# IMPACT OF LIFESTYLE ON VITAMIN D DEFICIENCY DURING PREGNANCY: A LITERATURE REVIEW

By

Mariam Zaman
19146096

A thesis submitted to the School of Pharmacy in partial fulfillment of the requirements for the degree of

Bachelor of Pharmacy (Hons.)

School of Pharmacy
BRAC University
February 2023

## Declaration

It is hereby declared that.

1. The thesis submitted is my/our initial work while completing our degree at BRAC University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through complete and accurate referencing.
3. The thesis does not contain material that or submitted for any other degree or diploma at a university or other institution.
4. I/We have acknowledged all primary sources of help.

**Student's Full Name & Signature:**

**Mariam Zaman**
19146096

# Approval

The thesis/project titled "Impact of lifestyle on vitamin D deficiency during pregnancy: A literature review" submitted by Mariam Zaman (19146096) of Summer 2022 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Pharmacy on March 27, 2023.

**Examining Committee:**

**Supervised By:**

Dr. Sharmind Neelotpol
Professor, School of Pharmacy
BRAC University

**Approved By:**

Program Director:

Professor Dr. Hasina Yasmin
Program Director and Assistant Dean
School of Pharmacy
BRAC University

Dean:

Professor Dr. Eva Rahman Kabir
Dean
School of Pharmacy
BRAC University

## Ethics Statement

No human or animal testing was done for this research.

## Abstract

Vitamin D is essential for fetal growth and maternal health, and vitamin D deficiency during pregnancy can lead to various health issues, such as preeclampsia, gestational diabetes and preterm birth in mothers and low birth weight, neonatal hypocalcemia, and increased incidence of autoimmune diseases in infants. This literature review explores the impact of lifestyle factors on vitamin D deficiency during pregnancy. It is an important nutrient for fetal growth and maternal health and inadequacy during pregnancy can lead to various health issues. This study focuses on the impact of sun exposure, nutrition, body mass index (BMI), and other lifestyle and environmental factors on the role of Vitamin D During Pregnancy. The findings indicated that insufficient sun exposure, low nutritional consumption, and a high BMI are significant causes of vitamin D insufficiency during pregnancy and incorporating lifestyle adjustments may assist pregnant women in avoiding vitamin D insufficiency.



**Keywords:** “Lifestyle”; “Vitamin D”; “Pregnancy”; “maternal”; “deficiency”; “impact”

# Dedication

*Dedicated to my parents*

## Acknowledgment

I am writing to express my sincere gratitude to Allah for granting me the opportunity to study Pharmacy and complete this project paper as a requirement for my Bachelor's degree in Pharmacy. I want to extend my heartfelt appreciation to my supervisor, Dr. Sharmind Neelotpol, Professor at the School of Pharmacy, BRAC University, for her immense assistance, direction, and inspiration during the project. Her expert advice and strategies have helped me to improve my abilities and complete this project effectively. Additionally, I am thankful to Dr. Eva Rahman Kabir., Professor and Dean at the School of Pharmacy, BRAC University, Dr. Hasina Yasmin, Deputy Chair at the School of Pharmacy, BRAC University, and the other faculty members of the School of Pharmacy, BRAC University for their support and assistance whenever I needed it. Lastly, I would like to express my gratitude to my parents for their continuous support, encouragement, and motivation throughout my life. Their prayers, love, and strength have been instrumental in helping me reach this far. I would also like to acknowledge the cooperation of all involved in this project and make it inaccessible.

# Table of Contents

**Declaration**.....ii

**Approval** ..... iii

**Ethics Statement**.....iv

**Abstract**.....v

**Dedication** .....vi

**Acknowledgment**.....vii

**Chapter 1 Introduction**.....1

**1.1 An Overview of vitamin D**.....1

**1.2 Function of Vitamin D:**.....2

**1.3 Importance of Vitamin D during pregnancy:** .....2

**1.4 Association of Lifestyle with maternal hypovitaminosis D:**.....3

**1.5 Rationale of the Study:** .....3

**1.6 Aim of the Study:** .....4

**1.7 Objectives of the study:** .....4

**Chapter 2 Methodology**.....5

**Chapter 3 Finding and Discussion**.....6

**3.1 The Sunshine Vitamin:**.....6

**3.2 Chemistry of Vitamin D:**.....6

**3.3 Mechanism of Action of Vitamin D:**.....7

**3.4 Requirements of Vitamin D at different ages:** .....7

**3.5 Maternal Vitamin D Requirement:**.....8

**3.6 The severity of Maternal Hypovitaminosis D: ....8**

**3.7 Region-wise Maternal Vitamin D deficiency status worldwide:....9**

**3.8 Lifestyle Factor Affecting Hypovitaminosis D:....9**

**3.9 Socioeconomic status: ....10**

**3.10 Clothing: ....10**

**3.11 Nutritional Uptake:....11**

**3.12 Physical Activity: ....11**

**3.13 Skin color:....12**

**3.14 Sun-exposure:....12**

**3.15 Time of day:....13**

**3.16 Geographical location:....13**

**3.17 Latitude:....14**

**3.18 Level of air pollution: ....15**

**3.19 Best-suited Lifestyle for preventing maternal Hypovitaminosis D: ....15**

**3.20 Systematic prenatal testing for vitamin D deficiency:....16**

**Chapter 4 ....17**

**4.1 Conclusion: ....17**

**4.2 Future Directions:....17**

**4.3 Limitations: ....18**

**Reference: ....19**

# Chapter 1

# Introduction

## 1.1 An Overview of vitamin D

Calciferol, another name for vitamin D, a hormone that functions as a steroid and is produced from cholesterol that the body produces in reaction to sunlight. For the biologically inert vitamin D consumed via food, supplements, and sunlight to become active in the body, it must undergo two hydroxylations. The liver is where vitamin D undergoes its first hydroxylation; 25-hydroxyvitamin D [25(OH)D], in most cases, this refers to "calcidiol," is produced. The second hydroxylation, which mostly takes place in the kidneys, generates 1,25-dihydroxy vitamin D [1,25(OH)2D], often referred to as "calcitriol," which possesses physiological activity. Ergocalciferol and cholecalciferol are the two most prevalent forms of vitamin D found in foods and dietary supplements; they only vary chemically in their side-chain topologies. The small intestine quickly absorbs both types. Absorption may be facilitated by passive diffusion alone or by a process involving intestinal membrane carrier proteins. When fat is present in the stomach simultaneously with vitamin D absorption, vitamin D absorption is inhibited. When fat is present in the stomach simultaneously with vitamin D absorption, vitamin D absorption is hindered. It is more effective, albeit some vitamin D may still be absorbed without dietary fat. Age or obesity does not affect the gut's ability to absorb vitamin D (Institute of Medicine Committee to Review Dietary Reference Intakes for Vitamin & Calcium). Salmon, egg yolks, red meat, liver, and other foods naturally contain vitamin D. Additionally, it is offered in the form of a vitamin supplement.

