



A Comprehensive Review of Factors Influencing Precocious Puberty in Iranian Children: A Comparative Global Perspective

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Abstract

Background: Puberty marks a critical stage of physical and psychological development, but precocious puberty poses significant health and psychosocial risks worldwide. This review examines factors influencing precocious puberty in Iranian children compared to those in global populations.

Materials and Methods: This narrative review conducted searches up to April 2025 across databases including PubMed, Scopus, Web of Science, ScienceDirect, SID, CIVILICA, and Google Scholar. Both English and Persian keywords such as "Precocious puberty," "Central precocious puberty," "Genetic factors," "Environmental factors," "Nutritional factors," "Socioeconomic factors," and "Risk factors" were used. Data extraction was independently performed by two reviewers.

Results: This review highlights that precocious puberty in Iranian children arises from a complex interplay of genetic, environmental, nutritional, and socio-economic factors, reflecting global trends alongside distinct regional influences. Key genetic mutations in *KISS1*, *KISS1R*, and *MKRN3*, together with epigenetic modifications, significantly affect puberty onset. Environmental factors include elevated BMI, reduced physical activity, exposure to pollution, and secondhand smoke. Nutritional influences such as high animal protein intake and low dietary fiber are associated with earlier puberty, while breastfeeding provides a protective effect. Socioeconomic and cultural conditions uniquely influence the timing, diagnosis, and management of precocious puberty in Iran. Although many cases are idiopathic and benign, the condition poses risks including reduced adult height, increased susceptibility to chronic diseases, and psychological and social challenges, emphasizing the need for tailored prevention and intervention strategies.

Conclusion: Precocious puberty in Iranian children stems from genetic, environmental, nutritional, and socio-economic factors reflecting global trends. Key genetic mutations, higher BMI, pollution exposure, and diet accelerate puberty, while breastfeeding protects. Regional and cultural differences affect the condition's prevalence, timing, and management in Iran.

Key Words: Global trends, Iranian children, Precocious puberty, Risk factors, Review.

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1- INTRODUCTION

Puberty is a critical transitional period in the physical and psychological development of children, marked by the emergence of secondary sexual characteristics and hormonal changes. Precocious puberty, defined as the onset of these changes before the age of 8 in girls and 9 in boys, is a clinical condition with significant and lasting consequences on physical, psychological, and social health. The rising prevalence of precocious puberty worldwide has made it a serious public health concern (1).

Consequences include shortened adult height due to early growth plate closure, increased risk of metabolic diseases, psychological disorders such as anxiety and depression, and social difficulties including impaired relationships and reduced quality of life (2–5). Understanding the factors contributing to precocious puberty is essential for effective prevention and treatment.

Extensive evidence shows that precocious puberty results from a complex, multifactorial interplay influencing pubertal timing (6–9). Genetic studies identify key mutations in genes like *KISS1*, *KISS1R*, and *MKRN3* as crucial regulators of puberty initiation (10, 11). Epigenetic mechanisms also mediate environmental and genetic factors affecting onset (7, 12).

Environmental influences—such as pollutants, endocrine-disrupting chemicals, secondhand smoke, and sedentary lifestyles—are strongly linked to increased risk (8, 13, 14). Nutritional status, especially high animal protein and low fiber intake, further contributes (15). Socioeconomic and cultural factors, including parental education, healthcare access, and cultural attitudes, play vital roles in detection, management, and prevention (2, 5, 13, 16).

Given the multifaceted nature of precocious puberty and its variability

across contexts, studying this phenomenon in different populations is crucial. In Iran, unique demographic, environmental, and cultural conditions necessitate comprehensive, comparative research. Analyzing factors in Iranian children alongside global data can clarify regional differences and similarities, enabling culturally sensitive and biologically appropriate strategies (1).

This review aims to investigate and compare factors influencing precocious puberty in Iranian children with those in global populations to enhance understanding, identify commonalities and differences, and provide a foundation for tailored preventive and therapeutic interventions.

2- MATERIALS AND METHODS

2-1. Study Design

This narrative review was designed to comprehensively examine factors influencing precocious puberty in Iranian children and to compare these findings with international data. Scientific searches were conducted up to April 2025 by two independent reviewers across reputable and up-to-date databases, including PubMed, Scopus, Web of Science, Science Direct, SID, CIVILICA, and Google Scholar, ensuring thorough identification and evaluation of relevant studies.

Searches employed a comprehensive combination of specialized English keywords and their Persian equivalents. Key terms included “Precocious puberty,” “Central precocious puberty,” “Genetic factors,” “Environmental factors,” “Nutritional factors,” “Socioeconomic factors,” and “Risk factors.” Titles and abstracts were independently screened and assessed by two reviewers. In cases of disagreement, a third reviewer adjudicated to ensure consistency and accuracy in study selection.

