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Original Paper

TRENDS IN IDIOPATHIC CENTRAL PRECOCIOUS PUBERTY AMONG GIRLS TREATED AT THE MAIN PAEDIATRIC ENDOCRINOLOGY UNIT IN LATVIA

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The development of precocious puberty is multifactorial, influenced by both genetic and environmental factors, including excessive weight gain, dietary habits, sleep duration and quality, and other lifestyle-related factors. Post-COVID-19 pandemic studies have reported an increased incidence of precocious puberty in children, which may be partly due to the rapid weight gain observed during the pandemic. The aim of this study was to evaluate trends in idiopathic central precocious puberty among female patients managed at the main paediatric endocrinology unit in Latvia, with a focus on healthcare utilisation, clinical manifestations, and therapeutic approaches, as well as to explore potential differences before and after the COVID-19 pandemic. This retrospective cross-sectional study included 27 female patients with idiopathic central precocious puberty. The median age at first visit was 7.9 years (IQR 1.7). The most common presenting secondary sexual characteristic was breast development, observed in 26 patients (96%). No statistically significant differences were identified in BMI-for-age percentiles across the study years (p = 0.396). However, a significantly longer delay in seeking medical care was observed in the post-COVID period (median = 12 months, IQR 6), compared with the pre-COVID period (median = 6 months, IQR 7) (p = 0.035). This study demonstrates stable trends in the development of idiopathic central precocious puberty in girls treated at the main paediatric endocrinology centre in Latvia, with clinical features remaining largely unchanged over time. However, a significantly longer delay in seeking medical evaluation was observed in the post–COVID period (median 12 months, IQR 6) compared with the pre–COVID period (median 6 months, IQR 7) (p = 0.035). The study results show that trends and clinical features of precocious puberty in girls remain largely unchanged over time. However, the longer delay in seeking medical attention after the pandemic could reflect insufficient recognition of signs of precocious puberty at the primary care level, limited access to paediatric endocrinology consultations, or long waiting times for diagnostic tests.

Keywords: precocious puberty, overweight, bone age, Tanner scale.

INTRODUCTION

Precocious puberty (PP) is a significant problem in paediatric endocrinology that can negatively affect a child's physical, psycho-emotional, and social development (Henriques-Neto *et al*., 2023). Precocious puberty is characterised by the early development of secondary sexual characteristics in girls before the age of eight and in boys before the age of nine. PP is classified into central precocious puberty (CPP), when there is premature activation of the hypothalamic–pituitary–gonadal axis, and peripheral precocious puberty (PPP), when there is increased production of gonadal steroid hormones, independently of gonadotropin secretion (Tzounakou *et al*., 2024). Its causes may be various; precocious puberty may be idiopathic in origin, caused by endocrinological pathologies, genetic syndromes or associated with pathologies of the central nervous system. In females,

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CPP is predominantly idiopathic, whereas in males it may arise because of underlying pathology (De Sanctis *et al*., 2019).

Elevated concentrations of sex hormones may lead to accelerated closure of the epiphyseal growth plates, potentially resulting in a reduced final adult height (Pérez *et al*., 2025). Precocious puberty can pose a psychological burden on affected children, leading to fear, anxiety, low self-esteem and other psychological disorders (Cesario *et al*., 2007). Furthermore, precocious puberty is associated with an increased risk of hypertension, type 2 diabetes, obesity, dyslipidaemia, polycystic ovary syndrome, and adverse psychosocial outcomes in adulthood (De Sanctis *et al*., 2019). Early diagnosis and a better understanding of this phenomenon are essential, as they may help reduce the negative psycho-emotional and physical consequences for affected children.

In recent years, a global trend toward an earlier onset of puberty has been observed. This phenomenon may be associated with various factors, such as changes in lifestyle, an increased prevalence of overweight and obesity in the paediatric population, as well as various environmental factors. However, the incidence of precocious puberty differs across regions of the world. Data from Europe, Korea, and China indicate a significant increase in the incidence of central precocious puberty in recent years. The main reason for this increase in incidence is still under investigation; however, several sources of literature indicate a twofold increase in the incidence of obesity occurring in parallel with the rise in cases of idiopathic central precocious puberty (Kim *et al*., 2019; Bräuner *et al*., 2020; Han *et al*., 2022). Several studies suggest that pandemic-related lifestyle changes, such as reduced physical activity, increased sedentary behaviour, altered dietary patterns, and increased screen time, may have influenced pubertal timing (Cheuiche *et al*., 2025).

