

Precocious Puberty: Causes, Consequences, Daily Environmental Factors, and the need for Community/Societal Support

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Abstract :

Precocious puberty, otherwise described as a group of medical conditions that cause early puberty onset, such as a pre-adolescent boy presenting with adult pattern of penile and testicular enlargement or a pre-adolescent girl presenting with mature breast development and onset of menses. Although the sexual and physical characteristics for this condition are well-described in medical literature, the causes are very rarely known. Nevertheless, it has substantial impacts on children's lives. This is a review on sexual development, premature sexual development, the social complications children suffer from due to early onset puberty, and the associations with daily environmental exposures as possible influences for developing precocious puberty..

Keywords : morphine-covid 19; mutagenicity

Introduction

Sexual development is beginning earlier and earlier. The average age of puberty has been steadily decreasing in the last century. And since the past century, society has changed significantly in regards to finding and creating effective and efficient methods of mass food production, such as the animal industry, and other consumer production, such as the use of plastics as tools we use in our daily lives. Our dietary habits have changed as well; food that has high caloric content, high fat and sugar has considerably contributed to the obesity epidemic. Although the FDA in the United States regulates the chemicals used in the industries, there have been major incidents, in which exposure to these chemicals have adversely affected reproductive development in children. In addition, recent studies have found many associations between premature sexual development and various environmental factors, such as hormones used for livestock production and endocrine disruptors found in common household items, such as toys and pesticides.

Body

A. Normal limits of sexual maturity

Sexual development, also known as puberty, is a natural process in a human's life, in which a child transitions into an adult. The normal age range of this transition is from the age 8 to 14 years old in girls and 9 to 16 years old in boys. [1-3] Signs of sexual development for males begin

with enlargement of the testes and the penis followed by pubic and axillary hair then lastly, the appearance of facial hair, muscle development, and voice deepening. [1-3] For females, the first sign of sexual development is breast development followed by pubic and axillary hair then finally, menstruation. [1-3] other signs include growth spurt and acne. [1]

A common method for physicians to monitor sexual maturity in patients is recording observations according to the Tanner Staging system, which has five stages total; it focuses on the progression of pubic hair development in both boys and girls as well as specific signs of breast development in girls while also tracking the gradual progression of penile and testicular enlargement in boys.[4] Stage I is the pre-adolescent stage, in which, there is no sign of pubic hair development or breast development. Stage II is the onset of sparse pubic hair development and breast budding in girls. Stage III consists of coarser, darker pubic hair. Stage IV consists of continued distribution of pubic hair with development of the secondary breast mound in girls. Lastly, Stage V is the equivalent of adult sexual maturity, in which the pubic hair spreads to the medial thighs while penile and testicular development as well as breast development are determined as sexually mature.

While puberty takes place over a range of years and has predictable patterns, [4] not every child experience sexual maturity at the same rate and may appear with what seems to be abnormal development but is

actually benign. There are instances, in which, a child may appear to develop sexual features earlier or later. For the purposes of this review, only early benign variants are discussed. The first common variant is premature adrenarche- children may appear with pubic and/or axillary hair, odor, or mild acne and it usually occurs before eight years old in girls and nine years old in boys.[5-6] What defines this diagnosis as benign are normal growth rate and the absence of breast, penile, and/or testicular enlargement; reassurance and continued routine physician visits are advised. [5-6] Another common variant is premature thelarche- girls appear with non-progressive breast enlargement over a four- to six-month period and the absence accelerated growth; this is usually observed before three years old and in this case, reassurance is also advised. [5-6]

B. Precocious Puberty

Precocious puberty is defined as the process in which a child's body prematurely begins the development into an adult's body. [1-3] From the previous discussion on common benign variants, indications of abnormal pubertal development include accelerated growth rate, Tanner Stage III breast development in girls before eight years old, and testicular and/or penile enlargement in boys before nine years old. [5-6]

a. Statistics

The incidence of precocious puberty is 1 in 5,000 to 10,000 children with a female to male ratio of 20 to 1.⁷ About 80-90% of female cases are of unknown causes and about 50% of male cases have identifiable causes.⁷

b. Causes/classification

The causes of precocious puberty are unknown a majority of the time, however, there are two classifications that describe possible and common presentations that are seen according to the hormonal pathways and signals that are disrupted in the human body.

