age at Last Birthday</th>
<th>Early (&lt;11.1 Years)</th>
<th>Mid (11.1–13.0 Years)</th>
<th>Late (&gt;13.0 Years)</th>
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Note: Timing of sexual maturation was defined by race-specific quintiles of menarche: Early-onset and late-onset girls had ages at menarche that fell below the 20th and exceeded the 80th percentile, respectively, of Black girls in the National Growth and Health Study. Wilcoxon p values for cross-sectional differences by timing of onset of menses at each age were all <.001 (X² ≥ 9.21 with 2 df).

Table 2. Mean body mass index (BMI) by timing of sexual maturation and age at last birthday in White girls

<table>
<thead>
<tr>
<th>Age at Last Birthday</th>
<th>Early (&lt;11.7 Years)</th>
<th>Mid (11.7–13.6 Years)</th>
<th>Late (&gt;13.6 Years)</th>
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<td>80</td>
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</table>

Note: Timing of sexual maturation was defined by race-specific quintiles of menarche: Early-onset and late-onset girls had ages at menarche that fell below the 20th and exceeded the 80th percentile, respectively, of white girls in the National Growth and Health Study. Wilcoxon p values for cross-sectional differences by timing of onset of menses at each age were all <.001 (X² ≥ 9.21 with 2 df).

**Timing of Sexual Maturation and Concerns About Body Image and Eating**

**Body Dissatisfaction**

Figure 1A shows the unadjusted means of the EDI Body Dissatisfaction scores for early mid, and late-onset Black girls at ages 11–19 years. In general, body dissatisfaction increased modestly with age. Adjusting for age, significant differences by timing of sexual maturation were found. Although the magnitude of these differences varied with age, these variations were not statistically significant (X² = 23.8, p = .09). Over ages 11–19 years, the mean difference in Body Dissatisfaction scores between early-onset and mid-onset Black girls was 0.9 (SE = 0.5, z = 1.85, p = .06) and between mid-onset and late-onset Black girls the mean difference was 1.4 (SE = 0.5, z = 3.31, p < .001).
Figure 1(A). Means and 95% confidence intervals by age for Eating Disorder Inventory (EDI) Body Dissatisfaction scores in National Growth and Health Study (NGHS) Black girls by timing of menarche and age at last birthday: early (<11.0 years), mid (11.0–13.0 years), or late (>13.0 years). (B) Means and 95% confidence intervals by age for EDI Body Dissatisfaction scores in NGHS White girls by timing of menarche and age at last birthday: early (<11.7 years), mid (11.7–13.6 years), or late (>13.6 years).

After adjusting for parental education and BMI percentile, the average differences over all years by timing of sexual maturation were no longer statistically significant ($X^2 = 1.63$, $p = .44$). Body Dissatisfaction scores were significantly associated with BMI rank and increased by 0.13 ($SE = 0.005$, $z = 25.7$, $p < .001$) for every one-unit increase in BMI percentile.

Figure 1B shows the unadjusted means of the EDI Body Dissatisfaction scores for early, mid, and late-onset White girls at ages 11–19 years. In general, body dissatisfaction increased with age. Adjusting for age, significant differences by timing of sexual maturation were found. Although the magnitude of these differences varied with age, these variations were not statistically significant ($X^2 = 13.3$, $p = .65$). Over ages 11–19 years, the mean difference in Body Dissatisfaction scores between early and mid-onset White girls was 1.8 ($SE = 0.6$, $z = 3.25$, $p < .001$) and the mean difference in Body Dissatisfaction scores between mid and late-onset White girls was 2.6 ($SE = 0.6$, $z = 5.72$, $p < .001$).

After adjustment for parental education and BMI percentile, the average differences over all years by timing of sexual maturation were not statistically significant ($X^2 = 3.01$, $df = 2$, $p = .22$). Body Dissatisfaction scores were associated significantly with BMI
percentile and increased by 0.15 \( (SE = 0.006, z = 25.8, p < .001) \) for every one-unit increase in BMI percentile.

**Drive for Thinness**

Figure 2A shows unadjusted mean Drive for Thinness scores in Black girls. Among Black girls ages 11–19 years, average Drive for Thinness scores of early-onset girls compared with mid-onset girls were higher by 0.7 \( (SE = 0.3, z = 2.04, p = .04) \) and the Drive for Thinness scores of late-onset girls compared with mid-onset girls were lower by 0.9 \( (SE = 0.3, z = 2.97, p < .003) \). The magnitude of these differences varied with age, but these variations only approached statistical significance \( (X^2 = 26.3, p = .05) \).

After adjustment for parental education and BMI percentile, the average differences over all years by timing of sexual maturation were not statistically significant \( (X^2 = 0.84, p = .66) \). Drive for thinness scores in Black girls increased by 0.09 \( (SE = 0.003, z = 26.1, p < .001) \) for every one-unit increase in BMI percentile.

Figure 2B shows unadjusted Drive for Thinness scores in White girls. Among White girls averaging over ages 11–19 years, Drive for Thinness scores in early compared with mid-onset girls were higher by 1.3 \( (SE = 0.4, z = 2.99, p < .001) \) and were higher in mid compared with late-onset White girls by 1.4 \( (SE = 0.3, z = 4.28, p < .001) \). Drive for Thinness generally increased with age in White girls. The magnitude of differences
Figure 2(A). Means and 95% confidence intervals for Drive for Thinness scores in National Growth and Health Study (NGHS) Black girls by timing of menarche and age at last birthday: early (<11.0 years), mid (11.0–13.0 years), or late (>13.0 years). (B) Means and 95% confidence intervals for Drive for Thinness scores in NGHS White girls by timing of menarche and age at last birthday: early (<11.7 years), mid (11.7–13.6 years), or late (>13.6 years).

among early, mid and late-onset girls did not change significantly with age ($X^2 = 19.8, p = .23$).

