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Research Article

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The Association of Maternal Vitamin D Deficiency with the Risk of Preeclampsia in Al-Jabal Al-Akhdar, Libya

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Abstract

According to the World Health Organization, preeclampsia is one of the leading causes of maternal and fetal morbidity and mortality in developing countries. The aim was to evaluate whether an association exists between vitamin D deficiency and preeclampsia in Al-Jabal Al-Akhdar, Libya. A total of 158 pregnant women, ranging in gestational age from 27 to 40 weeks, were included in the study. Each participant had their vitamin D level measured, and then they were categorized into two groups: control and preeclampsia. The preeclampsia cases were further divided into mild and severe preeclampsia. Patients with preeclampsia had lower serum vitamin D levels than the control group. A logistic regression analysis revealed no significant difference in serum vitamin D levels between preeclampsia and control groups. The total odds ratios for the preeclampsia group were not statistically significant. The preeclampsia group showed an OR of 2.457 (95% CI: 1.330 to 4.541), which suggests a statistically significant increased risk. Patients with preeclampsia had lower serum vitamin D levels than the control group, vitamin D deficiency may be associated with an increased risk of severe preeclampsia.

Keywords: 25-hydroxyvitamin D; Preeclampsia; Hypertension; Maternal welfare; Pregnancy-induced hypertension.

INTRODUCTION

Preeclampsia is regarded as a significant contributor to maternal and fetal morbidity and mortality in developing countries (Jeyabalan, 2013). The prevalence of preeclampsia has risen over the last twenty years (Malm et al., 2023) and now affects 2–8% of pregnancies globally (Ahmed et al., 2014). Preeclampsia is a systemic condition that affects the vascular endothelium and elevates the risk of subsequent cardiovascular disease (Bellamy et al., 2007). Epidemiology, clinical manifestation, and related morbidity are very heterogeneous, and the pathobiological processes underlying the illness remain little understood. Early-onset or 'placental' preeclampsia, occurring before 34 weeks, is linked to a significant risk of intrauterine growth restriction, whereas late-onset or maternal preeclampsia, occurring beyond 34 weeks, is often associated with maternal risk factors such as obesity and systemic disorders. The newborns are often large for their gestational age (Burton et al., 2019).

An enhanced comprehension of the etiology of preeclampsia would facilitate the prevention and treatment of the condition (Phipps et al., 2016). Recent studies indicate that decreased vitamin

D levels during pregnancy correlate with a heightened risk of preeclampsia. Vitamin D may influence early placental development, suggesting a potential preventative function for vitamin D supplementation (Hyppönen et al., 2014; Mirzakhani et al., 2016). The findings on the correlation between vitamin D and preeclampsia are incongruous and need elucidation (Agarwal et al., 2018). Vitamin D insufficiency is a worldwide health issue, particularly prevalent among pregnant women, especially in several low- and middle-income countries (LMIC) (Roth et al., 2018).

Maternal vitamin D is crucial for calcium metabolism, immunological function, and vascular health. Possible mechanisms connecting vitamin D deficiency to preeclampsia have been explored in research (observational, cohort, case-control) investigating the correlation between maternal vitamin D levels and the risk of preeclampsia. Optimal nutritional status and food consumption patterns during pregnancy correlate with reduced incidences of poor pregnancy outcomes, including preeclampsia (Baker et al., 2018). Micronutrient insufficiency during pregnancy must be meticulously handled, since it may lead to a wide array of detrimental effects, including placental malfunction. Certain micronutrient deficiencies have been closely linked to hypertensive diseases of pregnancy, such as the development of preeclampsia (Del Valle et al., 2011; Keshavarz et al., 2017; de Souza et al., 2019). Insufficient pre-pregnancy vitamin D levels have been associated with the development of preeclampsia. The influence of vitamin D on placental vascularization and angiogenesis is crucial for proper placentation, which may be inadequate in women with preeclampsia (von Websky & Hasan, 2017). Multivitamin and vitamin D supplementation have been shown to diminish the risk of preeclampsia development (Fu et al., 2018).

