International Journal of Systems Biology and Bioinformatics, 2025, 1(1), 4-8
https://www.hillpublisher.com/Journals/ijsbb/
ISSN Online:

Research Progress on the Correlation Between CYP19A1 Gene Single Nucleotide Polymorphism and Growth Hormone

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How to cite this paper: Huanxi Wang, Aiping Wang. (2025). Research Progress on the Correlation Between CYP19A1 Gene Single Nucleotide Polymorphism and Growth Hormone. *International Journal of Systems Biology and Bioinformatics*, 1(1), 4-8.
DOI: 10.26855/ijsbb.2025.12.002

Received: September 22, 2025
Accepted: October 16, 2025
Published: November 26, 2025

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Abstract

CYP19A1 gene encodes an important enzyme - aromatase, which is a key enzyme in the process of estrogen synthesis. The variation of the CYP19A1 gene can change the aromatase activity encoded by it, thus affecting the level of estrogen. In recent years, the single nucleotide polymorphism of the CYP19A1 gene has become one of the hot issues in research. Growth hormones play an important role in human growth and development. Growth hormone deficiency caused by complete or partial lack of growth hormone is a common endocrine disease that affects children's height and leads to children's shortness. Its incidence is increasing year by year in China. Studies have shown that CYP19A1 gene SNP There is a correlation between height variation and growth hormone levels. This article will review the research progress of the correlation between CYP19A1 gene polymorphism and growth hormone based on the current research results.

Keywords

CYP19A1 gene; Single nucleotide polymorphism; Growth hormones

Aromatases are complex enzymes belonging to the cytochrome P450 enzyme system, also known as estrogen synthases. These enzymes catalyze the conversion of testosterone to estradiol and androstenedione to estrone in vivo, making them key and rate-limiting enzymes in estrogen synthesis. The CYP19A1 gene encodes aromatase P450 19A1. The CYP19A1 gene contains several single nucleotide polymorphisms (SNPs), which may affect gene expression and function. In research on growth hormone, some studies have shown an association between CYP19A1 gene SNPs and growth hormone levels. This polymorphism may affect estrogen synthesis, thereby influencing growth hormone regulation. However, it should be noted that the relationship between CYP19A1 gene SNPs and growth hormone requires further investigation and interpretation. Growth hormone regulation is a complex process involving the interaction of multiple genes and mechanisms.

Therefore, the influence of a single gene may be relatively small, and is more determined by the overall variability of the genome and the combined effect of environmental factors. Current research mainly focuses on the correlation between aromatase gene polymorphism and the initiation of female puberty, its relationship with menarche, its association with height, and its relationship with puberty abnormalities caused by gene mutations in the coding region of the CYP19A1 gene. [1] However, it should be noted that growth and development is a complex process involving the interaction of multiple genes and environmental factors. [2] Although the CYP19A1 gene and estrogen play important roles in this process, the variation of a single gene may have a relatively small impact on growth and development and is affected by other factors. Therefore, further research and verification are needed to fully understand the specific mechanism of action of aromatase and its related genes in relation to growth and development. Therefore, this article reviews the relationship between growth hormone and the CYP19A1 gene as follows.

Note: The article was originally published in *International Journal of Clinical Research*, and this is an authorized translation of it.

1. CYP19A1 Gene and Its Single Nucleotide Polymorphisms

1.1 Function of the CYP19A1 Gene

The CYP19A1 gene, also known as the aromatase gene, is located in the first subband of region 1, band 2 of the long arm of chromosome 15. The aromatase encoded by this gene is an important cytochrome P450 enzyme responsible for regulating the balance between testosterone and estrogen [3]. Aromatase plays a key role in the conversion of androgens to estrogens; therefore, the expression of the CYP19A1 gene in gonadal tissues and other estrogen-sensitive tissues is essential for normal reproductive development and function.