The first classification is central; these are often caused by lesions of the central nervous system, such as tumors of the brain or having been exposed to radiation of the central nervous system. Having these lesions result in activating signals to begin the process of puberty much too early. [8]

The second classification is peripheral, which includes areas of the human body outside of the central nervous system, such as the gonads and adrenals. Commonly, children with peripheral precocious puberty would present with tumors of the ovaries, the testes, or the adrenal glands. Another subcategory in the peripheral classification is the exposure to exogenous sex hormones, such as oral contraceptives, skin and/or creams with testosterone ingredients. In other words, peripheral precocious puberty results from an excess of sex hormones and acting independently from the signals originally from the brain to regulate sexual maturity. [8]

c. Diagnosis

As most of the causes of precocious puberty are unknown, there is no definitive gold standard. Rather, diagnosis relies on a combination of observations, laboratory tests, and imaging. Observations include thorough medical history and physical exam as well as growth rate monitoring by the child's primary care provider. Laboratory tests include testing specific sex hormone levels at baseline and when medically stimulated. Imaging include obtaining X-rays to test bone age, which is usually older than the calendar age in children with precocious

puberty. Further testing includes ultrasound of the pelvis/testes/ovaries and brain MRI if observations and lab results indicate high likelihood of tumors in those respective areas of the body. [5-8]

C. Impacts of precocious puberty

The physical consequences from precocious puberty are often well-known in the medical field, however, there are also major behavioral, psychological, and social complications that, just as importantly, affect these children and must be taken into consideration when managing this condition.

Physical

Aside from the development of sexual characteristics, children who develop precocious puberty may experience accelerated growth, which would cause them to obtain a taller stature compared to their peers. However, despite this tall stature, these children end up with short stature for the reason that precocious puberty causes puberty to end early and growth stops before they reach the height that they would have obtained had they experienced puberty at the normal timeframe. [9-10]

Behavior

Children may suffer from mood swings or disruptive behavior due to precocious puberty. There also have been suggestions that these children may become sexually active earlier. Studies have also found that these children have higher rates of anxiety, depression, and substance use. [9-11]

Psychological

Children who develop precocious puberty often have mature outward appearances when they remain in the mindset of a child. This incongruence causes these children to experience higher social pressure and unrealistic expectations from their elders because they look older. In regards to interactions with their age group, children with precocious puberty may feel very uncomfortable with appearing more mature than they actually are and they may have low self-esteem from being different from their peers. This inevitably results in stress that are not otherwise experienced by pre-pubescent children. [9-11]

Social

Just as essential are the social complications for children with precocious puberty, as portrayed by the case of Lina Medina in the year 1939. Lina Medina was diagnosed with precocious puberty and gave birth at the age of five years old. [12] This portrays the elevated risks of physical and sexual abuse either during puberty or afterwards; this is termed as adolescent dating abuse. [13] Children who experience early sexual maturity often experience sexual harassment or aggression victimization, which may involve coercion with the use or threat of physical force, verbal pressure, or exploitation of an incapacitated state. [13-14] Also, they may have more friends who are male, older, or friends who engage in risk behavior compared to their peers. [13] In addition, there is the elevated risk of unwanted pregnancies. [13]

Pregnancy

Lastly, adding on to the case of Lina Medina, her baby was born by Caesarean section. [12] It is well-known that pregnancy before fifteen years old are associated with a great number of risks, not only to the prospective mother but also to her infant. [15] A few such risks include anemia, pregnancy-induced hypertension, and premature birth. [15] Another risk that is particularly relevant in mothers like Lina Medina is cephalo-pelvic disproportion, in which the baby's head is wider than the pelvic opening and the safest delivery would be C-section. [16] Although

life saving, undergoing C-sections is a great risk itself both during and after the procedure. As with any surgery, there are possible complications that may lead to permanent damage; [17] complications include infection, instrumental injury to organs close to the uterus such as the bladder or the intestines, and scar tissue, which may lead to future pregnancy complications. [18] If one applies this to a child with precocious puberty, there would logically be even higher risks particularly if she wishes to be pregnant in the future.

D. High Risk Groups

Precocious puberty has a predilection to affect females and African Americans. Children who are obese, have complications from other medical conditions that influence the hormonal pathways, such as congenital adrenal hyperplasia, or have had radiation of central nervous system, such as for tumor or leukemia treatments are also at risk for developing precocious puberty. Another high risk group are those who have had exposure to exogenous sex hormones.[2]

E. Trends of sexual development and associations

The age of puberty onset has been steadily decreasing. In the last century, the average age of puberty was 16 years old. In the early 21st century, the age decreased to 13 years old. Currently, the age of puberty is around 10 years old.¹⁹⁻²¹ Studies have shown significant associations with daily environmental factors. Although many of these anthropogenic products contain only trace amounts- as approved and regulated by the FDA-²³ children naturally have much smaller weights than adults, therefore, a trace amount that may not have effects on an adult hormonal system may have a significant impact on a child. [24]

a. Residuals from livestock production

With increasing population comes with increasing food demand and with it, the pressure of creating techniques for efficient livestock production. The livestock industry has since changed from small farms to factory-like production. The FDA, from the 1950s onwards, have approved the use of using numerous sex hormones in the form of implants or supplemental feed to increase growth rate and increase the efficiency of turning livestock into meat. [23] Traces of these hormones have continuously been found in human food. For example, sex hormones have been found in cow's milk and breast milk which would transfer to infants and children. [26] In addition, the sex hormone estrogen accumulate in fat, suggesting that the physique and health of the livestock we consume also influence the amount of hormones humans are exposed to. Also, steroid precursors have been found in high concentrations in goose-fat and egg-laying hens. [26] Furthermore, the amount of sex hormones found in livestock also depends on where they are in their life cycle; whether humans consume adult cattle versus calves versus pregnant livestock also influence the amount of estrogen found in the meat we consume. [26] Although tests have deemed these safe for humans to eat, the amount of hormones found in livestock and consumed by humans are vastly variable. Also, studies have found positive associations between children with a diet rich in meat and developing precocious puberty. [19]