Oxidative stress and inflammation associated with placental failure may result in modified vitamin D receptor expression. Decreased receptor levels and impaired metabolism are seen in preeclampsia (PE). Insufficiency of bioactive placental vitamin D during pregnancy may lead to adverse consequences, such as preeclampsia, owing to increased inflammatory processes (Baker et al., 2018; de Souza et al., 2019). Insufficient vitamin D intake has been linked to potential harm to fetal development, intrauterine growth restriction, preeclampsia, and infections in both mothers and neonates. Feng et al. (2017) reported that women with elevated calcium and vitamin D intake had enhanced postprandial glycemia, insulin response, and hypertension. The use of vitamin D seems to reduce the incidence of preeclampsia. A meta-analysis corroborated this in trials of vitamin D supplementation (Fu et al., 2018). The purpose of this study is to evaluate whether an association exists between vitamin D deficiency and preeclampsia in Al-Jabal Al-Akhdar, Libya.

MATERIALS AND METHODS

Study Design

A prospective case-control study.

Study Setting

Data Collection

The data were collected over one year at an obstetrics and gynecology ward in a secondary-level hospital in Al-Jabal Al-Akhdar, Libya. Maternal blood samples were collected throughout the second and third trimesters (28–40 weeks of gestation).

The inclusion criteria for the study included

1. Patients were admitted to the obstetrics and gynecology ward from 1st January 2023 to 1st

December 2023.
2. A blood pressure > 140 mmHg or a diastolic blood pressure > 90 mmHg
3. Proteinuria > 0.3 g/24 h.

Assessment of vitamin D status

25(OH)D was measured in maternal blood samples obtained during the second and third (28–40 weeks) trimesters.

Ethical Considerations

Ethical approval was obtained from the data collection site for permission to retrieve data from hospital archives. Furthermore, written informed consent was obtained from each respondent prior to the interview, and the confidentiality and anonymity of the data were ensured.

Statistical Analysis

The data were examined using the Statistical Package for the Social Sciences (SPSS) software, version 20.0. The Kolmogorov-Smirnov test was used to assess the normality of the distribution. Quantitative data were characterized by range (minimum and maximum), mean, and standard deviation. The significance of the findings obtained was assessed at the 5% significance level. The Chi-square test was used for categorical data, while the student t-test was used for normally distributed quantitative variables.

RESULTS

The study included 158 pregnant women, comprising 50 women with preeclampsia (cases) and 108 normotensive pregnant women (controls). Table 1 compares the clinical and demographic characteristics of women with preeclampsia and controls. Gestational age was significantly lower in the case group (34.4 ± 3.6 vs. 35.4 ± 2.3 weeks; $p = 0.028$), indicating a tendency toward earlier delivery. Serum calcium levels were also significantly reduced in cases (8.0 ± 0.9 vs. 8.4 ± 0.7 mg/dL; $p = 0.017$), suggesting a possible role in disease risk. In contrast, differences in BMI (28.8 vs. 30.4; $p = 0.068$), serum vitamin D (22.2 vs. 24.2 ng/mL; $p = 0.259$), fetal weight (2894 vs. 2947 g; $p = 0.643$), and maternal age (29.9 vs. 28.9 years; $p = 0.464$) were modest and not statistically significant, indicating that these parameters were not major differentiating factors between the groups. The 31.6% is not the prevalence of preeclampsia in the population; it is simply the proportion of cases in our study sample.

Table (1). Clinical and demographic profiles of preeclamptic cases compared to matched healthy controls.

