

# Precocious Puberty in Girls

S. Sudha<sup>1</sup>, Reshma V. Menon<sup>2</sup>, Priyanka Verma<sup>3</sup>, Sakshi Shukla<sup>4</sup>,  
Anna Senrjung<sup>5</sup>, Sarita Nanda<sup>6</sup> and Anju Jain<sup>7</sup>

<sup>1,2,3,4,5,7</sup>Dept. of Zoology, Daulat Ram College

<sup>6</sup>Dept. of Biochemistry, Daulat Ram College

E-mail: <sup>1</sup>ssudha247@gmail.com, <sup>2</sup>reshmamenon253@gmail.com, <sup>3</sup>priyanka.smart99@gmail.com, <sup>4</sup>jjidisakshi@gmail.com,  
<sup>5</sup>annasenrjung@yahoo.in, <sup>6</sup>saritananda123@gmail.com, <sup>7</sup>anju37@gmail.com

**Abstract**—This review article explores the phenomenon of early occurrence of puberty and related changes in girls. It is aimed at creating awareness about precocious puberty by throwing light upon its various facets. In simple terms, precocious puberty refers to the appearance of pubertal symptoms at an age that is deemed as early for the given race or ethnicity. There are two main types of precocious puberty – Central Precocious Puberty (gonadotropin dependent) and Peripheral Precocious Puberty (gonadotropin independent). Factors (both chemical and lifestyle-related) that contribute to their occurrence are dealt with in detail. It awakens us to the astonishing reality of precocious puberty being a consequence of the present-day sedentary lifestyle, obesity being the major culprit. This is further supported by statistics which show a significant reduction in the age of onset of puberty worldwide in the past century. Though the values vary for populations of different ethnicities, the trend that is observed is towards the decline in age at which puberty starts. The need to propagate knowledge about this phenomenon is thus backed by its occurrence all over the globe. There is also in-depth analysis of the biological and social implications of precocious puberty. This serves to highlight the emotional strain borne by children having precocious puberty and the numerous problems arising from it. The role of parents and other elders in understanding these problems and responding effectively to combat them in order for the healthy physical and mental development of children is stressed upon. Finally, the available treatment options for different kinds of precocious puberty are explored.

## 1. INTRODUCTION

Precocious puberty is a condition that has been plaguing a large number of children in the recent times. Puberty in itself can be referred to as the onset of sexual maturity. It is denoted by a variety of physical and physiological changes and is crucial for the development of reproductive capability. It usually starts within the ages of 8-12 years in girls and 9-14 years in boys. On an average, the occurrence of the signs of puberty in the form of secondary sexual characteristics below the age of 8 and 9 in girls and boys respectively can be classified as precocious puberty or early puberty. However, this age definition cannot be considered universal. Therefore, in the most simplified form, **precocious puberty can be explained as the appearance of pubertal symptoms at an age that is deemed as early for the given race or ethnicity.**

A case study conducted by the US Paediatric Research in Office Settings (PROS) sampled 17077 healthy girls between the ages of 3-12 years. Stage 2 breast and pubic hair development was observed to have taken place a year earlier in white girls and two years earlier in African American girls than the observations of similar studies conducted in the past. This resulted in Lawson-Wilkins Paediatric Endocrine Society suggesting that girls showing signs of puberty before the age of 7 in white girls and 6 in African American girls should be tested for precocious puberty.

### 1.1 Types of precocious puberty

Precocious puberty can be classified as peripheral precocious puberty (PPP) and Central precocious puberty (CPP).

**Central Precocious Puberty:** It is gonadotropin-dependent and is correlated with the early development of hypothalamus and pituitary. Nearly 80% cases of precocious puberty fall under CPP which is generally more prevalent in girls than boys with a girl to boy ratio of 3:1. CPP can be further subdivided into *true* or *rapidly progressive puberty* and *slowly progressive puberty*. Rapidly progressive puberty can be identified by rapid transition from one pubertal stage to the next within a short span of 6 months or less. Premature pubarche and premature thelarche are often associated with slowly progressive or non-progressive precocious puberty. Premature pubarche refers to the development of pubic hair in girls or boys at an early age whereas premature thelarche refers to the development of breast in girls below the age of 3 years, independent of other signs of puberty.