## 1.2 Function of Vitamin D:

From maintaining the vital calcium balance in the blood to decreasing individuals' risk of developing severe diseases like cancer, hypertension, and osteoporosis, vitamin D exerts significant functions in the human body. Vitamin D's principal biological job is to maintain healthy blood calcium and phosphorus levels. Calcium is more readily absorbed in the presence of vitamin D, which contributes to the development and maintenance of healthy bones. Additionally, Recent research suggests that adequate intake of this fat-soluble vitamin may reduce the risk of developing cancer, high blood pressure, osteoporosis, and other inflammatory diseases. Vitamin D has been shown to increase antibody production by the body's immunological cells; as a result, it helps the immune system become more robust. Over 500 studies have been conducted to establish vitamin D's role in immunological health(Charoenngam & Holick, 2020). According to the research findings, Vitamin D helps preserve the health of the prostate, intestines, and breasts, as we as comforting muscles. Until recently, vitamin D pro-hormone was solely assumed to aid in calcium and phosphorus balance. However, Vitamin D has various biological activities beyond its well-known effects on traditional target tissues, as shown by the identification of vitamin D receptors on several cell types (including keratinocytes, lymphocytes, cells of the parathyroid and pituitary glands, pancreatic cells, and so on). Vitamin D has several non-traditional roles, including control of cell proliferation, differentiation, and immunological modulation. Because of its ability to bind to the VDR, a nuclear hormone receptor, vitamin D mediates its function(Umar et al., 2018).

## 1.3 Importance of Vitamin D during pregnancy:

Recent studies show that vitamin D plays a critical role during pregnancy and also improves the long-term health of children (Fiscaletti et al., 2017). Around the globe, people are suffering from vitamin D insufficiency in alarming numbers, primarily in women, especially pregnant women. According to one of our most recent studies Possibly attributable to the high frequency

of Pregnant women's vitamin D deficiency in South Asia (65%). A sufficient level of vitamin D is necessary for maternal and fetal health during pregnancy. Maternal hypovitaminosis D may diminish fetus development and cause pregnancy-related severe complications. Vitamin D prevalence during pregnancy causes preeclampsia and gestational diabetes mellitus., intrahepatic cholestasis, pre-term birth, cesarian section delivery, gum disease, etc. Due to maternal hypovitaminosis D, substandard health outcomes for neonates have been outlined, with a high risk for low birth weight as a consequence of pre-term birth, small body composition, cardiovascular disorder, poor immunity, abnormal skeletal development, respiratory complications like asthma, wheezing, type 1 diabetes. Due to maternal vitamin D deficiency, young children commonly suffer Rickets in early infancy(Sudfeld et al., 2019).

## 1.4 Association of Lifestyle with maternal hypovitaminosis D:

The lack of vitamin D is widespread. Vitamin D deficiency is not simply a problem in countries with low rates of sun exposure but also in those with more conservative cultural and religious dress norms(Roomi et al., 2015). Vitamin D supplementation is essential for perfecting the health of millions. More than a billion individuals throughout the globe likely suffer from vitamin D deficiency(Nair & Maseeh, 2012). Most persons with vitamin D insufficiency don't have any symptoms, making the condition difficult to spot. The scientists regard serum 25(OH) D circumstances lower than 20 ng/ ml as an indicator for vitamin D deficiency. Serum vitamin D levels in the research group were below average. Femininity, inactivity, indoor work, limited sun exposure, higher education, affluence, and fair complexion were all associated with them.

## 1.5 Rationale of the Study:

This literature review investigates current studies on the impact of lifestyle factors on vitamin D deficiency during pregnancy. Vitamin D is necessary for maternal and fetal health, and optimum levels must be maintained during pregnancy. However, many women experience

vitamin D deficiency, which can adversely affect their health and their newborn. By reviewing the current literature, this study aims to identify the lifestyle factors contributing to Describing vitamin D insufficiency and offer an exhaustive summary of the existing information. The findings of this literature review can influence future research, health policy, and clinical practices to enhance mother and fetal outcomes by treating vitamin D insufficiency during pregnancy.

## 1.6 Aim of the Study:

The intent of this is article is to provide a concise overview of the literature about the correlation between vitamin D insufficiency in pregnant mothers and other lifestyle factors. Lifestyles that are effective and realistic for sustaining a healthy level of vitamin D throughout pregnancy are also introduced.

## 1.7 Objectives of the study:

The followings are the objectives of the study:

1. What is the significance of vitamin D's impact on pregnant mothers and their infants?

2. What is the extent of the high prevalence of vitamin D deficiency when pregnant, and the results on maternal and fetal health?

3. Is there a correlation between a mother's lifestyle and the occurrence of maternal hypovitaminosis D during pregnancy?

4. What is the most effective and practical lifestyle approach to ensure adequate vitamin D levels during pregnancy?

# Chapter 2 Methodology

To write this literature review, keywords were searched in a structured way at databases such as PubMed, web of science, and Elsevier. The most used keywords were vitamin D, pregnancy, maternal, Lifestyle, deficiency, women, and sun exposure. To find the most recent publications, the time range of the published article had been customized from 2005 to 2023. Cross-referencing was also used to locate additional sources of data and journals.

