



## Co-education with Environmental Cues May Kindle Early Onset of Female Puberty

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### DEAR EDITOR,

Puberty is a complex process of neural, hormonal and environmental interactions by which a person matures sexually and gains capability of reproduction.<sup>[1]</sup> Puberty brings about physical and emotional developments through enhanced activity of hypothalamic-pituitary gonadal (HPG) axis. Puberty may certainly be precocious and stimulus for such precocious pubertal changes lead to initiation of enhanced HPG activity (specifically by the effect of GnRH).<sup>[2]</sup> Children facing precocious puberty are unaware of the cause of the physical changes taking place in their bodies; in case of girls, it is tough to accept the pain and discomfort associated with menstruation and enlargement of mammary glands that make them mismatched and odd among children of their age group.<sup>[1,2]</sup> Precocious puberty currently affects 1 in 5,000 children and is 10 times more common in girls. Statistics indicate that girls in the United States are maturing at an earlier age than they did 30 years ago and the number of girls with diagnosed precocious puberty (the appearance of secondary sex characteristics before 8 years of age or the onset of menarche before age 9) is on the rise.<sup>[2]</sup>

Puberty is one of the most frequently discussed time periods in which there is the highest risk for the development of eating disorders. Research pronounces that increasing rates of childhood obesity may be responsible for a dramatic increase in early-onset puberty in girls. It has been reported that obesity, especially when combined with low birth weight, raises the risk for premature pubarche. In the case of pubarche, rapid weight gain, rather than high BMI *per se*, appears to be the cause for early onset.<sup>[3]</sup> Many other studies demonstrate that childhood obesity is associated with an earlier menarche and thelarche.<sup>[4,5]</sup>

“Environmental obesogens” act to disrupt homeostatic control over energy balance or stimulate the growth of fat cells and thus affect pubertal onset. Prevailing theories propose that environment oriented risks actually arise from the psychosocial effects (e.g., increased body dissatisfaction, decreased self-esteem) of pubertal development in girls.<sup>[6]</sup> Thus, the metabolic control of puberty in such a spectrum of situations, ranging from energy deficit to extremely overweight condition, is the result of the concerted action of different peripheral hormones and central transmitters that sense the metabolic state of the organism and transmit this information to the various elements of the reproductive axis, mainly the GnRH neurons. Among the peripheral signals, the adipose hormone, leptin, is known to play an essential role in the regulation of puberty, especially in females.<sup>[7]</sup>

Studies revealed that another cause of early onset of puberty in girls may be familial and other psychological stress that has also received some attention. Cortisol released as part of a stress response may modulate hormones in ways that encourage early puberty.<sup>[8]</sup> Early childhood experiences are known to shape the basal rhythms of the HPG (hypothalamic-pituitary-adrenal [HPA]) axis and set its reactivity.<sup>[9]</sup> Maltreated children have altered HPA axes and respond to stress differently through crosstalk between HPG and HPA axis.<sup>[9,10]</sup>

In several species, it has been shown that priming pheromones (i.e., those having a slower onset and longer duration), emerging from males, play the key role in regulating the onset of puberty in females. In most of the species, such as the tamarin, specialized glands may be involved,<sup>[11]</sup> or skin secretions deposited on the fur, as in sheep.<sup>[12]</sup> Evidences bring it to the limelight that chemical communication among animals could be involved

in the regulation of puberty onset as was presented by Vandenberg.<sup>[13]</sup> Extensive data from nonhuman mammalian studies indicate that puberty in females is delayed by exposure to adult females, and accelerated by exposure to adult males. Among rodents, the mechanism by which social cues schedule puberty is mediated by pheromones-chemical signals that influence the behavior of others. Some of these pheromones have been identified and even synthesized. Puberty-suppressing pheromones in mice, for example, come from the adrenal gland. When the adrenal glands are removed from a female, she can no longer suppress puberty in her sister.<sup>[14]</sup> Mice exposed to adrenal-derived pheromones dissolved in water experience delayed puberty.<sup>[14]</sup>

The onset of puberty in human females has been documented in various studies to be influenced by several factors. Not only obesity and psychological stress, as discussed above, are the sole factors of early menarche, but perhaps the role of pheromones, as mentioned in nonhuman mammals, may also be the prime factor of the same in human as well.<sup>[15]</sup> Several studies have indicated that interpersonal relations among girls, as well as between boys and girls, may alter reproductive functions, suggesting the presence of primer pheromone activity. These relations include menstrual synchrony among girls that have been first documented in all-women groups<sup>[16]</sup> and later replicated in a variety of other situations.<sup>[16,17]</sup> Extracts of male axillary secretions also appear to affect girls with a history of irregular cycle lengths. The lengths of the menstrual cycles of these girls showed a significant shift toward the normal cycle length when the male axillary secretion was applied to the upper lip of the recipient female.<sup>[18]</sup> Some studies reported that the presence of a brother or stepbrother can also accelerate the timing of puberty in girls.<sup>[19]</sup> Studies have also reported that prepubertal girls also have elevated levels of androgens that may also contribute to earlier onset of puberty among exposed girls.<sup>[20]</sup> One outstanding report of Ellis and Garber mentioned that girls who live with a stepfather go through puberty earlier than girls who live with their biological father.<sup>[21]</sup> The absence of biological father but not the mother has been consistently reported to be associated with early menarche,<sup>[22,23]</sup> and the longer the absence, the earlier the first menstruation.<sup>[24]</sup> More time spent by fathers in childcare, more father-daughter affection and more paternal investment in the family all appear to be protective against early puberty among United States girls.<sup>[21]</sup>

Schooling system plays an important role in this regard. Some studies in the United States reported that the home schooling delays onset of puberty in girls.<sup>[25]</sup> Conversely, a correlation has been found between schooling in

co-education and pubertal onset in girls. One of such comparative studies in Tanzania reported girls attending schools with boys are reporting early onset of puberty and experience menarche.<sup>[26]</sup> Thus, the question may arise how spending time with juvenile males in school could be responsible for early puberty, as they themselves are not rich in sex hormones? In this regard, some stimulating research works have been done which report an increasing trend of androgen levels in prepubertal males for last 30 years.<sup>[27-32]</sup> According to those articles, the testis is not completely silent before onset of puberty. It has been shown that the fluid around the testis is very rich in testosterone several years before puberty. Several studies have revealed that the circulating testosterone and other androgen levels are quite detectable by sensitive immunoassays and show an increasing trend during last 30 years. These studies have shown that testosterone levels of prepubertal boys (0–10.5 years of age) ranges from 0.16 nmol/L to 182 nmol/L.<sup>[27]</sup> They have shown a greater median value of circulating testosterone that influences peritesticular tissues such as the epididymis, gubernaculum and scrotum. These instigate to predict that increased circulating androgens in prepubertal boys may influence pheromone biosynthesis and thus could be responsible for early puberty in girls.

Thus, it can be hypothesized that along with nutritional status, psychological stress and several other common factors (like television viewing, etc.), co-education schooling can affect onset of puberty.

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