ISSN 2348-0319 International Journal of Innovative and Applied Research [2023]
(Volume 11, Issue 12)
26-34

Journal home page: http://www.journalijiar.com

INTERNATIONAL JOURNAL
OF INNOVATIVE AND APPLIED RESEARCH

RESEARCH ARTICLE

Article DOI: 10.58538/IJIAR/2058
DOI URL: http://dx.doi.org/10.58538/IJIAR/2058

NUTRITIONAL REQUIREMENTS DURING PREGNANCY: A COMPREHENSIVE OVERVIEW

Esther Ugo Alum[1,2], *Emmanuel Ifeanyi Obeagu[3], Okechukwu P. C. Ugwu[1], Chinyere Nneoma Ugwu[1], Daniel Ejim Uti[4], Awotunde O. Samson[5] and Dorcas Ibukun Akinloye[6]

1. Department of Publications and Extension, Kampala International University, P. O. Box 20000, Uganda.
2. Department of Biochemistry, Faculty of Science, Ebonyi State University, P.M.B. 053 Abakaliki, Ebonyi State, Nigeria, 0000-0003-4105-8615
3. Department of Medical Laboratory Science, Kampala International University, Uganda.
4. Department of Biochemistry, Faculty of Basic Medical Sciences, Federal University of Health Sciences, Otukpo, Benue State Nigeria.
5. Department of Biochemistry, Habib Medical School, IUIU, Kampala, Uganda.
6. Department of Biochemistry, College of Biosciences, Federal University of Agriculture, Abeokuta. P.M.B. 2240, Nigeria.

Manuscript Info

Manuscript History
Received: 01 November 2023
Final Accepted: 13 December 2023
Published: December 2023

Keywords:
Nutritional Needs, Pregnancy, Micronutrients, Supplements, Nutritional Counseling

Abstract

Pregnancy demands unique nutritional necessities different from those of women who are not pregnant, involving vital roles of vitamins, minerals, and omega-3 fatty acids. These elements are pivotal for the progression of a healthy pregnancy, aiding mothers in coping with common discomforts and averting complications. Presently, supplementation recommendations for pregnant women vary across nations, prompting the need for comprehensive nutrition counseling as a pivotal aspect of prenatal care. The state of a woman's nutrition has a major effect on her health, the course of her pregnancy, and the welfare of her fetus and newborn. Providers of healthcare must recognize and address these distinctive nutritional requisites, advocating for tailored counseling that considers diverse factors such as availability of food, social, ethnic background, cultural dietary selections, and body mass index. Adjustments become imperative in instances of pregnancy complications like gestational diabetes. Collaboration with nutritionists or registered dietitians is instrumental in delivering effective dietary interventions. This review underscores the benefits and current guidelines for mineral, vitamin, and omega-3 fatty acid intake during pregnancy while cautioning against the adverse effects of excessive nutrient consumption and advocating for consistent nutritional guidance.

***Corresponding Author:** - **Emmanuel Ifeanyi Obeagu,** *Department of Medical Laboratory Science, Kampala International University, Uganda.*

Introduction: -

Pregnancy initiates a cascade of physiological changes pivotal for fetal development and maternal health [1, 2]. Weight gain marks the initial observable change during pregnancy, with recommended gestational weight gain

(GWG) differing based on pre-pregnancy weight. Optimal maternal and neonatal outcomes are associated with normal-weight pre-conception [3, 4]. Hormonal shifts, encompassing increased estrogen, progesterone, and prolactin production, and placental hormone synthesis like human chorionic gonadotropin (hCG), are vital for a healthy pregnancy [5]. Cardiovascular adaptations, including increased plasma volume and cardiac output, accompany hematological alterations characterized by decreased hemoglobin concentration and platelet counts [6-8]. Elevated oxygen demand prompts respiratory changes, explaining common symptoms like shortness of breath [9]. Gastrointestinal, renal, and urinary alterations further manifest during pregnancy [10]. Elevated nutritional needs, mainly met through a balanced diet, underscore the significance of micronutrients vitamins, minerals, and omega-3 fatty acids in supporting various physiological functions crucial for fetal development [11]. While deficiencies, notably vitamin D and iron, pose concerns for pregnant women, maintaining adequate micronutrient levels remains imperative [12-14]. Vitamins, minerals, and omega-3 fatty acids are integral in sustaining a healthy pregnancy, mitigating common discomforts, and averting complications. This review delves into recommendations for these vital nutrients during pregnancy, emphasizing their potential benefits. Extensive research through databases such asWeb of Science, Google Scholar, PubMed, and Scopus from 2013 to 2023 was conducted using pertinent keywords related to pregnancy nutritional needs.