# Chapter 3 Finding and Discussion

## 3.1 The Sunshine Vitamin:

Vitamin D, sometimes known as the "sunshine vitamin," is a crucial nutrient. Produced by the sun's UV rays hitting our skin and is necessary for maintaining the body's regular functions. Deficiency in vitamin D can lead to serious health complications and is a significant worldwide public health issue. Causes of poverty include environmental factors, such as air pollution, and lifestyle factors, such as decreased outdoor activities, which reduce exposure to sunshine and UV radiation, the core mechanism for vitamin D synthesis in the skin(Holick, 2011; Nair & Maseeh, 2012)

## 3.2 Chemistry of Vitamin D:

A class of lipid-soluble substances known as vitamin D has steroid-like structures or four interconnected carbon rings. D3 is also synthesized in the body if the skin is exposed to ultraviolet radiation with a wavelength between 290 and 315 nanometers. Two varieties, D2 (1) and D3 (2), are present naturally in the food (i.e., UV-B). When exposed to UV-B, the substance 7-dehydrocholesterol, prevalent in skin cells, undergoes a chemical rearrangement to produce the energetically more stable D3. Once vitamin D3 is generated, liver and kidney enzymes transform it into the more active 25-hydroxyvitamin D (25(OH)D). Together with specific proteins, this hormone enables efficient transit of calcium and phosphate ions through the blood. Lack of this substance inhibits the absorption of these ions from the gut and prevents the formation of new bone. A network of collagen fibers impregnated with hydroxyapatite, Ca5(PO4)3(OH) crystals, makes up bone. Vitamin D3 can be produced in the body by the action of UV light on the precursor sterol 7-dehydrocholesterol in the skin. This process is known as photochemical synthesis. The molecule's double-bond system allows for the absorption of UV light; This sets in motion a chain reaction leading to the production of vitamin

D3, which means that as long as a person has regular access to sunlight, there is no dietary requirement for vitamin D3(Holick, 2011).

## 3.3 Mechanism of Action of Vitamin D:

The Vitamin D receptor's transcription factor binds to 1,25(OH)2D (VDR), hormone-bound vitamin D (Bikle, 2021). The preponderance, if not all, of 1,25(OH)2D's effects are mediated by VDR, which regulates gene expression by binding to vitamin D response elements (VDREs) in the promoters of specific genes. The gene has hundreds of VDREs, many located far from the gene's coding region, and some initial effects of 1,25(OH)2D may be due to the VDR operating outside the nucleus or a less well-studied membrane-bound receptor. Some VDR functions can be achieved without its ligand, 1,25(OH)2D. There has been significant improvement in understanding VDR's mechanism of gene expression control over time (Bikle, 2000)

## 3.4 Requirements of Vitamin D at different ages:

Four hundred international units (IU) of vitamin D are advised for infants up to 12 months old, 600 IU for those between 1 and 70 years old, and 800 IU for those beyond 70 years old.

Specifically, Women between the ages of 14 and 70 should eat 600 IU of Vitamin D daily, while women aged 71 and above should consume 800 IU (Mayo Clinic Staff, n.d.). However, it is essential to remember that these guidelines(Padhi et al., 2014)are general. Individual needs for vitamin D may vary due to age, skin pigmentation, sun exposure, and health status. It is advisable to consult a healthcare provider professional to establish the optimal vitamin D dosage for an individual's needs (Padhi et al., 2014).

## 3.5 Maternal Vitamin D Requirement:

Institution of Medicine's Food and Nutrition Board of the National Academies determined in 2010 that 600 international units of vitamin D per day during pregnancy and breastfeeding constituted an appropriate intake (Institute of Medicine of the National Academies (US), 2010). Most prenatal vitamins usually provide 400 IU of vitamin D in each pill (Lim, Seul-Ki, et al., 2016). The serum concentration of 25-OH-D can be employed as a nutritional vitamin D status indicator for the specific pregnant lady who is at a higher risk of vitamin D deficiency. Most experts agree that a serum concentration of at least 20 ng/mL (50 nmol/L) is required to prevent bone disorders(Schnatz & Manson, 2014). Some experts have proposed that vitamin D deficiency be defined as circulating 25-OH-D levels less than 32 ng/mL (80 nmol/L)(Schnatz & Manson, 2014). There is still ongoing research in this field because there is no established ideal serum level for pregnant women.

## 3.6 The severity of Maternal Hypovitaminosis D:

According to a review of studies by (Akbari et al., 2018), increased risk of gestational diabetes and hypertension are two of the consequences associated with maternal hypovitaminosis D. Another study (Hyppönen et al., 2001), Maternal hypovitaminosis D increases the risk of pre-eclampsia, premature delivery, and newborn infections, according to research. Moreover, the same study found that insufficient vitamin D levels during pregnancy may reduce fetal development. A more recent study indicated that maternal hypovitaminosis D is also associated with preterm birth h, an increased risk of childhood asthma and allergies, and an increased risk of type 1 diabetes in the offspring. Therefore, pregnant women must maintain enough vitamin D levels to promote their children's health.

## 3.7 Region-wise Maternal Vitamin D deficiency status worldwide:

Maternal vitamin D deficiency prevalence varies worldwide, with some regions having higher rates than others. Maternal vitamin D insufficiency incidence varies globally, with some countries having more excellent rates than others. In general, locations with less sun exposure, such as northern Europe, North America, and Asia, have more maternal vitamin D insufficiency rates than those closer to the equator with greater light exposure, such as Africa and South America(Holick, 2011). However, additional variables like skin pigmentation, clothing style, and food have a role in maternal vitamin D status(Bonilla et al., 2014). Overall, it is crucial for pregnant women worldwide to maintain appropriate levels of vitamin D through a mix of nutrition, sun exposure, and, if necessary, vitamin supplements.

## 3.8 Lifestyle Factor Affecting Hypovitaminosis D:

Limited sun exposure, dark skin, sunscreen usage, indoor living, northern latitudes, wearing garments covering most of the skin, aging, obesity, and medical disorders like inflammatory bowel disease or kidney/liver ailments can all lead to vitamin D deficiencies. These variables can cause vitamin D deficiency from sun exposure or food. Research shows that several lifestyle variables might affect vitamin D insufficiency during pregnancy(Holick, 2007). These causes include restricted sun exposure, lack of vitamin D-rich items in the diet, increased skin pigmentation, covering the skin with clothing, living distant from the equator, reduced sun exposure during the winter months, spending the majority of time inside, and obesity. Based on the results of the research, it is especially important for pregnant women to keep their vitamin D levels up since it is absorbed less as body fat increases. Furthermore, women with darker skin pigmentation may be at a greater risk for vitamin D deficiency since melanin reduces the skin's ability to produce vitamin D in response to sun exposure. These results highlight the significance of pregnant women maintaining healthy vitamin D levels via diet and protected sun exposure(Heaney, 2008).