2-2. Eligibility Criteria

Only studies presenting valid empirical data, systematic analyses, or comprehensive and structured reviews addressing factors influencing precocious puberty in Iranian children with precise comparisons to global data were included. Articles published in Persian or English up to April 2025 were considered. Studies lacking direct relevance, case reports, non-systematic reviews, articles with insufficient or incomplete data, and those published in other languages or without essential evidence were excluded to maintain methodological rigor and focus.

2-3. Data Extraction and Analysis

Relevant data from the selected articles were independently extracted and compiled using a researcher-designed form by two reviewers. To ensure accuracy, consistency, and data integrity, the extracted information was subsequently reviewed and confirmed by the research team. The compiled data, encompassing key components such as genetic, environmental, nutritional, socioeconomic, and other factors affecting precocious puberty, were systematically organized and presented in **Table 1**.

2-4. Ethical Considerations

This study involved the analysis of published data and scientific sources only, without direct involvement of human participants; therefore, ethical approval was not required. Nonetheless, full respect for intellectual property rights and responsible use of sources were maintained throughout the review. All stages of data collection, evaluation, and reporting adhered to scientific integrity and ethical principles to safeguard academic and research interests.

3- RESULTS

The aim of this review was to comprehensively investigate the factors influencing precocious puberty among Iranian children and compare them with

global data. The findings indicate that precocious puberty is a multifactorial condition shaped by a complex interplay of genetic, environmental, nutritional, and socio-economic factors. While many factors are similar between Iranian children and global populations, notable regional and cultural differences exist that affect prevalence and management. **Table-1** summarizes the factors influencing precocious puberty and its associated consequences.

3-1. Prevalence and Incidence of Precocious Puberty

Epidemiological evidence worldwide demonstrates a clear upward trend in the prevalence of precocious puberty, with an average decline of about three months per decade in the age of thelarche onset (1). Similar patterns have been observed in Iran; however, prevalence estimates vary considerably due to regional differences, diverse diagnostic criteria, environmental exposures, and socio-economic disparities. The majority of Iranian cases are idiopathic and generally benign, consistent with global data (2, 17–20). Notably, Iranian girls tend to experience menarche later than their global counterparts, reflecting unique socio-cultural influences on pubertal timing (3). These variations underscore the importance of standardized diagnostic approaches and comprehensive regional surveillance to accurately characterize prevalence, identify key risk factors, and guide tailored prevention and management strategies within the Iranian population.

3-2. Contributing Factors

- **Genetic Factors:** Mutations in genes such as *KISS1*, *KISS1R*, and *MKRN3* play central roles in central precocious puberty (CPP), with *MKRN3* representing the most common identifiable genetic cause (21–25). Epigenetic modifications are also

critical, mediating environmental impacts on gene expression regulation.

- **Environmental Factors:** Body mass index (BMI), physical activity, exposure to pollutants, and secondhand smoke are significantly associated with earlier puberty onset. A study from Ahvaz, Iran, found a strong correlation between lower physical activity and precocious puberty, whereas nutrition showed no strong direct association in that cohort (8, 9, 26, 27).
- **Nutritional Factors:** High animal protein intake and low dietary fiber consumption are linked to earlier menarche and puberty onset. Preventive healthcare access and nutrition education programs are important strategies for mitigating risk (15, 27–33).
- **Socioeconomic and Cultural Factors:** Cultural stigma, communication barriers, and socioeconomic challenges contribute to delayed diagnosis and suboptimal treatment in Iranian children, despite many cases being idiopathic and benign (2, 13, 19, 26, 34).

3-3. Consequences of Precocious Puberty

Precocious puberty is associated with various physical, psychological, and social consequences:

- **Physical Consequences:** Early rapid growth may lead to reduced final adult height. Additionally, there is an increased long-term risk of chronic diseases such as type 2 diabetes, cardiovascular diseases, and metabolic syndrome
- **Psychological Consequences:** Children with precocious puberty face higher risks of anxiety, depression, behavioral problems, and difficulties in

psychological and social adaptation (38, 39).

- **Social Consequences:** Children with precocious puberty frequently experience peer rejection, bullying, social isolation, academic difficulties, and emotional dysregulation, requiring multidisciplinary psychosocial interventions involving families, schools, and mental health specialists (40–43).

These multifaceted consequences underscore the importance of early diagnosis, comprehensive management, and long-term follow-up in precocious puberty (44).

3-4. Comparison with Global Data

Data from Iranian children largely mirror global trends regarding genetic and environmental contributors as well as clinical outcomes in precocious puberty. Key genetic factors, including variants in *KISS1*, *KISS1R*, and *MKRN3*, have been implicated both globally and in Iranian populations (7, 45). Environmental influences such as increased BMI, lifestyle changes, physical activity levels, exposure to pollutants, secondhand smoke, socio-economic status, and nutritional habits are recognized worldwide as significant contributors to rising rates, similarly affecting Iranian children (26, 39, 40).