1.2 Single Nucleotide Polymorphisms of the CYP19A1 Gene

1.2.1 Definition and Classification of Single Nucleotide Polymorphisms

Nucleotide polymorphisms (SNPs) are common forms of variation in DNA sequences. They refer to DNA sequence polymorphisms caused by variations in a single nucleotide in the genome, namely, the transversion or conversion of a single base, or the deletion or insertion of a base. These variations can affect gene function, expression, and subtype distribution, thereby influencing an individual's physiology and disease susceptibility. Based on their location and impact on gene function, SNPs can be classified into upstream regulatory region SNPs, coding region SNPs, and 3' non-coding region SNPs, etc. SNPs are frequently distributed in the genome and are extremely numerous, making them the most common type of heritable variation in humans. Furthermore, compared to other DNA polymorphisms, SNPs have a significant advantage in genetic stability. With the continuous development of sequencing technology, we can obtain the correlation between diseases and SNPs more efficiently and accurately.

1.2.2 Common Single Nucleotide Polymorphism Sites in the CYP19A1 Gene

Many SNP sites have been identified in the CYP19A1 gene, some of which have a high frequency in the human population. For example, SNPs such as rs4646 [4], rs700519 [5], rs1004982 [6], rs2414096 [4] and rs727479 [7] have been extensively studied and are closely related to the function and expression level of the CYP19A1 gene.

Polymorphisms at these SNP sites may lead to different aromatase subtypes after the translation of the CYP19A1 gene, thereby affecting the synthesis and metabolism of estrogen. In a 2006 study by Yang et al. on the correlation between CYP19A1 gene polymorphism and height in Caucasians, it was found that intron 1 (SNP rs730154) in the CYP19A1 gene was highly correlated with height variation, and sex-specific analysis showed that the correlation was mainly enhanced by females [8].

1.2.3 Effects of Single Nucleotide Polymorphisms on CYP19A1 Gene Expression

Single nucleotide polymorphisms (SNPs) in the CYP19A1 gene play an important role in gene regulation and expression. Some studies have found that SNP sites in the CYP19A1 gene can alter the binding ability of transcription factors, affect the transcriptional activity of the CYP19A1 gene, and thus regulate the expression level of aromatase [3]. In addition, some SNP sites may also interact with epigenetic regulatory mechanisms such as DNA methylation and histone modification, further regulating the expression of the CYP19A1 gene.

2. The Relationship Between Growth Hormone and Human Growth and Development

2.1 Functions and Regulation of Growth Hormone

Growth hormone, also known as human growth hormone (HGH), is synthesized and secreted by basophilic cells of the anterior pituitary gland. It is a single-chain polypeptide composed of 191 amino acids. Its most important function is to stimulate the growth and differentiation of bone and cartilage cells, while also regulating the metabolism of proteins, sugars and fats.

Growth hormone exerts its effects mainly through two pathways: one is by directly acting on target cells to exert biological effects; the other is by inducing hepatocytes and myocytes to produce growth hormone mediators (Somatomedin, SM), which then exert their effects indirectly through SM [9]. However, regardless of the pathway, it must first bind to growth hormone receptors in the body to trigger a series of biological effects. Growth hormone promotes protein synthesis and bone cell proliferation, and can also promote fat breakdown, increase blood glucose levels, and increase the synthesis of insulin-like growth factor-1 (IGF-1). Overall, growth hormone plays an important role in regulating human physical development, bone growth, and metabolism.

2.2 The Relationship Between Growth Hormone and Human Growth and Development

Growth hormone plays a crucial regulatory role in human growth and development. During childhood and adolescence, the secretion level of growth hormone is high, which directly affects the growth rate of bones and the increase in height. Growth hormone promotes the division and differentiation of chondrocytes in the growth plate and accelerates the linear growth of long bones. In addition, growth hormone also stimulates protein synthesis and promotes the development of muscles and tissues. Premature or delayed secretion of growth hormone may lead to growth disorders such as growth retardation or gigantism [10]. In adulthood, although the secretion level of growth hormone declines, it still plays an important role in maintaining bone density, muscle mass and body fat distribution. Growth hormone helps muscle repair and regeneration by promoting protein synthesis. In addition, growth hormone is involved in the regulation of energy metabolism, promoting fat breakdown and reducing fat storage.