The general causes of CPP may be:

- Hypothyroidism
- Accumulation of fluid in brain or spine or affliction with brain or spinal injury
- Genetic conditions such as McCune-Albright syndrome and congenital adrenal hyperplasia.

**Peripheral Precocious Puberty:** It is also termed as gonadotropin-independent precocious puberty. In such cases,

the main cause of premature puberty is attributed to a rise in the adrenal or gonadal secretions. This may further lead to the activation of LH receptors and consequently, increase in the levels of testosterone.

Some of the causes of PPP may be stated as:

- Ovarian cysts
- Exposure to external sources of sex hormones such as estrogen through a variety of media
- Adrenal or pituitary tumours.

## **2. OTHER CAUSES OF PRECOCIOUS PUBERTY**

Following are the other causes of precocious puberty:

### **2.1 Obesity**

Obesity is considered to be one of the main causes of precocious puberty. If a girl falls prey to obesity at an early age, she may experience early changes in her body such as development of breasts, pubic hair etc. This is because obesity is an endocrine disruptor. It alters the levels of hormones in the body. The levels of insulin, leptin and aromatase are affected dramatically. Thus, girls who are obese have higher chances of having precocious puberty as compared to the lean ones.

The ways by which obesity can cause early puberty are high calorie intake, lack of exercise and television viewing at night etc.

Various studies have shown that obesity tends to release more estrogen because estrogen is stored in fat tissues. Also, overweight girls have high levels of insulin and are highly capable of converting various hormones into estrogen. Obese girls have higher ability to store environmental toxins in their fat tissues which can cause early puberty.

Television viewing at night depresses the level of melatonin which can cause early puberty. Since breast milk contains higher levels of melatonin and fewer calories in accordance to infant need, therefore it is considered protective against precocious puberty. Obesity is considered as a contributor as well as a consequence of early puberty.

### **2.2 Chemicals in food and water**

Certain foods contain chemicals that lead to sexual maturity by disturbing the level of hormones that are normally present in the body of a child. It is seen that the plastics in which the food is served usually contain chemicals such as bisphenol A and phthalates. (Bisphenol A is a well-known teratogen but it may also lead to precocious puberty in girls.) These chemicals get easily dissolved in the food and thus reach inside the body.

Consumption of water containing chemicals like bisphenol A (which is easily soluble in water) can lead to this condition. If water is stored in plastic containers made up of bisphenol A,

the chemical gets dissolved in the water and thus enters into the body.

These chemicals act as disruptors of hormones which control development and function of the body.

Estrogenic chemicals are equally responsible as plastic chemicals. If a girl is exposed to estrogenic chemicals accidentally, she develops signs of puberty. The estrogenic chemicals are polybrominated biphenyls (PBB) and estrogen creams. These chemicals dramatically change the timing of sexual maturity.

Some synthetic foods like non organic meats and synthetic dairy products have puberty inducing chemicals. A hormone called Bovine Growth Hormone (BGH) is injected into cows and buffalos to produce high amount of milk. The recombinant BGH-containing milk contains high level of natural growth factor which, in addition to causing precocious puberty, is also responsible for breast and colon cancers.

## **3. CONSEQUENCES OF PRECOCIOUS PUBERTY**

### **3.1 Short stature**

The increase in height during the course of childhood occurs primarily due to the elongation of long bones (humeri, radii, ulnas, femurs, tibiae and fibulas). The long bones grow by elongation of the hyaline cartilage-containing region, known as epiphysis, present at each end of these bones. Bone growth is mainly stimulated by Growth Hormone (GH). As children enter puberty, the levels of sex steroids in their bodies increase due to the action of Gonadotropin Releasing Hormone (GnRH). This serves to cause bone maturation, i.e., the cartilaginous regions at the ends of growing bones become obliterated and calcified. This is termed as the “closure of epiphyses”. The bones attain their final shape and size. Once the period of transformation to adolescence is over, growth of the long bones stops and consequently body stature does not increase further.

In a study conducted by Porcu et al in Italy, among 82 girls belonging to the age group 12-19, the presence of open epiphyses was reported to be 61% in the first year after menarche and there was a steady decline in this value with each passing year. The average increase in height in girls with open epiphyses (at initial evaluation) was found to be only 3.5cm.