Data on the incidence of precocious puberty in Latvia are limited; therefore, studying this condition is essential to characterise national epidemiological patterns and to support timely recognition, referral, and management within the local healthcare system.

The aim of this study was to describe trends in idiopathic central precocious puberty among female patients treated at the main paediatric endocrinology unit in Latvia, with a focus on healthcare utilisation, clinical manifestations, and therapeutic approaches, as well as to explore potential differences before and after the COVID-19 pandemic.

MATERIALS AND METHODS

Study design and setting

This retrospective, cross-sectional study was conducted at the Children's Clinical University Hospital (CCUH), the main tertiary paediatric referral centre in Latvia, where complex paediatric endocrine cases are routinely evaluated.

Study population

Study data were obtained retrospectively from the outpatient electronic health record system. Electronic medical records of patients attending the paediatric endocrinology outpatient clinic with an ICD-10 diagnosis code E30.1 (precocious puberty) were identified and reviewed. Patients evaluated between January 2018 and December 2025 were included.

Female patients diagnosed with idiopathic precocious puberty were included in the analysis.

Inclusion and exclusion criteria

The inclusion criterion was a diagnosis of idiopathic precocious puberty in female patients. Patients with precocious puberty of known organic, genetic, or syndromic aetiology were excluded from the analysis.

Data collection

The following parameters were retrospectively collected from medical records: age at first visit, weight, height, parent-reported time from symptom onset to the first clinical visit, clinical signs of sexual maturation (axillary hair, pubic hair, breast development, and menarche), pubertal stage assessed according to the Tanner scale, bone age, and initiation of gonadotropin-releasing hormone agonist (GnRHa) therapy.

Anthropometric assessment

Body mass index (BMI) was calculated for all study participants using weight and height measurements obtained at the first clinical visit. BMI was assessed using World Health Organisation (WHO) BMI-for-age percentile charts, adjusted for age and sex, and categorised as follows:

- Underweight: BMI < 5th percentile
- Normal weight: BMI ≥ 5th percentile and < 85th percentile
- Overweight: BMI ≥ 85th percentile and < 95th percentile
- Obesity: BMI ≥ 95th percentile

Assessment of pubertal development and bone age

Pubertal development was evaluated according to the Tanner staging system. Bone age was assessed using an X-ray of the left hand. A bone age advancement of more than two years compared with the chronological age was considered clinically significant.

Statistical analysis

All collected data were compiled into a Microsoft Excel database and analysed using IBM SPSS Statistics version 22.0. Continuous variables were summarised using medians and interquartile ranges or means and standard deviations, as appropriate. Categorical variables were presented as frequencies and percentages.

Normality of data distribution was assessed using the Shapiro–Wilk test. Group comparisons were performed using the Mann–Whitney U test, Kruskal–Wallis H test, one-way analysis of variance (ANOVA), or chi-square test, as appropriate. A p value of < 0.05 was considered statistically significant.

RESULTS

Trends in attendances at the paediatric endocrinology unit are presented in Table 1. Although statistically significant differences were observed across years in the proportion of visits associated with diagnosis E30.1 relative to the total number of visits to the paediatric endocrinology unit ($p = 0.024$), no statistically significant changes were found in the proportions of unique or first-time patients with diagnosis E30.1 ($p = 0.81$ and $p = 0.96$, respectively). This pattern remained unchanged when the pre–COVID-19 year (2018) was compared with the post–COVID-19 years (2023–2025) ($p = 0.93$)

Altogether, 27 unique female patients with idiopathic central precocious puberty were included in the analysis. In our study population, the median age at first presentation was 7.9 years (IQR 1.7). When analysed by year, the median age at first visit was 7.1 years (IQR 1.66) in 2018, 7.95 years (IQR 0.89) in 2023, 7.7 years (IQR 0.73) in 2024, and 7.5 years (IQR 1.73) in 2025; no statistically significant differences in age were observed across years ($p = 0.751$).