3. Correlation Study Between CYP19A1 Gene Single Nucleotide Polymorphism and Growth Hormone

3.1 Association Study between CYP19A1 Gene Polymorphism and Growth Hormone Levels

Many studies have explored the association between single nucleotide polymorphisms of the CYP19A1 gene and growth hormone levels. Some of these studies have found significant associations between certain SNP sites of the CYP19A1 gene and growth hormone levels. For example, aromatase inhibitors have also been used for children with congenital adrenocortical hyperplasia who have advanced bone age and a tendency for premature closure of the growth plates, resulting in short stature. Some studies have shown that this treatment can have a positive effect on the height of children with this condition. [11]

These findings suggest that single nucleotide polymorphisms (SNPs) in the CYP19A1 gene may affect growth hormone levels by regulating the expression and function of the CYP19A1 gene [11]. However, some conflicting results have been found in different studies, which may be due to factors such as sample size, racial differences, study design, and methodology. Therefore, further large-scale, multicenter studies are still needed to verify the association between CYP19A1 gene polymorphisms and growth hormone levels.

Furthermore, the mechanism of action between CYP19A1 gene polymorphism and growth hormone levels is not fully understood. Further experimental studies can explore the interaction between CYP19A1 gene polymorphism and growth hormone signaling pathway at the cellular level and in animal models [12]. For example, gene knockout technology, in vitro cell experiments, and gene expression and protein analysis can be used to study the effects of CYP19A1 gene polymorphism on CYP19A1 gene expression, enzyme activity, and interaction with growth hormone signaling pathway [13]. These studies will help to more comprehensively understand the relationship between CYP19A1 gene polymorphism and growth hormone and its potential biological significance.

3.2 Correlation between CYP19A1 gene polymorphism and the mechanism of growth hormone action

Beyond growth hormone levels, some studies have also explored the correlation between single nucleotide polymorphisms (SNPs) in the CYP19A1 gene and the mechanism of growth hormone action. Growth hormone activates signal transduction pathways by binding to growth hormone receptors on the cell surface, ultimately affecting gene expression and cellular function. Some studies have found that SNP sites in the CYP19A1 gene may affect the structure or function of growth hormone receptors, thereby influencing the effectiveness of growth hormone signal transduction.

Although we have learned about the correlation between CYP19A1 gene single nucleotide polymorphism and growth hormone, its specific mechanism of action still needs further research and explanation [3]. Future research can explore the relationship between CYP19A1 gene polymorphism and growth hormone and its potential molecular mechanisms through various methods such as cell experiments, animal models and human epidemiological studies.

4. Research Progress and Prospects

4.1 Research Progress

In recent years, some progress has been made in the study of the correlation between single nucleotide polymorphisms of the CYP19A1 gene and growth hormone. Existing studies have shown that there may be an association between

the SNP sites of the CYP19A1 gene and growth hormone levels, and that growth hormone function may be regulated by affecting the expression of the CYP19A1 gene, enzyme activity, or interaction with the growth hormone signaling pathway [15]. These studies provide a preliminary understanding of the relationship between the CYP19A1 gene and growth hormone.

Furthermore, some studies have revealed the association between CYP19A1 gene polymorphisms and individual growth and development. Some SNP sites are correlated with growth and development indicators such as height, body mass index (BMI), and bone mineral density. This further supports the potential role of CYP19A1 gene single nucleotide polymorphisms in the regulation of growth and development.