## 3.9 Socioeconomic status:

Evidence suggests a correlation between mothers' socioeconomic level (SES) and deficiency of vitamin D. According to studies, females with a lower socioeconomic status are more likely to have lower vitamin D levels during pregnancy than women with a higher socioeconomic status(Sherchand et al., 2022). This may result from several causes, including reduced access to a good diet and outdoor physical exercise, limited sun exposure, and a diminished capacity to afford vitamin D pills. These data imply that an increase in socioeconomic level may favor the vitamin D status of moms and the overall health of mothers and neonates is investigated. Further study is required to completely comprehend the complicated link between SES and maternal vitamin D insufficiency(Lin et al., 2021).

## 3.10 Clothing:

Clothing can affect vitamin D levels in pregnancy by blocking UVB rays from reaching the skin. UVB rays are required for vitamin D production in the body. Wearing clothing that covers most of the skin can decrease the amount of vitamin D the body can produce, leading to a higher risk of deficiency(Hajizadeh et al., 2019).According to studies, the vitamin D levels of women who wore covered garments were much lower than those of uncovered women (Bassil et al., 2013). These findings suggest that covered clothing is a crucial risk factor for vitamin D insufficiency in pregnant women. It is recommended to spend some time in the sun without clothing covering the arms and legs, especially when UVB rays are the strongest in the middle of the day(Al-Yatama et al., 2019). However, it is crucial to avoid excessive sun exposure, especially during peak hours, as it can increase the risk of skin damage and skin cancer(US Department of Health and Human Services, 2014).

## 3.11 Nutritional Uptake:

Significant effects of diet on vitamin D levels and deficiency can be observed. Salmon and tuna and other fatty fish, egg yolks, and, and mushrooms exposed to UV rays are dietary sources of vitamin D. In addition to milk, orange juice, cereal, and fortified foods can also deliver vitamin D. A diet lacking in these vitamin D sources might raise the risk of insufficiency. In addition, many medical disorders and drugs may impair physical potential to absorb vitamin D from the diet, increasing the risk of drought. Discussing a person's unique dietary needs and risk of deficiency is vital with a healthcare professional (Catharine Ross, 2011). A diet deficient in vitamin D during pregnancy mother and developing kid to potential danger. A vitamin D deficiency during pregnancy might increase the dangers of premature birth, low birth weight, and preeclampsia. Vitamin D is essential for bone health—the correct functioning of the immunological and neurological systems. To lessen the risk of vitamin D insufficiency, pregnant women should consume vitamin D-rich foods, such as fatty fish, egg yolks, and fortified meals, and discuss the need for supplements with their healthcare practitioner. To promote the mother's and child's health and developing fetus, it is essential to consume an appropriate and well-balanced diet throughout pregnancy(National Institute of Health, 2022).

## 3.12 Physical Activity:

For optimal health, it's recommended that adults engage in 30 minutes of moderate-intensity physical exercise on at least five days a week, as stated by the American Heart Association and the American College of Sports Medicine. For moderate physical activity, it's recommended that you get 150 minutes per week of aerobic activity at a moderate intensity. The recommended weekly amount of physical activity is 150 minutes, which may be achieved in numerous shorter spurts of at least 10 minutes weekly all during the course of the week. Include the time spent on each session: 15 minutes of moderate intensity exercise, ten times each week. Recreational activities in this category include cycling, walking, water aerobics, gardening, and

volleyball. Physical activity on a scale lower than this is considered mild exercise, while on a scale higher than this is considered severe/vigorous physical activity(Roomi et al., 2015).It has been demonstrated that exercise during pregnancy has a favorable influence on vitamin D levels. Regular physical activity can boost vitamin D levels by increasing sun exposure and enhancing food absorption. In addition, exercise has been demonstrated to improve general health and well-being, which can contribute to a higher vitamin D level. To identify the optimal amount and type of activity during pregnancy, it is essential to check with a healthcare expert (Gustafsson et al., 2019)

## 3.13 Skin color:

According to studies, pregnant women with darker complexion are more susceptible to vitamin D shortage than those with lighter skin. This is because Skin melanin lowers the skin's ability to produce vitamin D. when exposed to sunlight. Pregnant women with darker complexion may require greater vitamin D pills or additional sun exposure to achieve their daily vitamin D needs. Consultation with a physician is needed for proper vitamin D recommendations during pregnancy(Richard et al., 2017)

## 3.14 Sun-exposure:

Sunlight is a major contributor to low vitamin D levels in pregnant women. The effects of ultraviolet (UV) radiation on the skin, and vitamin D is created. However, factors such as limited sun exposure, the use of sunblock, living far from the equator, decreased sun exposure during winter months, spending the majority of time inside, and covering the skin with clothing might inhibit the skin's capacity to generate vitamin D. This can cause a deficiency of vitamin D in the body, leading in hypovitaminosis D in the mother(Holick, 2011). For maintaining optimal vitamin D levels. Pregnant women must balance safe sun exposure and shielding their skin from dangerous UV radiation

## 3.15 Time of day:

Sunlight's ultraviolet B (UVB) rays cause our skin to produce vitamin D, a vital nutrient. The time of day can impact the quantity of vitamin D produced by the body. Sunlight is the most crucial vitamin D source for the majority of humans. The capacity of the body to produce vitamin D from sun exposure is affected by many variables, including but not limited to: time of day, latitude, season, and skin color. The ideal time to obtain vitamin D from sunlight is midday when the sun is at its highest point in the sky. However, the precise timeframe may vary according to the season. The sun is at its highest between 10 a.m. and 2 p.m.(Holick, 2007). Depending on a person's location and latitude, the timing of optimum sun exposure, and hence the maximum potential for vitamin D generation from sunshine, can vary even though this is generally true for South Asian nations, but this can change by several hours depending on latitude and the season. It is also crucial to remember that the intensity of UVB radiation diminishes with distance from the equator and age. This means that persons living at higher latitudes, such as those in northern Europe, may be unable to create enough vitamin D from the presence of sunshine in the winter. Time of day might have a role in the amount of vitamin D your body can develop from sunshine. Still, other factors, including latitude, season, and skin pigmentation, all play a role(Holick, 2007).