Nutritional Requirements During Pregnancy

Micronutrient Requirements in Pregnancy

Pregnant women's daily micronutrient intake is determined using the Recommended Dietary Allowances (RDA). The Food and Nutrition Board of the Institute of Medicine (IOM) sets these RDAs, which represent the amounts of essential nutrients that are thought to be enough to satisfy the needs of almost all healthy people. Pregnant women's RDAs have undergone specific changes. The dietary recommendations for a variety of vitamins and minerals during pregnancy are listed in Table 1.

Nutrient	Non-Pregnant	Pregnant
Vitamin A (µg/d)	700	770
Vitamin D (µg/d)	5	15
Vitamin E (mg/d)	15	15
Vitamin K (µg/d)	90	90
Folate (µg/d)	400	600
Niacin (mg/d)	14	18
Riboflavin (mg/d)	1.1	1.4
Thiamin (mg/d)	1.1	1.4
Vitamin B6 (mg/d)	1.3	1.9
Vitamin B12 (µg/d)	2.4	2.6
Vitamin C (mg/d)	75	85
Calcium (mg/d)	1,000	1,000
Iron (mg/d)	18	27
Phosphorus (mg/d)	700	700
Selenium (µg/d)	55	60
Zinc (mg/d)	8	11

Table 1:- Dietary recommendations for expectant mothers, per day [15].

Iron

Iron assumes a critical role in hemoglobin production and oxygen transport, crucial amid amplified blood volume, fetal development, and the growth of crucial structures like the placenta, significantly elevating iron needs in expectantwomen (22–27 mg/day). Consequently, during pregnancy, there's a global increase in the intestinal absorption capacity of iron, rising from 10 to 40% by the end of gestation. Notably, vitamin C aids iron absorption, while tea and coffee hinder it as a result of polyphenol presence [16]. Iron deficiency anemia is prevalent among

pregnant women, affecting 2 to 5% in the first trimester. Anemia is categorized as severe (less than 7 g/dL) or moderate (hemoglobin 7–9 g/dL). The following thresholds are taken into account when diagnosing iron deficiency anemia: ferritin level <30 µg/L, which indicates insufficient iron reserve, and Hb level <11 g/dL in the first and third trimesters and <10.5 g/dL in the second trimester [17–19]. An increased chance of developing post-traumatic stress disorder is associated with postpartum hemoglobin levels of less than 9 g/dL [20]. An adequate intake of iron by mothers increases the average birth weight of their offspring and reduces the likelihood of having a low birth weight or preterm delivery [16]. Given the nearly doubled iron requirements during pregnancy, routine iron supplementation is recommended. Standard prenatal vitamins encompass 27 mg of elemental iron. Vitamin C supplements aid absorption, while milk and tea hinder it. For women with iron deficiency (ferritin <15 µg/L), daily elemental iron replacement of 60-120 mg can raise hemoglobin by 2 g/dL in a month. Common iron side effects like stomach discomfort, constipation, nausea, and vomiting often deter compliance. Foods high in iron, such as fish, eggs, pork, and meat from animals are beneficial [21, 22].

Calcium

Calcium's pivotal role in fetal skeletal mineralization necessitates increased maternal intake, with three-quarters deposited in the final trimester [16]. Early pregnancy witnesses heightened calcium absorption, potentially augmented by seventh-month vitamin D supplementation. Inadequate calcium intake may exacerbate last-trimester bone loss and increase pre-eclampsia risk, a recommendation by WHO. WHO suggests calcium supplementation for populations with low intake to mitigate pre-eclampsia risk and alleviate leg cramps in pregnant women [16]. Studies indicate improved bone resorption with calcium supplementation during pregnancy, especially in winter pregnancies. High-dose supplementing may lower the risk of premature births and preeclampsia, particularly in low-calcium populations, as per a Cochrane review. However, further research is warranted to affirm these effects without adverse fetal implications [23, 24]. In people with low calcium intake, supplementing (1.5–2.0 g per day) is advised to reduce pre-eclampsia risk [23]. While evidence highlights calcium's impact on hypertension/pre-eclampsia, extensive research is needed for other outcomes [25].