It has been seen that the maximum increase in height occurs about one and a half years before menarche (Tanner, 1972). Children entering puberty early initially grow faster than their peers. But this eventually causes earlier maturation of their bones. Ultimately they mature into adults who are shorter than the average individual of their age and sex.

### **3.2 Body image/ Self-esteem problems**

The fat-storing cells of the body, or adipocytes, synthesize a protein called leptin. It is involved in the regulation of body

fat levels and body mass index (BMI). Many studies have elicited the role of leptin in triggering the onset of puberty in females. In a study performed by Matkovic et al, the relationship between three variables – body composition, serum leptin levels and the timing of menarche – was determined. The increase in serum leptin concentration corresponded to both an increase in body weight (due to rise in fat levels) and to the decline in age at menarche. A stunning observation was the lowering of age at menarche by a whole month with an increase in serum leptin by as little as 1ng/ml. This means that with an increase of each kilogram in body weight, menarche is likely to get advanced by about 13 days.

The obesity epidemic which has gained stronghold in many parts of the world in the past few decades has often been cited as a leading cause of precocious puberty. Childhood obesity in girls automatically causes a surge in the serum leptin levels. This contributes to the early occurrence of menarche and premature breast development.

Further, onset of menstruation might be accompanied by weight gain. Early maturing girls, on account of their weight gain, might physically distance themselves from their thinner (normally maturing or less developed) peers. This may result in ‘body dissatisfaction’ and they may resort to unhealthy practices like excessive dieting, starving etc. to become ‘likeable’ in their social circles. Poor body image seems to persist in early maturers even after their peers have attained puberty (Graber et al).

Precocious children may be unable to comprehend the sudden differences between their bodies and those of their peers. The change in their physical appearance might make them self-conscious as they interact with others. This may be compounded by the differential treatment meted out to them and their peers. Children maturing early might be expected by adults to behave more responsibly (like “grown ups”).

Precocious children find it hard to “fit in” among their peers. Teasing or bullying by friends could lower their self-esteem which, in turn, might make them introverted.

### **3.3 Stress**

The lack of proper sex education in schools and the social stigma associated with menstruation have long hindered the efforts for open discussions about the problems faced by pre-teens and teenagers. Even in cases where onset of puberty is normal, children find it difficult to cope with the physical and behavioural changes experienced by them. A child entering puberty earlier than her peers encounters these problems at a much tender age. Sexual maturity is not accompanied by emotional maturity and this leads to the child experiencing confusion regarding the bodily changes.

Higher incidences of sleep disturbances, headaches, gastric trouble, and breathlessness have been reported in precocious children (Aro et al).

### **3.4 Behavioural problems/Substance abuse**

Generally parents hesitate to initiate talks regarding sex education with their children. Most parents are unaware of the emotional strain on children who enter puberty very early. The reluctance on the part of parents to share vital information about puberty and related changes inevitably creates a communication gap between them and their maturing children. Thus, many such children become unwilling to confide in their parents as well as their “more normal” peers.

In extreme cases, the absence of efficient counselling might push the child into depression. The tendency to remain aloof and withdrawn increases the risk of substance abuse.

A study performed by Dick et al elucidates the relationship between the existing trends of substance abuse and precocious puberty. The subjects for this study were twins who were not only genetically very similar but also were brought up in the same environment. The results obtained indicated that not only was the earlier maturing twin more likely to engage in smoking and drinking at a younger age but also more vulnerable to continue these habits in later life.

Early maturing girls have been found to smoke and consume alcohol in greater quantities and at higher frequencies than late maturing girls (Lanza & Collins, 2002). It is highly probable that early maturing girls enter into romantic relationships with older boys much earlier than their peers. The risk of exposure to alcohol, tobacco or drugs due to interaction with an older social group also increases in such situations (Stattin et al).

### **3.5 Early indulgence in sexual activity**

As noted previously, early onset of puberty in girls increases their chances of affiliations with older boys/men. Many findings have reported early incidences of sexually intimate behaviour, like kissing, in precocious girls (Flannery et al, Lam et al, and Wyatt et al). Moreover, girls experiencing menarche early are more likely to indulge in sexual intercourse at an earlier age. This explains the higher probability of occurrence of human papillomavirus (HPV), a sexually transmitted virus, in early maturing girls.