After adjustment for parental education and BMI percentile, differences in Drive for Thinness scores among early, mid, and late-onset girls were not significant ($X^2 = 1.92, p = .38$). Drive for Thinness scores in White girls increased by 0.09 ($SE = 0.005, z = 18.4, p < .001$) for every one-unit increase in BMI percentile.

Bulimia

As shown in Figure 3A, there were no significant differences in Bulimia scores among early, mid, and late-onset Black girls in models adjusting for age only or for age, parental education, and BMI percentile ($X^2 = 0.23, p = .89$). BMI percentile was not associated with Bulimia in Black girls ($z = 0.98, p = .33$).

In White girls, there were no statistically significant differences among early, mid, or late-onset girls, whether adjusting for age alone or for age, parental education, and BMI percentile ($X^2 = 0.51, p = 0.78$). In White girls, Bulimia scores increased by 0.01 ($SE = 0.002, z = 5.19, p < .001$) for each one-unit increase in BMI percentile.
DISCUSSION

Using longitudinal data from a large cohort of Black and White girls, we sought to explore the relationship between timing of sexual maturation and the development of eating disorder symptoms in three domains: body image concerns, drive for thinness, and bulimic symptoms. The methodological strengths of our study were the high retention rate, objective measurements of height and weight, longitudinal data covering a 10-year developmental period of chief importance to the understanding of the development of eating disorder symptoms, and the inclusion of a large number of Black girls, a population for which very little data exist about the impact of timing of sexual maturation on eating disorder symptoms.

In our sample of Black and White girls, the mean ages of menarche of Black (12.0 years) and White girls (12.7 years) were comparable to the mean ages of menarche reported for Black (12.2 years) and White girls (12.9 years) by Herman-Giddens et al. (1997). Consistent with cross-sectional and longitudinal studies (Frisch, 1976; Taranger et al., 1976), we found that BMI was significantly correlated with timing of sexual development. Specifically, in both ethnic groups, early-maturing girls had a greater ponderosity at study entry (age 9 or 10 years) than girls with mid-onset or late-onset menarche and they continued to have greater ponderosity at each of the 10 annual measurements during the study. Indeed, as young adults, early-maturing White girls were overweight and early-maturing Black girls were obese. Moreover, late-maturing girls in both ethnic groups...
Figure 3(A). Means and 95% confidence intervals for Bulimia scores in National Growth and Health Study (NGHS) Black girls by timing of menarche and age at last birthday: early (<11.0 years), mid (11.0–13.0 years), or late (>13.0 years). (B) Means and 95% confidence intervals for Bulimia scores in NGHS White girls by timing of menarche and age at last birthday: early (<11.7 years), mid (11.7–13.6 years), or late (>13.6 years).

were significantly thinner than mid or early-maturing girls. Late maturation confers an advantage over early or on-time maturation in terms of a decreased likelihood of adiposity.

Our results supported the stage termination hypothesis: Premature sexual development was associated with more symptoms than delayed sexual development. Specifically, among both Black and White girls, early-onset menarche was associated with body image dissatisfaction and thinking about or actually engaging in efforts to lose weight. These findings are consistent with results reported by other investigators who studied White girls (Graber Brooks-Gun, Paikoff, & Warren, 1994; Graber, Lewinsohn, Seeley, & Brooks-Gunn, 1997; Hagward, Killen, Wilson, & Hammer, 1997; Killen et al., 1992). Our results also go beyond these previous investigations because they focus not only on the impact of early sexual development but also on the impact of late sexual development. Late-developing girls reported less body dissatisfaction and less drive for thinness than mid or early-developing girls. Our results suggest a protective function of late sexual maturation in regards to body image concerns.
Further analyses from our study found that these relationships among timing of menarche and measures of body image and dieting concerns were no longer significant when adjusting for parental education and BMI percentile. Several prospective studies based on smaller cohorts of White girls reported similar results (Attie & Brooks-Gunn, 1989; Graber et al., 1994; Smolak et al., 1993). We believe that the association among timing of sexual maturation and body image concerns and dieting is the result of the association between timing of maturation and body weight.

Our study failed to find a significant association between timing of sexual maturation and our measure of bulimic symptoms (Bulimia) in this nonclinical sample. Although larger than most community-based studies in the field of eating disorders, our sample may have been too small to contain enough girls who were binge eating to permit examining more fully the role timing in the development of bulimia nervosa or binge eating disorder.

In conclusion, our results underscore the clear association between timing of sexual maturation and adiposity. Moreover, as has been shown in other studies, adiposity was an important determinant of body image concerns both among White girls and girls from ethnic minority groups (Siegel, Yancey, Aneshensel, & Schuler, 1999; Stice, Hayward, Cameron, Killen, & Taylor, 2000). Our findings suggest that timing of sexual maturation does not increase the risk for developing body image concerns above and beyond the risk conferred by elevated ponderosity. The critical importance of pediatric obesity as a risk
factor for poor health and mental health outcomes is well recognized. Experts also warn of the adverse consequences of body image concerns (Stice et al., 2000). Coherent, effective public health efforts are needed to address both the epidemic of pediatric obesity and the widely prevalent weight concerns.

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