Distinct socio-cultural differences also exist, including a generally later onset of menarche in Iranian girls compared to global counterparts, highlighting unique local influences on pubertal timing (5, 46, 47). Nutritional patterns, such as high consumption of animal protein and low dietary fiber intake, correlate with earlier pubertal onset across various populations, including Iran (15). Additionally, breastfeeding has been shown to have a protective effect against early puberty, supported by both global and Iranian data (48). Considering these multidimensional

factors is essential for developing targeted interventions and preventive strategies

adapted to the Iranian context while acknowledging broader global patterns.

Table 1: Summary of Contributing Factors and Associated Consequences.

Factor Category	Key Details	References
Genetic Factors	Mutations in <i>KISS1</i> , <i>KISS1R</i> , and <i>MKRN3</i> genes; influence of epigenetic modifications	21–25
Environmental Factors	Impact of BMI, physical activity, pollutant exposure, and secondhand smoke	8, 9, 26, 27
Nutritional Factors	High intake of animal protein, low dietary fiber; limited healthcare access and nutrition education	15, 27–33
Socioeconomic/Cultural Factors	Delayed diagnosis due to stigma and economic barriers; majority of cases remain idiopathic	2, 13, 19, 26, 34
Physical Consequences	Accelerated early growth, reduced adult height, and increased risk of chronic diseases	35–37
Psychological Consequences	Presence of anxiety, depression, and behavioral or adaptation difficulties	38, 39
Social Consequences	Peer pressure, academic difficulties, and social adjustment challenges	40–43

BMI: Body mass index.

4- DISCUSSION

This review examined factors affecting precocious puberty among Iranian children and compared the findings with global data. Results indicate that precocious puberty is influenced by a complex interaction of genetic, environmental, nutritional, and socio-economic factors. While many factors align with global patterns, unique cultural and regional differences in Iran affect the prevalence and management of this condition (7, 21–25).

Genetic factors, including mutations and variants in the *KISS1*, *KISS1R*, and particularly *MKRN3* genes, play a central role in the premature activation of the hypothalamic-pituitary-gonadal axis. Epigenetic mechanisms may mediate environmental influences on gene expression and puberty timing (10–12, 21–25). These findings underscore the need for further genetic and epigenetic investigations within the Iranian population to identify population-specific patterns.

From an environmental perspective, increased body mass index (BMI), reduced physical activity, and exposure to environmental pollutants such as secondhand smoke are significant contributors to precocious puberty (8, 9, 26, 27). Modern lifestyle factors, including higher consumption of processed foods and sedentary behavior, substantially impact this trend. However, the relationship between nutrition and precocious puberty is complex, as some regional studies, like one conducted in Ahvaz, found no direct association between nutritional factors and early puberty onset (26, 30, 31).

Socioeconomic and cultural factors, such as social stigma, economic barriers, and delayed medical consultation, have adverse psychological and social consequences, including increased anxiety and depression among children affected by precocious puberty. These issues highlight the necessity of culturally sensitive educational programs to reduce stigma and improve early diagnosis and treatment (2, 13, 19, 34, 40–43).

The consequences of precocious puberty extend beyond physical health, including reduced final height due to accelerated bone maturation and heightened risk for chronic metabolic diseases like type 2 diabetes and metabolic syndrome. Psychological and social difficulties, including behavioral problems and social maladaptation, further necessitate comprehensive medical and psychosocial interventions (35–39).

Comparison with global data reveals fundamental similarities in genetic and environmental risk factors; however, differences in cultural, economic, and lifestyle factors in Iran contribute to variations in disease incidence and clinical features. This highlights the importance of developing targeted, culturally appropriate preventive and treatment strategies (1, 5, 26, 39, 40, 45–48).

Limitations of this study include the lack of longitudinal data and geographically limited sampling, restricting the generalizability of findings. Future research should involve broader, longitudinal studies to better understand the multifactorial nature of precocious puberty and gene-environment interactions (44).

In summary, effective management of precocious puberty requires a multidisciplinary approach incorporating medical treatment, nutritional counseling, promotion of physical activity, reduction of harmful environmental exposures, and provision of psychological and social support. Such comprehensive interventions can mitigate adverse outcomes and improve the quality of life for affected children and their families (28, 35, 38, 42).

5- CONCLUSION

Precocious puberty in Iranian children arises from complex interactions among genetic, environmental, nutritional, and socio-cultural determinants.

Pathogenic variants in *KISS1*, *KISS1R*, and particularly *MKRN3* drive early hypothalamic-pituitary-gonadal axis activation, while modifiable risk factors—including elevated body mass index, sedentary lifestyles, and secondhand smoke exposure—exacerbate prevalence. Socio-economic constraints and cultural attitudes further shape diagnosis, management, and clinical outcomes in this context.

These findings both corroborate international patterns and underscore Iran-specific characteristics that demand contextually adapted interventions. Considering the extensive sequelae of precocious puberty—compromised final height, heightened chronic disease risk, psychological distress, and culturally amplified social challenges—multifaceted strategies are imperative. Essential components include genetic counseling, lifestyle optimization, nutritional guidance, environmental risk mitigation, and culturally attuned psychosocial support to optimize long-term health outcomes.

6- CONFLICT OF INTEREST: None.

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