Variable	Cases (n = 50)	Controls (n = 108)	t	p
	Mean (SD)	Mean (SD)		
Gestational age (week)	34.36 (3.590)	35.41 (2.276)	2.221	.028
BMI	28.76 (6.808)	30.42 (4.357)	1.841	.068
Serum vitamin D	22.20 (10.392)	24.17 (10.041)	1.132	.259
Serum calcium	8.04 (.880)	8.36 (.729)	2.408	.017
Fetal weight	2894.14 (643.605)	2947.05 (675.614)	.465	.643
Maternal age	29.88 (6.730)	28.92 (8.077)	-.733-	.464

t: Paired t-test
*: Significant at $p \leq 0.05$

Table 2 illustrates the clinical and obstetric characteristics of the study population. A prior history of preeclampsia was reported by 76.0% of cases (n=38) and 84.3% of controls (n=91), showing no statistically significant difference between the groups (p=0.212). Current clinical parameters were similarly comparable, with the distribution of chronic illnesses yielding no significant varia-

tion (p=0.121); the vast majority of both cases (74.0%) and controls (73.1%) reported no baseline medical comorbidities. Furthermore, maternal semi-quantitative proteinuria levels were statistically equivalent between the preeclamptic and normotensive groups (p=0.254).

Table (2). Comparison of clinical and demographic data between preeclamptic patients (cases) and healthy pregnant women (controls).

Variable	Cases (n = 50)	Controls (n = 108)	p
History of preeclampsia	38 (76.0%)	91 (84.3%)	.212
Chronic illness			
None	37 (74.0%)	79 (73.1%)	.121
Renal diseases	2 (4%)	0%	
Blood disorder	1 (2%)	1 (0.9%)	
APS	1 (2%)	1 (0.9%)	
Thyroid disorder	2 (4%)	3 (2.8%)	
Bronchial asthma	2 (4%)	0%	
Breast cyst	0%	1 (0.9%)	
Hypertension	2 (4%)	9 (8.3%)	
Diabetes mellitus	1 (2%)	8 (7.4%)	
Ulcerative colitis	0%	1 (0.9%)	
Idiopathic thrombocytopenic purpura	0%	4 (3.7%)	
Anemia	2 (1.9%)	1 (2%)	
Urine protein			
Nil	22 (20.4%)	4 (8%)	.254
+	57 (52.8%)	32 (64%)	
++	25 (23.1%)	10 (20%)	
+++	3 (2.8%)	3 (6%)	

When comparing biochemical parameters, serum vitamin D and calcium levels were consistently lower in cases than in controls. Although the differences in vitamin D were modest (22.20 ± 10.392 vs. 24.17 ± 10.041; $p = 0.259$), calcium levels showed a statistically significant reduction in the case group (8.04 ± 0.880 vs. 8.36 ± 0.729; $p = 0.017$, t-test). This downward trend highlights a potential link between diminished vitamin D and calcium status and the condition under study, as illustrated in Figure 1.