In addition, recent studies have discovered some new CYP19A1 gene SNP sites and conducted preliminary research on their correlation with height and androgenemia [16]. This provides new clues for further in-depth exploration of the relationship between CYP19A1 gene polymorphism and growth hormone. A scholar reported a case of a 7.5-year-old child with familial hyperandrogenemia and central precocious puberty caused by long-term androgen exposure. The clinical symptoms began at age 4, manifested as rapid growth, pubic hair and axillary hair growth, bone age 13 years, and received combined treatment with anastrozole + bicalutamide + triptorelin acetate for 3 years. No treatment- related adverse reactions were observed during the treatment period. Gene testing showed that the child had a heterozygous mutation in the LH/CGR gene. During the treatment and follow-up period, the child's testosterone level gradually decreased and the height increased by 5 cm per year [17].

4.2 Research Prospects

Differences in the study population are one of the important factors affecting the consistency of the study results. There is genomic diversity in different populations, which may lead to differences in the relationship between CYP19A1 gene polymorphism and growth hormone in different populations. Therefore, future research should pay more attention to the relationship between CYP19A1 gene polymorphism and growth hormone in different populations, including people from different geographical regions, different ethnic groups and different age groups [18]. Such research will help us understand the universality and specificity of these relationships in different populations.

Currently, the specific mechanisms of action between CYP19A1 gene polymorphisms and growth hormone remain unclear. Further experimental studies can elucidate the interaction mechanisms between CYP19A1 gene polymorphisms and growth hormone signaling pathways at the cellular level and in animal models. For example, cell lines and gene knockout techniques can be used to study the effects of CYP19A1 gene polymorphisms on gene expression, protein function, and enzyme activity. Furthermore, animal models can be used to investigate the effects of CYP19A1 gene polymorphisms on growth hormone regulation and organismal growth and development. These studies will contribute to revealing the detailed mechanisms between CYP19A1 gene polymorphisms and growth hormone and deepen our understanding of this relationship.

In addition, clinical epidemiological studies are crucial for assessing the association between CYP19A1 gene polymorphism and human growth and development and related diseases. By collecting large-scale population samples and clinical data, the correlation between CYP19A1 gene polymorphism and growth and development indicators such as height, BMI, and bone density can be studied [19]. Furthermore, the association between CYP19A1 gene polymorphism and related diseases (such as osteoporosis and obesity) can be explored. These research results will provide important theoretical and practical basis for the development of personalized medicine, help accurately predict the risk of individual growth and development and related diseases, and formulate individualized intervention strategies.

5. Conclusion

Through the study of single nucleotide polymorphisms of CYP19A1 gene and growth hormone, we can draw the following conclusions: (1) Single nucleotide polymorphisms of CYP19A1 gene may be related to growth hormone levels. Some SNP sites may be significantly correlated with growth hormone levels, and there are certain contradictions between different research results. This may be due to factors such as sample size, racial differences, research design and methods ; (2) Single nucleotide polymorphisms of the CYP19A1 gene may affect the function of growth hormone by regulating the expression of the CYP19A1 gene, enzyme activity or interaction with the growth hormone signal transduction pathway; (3) There is a correlation between single nucleotide polymorphisms of the CYP19A1 gene and individual growth and development indicators (such as height, BMI and bone density), which further proves the importance of the CYP19A1 gene in the regulation of growth and development; (4) The specific mechanism of

action of CYP19A1 gene polymorphism and growth hormone is not yet clear . Therefore, further experimental research is needed to analyze their relationship and molecular mechanism; (5) Future research should focus on the relationship between CYP19A1 gene polymorphism and growth hormone in different populations, cell levels and animal models, in order to fully understand its mechanism of action. In summary, the relationship between CYP19A1 gene single nucleotide polymorphisms and growth hormone is a complex and challenging research area. By delving into their interactions and mechanisms of action, we can further understand the importance of the CYP19A1 gene in growth hormone regulation and provide new research perspectives and strategies for the prevention and treatment of related diseases.

References

[1] Chang GY. Research progress on aromatase and its related genes in children's growth and development. Int J Pediatr. 2010;37(3):3.