## 3.16 Geographical location:

Geographical location may also impact maternal hypovitaminosis D. People endure being subjected to less UV irradiation, which is required to produce vitamin D by "the skin", which can lower vitamin D levels and raise the risk of maternal hypovitaminosis D(Kimlin, 2008). Furthermore, geographical variables such as cloud cover, air pollution, and altitude affect both how much time individuals spend outside and what level of vitamin D doner get from the sun produced by the body. Getting adequate vitamin D via food or safe sun exposure may require more work for pregnant women in areas with little sun.

## 3.17 Latitude:

Latitude is a significant factor in determining the degree of ultraviolet B (UVB) radiation that reaches the surface of the planet and, consequently, vitamin D production below the surface of the skin. The skin produces vitamin D when exposed to UVB light from the sun. The greater the latitude away from the equator, as a result of a decrease in ultraviolet radiation reaches the surface, and the less vitamin D may be made by the skin(Michael F. Holick, 2011). The risk of vitamin D insufficiency, commonly known as hypovitaminosis D, is increased for those living at higher latitudes(Spiro & Buttriss, 2014). In general, people living at latitudes above 37 degrees North (in the Northern Hemisphere) or below 37 degrees South (in the Southern Hemisphere) are at risk of vitamin D deficiency because the sun's angle is such that UVB radiation is insufficient to trigger vitamin D production in the skin for the majority of the year(Wacker & Holick, 2013). This comprises residents of the northern regions of Europe, North America, Asia, Australia, and South America. In the colder months when sunlight is scarce, and vitamin D production in the skin is low; it is particularly vital for persons living in these regions to obtain adequate vitamin D through diet or supplementation. This can help prevent hypovitaminosis D and ensure that the individual has sufficient vitamin D to support bone health and other vital processes(Holick & Chen, 2008). Hypovitaminosis D in mothers negatively affect fetal health, as having a child with a low birth weight, developing diabetes during pregnancy, or having pre-eclampsia(Özdemir et al., 2018). Pregnant women, particularly those living at higher latitudes, must ensure adequate vitamin D consumption through food and supplementation. vitamin D is essential for good health, and keeping your levels in check may help you avoid a number of potential problems for both mother and baby(Bodnar et al., 2007).

## 3.18 Level of air pollution:

Air pollution can influence vitamin D insufficiency and levels. Certain air pollutants, like ozone and particulate matter, can prevent UVB rays from reaching the skin, hence decreasing the body's capacity to generate vitamin D. Prolonged exposure to high intensity of air pollution can raise the risk of vitamin D insufficiency, particularly in those who spend the majority of their time inside or who have minimal sun exposure. Moreover, air pollution can raise oxidative stress and inflammation in the body, diminishing its capacity to make and absorb vitamin D. It is vital to take steps to reduce air pollution exposure., such as utilizing air purifiers and avoiding outdoor activities during high air pollution levels. A healthcare physician should also be consulted for an individual's unique needs and risk of insufficiency (Rockwell et al., 2018). During pregnancy, air pollution might raise the risk of vitamin D insufficiency. As previously indicated, many air pollutants can block UVB rays, lowering the body's capacity to generate vitamin D. Long-term exposure to high air pollution can further reduce vitamin D levels, increasing the likelihood of insufficiency. Pregnant women should take precautions to decrease their exposure to air pollution, such as utilizing air purifiers and avoiding outdoor activities during high air pollution. They should also discuss their unique requirements and risk of deficiency with their healthcare physician (Bodnar et al., 2015).

## 3.19 Best-suited Lifestyle for preventing maternal Hypovitaminosis D:

The best-suited lifestyle for preventing maternal hypovitaminosis D will be integrated with many factors. A variety of sunlight exposure, nutrition, food fortification, supplements, vitamin D status, Physical activity, and adequate body weight is desirable to obtain sufficiently.

**Sun Exposure:**

The American College of Obstetricians and Gynecologists(The American College of obstetrician and Gynecologist, 2018)suggests that pregnant women aim for 15 minutes of sun

exposure without sunscreen on their face, arms, legs, or back a few times per-week, obtaining proper sun exposure, especially during mid-day. It is important to note that having too much time in the sun may cause accelerated aging of the skin and increase the likelihood of developing skin cancer. So, it is crucial to practice safe sun behavior(Barysch et al., 2010).

**Diet:** The ingestion of a balanced diet that includes Diets high in Dietary sources of vitamin D include fatty fish, eggs, and fortified milk, or orange juice can improve vitamin D status. Increasing the half-life of 25(OH)D by dietary calcium consumption has a vitamin D sparing effect.

**Vitamin D supplementation:** Taking vitamin D supplement as doctor's advice.

**Clothing:** Avoid extended periods of staying at indoors and limit skin coverage while outside.

**Exercise and body weight:** Exercising regularly and maintaining a healthy body weight.

## 3.20 Systematic prenatal testing for vitamin D deficiency:

The routine screening of pregnant women or systemic prenatal testing for vitamin D inadequacy is a continuous discussion among healthcare professionals. Some studies show that frequent screening is vital to identify and treat vitamin D insufficiency in mothers; vitamin D levels are crucial to prenatal and maternal health(Bodnar et al., 2007). Others, however, warn that broad screening may lead to overdiagnosis and overtreatment, as many women with low vitamin D levels may not need treatment(Holick, 2011). There is currently no globally acknowledged protocol for routine vitamin D screening during pregnancy, and the choice to check often mainly on the healthcare professional and the patient's risk factors for insufficiency. Many healthcare practitioners do, however, advocate screening for pregnant mothers at high vitamin d threat-deficits, it includes those with dark skin, or a history of low vitamin D levels(Holick, 2007).

# Chapter 4

## 4.1 Conclusion:

insufficiency during pregnancy is a rising issue, potentially impacting maternal and fetal health. Lifestyle Diet, sun exposure, and supplements, among others, significantly determine vitamin D levels during pregnancy. Having sufficient quantities of vitamin D is crucial for optimum prenatal and maternal health. Addressing lifestyle-related factors can effectively prevent and treat vitamin D deficiency during pregnancy. Additional research is required to understand lifestyle's effect on vitamin D levels, determine what vitamin D dosage is best for pregnant women, and take into consideration ethnic differences in lifestyle habits. Educating pregnant women and healthcare providers about the significance of adequate vitamin D levels and the role of lifestyle changes in achieving this can be essential in Treatment and prevention of vitamin D insufficiency during pregnancy.