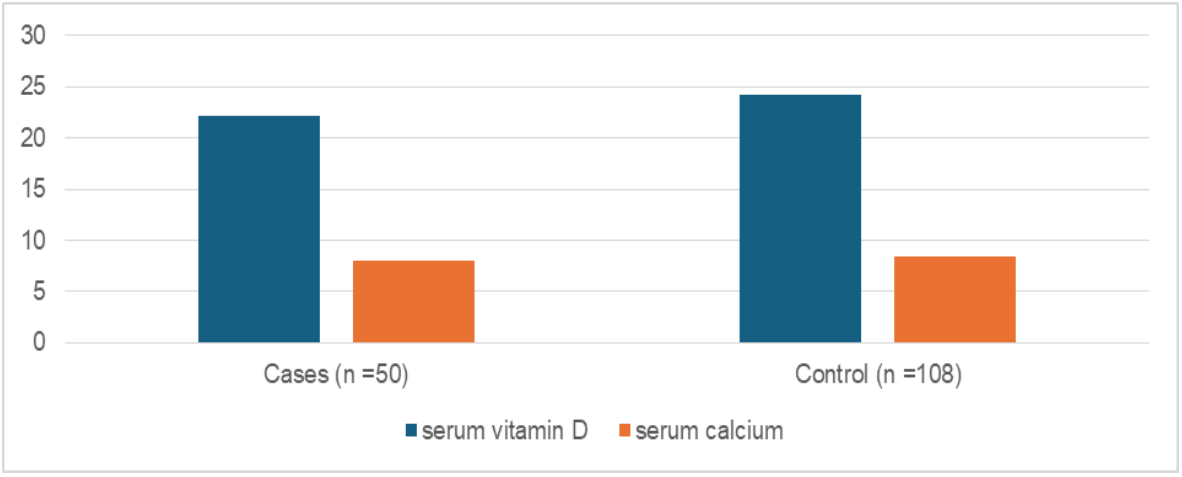

Figure (1). Mean 25(OH)D concentrations in maternal serum of the study groups.

Vitamin D status in the third trimester showed similar distributions between cases and controls. Low levels (≤10 ng/mL) were found in 5 cases (45.5%) and 6 controls (54.5%; p = 0.439). Middle levels (10–30 ng/mL) were more common in controls [73 (67.9%)] than in cases [35 (32.1%)]; p = 0.445. High levels (≥30 ng/mL) occurred in 10 cases (20.0%) and 29 controls (26.9%; p = 0.218).
Overall, the distribution of vitamin D categories was comparable between the two groups, with no statistically significant differences observed.

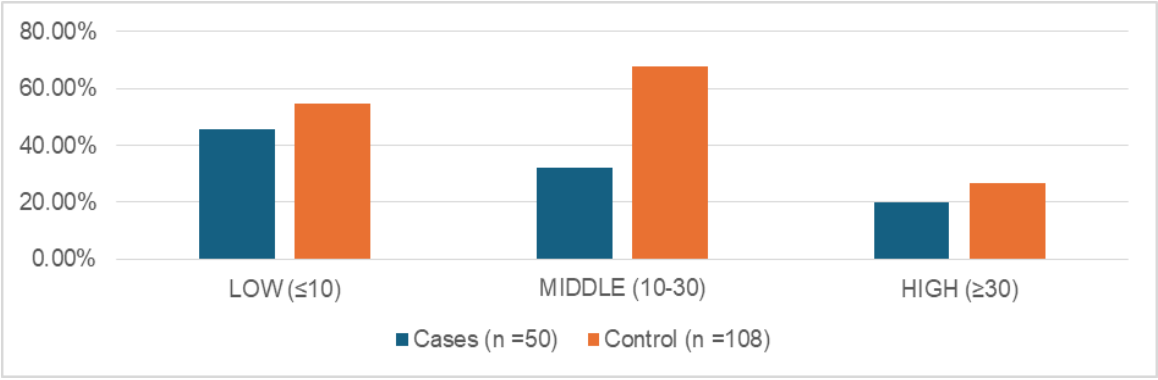

Figure (2). Vitamin D level in the third trimester in both groups: controls and cases.

Table 3 presents the odds ratios (ORs) and 95% confidence intervals (CIs) for the association between maternal vitamin D levels during the third trimester, gestational age category (GAC), and preeclampsia. No odds-ratio estimate was available for the low vitamin D group (≤10 ng/mL). In the middle vitamin D group (10–30 ng/mL), GAC showed an OR of 0.472 (95% CI: 0.029–7.778), suggesting lower odds of the outcome. Within the same vitamin D category, the ORs for the control and preeclampsia groups were 0.736 (95% CI: 0.183–2.961) and 1.559 (95% CI: 0.379–6.406), respectively, with confidence intervals crossing 1.
In the high vitamin D group (≥30 ng/mL), preeclampsia cases exhibited significantly higher odds (OR = 4.625, 95% CI: 2.504–8.542).

Table (3). Risk of preeclampsia (odds ratios) categorized by maternal vitamin D levels during the third trimester.