Teenage pregnancy is more commonly seen in girls whose menarche occurred at an earlier age. This is because most menstrual cycles occurring after one year of menarche are ovulatory and consequently there is a higher chance of pregnancy.

## **4. GLOBAL TRENDS**

In China, significant changes have appeared over the past two decades with respect to the early onset of puberty. In girls, the age of occurrence of menarche has dropped from 13 years to 12.7 years. Timing of puberty also shows variation depending upon the area. In urban areas, the onset of puberty was earlier than that in rural areas by 0.3 years.

In Northern Europe, it was during the 1800s that the trend of precocious puberty was carefully observed. The past century has seen a further reduction in the age by 3 years and it is an ongoing process.

Among Danish girls, the average age of menarche has dropped by 3.5 months during 1991 and 2006. Another study indicates that the age of onset of puberty (as measured by breast development) has decreased from a mean age of 10.9 in 1991 to 9.9 in 2006.

In Western Europe, there has been a substantial decrement of age from 17 years to 12.8 years.

Surveys conducted in America have shown that on an average, breast development begins at the age of 8 years 10 months. Among Hispanic girls, it is observed at the average age of 9 years and 4 months while for white and Asian girls residing in America, the average age is 9 years and 8 months. By the age of 8, as much as 48% of African-American girls and 15% of white girls display signs of puberty.

Studies conducted in urban regions of India have shown that the menarche age has decreased from 12.6 years in 1992 to 12.5 years in 2005. On the other hand, in rural areas, data is insufficient to draw concrete results.

## 5. TREATMENT OPTIONS

Precocious puberty has physiological, social as well as psychological traumas associated with it. In order to overcome these and ensure holistic development of the individual diagnosed with precocious puberty, it is essential to get the adequate treatment.

The necessity of the identification of this condition as its central or peripheral form is highlighted by the difference in the treatment procedures.

### 5.1. Treatment of Central Precocious Puberty

Once the individual has been identified as having CPP, the required therapy can be put into action.

The goals of the treatment can be divided into long-term and short-term goals. The short-term goals lie in delaying the signs of puberty whereas the long-term goals deal with the prevention of decreased height in the adult stage.

Since CPP is also referred to as being gonadotropin-dependent form of precocious puberty, the primary mode of treatment involves the administration of gonadotropin releasing hormone (GnRH) agonists. These work by suppressing the secretions of pituitary gland which would further result in the decline in sex hormones whose production is triggered by the pituitary secretions. GnRH agonists assist by delaying the process of puberty. Once the child reaches the optimal age of puberty, this therapy is halted.

### 5.2. Treatment of Peripheral Precocious Puberty

The treatment for PPP greatly depends upon its underlying cause. One such form is FMPP (familial male-limited precocious puberty). FMPP is caused by mutation in a gene encoding for LH receptor. The treatment includes androgen receptor blockage and aromatase inhibition. Androgen receptor blockage is usually carried out with spironolactone and aromatase inhibition is done by testolactone. Several doses of these drugs are administered on a daily basis.

Another form is MAS (McCune-Albright Syndrome). Girls suffering from McCune-Albright syndrome are slightly more complicated to deal with. The therapy involves testolactone, an aromatase inhibitor that prevents the conversion of androgens to estrogen.

In cases involving PPP due to the presence of ovarian, testicular or adrenal tumours, surgical removal is preferred. Metastatic tumours may be dealt with by the use of radiotherapy or chemotherapy.

Other than the stated treatment options which predominantly concern the normal physiological and physical development, care must also be given to ensure psychological well-being of the individual. Counselling sessions are a necessity, both for the individual suffering from PP as well as those around him/her. It is important to reinforce it to the individual that the changes occurring in his/her body are completely normal albeit early. Parents, friends and teachers must be counselled to eradicate social stigma and for the establishment of healthy social relationships between them and the affected individual.

## 6. CONCLUSION

The problem of precocious puberty has managed to attract the attention of researchers and medical professionals worldwide over the past few decades and several studies have been performed to supplement the existing knowledge about its various facets. It is the responsibility of the scientific community to spread awareness about the causes and consequences of precocious puberty among parents and children alike. Such programmes must not lay emphasis solely upon educating the masses but also upon communicating the importance of timely diagnosis, treatment and proper counselling in the effective management of precocious puberty.

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