[2] Deberles E, Durand I, Mittre H, et al. Local aromatase excess with recruitment of unusual promoters of CYP19A1 gene in prepubertal patients with gynecomastia. J Pediatr Endocrinol Metab. 2022;35(7):924-30.

[3] Rui WL. Association between single nucleotide polymorphisms of CYP19A1 gene and CAG repeat sequences of AR gene with female pattern baldness in Han Chinese population [dissertation]. Shanghai: Fudan University; 2014.

[4] Liu Y. Association between single nucleotide polymorphisms of CYP19a1 gene and acne vulgaris in Han Chinese adults [dissertation]. Shanghai: Fudan University; 2012.

[5] Zhang DJ, Yuan WX, Ma LN, et al. Single nucleotide polymorphisms associated with ovulation disorders in polycystic ovary syndrome. Chin J Eugenics Genet. 2023;31(4):871-5.

[6] Wang SR, Tuoya. Research progress on gene polymorphism in endometriosis. J Med Postgrad. 2020;33(2):206-9.

[7] Liu FY. Effects of single nucleotide polymorphisms in genes such as CYP19A1 on lipid changes in postmenopausal breast cancer patients induced by nonsteroidal aromatase inhibitors [dissertation]. Beijing: Med Coll Chin PLA; 2019.

[8] Association analyzes of CYP19 gene polymorphisms with height variation in a large sample of Caucasian nuclear families. Hum Genet. 2006;120(1):119-25.

[9] Sun X, Zhu SQ. Structure and function of growth hormone. Foreign Med Sci (Physiol Pathol Clin Sci). 1999;(1):6-9.

[10] Ma HJ, Fu SC, Xiao A, et al. The associations of CYP19A1 rs700518 polymorphism with bone mineral density and risk of osteoporosis: a meta-analysis. Gynecol Endocrinol. 2020;36(7):626-31.

[11] Hawton K, Walton-Betancourth S, Rumsby G, et al. Growth Hormone With Aromatase Inhibitor May Improve Height in CYP11B1 Congenital Adrenal Hyperplasia. Pediatrics. 2017;139(2).

[12] Wang X, Liang Y, Liu Q, et al. Association of CYP19A1 Gene, Plasma Zinc, and Urinary Zinc with the Risk of Type 2 Diabetes Mellitus in a Chinese Population. Biol Trace Elem Res. 2023;201(9):4205-15.

[13] Ma JT, Zhang SZ, Yang CL, et al. Expression and significance of aromatase P450 and estrogen receptor at the endometrial-myometrial interface and lesions in adenomyosis. Chin J Matern Child Health. 2018;33(15):3529-32.

[14] Yenuganti VR, Ravinder, Singh D. Endotoxin induced TLR4 signaling downregulates CYP19A1 expression through CEBPB in buffalo granulosa cells. Toxicol In Vitro. 2017;42:93-100.

[15] Parween S, DiNardo G, Baj F, et al. Differential effects of variations in human P450 oxidoreductase on the aromatase activity of CYP19A1 polymorphisms R264C and R264H. J Steroid Biochem Mol Biol. 2020;196:105507.

[16] Cai Y, Diao HD. Analysis of the relationship between serum TGF-β1, Apelin, CYP19A1 levels and PCOS endocrine abnormalities. J Reprod Med. 2022;31(4):463-7.

[17] Kor Y. Central precocious puberty in a case of late-diagnosed familial testotoxicosis and long-term treatment monitoring. Hormones (Athens). 2018;17(2):275-8.

[18] Shi XJ. Research progress on endometriosis and aromatase P450, estrogen receptor and its subtypes. China Med Guide. 2012;10(9):389-90.

[19] Bulun SE, Sebastian S, Takayama K, et al. The human CYP19 (aromatase P450) gene: update on physiologic roles and genomic organization of promoters. J Steroid Biochem Mol Biol. 2003;86(3-5):219-24.