Magnesium

Pregnancy induces a decline in serum magnesium levels, reaching its lowest point in the last trimester and rebounding postpartum. Fetal demands escalate magnesium requirements due to a 25% increase in renal magnesium excretion. The umbilical cord exhibits higher magnesium concentrations than maternal levels, facilitating active transport through the placenta. Defining pregnant women's magnesium requirements proves challenging, as normo-magnesemia doesn't eliminate the possibility of deficiency [26]. Magnesium deficiency is linked with the limitation of intrauterine growth, premature labor, pregnancy-related diabetes mellitus, and hypertension [27]. O'Brien et al.'s study advocates oral magnesium administration for relieving lower extremity cramps during pregnancy [23]. Despite lower magnesium consumption in Europeans than recommended, there's inconsistent evidence for dietary magnesium supplementation. The World Health Organization (WHO) refrains from recommending it due to insufficient high-quality evidence. However, severe cases of magnesium deficiency, accompanied by neuromuscular cramps, warrant immediate supplementation with 200 mg/day [28].

Iodine

Maintaining thyroid homeostasis is crucial for brain development, learning, and intelligence acquisition, particularly in expectant mothers and infants. Natural iodine sources in the diet include fish, seafood, and dairy products, along with fortified or high-iodine additions like cooking salt [29-31]. However, pregnant women are advised to refrain from specific fish and seafood types due to the elevated risk of contamination. Iodine requirements surge by approximately 50% during pregnancy, attributed to fetal thyroid hormone synthesis, increased renal iodine clearance, and maternal thyroid stimulation by hCG, starting in the second trimester. The WHO recommends 220–250 µg of iodine daily for expectant mothers [16]. Certain scenarios heighten pregnant women's risk, such as residing in iodine-deficient areas, smoking, having closely spaced pregnancies, following specific diets (e.g., vegetarianism), and experiencing nausea and vomiting, which reduces food intake [32].

Zinc

Zinc is pivotal in various physiological functions like cell division, protein synthesis, and nucleic acid metabolism [33, 34]. Insufficient zinc during pregnancy can result in limitation of intrauterine growth, low weight at birth, congenital abnormalities, and premature delivery. Pregnant women require slightly more zinc (11 mg/day) compared to non-pregnant women. While meat, fish, and shellfish are primary sources of zinc, relying solely on diet might not suffice during pregnancy. Global zinc insufficiency is prevalent, especially in developing countries, albeit less

significant in European nations. Nonetheless, maintaining adequate plasma zinc levels is essential for favorable pregnancy outcomes [35]. Supplementing with zinc should only be considered upon thorough research and recommendation. A Cochrane review suggested a 14% decrease in preterm birth rates with zinc supplementation, particularly in low-income households, but evidence for other crucial outcomes remains insufficient [36]. Iron supplements can hinder zinc absorption, especially in solution form, hence so it's best to take them apart from food. Additionally, zinc enhances the process of absorbing ingested folic acid, aiding in the prevention of folic acid deficiencies [37].

Vitamins

Vitamin B9 (Folic acid)