## 4.2 Future Directions:

More research is required to comprehend lifestyle's effect on vitamin D deficiency during pregnancy. Literature suggests that longitudinal studies can investigate throughout pregnancy and after delivery. In contrast, interventional studies can test the efficacy of lifestyle modifications, such as dietary changes, sun exposure, and supplementation, in raising maternal vitamin D levels. Furthermore, determining the optimal vitamin D levels for pregnant women to ensure optimal fetal and maternal outcomes is a crucial area of research. The influence of cultural and social factors should be investigated in future studies. Ethnic differences in lifestyle, sun exposure, and dietary habits on pregnant women's vitamin D levels(The American

College of Obstetricians and Gynecologists, 2018). Campaigns may be launched to raise awareness among pregnant women and medical professionals about the need of maintaining healthy levels of vitamin D via diet and exercise.

## 4.3 Limitations of the Study:

This study has some limitations. Since this is a review paper, it is considered a secondary source of information. This review paper has summarized and synthesized the findings of primary sources and published research articles to provide a complete rundown of the subject. For the purposes of this investigation, limited by its reliance on published papers and limited access to some documents due to publisher restrictions. Due to other coursework, the article was also written with limited time and attention.

## Reference:

Institute of Medicine Committee to Review Dietary Reference Intakes for Vitamin, D., & Calcium. (2011). The National Academies Collection: Reports funded by National Institutes of Health. In A. C. Ross, C. L. Taylor, A. L. Yaktine, & H. B. Del Valle (Eds.), Dietary Reference Intakes for Calcium and Vitamin D. National Academies Press (US)

 https://doi.org/10.17226/13050

Charoenngam, N., & Holick, M. F. (2020). Immunologic Effects of Vitamin D on Human Health and Disease. Nutrients, 12(7). https://doi.org/10.3390/nu12072097

Umar, M., Sastry, K. S., & Chouchane, A. I. (2018). Role of Vitamin D Beyond the Skeletal Function: A Review of the Molecular and Clinical Studies. Int J Mol Sci, 19(6). https://doi.org/10.3390/ijms19061618

Fiscaletti, M., Stewart, P., & Munns, C. F. (2017). The importance of vitamin D in maternal and child health: a global perspective. Public Health Rev, 38, 19. https://doi.org/10.1186/s40985-017-0066-3

Sudfeld, C. R., Jacobson, D. L., Rueda, N. M., Neri, D., Mendez, A. J., Butler, L., Siminski, S., Hendricks, K. M., Mellins, C. A., Duggan, C. P., & Miller, T. L. (2019). Third Trimester Vitamin D Status Is Associated with Birth Outcomes and Linear Growth of HIV-Exposed Uninfected Infants in the United States. J Acquir Immune Defic Syndr, 81(3), 336-344. https://doi.org/10.1097/qai.0000000000002041

Roomi, M. A., Farooq, A., Ullah, E., & Lone, K. P. (2015). Hypovitaminosis D and its association with lifestyle factors. Pak J Med Sci, 31(5), 1236-1240. https://doi.org/10.12669/pjms.315.7196

A Catharine Ross, C. L. T. A. L. Y. and H. B. D. V. (2011). Dietary Reference Intakes for Calcium and Vitamin D.

Akbari, S., Khodadadi, B., Ahmadi, S. A. Y., Abbaszadeh, S., & Shahsavar, F. (2018). Association of vitamin D level and vitamin D deficiency with risk of preeclampsia: A systematic review and updated meta-analysis. Taiwanese Journal of Obstetrics and Gynecology, 57(2), 241–247. https://doi.org/10.1016/j.tjog.2018.02.013

Al-Yatama, F. I., AlOtaibi, F., Al-Bader, M. D., & Al-Shoumer, K. A. (2019). The Effect of Clothing on Vitamin D Status, Bone Turnover Markers, and Bone Mineral Density in Young Kuwaiti Females. International Journal of Endocrinology, 2019, 1–10. https://doi.org/10.1155/2019/6794837

Bassil, D., Rahme, M., Hoteit, M., & Fuleihan, G. E.-H. (2013). Hypovitaminosis D in the Middle East and North Africa: Prevalence, risk factors and impact on outcomes. Dermato-Endocrinology, 5(2), 274–298. https://doi.org/10.4161/derm.25111

Bikle, D. D. (2000). Vitamin D: Production, Metabolism, and Mechanisms of Action.

Bodnar, L. M., Platt, R. W., & Simhan, H. N. (2015). Early-pregnancy vitamin D deficiency and risk of preterm birth subtypes. Obstetrics and Gynecology, 125(2), 439–447. https://doi.org/10.1097/AOG.0000000000000621

Bodnar, L. M., Simhan, H. N., Powers, R. W., Frank, M. P., Cooperstein, E., & Roberts, J. M. (2007). High prevalence of vitamin D insufficiency in black and white pregnant women

residing in the northern United States and their neonates. The Journal of Nutrition, 137(2), 447–452. https://doi.org/10.1093/jn/137.2.447

Bonilla, C., Ness, A. R., Wills, A. K., Lawlor, D. A., Lewis, S. J., & Davey Smith, G. (2014). Skin pigmentation, sun exposure and vitamin D levels in children of the Avon Longitudinal Study of Parents and Children. BMC Public Health, 14, 597. https://doi.org/10.1186/1471-2458-14-597

Gustafsson, M. K., Romundstad, P. R., Stafne, S. N., Helvik, A.-S., Stunes, A. K., Mørkved, S., Salvesen, K. Å., Thorsby, P. M., Mosti, M. P., & Syversen, U. (2019). The effect of an exercise program in pregnancy on vitamin D status among healthy, pregnant Norwegian women: a randomized controlled trial. BMC Pregnancy and Childbirth, 19(1), 76. https://doi.org/10.1186/s12884-019-2220-z