Vitamin D Level	Variable	OR	95% CI Lower	95% CI Upper
Middle (10–30 ng/mL)	GAC	0.472	0.029	7.778
	Preeclampsia (Control group)	0.736	0.183	2.961
	Preeclampsia (Cases)	1.559	0.379	6.406
	Valid cases (108)		—	—
High (≥30 ng/mL)	Preeclampsia (Cases)	4.625	2.504	8.542
	Valid cases	39	—	—
Overall Sample	GAC	0.146	0.015	1.444
	Preeclampsia (Control group)	0.360	0.066	1.971
	Preeclampsia (Cases)	2.457	1.330	4.541
	Valid cases (158)		—	—

DISCUSSION

Our study demonstrated that serum 25(OH)D levels were lower in the preeclampsia group than in the control group; however, this difference was not statistically significant. Our findings are consistent with those of Wetta et al. (2014), who evaluated the association between vitamin D status and the risk of preeclampsia before 37 weeks of gestation or spontaneous preterm delivery before 35 weeks. Neither vitamin D insufficiency (adjusted odds ratio [OR] = 1.1, 95% confidence interval

[CI]: 0.6–2.0) nor vitamin D deficiency (adjusted OR = 1.4, 95% CI: 0.7–3.0) was significantly associated with preeclampsia. Furthermore, maternal vitamin D levels were not significantly associated with the occurrence of preeclampsia before 37 weeks of gestation.

Our findings align with those reported by Singla et al. (2015), who investigated the association between vitamin D insufficiency and preeclampsia and its adverse outcomes. Their study included 74 nulliparous women with preeclampsia carrying singleton pregnancies and without known medical disorders, as well as 100 age-matched healthy nulliparous controls. Serum vitamin D concentrations were compared between the two groups. The authors also evaluated vitamin D levels according to the severity of preeclampsia (moderate versus severe) and the presence of preeclampsia-related complications. They reported that vitamin D insufficiency was highly prevalent among pregnant women in India and that women with preeclampsia had significantly lower vitamin D levels than healthy controls. Furthermore, serum 25(OH)D concentrations were significantly lower in preeclamptic women (9.7±4.95 ng/mL) than in normotensive controls (14.8±6.68 ng/mL; $p = 0.0001$). Similarly, our study confirmed that maternal vitamin D deficiency significantly correlates with an increased risk of severe preeclampsia.

Moreover, according to the results of Zhao et al. (2017), serum 25(OH)D levels were considerably lower in pregnant women who later had severe preeclampsia compared to those who did not. Their results indicate that a maternal deficit in 25(OH)D is significantly correlated with a heightened risk of severe preeclampsia.

Sima et al. (Hashemipour et al., 2017) performed a case-control study with 74 pregnant women diagnosed with preeclampsia, comprising 46 with moderate preeclampsia and 28 with severe preeclampsia. The research included 75 healthy pregnant women. The researchers found that the mean serum 25(OH)D levels were 27.7±15.3, 22.9±15.9, and 27.6±16.6 in the normal, mild preeclampsia, and severe preeclampsia groups, respectively. This indicates that there was no substantial difference in 25(OH)D insufficiency across the groups. The severity of preeclampsia was not shown to correlate with vitamin D deficiency.

Based on the study's results, 25(OH)D levels were not associated with preeclampsia severity. The study by (Dabbaghmanesh et al. 2015) indicated that a comparison of 25(OH)D levels between normal primigravida women and those with severe preeclampsia showed no significant differences ($p > 0.05$). Furthermore, their results directly contradicted our findings.