As required by the Food and Drug Administration, folic acid, a synthetic version of the B vitamin folate, is frequently used in nutritional supplements and fortified foods such as bread, cereal, and pasta [38]. Sources of folate-rich foods encompass nuts, liver, citrus fruits, and vegetables. Increased cell division during fetal growth necessitates elevated folate requirements during pregnancy. A shortage of folic acid is frequently brought on by pregnancy, particularly in difficult pregnancies or pregnancies exacerbated by nausea. Before conception, folic acid supplementation (400–800µg daily) can lower the fetus's chance of neural tube disorders such as spina bifida and anencephaly [38]. To reduce the risk of neural tube abnormalities, recommendations include taking folic acid supplements or fortified meals daily in addition to eating a diet high in sources of folate. It is advised that women who have previously experienced neural tube abnormalities during their pregnancies take four milligrams of folic acid daily in any later pregnancy.Folate deficiency may lead to megaloblastic anemia during pregnancy [13, 18]. Caution is advised regarding excessive folate intake due to potential adverse effects, including certain cancers, medication interactions, and fetal development issues [39]. To prevent different difficulties for both mothers and fetuses, the World Health Organization (WHO) advises oral iron supplements with 30–60 mg of elemental iron per day and vitamin B9 supplements for women who have been diagnosed with iron insufficiency [16, 40]. It is advised to take a daily prenatal multivitamin both before and during pregnancy; the primary distinction is in the amount of folic acid included. A prenatal vitamin's usual composition is outlined in Table 2 below.

Component	Amount	% Daily Value for Pregnant and Lactating Women
Vitamin A	4,000 IU as beta carotene	50%
Vitamin D3	400 IU as Cholecalciferol	100%
Vitamin E	11 IU as dl-Alpha Tocopheryl acetate	37%
Folic acid	800 µg	100%
Niacin	18 mg as niacinamide	90%
Riboflavin	1.7mg as thiamin mononitrate	85%
Thiamin	1.5 mg	88%
Vitamin B6	2.6 mg as pyridoxine hydrochloride	104%
Vitamin B12	4 µg as cyanocobalamin	50%
Vitamin C	100 mg as ascorbic acid	167%
Calcium	150 mg as calcium carbonate	12%
Iron	27 mg as ferrous fumarate	150%
Zinc	25 mg as zinc oxide	167%

Table 2:- Standard micronutrient makeup in a vitamin for pregnancy [15].

Vitamin B6

B-group vitamin deficiencies typically occur alongside each other rather than singularly. Table 2 illustrates that recommended B-group vitamin intakes are higher during pregnancy compared to non-pregnant individuals. These increases align with data showing escalated maternal requirements and vitamin deposits in the fetus and placenta [40]. WHO recommends pyridoxine (vitamin B6) to alleviate early pregnancy nausea. Evidence from trials suggests vitamin B6 potentially reduces nausea but exhibits minimal impact on vomiting [41]. Overall, vitamin B6 supplementation isn't generally recommended for improving maternal and perinatal outcomes during pregnancy. Limited evidence suggests potential effects on preeclampsia and moderate evidence for alleviating pregnancy-related nausea [41].

Vitamin A

Vitamin A comprises retinols in food, pro-vitamin carotenoids, and their metabolites crucial for cell development, gene expression control, and overall cellular differentiation and proliferation. Its deficiency poses risks to offspring mortality. Excessive doses (>10,000 IU/day) can result in cranial-facial and birth abnormalities involving the heart. It is advised to take no more than 8000 IU of supplements per day, as the retinol form—rather than the carotenoid form found in food—is linked to teratogenic consequences [21]. Vitamin A supplementation is advisable only in areas where the shortage is a significant public health problem, aiming to stop night blindness.

Vitamin D

Vitamin D, available as D2 and D3, plays a crucial role in calcium homeostasis and bone mineralization. While D2 is found in plant-based foods, sunshine causes the skin to generate D3. Pregnant women, especially in high-risk populations, often exhibit low vitamin D levels, potentially leading to congenital rickets and fractures [46]. Determining ideal vitamin D levels during pregnancy remains uncertain, with no universal recommendation for testing pregnant women for deficiency of vitamin D. Pregnant women exhibiting symptoms of probable insufficiency should consider taking vitamin D tablets (200 IU/day), according to the WHO [47].

Vitamins C and E

Vitamins C and E act as antioxidants, countering the impact of free radicals, and are commonly found in fruits and vegetables [48-50]. Based on data from two comprehensive Cochrane reviews that included 17 studies from various high-income countries, the WHO does not advise pregnant women to take vitamin E or C supplements to improve the outcomes of pregnancy and delivery [61, 62]. Notably, strong evidence links vitamin C and E supplements to the increased likelihood of experiencing stomach pain during pregnancy [41, 51].