Hajizadeh, S., Rankin Shary, J., Gayle Reed, S., & Lynn Wagner, C. (2019). The prevalence of hypovitaminosis D and its risk factors in pregnant women and their newborns in the Middle East: A systematic review. International Journal of Reproductive Biomedicine, 17(10), 685–708. https://doi.org/10.18502/ijrm.v17i10.5284

Heaney, R. P. (2008). Vitamin D in health and disease. Clinical Journal of the American Society of Nephrology : CJASN, 3(5), 1535–1541. https://doi.org/10.2215/CJN.01160308

Holick, M. F. (2007). Vitamin D deficiency. The New England Journal of Medicine, 357(3), 266–281. https://doi.org/10.1056/NEJMra070553

Holick, M. F. (2011). Vitamin D: a d-lightful solution for health. Journal of Investigative Medicine : The Official Publication of the American Federation for Clinical Research, 59(6), 872–880. https://doi.org/10.2310/JIM.0b013e318214ea2d

Holick, M. F., & Chen, T. C. (2008). Vitamin D deficiency: a global problem with health consequences. The American Journal of Clinical Nutrition, 87(4), 1080S-6S. https://doi.org/10.1093/ajcn/87.4.1080S

Hyppönen, E., Läärä, E., Reunanen, A., Järvelin, M. R., & Virtanen, S. M. (2001). Intake of vitamin D and risk of type 1 diabetes: a birth-cohort study. Lancet (London, England), 358(9292), 1500–1503. https://doi.org/10.1016/S0140-6736(01)06580-1

Kimlin, M. G. (2008). Geographic location and vitamin D synthesis. Molecular Aspects of Medicine, 29(6), 453–461. https://doi.org/10.1016/j.mam.2008.08.005

Lin, S., Jiang, L., Zhang, Y., Chai, J., Li, J., Song, X., & Pei, L. (2021). Socioeconomic status and vitamin D deficiency among women of childbearing age: a population-based, case-control study in rural northern China. BMJ Open, 11(3), e042227. https://doi.org/10.1136/bmjopen-2020-042227

Michael F. Holick. (2011). The Vitamin D Solution: A 3-Step Strategy to Cure Our Most Common Health Problems.

Nair, R., & Maseeh, A. (2012). Vitamin D: The "sunshine" vitamin. Journal of Pharmacology & Pharmacotherapeutics, 3(2), 118–126. https://doi.org/10.4103/0976-500X.95506

National Institute of Health. (2022, August 12). Vitamin D Fact Sheet for Health Professionals.

Özdemir, A. A., Ercan Gündemir, Y., Küçük, M., Yıldıran Sarıcı, D., Elgörmüş, Y., Çağ, Y., & Bilek, G. (2018). Vitamin D Deficiency in Pregnant Women and Their Infants. Journal of Clinical Research in Pediatric Endocrinology, 10(1), 44–50. https://doi.org/10.4274/jcrpe.4706

Padhi, R., Panda, B., Jagati, S., & Patra, S. (2014). Vitamin D status in adult critically ill patients in Eastern India: An observational retrospective study. Lung India, 31(3), 212. https://doi.org/10.4103/0970-2113.135755

Richard, A., Rohrmann, S., & Quack Lötscher, K. (2017). Prevalence of Vitamin D Deficiency and Its Associations with Skin Color in Pregnant Women in the First Trimester in a Sample from Switzerland. Nutrients, 9(3), 260. https://doi.org/10.3390/nu9030260

Rockwell, M., Kraak, V., Hulver, M., & Epling, J. (2018). Clinical Management of Low Vitamin D: A Scoping Review of Physicians' Practices. Nutrients, 10(4). https://doi.org/10.3390/nu10040493

Roomi, M. A., ROOMI, M. A., FAROOQ, A., ULLAH, E., & LONE, K. P. (2015). Hypovitaminosis D and its association with lifestyle factors. Pakistan Journal of Medical Sciences, 31(5). https://doi.org/10.12669/pjms.315.7196

Schnatz, P. F., & Manson, J. E. (2014). Vitamin D and cardiovascular disease: an appraisal of the evidence. Clinical Chemistry, 60(4), 600–609. https://doi.org/10.1373/clinchem.2013.211037

Sherchand, O., Kishore Baranwal, J., & Gelal, B. (2022). Socioeconomic Determinants of Vitamin D Status in Women. Jundishapur Journal of Health Sciences, 14(3). https://doi.org/10.5812/jjhs-129396

Spiro, A., & Buttriss, J. L. (2014). Vitamin D: An overview of vitamin D status and intake in Europe. Nutrition Bulletin, 39(4), 322–350. https://doi.org/10.1111/nbu.12108

US Department of Health and Human Services. (2014). The Surgeon General's Call to Action to Prevent Skin Cancer.

Wacker, M., & Holick, M. F. (2013). Sunlight and Vitamin D: A global perspective for health. Dermato-Endocrinology, 5(1), 51–108. https://doi.org/10.4161/derm.24494

A Catharine Ross, C. L. T. A. L. Y. and H. B. D. V. (2011). Dietary Reference Intakes for Calcium and Vitamin D.

Akbari, S., Khodadadi, B., Ahmadi, S. A. Y., Abbaszadeh, S., & Shahsavar, F. (2018). Association of vitamin D level and vitamin D deficiency with risk of preeclampsia: A systematic review and updated meta-analysis. Taiwanese Journal of Obstetrics and Gynecology, 57(2), 241–247. https://doi.org/10.1016/j.tjog.2018.02.013

Al-Yatama, F. I., AlOtaibi, F., Al-Bader, M. D., & Al-Shoumer, K. A. (2019). The Effect of Clothing on Vitamin D Status, Bone Turnover Markers, and Bone Mineral Density in Young Kuwaiti Females. International Journal of Endocrinology, 2019, 1–10. https://doi.org/10.1155/2019/6794837

Bassil, D., Rahme, M., Hoteit, M., & Fuleihan, G. E.-H. (2013). Hypovitaminosis D in the Middle East and North Africa: Prevalence, risk factors and impact on outcomes. Dermato-Endocrinology, 5(2), 274–298. https://doi.org/10.4161/derm.25111

Bikle, D. D. (2000). Vitamin D: Production, Metabolism, and Mechanisms of Action.