b. Environmental endocrine disruptors

There are numerous chemicals used today, whether during production or as by-products of consumer industries. There have been incidents of exposure that have caused harm to children. One classical case was the accidental exposure of polybrominated biphenyls (PBB) in cattle feed in Michigan 1973. [25] PBB production began in the 1970s and was a component found in plastics, such as computers and TVs. [24] Girls with high exposure to PBB experienced puberty a year earlier than girls who

had lower exposure. [25] PBB has since been banned in the US in 1976 after the accident, however, synthetic chemicals continue to be used and created, such as chemicals in pesticides, BPA in food containers, and phthalates in toys. [25] There have been animal epigenetic studies, in which, they found that exposure to these endocrine disrupters in one generation leads to earlier puberty in subsequent generations. [25] It is well-known that there are other adverse conditions that can affect the next generation in humans; [25] it is not improbable that the daily chemicals we are commonly exposed to could also have the same effects.

Obesity

Diets heavy in dessert, fried foods, and snacks inevitably lead to obesity. Obesity in women is a risk factor for hormonal abnormalities that result in irregular menstrual cycles and reproductive disorders, such as polycystic ovarian syndrome and infertility. [27] Studies have found significant association between the age of obesity onset and menstrual irregularities. [27] In other words, a substantial proportion of obese adolescents are now suffering from abnormal reproductive development. In the case of children, the trend of decreasing age of puberty onset has coincided with the trend of increasing prevalence of childhood obesity. [28] Studies have found evidence of insulin resistance, a major risk factor for obesity, in children with precocious puberty. [28] With obese adult women and adolescents experiencing the effects of hormonal abnormalities, there is a high probability that obesity has a role in premature sexual development in children.

Prevention strategies

According to the risk factors listed as well as the largely unknown origins of precocious puberty, there are many non-modifiable risk factors. However, obesity and exposure to exogenous sex hormones are risk factors that can be controlled. For example, children can be encouraged to eat a balanced diet and maintain a healthy weight. If parents or caretakers use oral contraceptives or other products that has estrogen or testosterone as part of the ingredients, take precaution as one would with any medication and ensure they are out of reach from children. [1] Moreover, the precautionary principle can also be applied- in general terms, this principle is used to emphasize that if we are unsure about an ingredient, then attempt to find a safer alternative. There are numerous chemicals we are exposed to daily, therefore, it is not possible for science to definitively and thoroughly know the effects they have on the human body; however, steps can be taken to limit the exposure of environmental hormonal compounds including wearing protective wear when handling or working with chemicals. [20] Furthermore, family and school support are particularly important for children; [20] decreasing age of puberty onset would need to be acknowledged and sexual educational programs would also need to change accordingly. [21] Moreover, it is advised to encourage children to be open about their feelings. [9] Lastly, it is important to observe for signs of abuse, such as expressing genital soreness, contracting sexually transmitted illnesses, having sexually inappropriate behavior for the child's age, or having behavioral changes, such as avoiding the abuser. [22]

Case management

For the cases of precocious puberty that have known cause, such as tumors or prominent hormonal imbalance either from specific exogenous exposure or from a congenital medical condition, treatment and reversal is possible. [9] However, for children who have unknown causes, especially those in peripheral category, which is the majority of the cases,

case management is essential. Frequent monitoring with the child's primary care provider and referral to the pediatrics endocrinologist when abnormal signs appear are advised. [10] Social services and mental health services should also be made available as additional resources for both the children and their parents for financial assistance, coping strategies, or other forms of counseling. [9] Lastly, utilizing support groups or providing contact information of parents who have or have had children with precocious puberty will offer current parents personal connections with people who have gone through the same experience. [9]

Discussion

The age of puberty onset has been steadily decreasing. Precocious puberty places significant strain on children who may appear physically and sexually mature when they are not socially ready and are still developing psychologically as pre-adolescents. And with constant exposure to environmental factors that predispose children to develop precocious puberty, the trend of decreasing age of puberty onset is not surprising. Because of the predominantly unknown causes of precocious puberty, it is possible that multiple exposures are part of the reason for premature sexual development. Therefore, society and the community can implement prevention strategies to decrease the interactions between children and risk factors. Case management is also important not only for the children but also for parents.

Conclusion

Many correlations have been found between premature sexual development and environmental factors, factors that are not likely to decrease any time soon for the sake of industry and consumer demands. It is very likely that the complications these children experience would soon be widely spread across populations instead of a few cases and would inevitably influence their lives as adults in the future. Changes must be implemented especially at the communal and societal level to support these children, who are not at the age in which they can speak for themselves.

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