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Original article

Girls' Sleep Trajectories Across the Pubertal Transition: Emerging Racial/Ethnic Differences

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A B S T R A C T

Purpose: This study aims to examine the longitudinal association between puberty and sleep in a diverse sample of girls and explore racial/ethnic differences in this association.
Methods: Using latent growth curve modeling, the present study measured pubertal development (timing and rate) and sleep (wake time and bedtime) in 1,239 socioeconomically and ethnically diverse girls starting when they were 6–8 years old and followed longitudinally for up to 8 years. Pubertal assessment was conducted annually in clinic by physical examination, classified by sexual maturation stage for breast and pubic hair development by trained raters.
Results: In line with previous research, black girls had the earliest pubertal development, followed by Hispanic, white, and Asian girls. Black girls, on average, reported significantly shorter sleep duration than Hispanic ($\beta = -.20$, $p < .001$), Asian ($\beta = -.29$, $p = .002$), and white ($\beta = -.35$, $p < .001$) girls. In a series of dual-process models, we found that early pubertal timing predicted shorter sleep duration for early-maturing black girls (breast development: $\beta = .13$, $p = .005$; pubic hair development: $\beta = .14$, $p = .012$). There was no evidence of any association between pubertal rate and sleep. All models controlled for family socioeconomic status and body mass index.

IMPLICATIONS AND CONTRIBUTION

Earlier pubertal timing in girls was associated with later bedtimes across the transition from middle childhood to adolescence. Therefore, clinicians should consider using pubertal onset as a "teachable moment" to promote sleep health. Early intervention may be especially significant for black youth, who experience puberty-related changes in sleep before their peers.

Conflict of Interest: The findings and conclusions of this report are solely the responsibility of the authors and do not necessarily represent the official views of the NIH. The NIH played no role in the study design, data collection, writing, or decision to submit the manuscript for publication. All authors declare they have no actual or potential conflicts of interest. The first author wrote the first draft of this paper and received no compensation.

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Conclusion: Sleep is essential for many aspects of youth development, including emotional, cognitive, and physical functioning. Developmental changes associated with puberty may put some early maturing girls at risk of shorter sleep duration in adolescence and exacerbate racial/ethnic disparities in health and well-being.

Early pubertal timing in girls is associated with increased risk of social, emotional, behavioral, and physical problems during adolescence and beyond [1,2]. Interestingly, many of the same risk-taking behaviors and poor mental and physical health outcomes are also associated with insufficient sleep [3–5], yet the links between sleep and pubertal onset are not well understood. Furthermore, given well-established racial/ethnic differences in both pubertal timing and sleep, some youth may be at greater risk than others. In particular, black or African-American girls typically enter puberty earlier [6,7] and have shorter sleep duration [8] than girls from other racial/ethnic groups, which may exacerbate health disparities in the United States.

These early racial/ethnic sleep inequalities foreshadow well-documented differences in sleep among black and white adults in the United States [9,10]. There is also evidence for reduced sleep duration among Hispanic adults, compared with white adults, over the past several decades [11]. Psychosocial stressors are the main hypothesized pathway to racial/ethnic disparities in sleep quantity and quality. For instance, poor sleep has been linked to stressors such as negative life events, neighborhood disorder, and financial strain, which are significantly more common among black and Hispanic families compared with white families [12,13]. Additionally, a new body of research suggests that everyday discrimination and perceived racism also negatively impact sleep, independent of socioeconomic status and other psychosocial stressors [14,15].

Another plausible, yet understudied, risk factor of sleep disparities is early pubertal timing. Research from laboratory studies suggests that pubertal youth experience delayed sleep phase (i.e., the natural tendency for later bedtime, as measured by later melatonin secretion), longer sleep latency (i.e., time taken to fall asleep), less delta slow-wave sleep (i.e., deep sleep), and a greater tolerance to stay up late (regardless of daytime sleepiness) compared with prepubertal youth [16–21]. Therefore, girls who experience puberty before their peers (including a higher proportion of black and Hispanic youth in the United States) likely undergo neurological reorganization of their sleep-wake cycle, leading to later bedtimes and shorter sleep duration than their same-aged peers. Early pubertal timing may also influence sleep via increased psychosocial stress. Youth who develop relatively early (i.e., gain weight or develop secondary sex characteristics when their peers still have childlike appearances) may be treated differently by adults and other youth, or encounter more adult-like expectations, leading to heightened risk of psychosocial problems [22,23]. Indeed, studies suggest that stressful social experiences contribute to longer sleep latency and shorter sleep duration [24,25]. Links have been established between short sleep duration and key developmental outcomes, including poor cognitive performance [26], depressive symptoms [5], obesity [27], inflammation [28], and risky behaviors [3] in adolescence, which underscores the need to better understand the early biological precursors to sleep behavior.

Importantly, puberty is not a discrete transition, but rather a developmental process that begins in late childhood through a cascade of neuroendocrine changes that manifest in physical growth and sexual maturation that can be measured by phenotypic indicators (e.g., secondary sex characteristics). The typical progression from pubertal initiation to full, physical maturation spans approximately 4 years, but there is vast individual variation, with a range of 1 year to 7 or more years [29]. Although less studied, pubertal rate might also cause increased stress due to the maturation compression hypothesis: faster rate requires more rapid adaption to new biological and social milestones relative to slower rate [30]. Girls who transition through puberty quickly (i.e., faster rate) may also be at risk of worse sleep, both because they experience relevant neurological changes sooner, and because they may be under higher stress related to the rapid transition. Overall, there is a lack of relevant, longitudinal data to explore possible racial/ethnic disparities in pubertal rate.

To our knowledge, no studies have examined whether pubertal timing and rate may explain different sleep trajectories across adolescence. We address this gap, and also consider whether associations between puberty and sleep trajectories may differ across racial/ethnic groups. Although pubertal development and behavioral research to date has largely focused on white women, this study included clinic-based sexual maturation ratings in a large, diverse sample of girls, which provides a rare opportunity to explore whether puberty may be related to racial/ethnic differences in sleep. We expected racial/ethnic differences in both sleep and pubertal timing—with black girls developing earlier, and getting less sleep, than Hispanic, white, and Asian girls. We also hypothesized that earlier timing (Figure 1; hypothesis 1a) and faster rate (hypothesis 2a) would be related to shorter sleep duration in middle childhood, and increasingly less sleep across the transition from middle childhood to adolescence (hypotheses 1b and 2b). Furthermore, we expected that associations between puberty and sleep would be stronger in black girls than other racial/ethnic groups. We also hypothesized that this effect may be apparent in Hispanic girls, given evidence of earlier and faster puberty in Hispanic girls relative to white and Asian girls.

Methods

Participants and procedure

This project was conducted as part of the Puberty Studies of the Breast Cancer and the Environment Research Program funded by the National Institute of Environmental Health Sciences and the National Cancer Institute [31]. A total of 1,239 socioeconomically and ethnically diverse girls, aged 6–8 years, were enrolled between 2004 and 2007 from three locations led by the following institutions: (1) Mount Sinai School of Medicine (MSSM); (2) Cincinnati Children's Hospital Medical Center; and (3) Kaiser Permanente Northern California (KPNC). Girls having a