The most common secondary sexual characteristic among the study participants was breast development (Ma), observed in 26 patients (96%). Pubic hair development (Px) was present in 19 patients (70%), axillary hair (Ax) in 11 patients (41%), and menarche (Me) had occurred in three patients (11%) at the time of the first clinical evaluation. A detailed year-by-year distribution of secondary sexual characteristics is presented in Table 2.

The overall median BMI-for-age percentile among the study participants was 79 (IQR 36.5). When stratified by year, the median BMI-for-age percentile was 98 (IQR 59.45) in 2018, 86 (IQR 27.2) in 2023, 73 (IQR 62) in 2024, and 74 (IQR 50.5) in 2025. No statistically significant differences in BMI-for-age percentiles were observed across years ($p = 0.396$). Following the analysis of BMI-for-age percentiles, patients were further classified into BMI categories. Overall, 16 patients (61.5%) were classified as having normal weight, two patients (7.7%) as overweight, and eight patients (30.8%) as obese. When stratified by year, the distribution of BMI

Table 1. Annual distribution of E30.1-related visits and patients in the paediatric endocrinology unit

Visits and patients	2018	2023	2024	2025	p value
Total visits to the paediatric endocrinology unit, n	8293	9292	8920	9378	–
Visits associated with diagnosis E30.1, n	63	101	107	107	0.024
Unique patients with diagnosis E30.1, n	34	47	42	46	0.807
First-time patients with diagnosis E30.1, n	6	6	7	8	0.962

Table 2. Prevalence of secondary sexual characteristics among study participants (Tanner stage ≥ II). Values are presented as number (percentage) of patients exhibiting Tanner stage II or higher in the respective category. Ax, axillary hair; Px, pubic hair; Ma, breast development; Me, menarche

Year, n	Axillary hair (Ax)	Pubic hair (Px)	Breast development (Ma)	Menarche (Me)
2018, n (%)	5 (83%)	4 (67%)	6 (100%)	1 (17%)
2023, n (%)	2 (33%)	6 (100%)	6 (100%)	1 (17%)
2024, n (%)	1 (14%)	4 (57%)	7 (100%)	0 (0%)
2025, n (%)	3 (38%)	5 (63%)	7 (88%)	1 (13%)
Overall (n = 27)	11 (41%)	19 (70%)	26 (96%)	3 (11%)

Table 3. Distribution of BMI categories by year. Values are presented as number (percentage) of patients within each year. BMI categories were defined based on BMI-for-age percentiles: normal weight (<85th percentile), overweight (85th–94th percentile), and obesity (≥95th percentile)

Year (n)	Normal weight, n (%)	Overweight, n (%)	Obese, n (%)
2018 (n = 5)	2 (40.0)	0 (0)	3 (60.0)
2023 (n = 6)	3 (50.0)	1 (16.7)	2 (33.3)
2024 (n = 7)	5 (71.4)	0 (0)	2 (28.6)
2025 (n = 8)	6 (75.0)	1 (12.5)	1 (12.5)
Overall (n = 26)	16 (61.5)	2 (7.7)	8 (30.8)

categories did not differ significantly across study years (p = 0.709). The year-specific distribution of BMI categories is shown in Table 3.

The overall median bone age advancement was 3.0 years (IQR 2.3). When analysed by year, the median bone age advancement was 4.1 years (IQR 2.3) in 2018, 3.4 years (IQR 1.5) in 2023, 1.8 years (IQR 2.0) in 2024, and 2.4 years (IQR 2.5) in 2025, showing a trend toward differences across years, although statistical significance was not reached (p = 0.078). In 18 of 27 patients (66.7%), bone age exceeded chronological age by more than two years.

The median time from symptom onset to the first clinical visit differed across years, measuring six months (IQR 7) in 2018, 18 months (IQR 9) in 2023, 12 months (IQR 0) in 2024, and 12 months (IQR 10.5) in 2025. Based on the hypothesis that healthcare-seeking behaviour may have changed following the COVID-19 pandemic, the data were grouped into pre-COVID (2018) and post-COVID (2023–2025) periods. A longer delay in seeking medical care was observed in the post–COVID period (median = 12 months, IQR 6) compared with the pre–COVID period (median = 6 months, IQR 7), with the difference reaching statistical significance (p = 0.035).

Fourteen patients (52%) were eligible for initiation of gonadotropin-releasing hormone agonist therapy, and no statistically significant differences in eligibility rates were observed across years (p = 0.076).

