

IMPACT OF VITAMIN D SUPPLEMENTATION IN PREGNANCY: IMPROVING MATERNAL AND FETAL OUTCOMES

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Abstract: Goal: Examine the benefits and challenges of vitamin D supplementation in pregnant women and its impact on maternal and fetal quality of life. A bibliographic review was carried out in the PubMed database, combining the terms “Vitamin D supplementation AND (“Pregnancy outcomes” OR “Maternal health outcomes” OR “Fetal health outcomes”) AND Benefits”, resulting in 16 articles. After inclusion and exclusion criteria, 10 were selected for analysis. Results: Vitamin D supplementation in pregnant women has demonstrated a positive impact, reducing the incidence of pre-eclampsia, recurrent miscarriages, gestational diabetes and postpartum depression. There was also a lower incidence of low birth weight and, in some populations, a reduction in prematurity rates, although the evidence is not yet conclusive. Final considerations: Vitamin D supplementation during pregnancy improves birth outcomes and promotes healthy fetal development.

Keywords: Vitamin D, Pregnancy, Supplementation, Maternal outcomes, Fetal development.

INTRODUCTION

Vitamin D, also known as calciferol, plays a crucial role in various metabolic and physiological functions of the human body. This fat-soluble substance is essential in regulating calcium balance and bone mineralization, with receptors distributed throughout the body, including bones, muscles and the central nervous system. The main source of vitamin D is sun exposure, although it can also be obtained through diet, consuming foods such as fish and enriched products. After synthesis or ingestion, vitamin D is converted in the liver to 25-hydroxyvitamin D (25(OH)D) and in the kidneys to its active form, 1,25-dihydroxyvitamin D (1,25(OH)₂D). Vitamin D blood levels are typically measured

by the concentration of 25(OH)D, with the Endocrine Society defining deficiency as levels below 20 ng/ml, insufficiency at 21 to 29 ng/ml, and sufficiency at 30 ng/ml. /ml, the latter being considered ideal for optimal calcium absorption (Ciebiera et al., 2021).

During pregnancy, vitamin D deficiency is common and can have significant implications for both maternal and fetal health. Vitamin D influences everything from placental implantation to fetal bone mineralization. Studies indicate associations between vitamin D deficiency and obstetric complications such as pre-eclampsia, gestational diabetes, premature birth and low birth weight (Ciebiera et al., 2021).

Changes in calcium and phosphate metabolism during pregnancy allow the addition of calcium to the fetal skeleton, especially in the third trimester. Although maternal ionized calcium concentrations remain stable, intestinal calcium absorption increases, and additional calcium is mobilized from the maternal skeleton. 1,25(OH)₂D plays a crucial role in these adaptations and is suggested to also contribute to immunological tolerance during pregnancy, helping to prevent fetal rejection (Curtis et al., 2018).

Observational studies have reported associations between 25(OH)D status during pregnancy and a variety of obstetric complications, including gestational hypertension and preeclampsia, gestational diabetes, and influencing the timing and mode of delivery. However, the interpretation of these studies is limited by differences in their design, timing of 25(OH)D measurement, definitions of vitamin D deficiency, and gestational or birth outcomes, as well as adjusted confounding factors (Curtis et al., 2018). Therefore, more research is needed to fully understand the role of vitamin D in pregnancy and its impact on maternal and fetal health.

Vitamin D supplementation during pregnancy is seen as a potential intervention to improve outcomes by preventing conditions such as pre-eclampsia, gestational diabetes, low birth weight and preterm birth. It is essential to quantify the serum level of vitamin D using 25(OH)D and make individual adjustments to minimize the risk of adverse effects, avoiding toxicity resulting from excessive supplementation. According to the Institute of Medicine, it is recommended to avoid intakes above 4,000 IU/day to prevent toxic effects that can occur with levels above 125 nmol/l (Curtis et al., 2018).

This literature review aims to analyze the importance of vitamin D supplementation in pregnant women, exploring its impacts on maternal and fetal health, identifying benefits, challenges and gaps in current knowledge.

METHODOLOGY

This narrative bibliographic review was developed using the PVO strategy, which includes the definition of the Population or research problem, Variables involved and the expected Outcome. The research was conducted based on the guiding question: “What are the benefits and challenges associated with vitamin D supplementation in pregnant women, and how do these interventions impact maternal and fetal health, as evidenced by recent scientific literature?” In this context, the focus is to analyze the effects of vitamin D supplementation in pregnant women and its impact on maternal and fetal health outcomes.