The results of a logistic regression that investigated the relationship between vitamin D levels, GAC, and the history of preeclampsia are presented. The odds ratio (OR) indicates how much more likely a particular outcome is to occur in one group than in another. Odds ratios for comparisons are provided along with their 95% confidence intervals. An OR of 0.736 (95% CI: 0.183 to 2.961) for the control group means there is no strong evidence of an association between this group and the outcome (since the confidence interval includes 1). An OR of 1.559 (95% CI: 0.379 to 6.406) for the preeclampsia group suggests there may be an increased risk, but the confidence interval is wide, implying uncertainty. The total odds ratio for GAC: An OR of 0.146 (95% CI: 0.015 to 1.444) indicates that being in one gestational age category compared to another might reduce the odds of the outcome, but the confidence interval includes 1, so it’s not statistically significant. Likewise, the preeclampsia group shows an OR of 2.457 (95% CI: 1.330 to 4.541), which suggests a statistically significant increased risk. Odds ratios (ORs): Values above 1 suggest increased odds of the outcome, while values below 1 suggest reduced odds.

CONCLUSION

This study found that patients with preeclampsia had lower serum vitamin D levels compared to

controls. Although logistic regression did not show a consistent significant difference overall, the odds ratio of 2.457 (95% CI: 1.330–4.541) indicates a statistically significant increased risk in severe cases. These findings suggest that vitamin D deficiency may be a potential risk factor for severe preeclampsia and could aid in predicting its severity.

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ETHICS

The authors declare that no ethical issues are expected to arise after the publication of this manuscript.

Duality of interest: The authors declare that they have no duality of interest associated with this manuscript.

Author contributions: N.B.S. and A.A.A. developed the theoretical formalism, N.B.S. performed the analytic calculations. N.B.S., A.A.A., and N.A.S. contributed to the final version of the manuscript. A.A.A. supervised the project.

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ABBREVIATIONS

25(OH)D: 25-hydroxyvitamin D (Calcifediol)

APS: Antiphospholipid Syndrome

BMI: Body Mass Index

GAC: Gestational Age Category

LMIC: Low- and Middle-Income Countries

PE: Preeclampsia

REFERENCES

Agarwal, S., Kovilam, O., & Agrawal, D. K. (2018). Vitamin D and its impact on maternal-fetal outcomes in pregnancy: A critical review. Critical Reviews in Food Science and Nutrition, 58(5), 755–769. https://doi.org/10.1080/10408398.2016.1220915

Ahmed, R., Dunford, J., Mehran, R., Robson, S., & Kunadian, V. (2014). Pre-eclampsia and future cardiovascular risk among women: a review. Journal of the American College of Cardiology, 63(18), 1815–1822. https://doi.org/10.1016/j.jacc.2014.02.529

Baker, B. C., Hayes, D. J., & Jones, R. L. (2018). Effects of micronutrients on placental function: evidence from clinical studies to animal models. Reproduction, 156(3), R69–R82. https://doi.org/10.1530/REP-18-0130

Bellamy, L., Casas, J.-P., Hingorani, A. D., & Williams, D. J. (2007). Pre-eclampsia and risk of cardiovascular disease and cancer in later life: systematic review and meta-analysis. BMJ, 335(7627), 974. https://doi.org/10.1136/bmj.39335.385301.BE

Burton, G. J., Redman, C. W., Roberts, J. M., & Moffett, A. (2019). Pre-eclampsia: pathophysiology and clinical implications. BMJ, 366, l2381. https://doi.org/10.1136/bmj.l2381

Dabbaghmanesh, M. H., Forouhari, S., Ghaemi, S. Z., Khakshour, A., & Kiani Rad, S. (2015). Comparison of 25-hydroxyvitamin D and calcium levels between preeclampsia and normal pregnant women and birth outcomes. International Journal of Pediatrics, 3(6.1), 1047–1055. https://doi.org/10.22038/ijp.2015.5626

de Souza, E. A., Momentti, A. C., de Assis Neves, R., Minari, T. P., de Sousa, F. L. P., & Pisani, L. P. (2019). Calcium intake in high-risk pregnant women assisted in a high-complexity hospital. Molecular Biology Reports, 46(3), 2851–2856. https://doi.org/10.1007/s11033-019-04731-9

Del Valle, H. B., Yaktine, A. L., Taylor, C. L., & Ross, A. C. (2011). Dietary reference intakes for calcium and vitamin D. National Academies Press. https://doi.org/10.17226/13050

