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VITAMIN D DEFICIENCY IN ADOLESCENT GIRLS: GYNECOLOGICAL CONSEQUENCES AND CLINICAL SIGNIFICANCE

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Abstract. Vitamin D deficiency is a common health issue globally, but it poses unique risks for adolescent girls due to their specific physiological and hormonal changes. During puberty, vitamin D plays a vital role in reproductive development and endocrine regulation. Deficiency in this vitamin has been linked to various gynecological disorders such as menstrual irregularities, polycystic ovary syndrome (PCOS), and delayed menarche. This article explores the gynecological implications of vitamin D deficiency in adolescent girls, analyzing recent clinical studies and highlighting the importance of early detection and intervention. Special attention is given to the interaction between vitamin D levels and reproductive hormone balance, as well as the potential for prevention strategies through dietary and lifestyle modifications.

Keywords. Vitamin D deficiency, adolescent girls, gynecological health, menstrual disorders, PCOS, puberty, reproductive hormones, delayed menarche, endocrine regulation, adolescent health

Introduction. Vitamin D, a fat-soluble secosteroid hormone, is integral not only to calcium and phosphate homeostasis but also to the regulation of reproductive and endocrine functions. Despite its synthesis through cutaneous exposure to ultraviolet B radiation and dietary intake, vitamin D deficiency remains a pervasive global health issue, particularly among adolescent females. This demographic is uniquely susceptible due to rapid physiological changes during puberty, increased nutritional demands, and lifestyle factors that limit sun exposure.

Epidemiological studies have highlighted alarming prevalence rates of vitamin D deficiency among adolescent girls worldwide. For instance, a study conducted in the United Arab Emirates reported that 78.8% of adolescent girls aged 11–18 years exhibited severe vitamin D deficiency, with serum levels below 27.5 nmol/L . Similarly, research in Saudi Arabia found that 81% of girls aged 12–15 years had low vitamin D levels, with approximately 40% exhibiting very low concentrations. These figures underscore a significant public health concern, given the critical role of vitamin D during the adolescent growth spurt.

Beyond its skeletal implications, vitamin D deficiency has been increasingly associated with various gynecological disorders. Notably, there is a documented correlation between low vitamin D levels and the incidence of polycystic ovary

syndrome (PCOS), a condition characterized by hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology. Studies suggest that vitamin D deficiency may exacerbate insulin resistance and disrupt follicular development, thereby contributing to the pathophysiology of PCOS .

Moreover, vitamin D plays a pivotal role in menstrual regulation. Research indicates that women with oligomenorrhea or amenorrhea often exhibit significantly lower vitamin D concentrations compared to those with regular menstrual cycles. The hormone's influence on the biosynthesis of estrogen and modulation of anti-Müllerian hormone levels further implicates its involvement in menstrual health and ovarian reserve.

The high prevalence of vitamin D deficiency among adolescent girls and its association with gynecological disorders necessitate a comprehensive examination of this issue. This article aims to elucidate the gynecological implications of vitamin D deficiency in adolescent females, exploring the underlying mechanisms, clinical manifestations, and potential interventions to address this multifaceted health concern.

Vitamin D deficiency is a pervasive global health issue, with adolescent girls being particularly vulnerable due to factors such as rapid physiological changes during puberty, increased nutritional demands, and lifestyle behaviors that limit sun exposure. Studies have consistently demonstrated a high prevalence of vitamin D deficiency among adolescent females. For instance, a study conducted in the United Arab Emirates reported that 78.8% of adolescent girls aged 11–18 years exhibited severe vitamin D deficiency, with serum levels below 27.5 nmol/L. Similarly, research in Saudi Arabia found that 81% of girls aged 12–15 years had low vitamin D levels, with approximately 40% exhibiting very low concentrations.
Beyond its skeletal implications, vitamin D deficiency has been increasingly associated with various gynecological disorders. Notably, there is a documented correlation between low vitamin D levels and the incidence of polycystic ovary syndrome (PCOS), a condition characterized by hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology. Studies suggest that vitamin D deficiency may exacerbate insulin resistance and disrupt follicular development, thereby contributing to the pathophysiology of PCOS.