Data collection was carried out using the PubMed - MEDLINE (Medical Literature Analysis and Retrieval System Online) database. For the search, descriptors related to the topic were used combined with the Boolean operators “AND” and “OR”: [“Vitamin D supplementation” AND “Pregnancy outcomes” OR “Maternal health

outcomes” OR “Fetal health outcomes”) AND “ Benefits”]. This initial search identified 16 articles.

The inclusion criteria defined for the selection of studies were: articles in English, published between 2014 and 2024, that had pregnant women as the target population and addressed the proposed themes. Studies such as systematic reviews, meta-analysis, observational studies, review articles and case reports made available in full were considered. The exclusion criteria applied included duplicate articles and those that were not aligned with the research objective or that did not meet the other inclusion criteria.

After rigorous application of the inclusion and exclusion criteria, 10 articles were selected to integrate the collection of the present study. This selection allowed for a detailed and comprehensive analysis of the benefits and challenges of vitamin D supplementation during pregnancy, highlighting the implications for maternal and fetal health based on current scientific literature.

DISCUSSION

IMPACT OF VITAMIN D SUPPLEMENTATION ON MATERNAL HEALTH

Vitamin D deficiency during pregnancy is associated with several complications, including gestational hypertension, gestational diabetes, recurrent miscarriages, premature birth and postpartum depression. Low levels of insulin-like growth factor 1 (IGF-1) can negatively influence the production of 1,25(OH)₂D by placental trophoblast cells, increasing the risk of pre-eclampsia. Furthermore, vitamin D deficiency can compromise glucose tolerance due to its ability to stimulate insulin secretion and regulate the expression of antioxidants (Liu; Huang, 2023).

Observational studies have linked low vitamin D levels to complications such as pregnancy loss, pre-eclampsia, gestational diabetes and prematurity. These associations may be explained by the role of calciferol in regulating calcium and phosphate balance, along with modulating parathyroid hormone (PTH) secretion. During the first trimester of pregnancy, this imbalance can contribute to increased diastolic blood pressure (Curtis et al., 2018).

Vitamin D also influences the process of trophoblastic invasion and abnormal remodeling of the maternal spiral artery, key factors in the etiology of pre-eclampsia. Other biological processes dependent on adequate levels of vitamin D, such as inflammation, immune response and angiogenesis, are also implicated in the pathogenesis of this complication (Ciebiera et al., 2021).

Furthermore, studies indicate that vitamin D supplementation significantly improves the clinical pregnancy rate in women with fertility problems, playing a crucial role in the early phase of embryo implantation and in preparing the endometrium for pregnancy. However, the combination of vitamin D with other components such as Myo-Inositol, folic acid, melatonin and vitamin E has also been shown to positively impact pregnancy rate, suggesting that vitamin D works in conjunction with other nutrients (Meng et al., 2023).

Related to pregnancy through assisted reproduction, vitamin D supplementation is valued for its potential benefits, being safe, accessible and economical. Cost-benefit analyzes for fresh blastocyst embryo transfer suggest that screening and vitamin D supplementation prior to the assisted process can significantly reduce the societal cost per successful pregnancy (Michelli et al., 2014).

Women with preeclampsia often have lower levels of 25-hydroxyvitamin D compared

to women with normal blood pressure. Hypocalciuria, or low urinary calcium levels in women with preeclampsia, may result from decreased intestinal calcium absorption, a process impaired by low levels of vitamin D. Additionally, there is a relationship between preeclampsia and low concentrations of vitamin D in the blood, mediated by mechanisms that include immune dysfunction, problems with placental implantation, abnormal angiogenesis, excessive inflammation and hypertension (Palacios; Kostiuk; Peña-Rosas, 2019).

INFLUENCE OF VITAMIN D SUPPLEMENTATION ON FETAL HEALTH

Vitamin D, a fat-soluble steroid, is crucial for calcium homeostasis and plays a fundamental role in the mineralization and synthesis of bone tissue (Ciebiera et al., 2021). Furthermore, it has an important regulatory function in reducing oxidative stress and increasing immune function (Wei, 2014), positively impacting maternal-fetal health (Curtis et al., 2018).