DISCUSSION

The principal findings of this study indicate that the frequency of idiopathic central precocious puberty remained stable across the study years and that patients' clinical characteristics did not change substantially over time. However, a trend toward a longer delay between symptom onset and referral to a paediatric endocrinologist was observed.

In our study, the incidence of idiopathic central precocious puberty did not change significantly across the study years, including the period following the COVID-19 pandemic. This finding contrasts with several reports suggesting an increased incidence of precocious puberty during and after the pandemic, which has been attributed to lifestyle changes and rapid weight gain in both normal-weight and overweight children. For example, Fava *et al.* reported higher BMI standard deviation scores among patients diagnosed during the COVID-19 pandemic compared with those diagnosed before the pandemic (Fava *et al.*, 2023). Similarly, Acinikli *et al.* observed an approximately threefold increase in diagnoses of central precocious puberty during the pandemic, with 79% of cases identified during the pandemic period compared with 21% before (Acinikli *et al.*, 2022), and Chioma *et al.* reported a significant rise in consultations for precocious puberty from 2019 to 2020 (Chioma *et al.*, 2022). Although an increase in incidence was hypothesised in the post–COVID-19 period, our findings suggest that the higher number of consultations observed in 2023 may reflect delayed presentation of patients whose medical evaluation was postponed during the COVID-19 pandemic, rather than a true increase in disease incidence.

Another principal finding of this study was that patients' clinical characteristics did not change substantially over time. The median age at first presentation in our study population was 7.9 years (IQR 1.7), which is consistent with published data describing the typical age at diagnosis of precocious puberty. For instance, Fava *et al.* reported a mean age of 7.03 years (SD 0.99) in patients diagnosed before the COVID-19 pandemic and 6.89 years (SD 0.99) in those diagnosed during the pandemic, indicating only minor differences in age at presentation across periods (Fava *et al.*, 2023).

Regarding clinical presentation, breast development was the most frequently observed secondary sexual characteristic across all study years, consistent with previous reports identifying thelarche as one of the most common initial manifestations of precocious puberty in girls (Chioma *et al.*, 2023). In our cohort, more than one-third of patients (38.5%) were classified as overweight or obese; however, no statistically significant differences in body weight distribution were observed across the study years. While numerous studies have demonstrated an association between overweight or obesity and an increased risk of precocious puberty

(Umano *et al*., 2022; Calcaterra *et al*., 2023; Taheri *et al*., 2024), our findings suggest that, within this population, body weight characteristics remained relatively stable over time. Previous research has shown that obesity-related risk is likely multifactorial, with contributions from birth weight, infant feeding practices, parental weight, and maternal age at menarche (Liu *et al*., 2021; Song *et al*., 2023), which may partly explain the lack of temporal variation observed in our study.

Another important principal finding of this study was a significantly longer delay between symptom onset and the first specialist consultation in the post–COVID-19 period compared with the pre–COVID-19 period (pre–COVID: median six months; post–COVID: median 12 months; $p = 0.035$). This finding suggests that healthcare-seeking behaviour and access to care may have been affected during and after the COVID-19 pandemic, with families potentially postponing medical consultations due to pandemic-related restrictions, concerns about infection risk, or reduced availability of outpatient services. In addition, delayed referral may reflect limited recognition of early pubertal signs in primary care settings, as well as long waiting times for paediatric endocrinology consultations and diagnostic investigations. Importantly, this issue has recently been addressed at the national level: in Latvia's Mother and Child Health Improvement Plan for 2025–2027, one of the stated objectives is the mandatory annual assessment of pubertal development according to Tanner staging by family physicians, which may facilitate earlier recognition of pubertal disorders and more timely referral to specialist care (Cabinet of Ministers of the Republic of Latvia, 2024).

This study has several strengths and limitations. A major strength is that data were collected at the country's main paediatric endocrinology referral centre, where the most complex cases are evaluated and where nearly all patients in Latvia considered for gonadotropin-releasing hormone agonist therapy are managed. As a result, the study population is likely representative of the national clinical situation. A key limitation is the relatively small number of cases, reflecting the size of the national population. However, this limitation was partially mitigated by the availability of detailed longitudinal medical records for each patient, which enabled comprehensive multi-year review and ensured high-quality data. Additionally, the study included only girls with idiopathic central precocious puberty, which limits the generalisability of the findings to male patients and other aetiologies of precocious puberty. Potential referral bias should also be considered, as milder cases may not have been referred to a tertiary care centre. Furthermore, the assessment of time from symptom onset relied on parent-reported information, which may be subject to recall bias. The small sample size may also have reduced the statistical power to detect subtle differences between groups.