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These findings underscore the multifaceted role of vitamin D in female reproductive health, particularly during adolescence, a critical period for the establishment of endocrine and reproductive function.

Methodology. This study employed a systematic review methodology to analyze existing literature on the gynecological implications of vitamin D deficiency in adolescent girls. The review focused on peer-reviewed articles published between 2000 and 2025. Databases searched included PubMed, Scopus, and Web of Science. Search terms used were: "vitamin D deficiency," "adolescent girls," "gynecological health," "menstrual disorders," "PCOS," "anti-Müllerian hormone," and "reproductive hormones."

Inclusion criteria:

- Studies involving female participants aged 10–19 years.
- Research focusing on the relationship between vitamin D levels and gynecological outcomes such as menstrual irregularities, PCOS, and hormone levels.
- Articles published in English.

Exclusion criteria:

- Studies involving adult women over 19 years of age.
- Research not directly assessing the impact of vitamin D on gynecological health.
- Non-peer-reviewed articles, editorials, and commentaries.

Data extraction focused on study design, sample size, participant demographics, methods of vitamin D assessment, gynecological outcomes measured, and key findings. The quality of included studies was assessed using standardized tools appropriate for observational studies.

This methodological approach allowed for a comprehensive synthesis of current evidence on the role of vitamin D in adolescent gynecological health, highlighting areas of consensus and identifying gaps for future research.

Results. The systematic review encompassed data from multiple studies across various regions, highlighting the pervasive nature of vitamin D deficiency among adolescent girls and its associated gynecological implications.

Prevalence of Vitamin D Deficiency. A significant prevalence of vitamin D deficiency was observed among adolescent females globally. In the United Arab Emirates, a study involving 293 girls aged 11–18 years found that 78.8% had severe deficiency (serum 25(OH)D levels <27.5 nmol/L), with only 0.3% exhibiting sufficient levels (>75 nmol/L) . Similarly, research in Saudi Arabia reported that 81% of 433 schoolgirls aged 12–15 years had low vitamin D levels, with approximately 40% exhibiting very low concentrations. In Brazil, among female adolescents aged 11–18 years, 20.1% had vitamin D deficiency, and 1.5% had severe deficiency.

Gynecological Implications. The deficiency of vitamin D in adolescent girls has been linked to various gynecological disorders. Studies suggest a correlation between low vitamin D levels and the incidence of polycystic ovary syndrome (PCOS), characterized by hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology. Vitamin D deficiency may exacerbate insulin resistance and disrupt follicular development, contributing to the pathophysiology of PCOS. Additionally, vitamin D plays a pivotal role in menstrual regulation. Research indicates that women with oligomenorrhea or amenorrhea often exhibit significantly lower vitamin D concentrations compared to those with regular menstrual cycles. The hormone's influence on the biosynthesis of estrogen and modulation of anti-Müllerian hormone levels further implicates its involvement in menstrual health and ovarian reserve.

Predictive Factors and Risk Assessment. Several predictive factors for vitamin D deficiency were identified. A study in Korea demonstrated that girls had a higher prevalence of vitamin D deficiency than boys, attributed to less physical activity and lower dietary intake of calcium and vitamin D-rich foods. In Balochistan, Pakistan, urban adolescent girls exhibited higher rates of deficiency compared to their rural counterparts, with 33.3% being deficient and 17.5% severely deficient in urban areas. Seasonal variations also played a role; in Brazil, during winter months, 36% of adolescent girls had vitamin D deficiency, compared to lower rates in summer.

These findings underscore the multifaceted nature of vitamin D deficiency among adolescent girls and its significant gynecological implications. Addressing these deficiencies through targeted interventions is crucial for improving reproductive health outcomes in this population.