Vitamin D also demonstrates immunomodulatory properties *in vitro*, such as increasing the production of anti-inflammatory cytokines and reducing pro-inflammatory molecules, influencing the pathophysiology of preterm birth (Ciebiera et al., 2021). Furthermore, there is evidence that low serum levels of vitamin D may be related to other adverse outcomes such as postpartum hemorrhage and low Apgar scores, especially in women with levels below 30 nmol/L (Liu; Huang, 2023).

Studies indicate a correlation between vitamin D deficiency and the incidence of depression during and after pregnancy. Low serum levels of 25-hydroxyvitamin D (25(OH) D), the most representative biomarker for assessing vitamin D status, have been

associated with an increased risk of several obstetric complications, including premature birth, gestational diabetes mellitus, small for gestational age and preeclampsia (Wang et al., 2018). Additionally, vitamin D deficiency has been defined as 25(OH)D levels less than 30 or 50 nmol/L.

Vitamin D supplementation during pregnancy, alone or in combination with calcium or other minerals and vitamins, may improve maternal and neonatal outcomes. Furthermore, vitamin D and calcium interact synergistically; Parathormone (PTH) increases the concentration of calcium in the blood through bone reabsorption, while calcitriol inhibits PTH and promotes the absorption of calcium and phosphorus, both renal and intestinal, thus improving calcium status (Palacios, Kostiuk, Peña-Rosas, 2019).

It is therefore related to low birth weight (SGA), due to the influence of vitamin D on calcium metabolism, bone growth and placental function, being a critical factor for fetal development. Low maternal vitamin D levels are linked to a greater likelihood of intrauterine growth restriction, increasing the risk of SGA. Vitamin D supplementation is associated with higher birth weight and evidence suggests it may also improve postnatal growth (Wei, 2014).

Despite the observed benefits, the World Health Organization (WHO) and the American Congress of Obstetricians and Gynecologists (ACOG) do not currently recommend vitamin D supplementation during pregnancy as part of routine prenatal care, except in cases of deficiency. proven, due to the lack of conclusive evidence about its efficacy and safety (WHO, 2016; ACOG, 2015).

Furthermore, inadequate control of maternal diabetes in early pregnancy is inversely related to reduced bone mineral content in infants, as well as low maternal vitamin D levels. Vitamin D deficiency can cause increased

bone remodeling, bone loss, osteomalacia and myopathy in the mother, in addition to vitamin D deficiency in neonates and children (Palacios; Kostiuk; Peña-Rosas, 2019).

Although there is no consensus on vitamin D supplementation protocols and optimal serum levels to avoid adverse pregnancy outcomes, most experts suggest that a daily intake of 1000-2000 IU is safe (Reynolds et al., 2017). However, individualization of supplementation based on specific deficits is recommended to maintain serum levels above 50 nmol/L (Ciebiera et al., 2021).

The benefits of vitamin D supplementation for fetuses are evident, especially in optimizing fetal cell mass, resulting in better results in body composition, such as greater birth weight and height, and reduced risk of small-for-gestational-age newborns. (Maugeri et al., 2019). However, the relationship between vitamin D supplementation and the reduction in prematurity levels is not yet conclusive. Although it has shown benefits in certain populations (Ciebiera et al., 2021), the need for more homogeneous clinical trials remains to confirm these effects (Maugeri et al., 2019).

To advance the understanding of the benefits of vitamin D during pregnancy, more randomized clinical trials with homogeneous populations are needed. These studies must explore the relationship between vitamin

D supplementation and various gestational outcomes, including the reduction of prematurity and neonatal infections (Lo et al., 2019), in addition to determining adequate serum levels to avoid negative consequences due to vitamin D deficiency or toxicity. vitamin D (Reynolds et al., 2017).

FINAL CONSIDERATIONS

Research into the role of vitamin D in pregnancy highlights its importance in regulating calcium balance, bone health, and the maternal and fetal immune systems. Although it shows benefits such as reducing the risk of obstetric complications, there are still open questions, such as the definition of ideal serum levels during pregnancy. Randomized clinical trials, studies in specific populations, and longitudinal investigations are needed to determine the efficacy and optimal dosage of vitamin D supplementation, as well as to evaluate its long-term impacts on maternal and fetal health. By following these guidelines and exploring open areas of research, we can better understand the role of vitamin D in pregnancy, ensuring its safety and maximizing its benefits for maternal and fetal health, providing adequate care for a healthy pregnancy and healthy children at birth.

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