Feng, L., Hu, Z., & Wang, Q. (2017). Decreased Serum 25OHD Concentration in Chinese Women with Type 2 Diabetes. Journal of Nutritional Science and Vitaminology, 63(4), 222–227. https://doi.org/10.3177/jnsv.63.222

Fu, Z.-m., Ma, Z.-z., Liu, G.-j., Wang, L.-l., & Guo, Y. (2018). Vitamins supplementation affects the onset of preeclampsia. Journal of the Formosan Medical Association, 117(1), 6–13. https://doi.org/10.1016/j.jfma.2017.08.005

Hyppönen, E., Cavadino, A., Williams, D., Fraser, A., Vereczkey, A., Fraser, W. D., Bánhidy, F., Lawlor, D., & Czeizel, A. E. (2014). Vitamin D and pre-eclampsia: original data, systematic review and meta-analysis. Annals of Nutrition and Metabolism, 63(4), 331–340. https://doi.org/10.1159/000358338

Jeyabalan, A. (2013). Epidemiology of preeclampsia: impact of obesity. Nutrition Reviews, 71(suppl_1), S18–S25. https://doi.org/10.1111/nure.12055

Keshavarz, P., Gh, B. F. N. M., Mirhafez, S. R., Nematy, M., Azimi-Nezhad, M., Afin, S. A., Esmaily, H., Pourali, L., Hakak, A. M., & Soukhtanloo, M. (2017). Alterations in lipid profile, zinc and copper levels and superoxide dismutase activities in normal pregnancy and preeclampsia. The American Journal of the Medical Sciences, 353(6), 552–558. https://doi.org/10.1016/j.amjms.2017.03.022

Malm, G., Lindh, C. H., Hansson, S. R., Källén, K., Malm, J., & Rylander, L. (2023). Maternal serum vitamin D level in early pregnancy and risk for preeclampsia: A case-control study in Southern Sweden. PLoS One, 18(2), e0281234. https://doi.org/10.1371/journal.pone.0281234

Mirzakhani, H., Litonjua, A. A., McElrath, T. F., O'Connor, G., Lee-Parritz, A., Iverson, R., Macones, G., Strunk, R. C., Bacharier, L. B., & Zeiger, R. (2016). Early pregnancy vitamin D

status and risk of preeclampsia. The Journal of Clinical Investigation, 126(12), 4702–4715. https://doi.org/10.1172/JCI89031

Phipps, E., Prasanna, D., Brima, W., & Jim, B. (2016). Preeclampsia: updates in pathogenesis, definitions, and guidelines. Clinical Journal of the American Society of Nephrology, 11(6), 1102–1113. https://doi.org/10.2215/CJN.12081115

Roth, D. E., Abrams, S. A., Aloia, J., Bergeron, G., Bourassa, M. W., Brown, K. H., Calvo, M. S., Cashman, K. D., Combs, G., & De-Regil, L. M. (2018). Global prevalence and disease burden of vitamin D deficiency: a roadmap for action in low- and middle-income countries. Annals of the New York Academy of Sciences, 1430(1), 44–79. https://doi.org/10.1111/nyas.13968

Singla, R., Gurung, P., Aggarwal, N., Dutta, U., & Kochhar, R. (2015). Relationship between preeclampsia and vitamin D deficiency: a case-control study. Archives of Gynecology and Obstetrics, 291, 1247–1251. https://doi.org/10.1007/s00404-014-3550-8

von Websky, K., Hasan, A. A., Reichetzeder, C., Tsuprykov, O., & Hocher, B. (2018). Impact of vitamin D on pregnancy-related disorders and on offspring outcome. The Journal of Steroid Biochemistry and Molecular Biology, 180, 51–64.

Weissgerber, T. L., & Mudd, L. M. (2015). Preeclampsia and diabetes. Current Diabetes Reports, 15(3), 1–10. https://doi.org/10.1007/s11892-015-0580-0