Bodnar, L. M., Platt, R. W., & Simhan, H. N. (2015). Early-pregnancy vitamin D deficiency and risk of preterm birth subtypes. Obstetrics and Gynecology, 125(2), 439–447. https://doi.org/10.1097/AOG.0000000000000621

Bodnar, L. M., Simhan, H. N., Powers, R. W., Frank, M. P., Cooperstein, E., & Roberts, J. M. (2007). High prevalence of vitamin D insufficiency in black and white pregnant women residing in the northern United States and their neonates. The Journal of Nutrition, 137(2), 447–452. https://doi.org/10.1093/jn/137.2.447

Bonilla, C., Ness, A. R., Wills, A. K., Lawlor, D. A., Lewis, S. J., & Davey Smith, G. (2014). Skin pigmentation, sun exposure and vitamin D levels in children of the Avon Longitudinal

Study of Parents and Children. BMC Public Health, 14, 597. https://doi.org/10.1186/1471-2458-14-597

Gustafsson, M. K., Romundstad, P. R., Stafne, S. N., Helvik, A.-S., Stunes, A. K., Mørkved, S., Salvesen, K. Å., Thorsby, P. M., Mosti, M. P., & Syversen, U. (2019). The effect of an exercise program in pregnancy on vitamin D status among healthy, pregnant Norwegian women: a randomized controlled trial. BMC Pregnancy and Childbirth, 19(1), 76. https://doi.org/10.1186/s12884-019-2220-z

Hajizadeh, S., Rankin Shary, J., Gayle Reed, S., & Lynn Wagner, C. (2019). The prevalence of hypovitaminosis D and its risk factors in pregnant women and their newborns in the Middle East: A systematic review. International Journal of Reproductive Biomedicine, 17(10), 685–708. https://doi.org/10.18502/ijrm.v17i10.5284

Heaney, R. P. (2008). Vitamin D in health and disease. Clinical Journal of the American Society of Nephrology : CJASN, 3(5), 1535–1541. https://doi.org/10.2215/CJN.01160308

Holick, M. F. (2007). Vitamin D deficiency. The New England Journal of Medicine, 357(3), 266–281. https://doi.org/10.1056/NEJMra070553

Holick, M. F. (2011). Vitamin D: a d-lightful solution for health. Journal of Investigative Medicine : The Official Publication of the American Federation for Clinical Research, 59(6), 872–880. https://doi.org/10.2310/JIM.0b013e318214ea2d

Holick, M. F., & Chen, T. C. (2008). Vitamin D deficiency: a global problem with health consequences. The American Journal of Clinical Nutrition, 87(4), 1080S-6S. https://doi.org/10.1093/ajcn/87.4.1080S

Hyppönen, E., Läärä, E., Reunanen, A., Järvelin, M. R., & Virtanen, S. M. (2001). Intake of vitamin D and risk of type 1 diabetes: a birth-cohort study. Lancet (London, England), 358(9292), 1500–1503. https://doi.org/10.1016/S0140-6736(01)06580-1

Kimlin, M. G. (2008). Geographic location and vitamin D synthesis. Molecular Aspects of Medicine, 29(6), 453–461. https://doi.org/10.1016/j.mam.2008.08.005

Lin, S., Jiang, L., Zhang, Y., Chai, J., Li, J., Song, X., & Pei, L. (2021). Socioeconomic status and vitamin D deficiency among women of childbearing age: a population-based, case-control study in rural northern China. BMJ Open, 11(3), e042227. https://doi.org/10.1136/bmjopen-2020-042227

Michael F. Holick. (2011). The Vitamin D Solution: A 3-Step Strategy to Cure Our Most Common Health Problems .

Nair, R., & Maseeh, A. (2012). Vitamin D: The “sunshine” vitamin. Journal of Pharmacology & Pharmacotherapeutics, 3(2), 118–126. https://doi.org/10.4103/0976-500X.95506

National Institute of Health. (2022, August 12). Vitamin D Fact Sheet for Health Professionals.

Özdemir, A. A., Ercan Gündemir, Y., Küçük, M., Yıldıran Sarıcı, D., Elgörmüş, Y., Çağ, Y., & Bilek, G. (2018). Vitamin D Deficiency in Pregnant Women and Their Infants. Journal of Clinical Research in Pediatric Endocrinology, 10(1), 44–50. https://doi.org/10.4274/jcrpe.4706

Padhi, R., Panda, B., Jagati, S., & Patra, S. (2014). Vitamin D status in adult critically ill patients in Eastern India: An observational retrospective study. Lung India, 31(3), 212. https://doi.org/10.4103/0970-2113.135755

Richard, A., Rohrmann, S., & Quack Lötscher, K. (2017). Prevalence of Vitamin D Deficiency and Its Associations with Skin Color in Pregnant Women in the First Trimester in a Sample from Switzerland. Nutrients, 9(3), 260. https://doi.org/10.3390/nu9030260

Rockwell, M., Kraak, V., Hulver, M., & Epling, J. (2018). Clinical Management of Low Vitamin D: A Scoping Review of Physicians' Practices. Nutrients, 10(4). https://doi.org/10.3390/nu10040493

Roomi, M. A., ROOMI, M. A., FAROOQ, A., ULLAH, E., & LONE, K. P. (2015). Hypovitaminosis D and its association with lifestyle factors. Pakistan Journal of Medical Sciences, 31(5). https://doi.org/10.12669/pjms.315.7196

Schnatz, P. F., & Manson, J. E. (2014). Vitamin D and cardiovascular disease: an appraisal of the evidence. Clinical Chemistry, 60(4), 600–609. https://doi.org/10.1373/clinchem.2013.211037

Sherchand, O., Kishore Baranwal, J., & Gelal, B. (2022). Socioeconomic Determinants of Vitamin D Status in Women. Jundishapur Journal of Health Sciences, 14(3). https://doi.org/10.5812/jjhs-129396

Spiro, A., & Buttriss, J. L. (2014). Vitamin D: An overview of vitamin D status and intake in Europe. Nutrition Bulletin, 39(4), 322–350. https://doi.org/10.1111/nbu.12108

US Department of Health and Human Services. (2014). The Surgeon General's Call to Action to Prevent Skin Cancer.

Wacker, M., & Holick, M. F. (2013). Sunlight and Vitamin D: A global perspective for health. Dermato-Endocrinology, 5(1), 51–108. https://doi.org/10.4161/derm.24494