Directions for future research should focus on identifying patient-, family-, and healthcare system–related factors that contribute to delays in timely referral and evaluation of children with suspected precocious puberty. Improved understanding of barriers to early medical consultation, including parental awareness, socioeconomic factors, and access to specialised care, may facilitate earlier diagnosis and intervention. Additionally, future studies should aim to identify reliable clinical, biochemical, and imaging markers that can distinguish slowly progressive forms of precocious puberty from rapidly advancing cases. Such differentiation is crucial to optimise patient selection for gonadotropin-releasing hormone (GnRH) agonist therapy, ensuring that treatment is targeted to those most likely to benefit while avoiding unnecessary intervention in children with benign or slowly evolving pubertal variants.

CONCLUSIONS

This study demonstrates stable trends in the development of idiopathic central precocious puberty in girls treated at the main paediatric endocrinology centre in Latvia, with clinical features remaining largely unchanged over time. However, the observed delay in referrals following the COVID-19 pandemic highlights the need to improve early recognition and ensure timely specialist assessment.

ETHICS

The study was conducted in accordance with the Declaration of Helsinki and was approved by Rīga Stradiņš University Ethics Committee (Approval No. 2-PĒK-4/35/2025, issued on 31 October 2024). All study data were collected and analysed anonymously.

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IDIOPĀTISKAS CENTRĀLAS PRIEKŠLAICĪGAS PUBERTĀTES TENDENCES MEITENĒM, KURAS ĀRSTĒTAS BĒRNU ENDOKRINOLOĢIJAS CENTRĀ LATVIJĀ

Priekšlaicīgas pubertātes attīstība ir multifaktoriāla, to ietekmē gan ģenētiskie, gan vides faktori, tostarp pārmērīgs svara pieaugums, uztura paradumi, miega ilgums un kvalitāte, kā arī citi dzīvesveida aspekti. Pētījumi, kas veikti pēc COVID-19 pandēmijas, liecina par priekšlaicīgas pubertātes biežuma pieaugumu bērniem, kas daļēji var būt saistīts ar strauju svara pieaugumu pandēmijas laikā. Šī pētījuma mērķis bija izvērtēt idiopātiskas centrālas priekšlaicīgas pubertātes tendences meitenēm, kuras ārstētas Bērnu klīniskās universitātes slimnīcas endokrinoloģijas centrā Latvijā, īpašu uzmanību pievēršot veselības aprūpes pakalpojumu izmantošanai, klīniskajām izpausmēm un ārstēšanas stratēģijām, kā arī izvērtēt iespējamās atšķirības pirms un pēc COVID-19 pandēmijas. Retrospektīvā šķērsgriezuma pētījumā tika iekļautas 27 meitenes ar priekšlaicīgu pubertāti. Mediānais meiteņu vecums pirmajā vizītē bija 7,9 gadi (IQR 1,7). Visbiežāk novērotā sekundārā dzimumattīstības pazīme bija krūšu attīstība — 26 pacientēm (96%). Statistiski nozīmīgas atšķirības ķermeņa masas indeksā meitenēm pirms un pēc COVID pandēmijas netika konstatētas (p = 0,396). Tomēr pēc COVID periodā tika novērota būtiski ilgāka kavēšanās vērsties pie ārsta (mediāna 12 mēneši, IQR 6) salīdzinājumā ar periodu pirms COVID (mediāna 6 mēneši, IQR 7) (p = 0,035). Pētījuma rezultāti liecina, ka meiteņu priekšlaicīgas pubertātes tendences un klīniskās pazīmes laika gaitā lielākoties nemainās. Tomēr ilgāka kavēšanās meklēt medicīnisko palīdzību pēc pandēmijas varētu liecināt par nepietiekamu priekšlaicīgas pubertātes pazīmju atpazīšanu primārās aprūpes līmenī, ierobežotu piekļuvi bērnu endokrinologa konsultācijām vai ilgu gaidīšanas laiku diagnostisku izmeklējumu veikšanai.