Discussion. Vitamin D deficiency (VDD) is a prevalent issue among adolescent girls, with significant implications for gynecological health. The deficiency has been linked to various reproductive disorders, including menstrual irregularities and polycystic ovary syndrome (PCOS).

Vitamin D Deficiency and Menstrual Irregularities. Several studies have demonstrated a correlation between low vitamin D levels and menstrual disorders. For instance, women with oligomenorrhea and amenorrhea have been found to have significantly lower vitamin D concentrations compared to those with regular menstrual cycles. Lower plasma levels of 25(OH)D were associated with increased odds of having menstrual disorders, suggesting that vitamin D plays a role in regulating the menstrual cycle. Additionally, vitamin D deficiency has been associated with early menarche, which can have long-term health implications.

Vitamin D Deficiency and Polycystic Ovary Syndrome (PCOS). Vitamin D deficiency is highly prevalent among women with PCOS, with studies reporting deficiency rates ranging from 67% to 85%. The deficiency is associated with various metabolic and endocrine disturbances characteristic of PCOS, including

insulin resistance, hyperandrogenism, and ovulatory dysfunction. Vitamin D plays a role in calcium homeostasis and follicular development, and its deficiency may contribute to the pathophysiology of PCOS. Moreover, vitamin D supplementation has been shown to improve menstrual frequency and metabolic disturbances in women with PCOS.

Predictive Factors and Risk Assessment. Several predictive factors for vitamin D deficiency have been identified. A study in Korea demonstrated that girls had a higher prevalence of vitamin D deficiency than boys, attributed to less physical activity and lower dietary intake of calcium and vitamin D-rich foods. In Balochistan, Pakistan, urban adolescent girls exhibited higher rates of deficiency compared to their rural counterparts, with 33.3% being deficient and 17.5% severely deficient in urban areas. Seasonal variations also played a role; in Brazil, during winter months, 36% of adolescent girls had vitamin D deficiency, compared to lower rates in summer.

Implications for Public Health and Future Research. The high prevalence of vitamin D deficiency among adolescent girls and its association with gynecological disorders necessitate public health interventions. Strategies such as vitamin D supplementation, dietary modifications, and increased sun exposure should be considered to improve vitamin D status in this population. Further research is needed to elucidate the mechanisms by which vitamin D influences reproductive health and to establish standardized guidelines for prevention and treatment of vitamin D deficiency in adolescent girls.

Conclusion. Vitamin D deficiency represents a critical and often overlooked factor affecting the gynecological health of adolescent girls. As this developmental stage is marked by significant hormonal changes and reproductive system maturation, inadequate vitamin D levels can disrupt endocrine regulation, leading to a cascade of reproductive complications such as menstrual irregularities, delayed menarche, and polycystic ovary syndrome (PCOS).

The evidence synthesized in this review reveals a consistently high global prevalence of vitamin D deficiency among adolescent females, with particularly concerning rates observed in regions such as the Middle East and South Asia. These deficiencies correlate strongly with both metabolic and reproductive dysfunctions. Emerging data also highlight the modulatory role of vitamin D in anti-Müllerian hormone levels and estrogen synthesis, suggesting its broader influence on ovarian physiology.

Given the magnitude of this public health concern, early identification and correction of vitamin D deficiency should be integrated into adolescent healthcare protocols. Preventive strategies—including routine screening, targeted supplementation, dietary adjustments, and lifestyle interventions to increase sun exposure—are essential. Moreover, interdisciplinary collaboration between pediatricians, endocrinologists, gynecologists, and public health policymakers will be vital in implementing effective interventions.

Future longitudinal and interventional studies are warranted to explore the causative pathways in greater depth and to define optimal therapeutic thresholds for vitamin D in the context of adolescent reproductive health. Addressing this micronutrient deficiency early may offer a powerful avenue for preventing lifelong gynecological and metabolic complications.

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