Omega-3 Fatty Acids

Fatty acids, notably polyunsaturated fatty acids (PUFAs), particularly omega-3, are vital for maximum brain function [52]. Inadequate dietary omega-3, especially docosahexaenoic acid (DHA), is linked to developmental-behavioral and cognitive issues [32]. DHA accumulation in the brain during the perinatal stage is crucial for neural network formation. Consuming 3 mg/day of DHA during pregnancy supports neurological development. Omega-3-rich seafood may reduce pregnancy-related issues like low birth weight, preterm birth, and hypertension. There is evidence to suggest that omega-3 supplements can lower the risk of preterm birth while also slightly enhancing neonate weight at birth. However, conflicting benefits and risks arise from fish consumption due to varying levels of omega-3 fatty acids and mercury [53]. Defects in learning, and memory, are linked to elevated mercury levels in children [54]. Optimal fish choices for pregnant women include low-mercury fish like sardines, salmon, and anchovies, are the best options for pregnant women, whereas high-mercury fish, such as tilefish, king mackerel, shark, and swordfish ought to be shunned [21]. Interestingly, eating whole fish has better positive effects on health than taking supplements containing fish oil [55].

Macronutrients

The recommended daily consumption of protein rises to 60 grams during pregnancy from 46 grams in non-pregnant stages; this translates to an increase from 0.8 to 1.1 grams of protein per kilogram per day. 45–64% of daily calories should come from carbohydrates, with 6–9 portions of whole grains being the main focus. Fat should also make up 20–35% of daily calories, in line with recommendations for women who are not pregnant [16].

Nutritional Counseling during Pregnancy

The diet of expectant mothers significantly impacts fetal growth, development, and later susceptibility to chronic illnesses, child survival, and overall human capital acquisition [56, 57]. Despite this critical link, maternal malnutrition remains prevalent worldwide, particularly in Asian and Sub-Saharan African nations [58]. Incorporating nutritional counseling into routine antenatal care is imperative. Studies assessing nutrition education programs demonstrated improvements in pregnant women's nutritional status and gestational weight gain, leading to positive pregnancy outcomes [59, 60]. Overall, improved dietary status in women is associated with favorable pregnancy outcomes and increased child survival rates [16]. Prioritizing guidance on maternal diet during pregnancy is crucial for successful pregnancy outcomes, highlighting the need for nutritional counseling as an integral part of routine antenatal care. Nutritionists or registered dietitians can play a vital role in facilitating dietary counseling and interventions.

Conclusion:-

Nutritional needs must be significantly adjusted during pregnancy due to the unique physiological state of pregnancy, which supports both the health of the mother and the development of the child. Micronutrients, such as vitamins and minerals, plus omega-3 fatty acids are indispensable for achieving the best possible pregnancy outcomes since they affect both the developing fetus's health and that of the mother. Crucial micronutrients that affect fetal growth, neural development, and general maternal health during gestation include iron, calcium, magnesium, iodine, zinc, and folic acid. Furthermore, dietary counseling becomes apparent as a vital part of prenatal care, providing pregnant mothers with priceless assistance. Maternal nutrition education programs have demonstrated beneficial effects on gestational weight growth and pregnancy outcomes, highlighting the significance of incorporating nutritional counseling into standard prenatal care.

Nevertheless, even with the importance of a healthy diet, maternal malnutrition is still a major problem in the world, particularly in some areas, necessitating further efforts to address this problem in its entirety. This article emphasizes the complex connection between maternal nutrition and the course of the pregnancy. Ensuring optimal maternal-fetal health and fostering favorable outcomes for both mother and child throughout pregnancy requires adequate micronutrient intake, balanced macronutrient consumption, and easily available nutritional counseling.

References:-

1. Soma-Pillay P., Nelson-Piercy C., Tolppanen H., Mebazaa A. Physiological changes in pregnancy. Cardiovasc. J. Afr. 2016;27:89–94. doi: 10.5830/CVJA-2016-021.
2. Obeagu, E. I., Obeagu, G. U., Igwe, M. C., Alum, E. U. and Ugwu, O. P. C. Neutrophil-Derived Inflammation and Pregnancy Outcomes.Newport International Journal of Scientific and Experimental Sciences. 2023**;** 4(2):10-19. https://doi.org/10.59298/NIJSES/2023/10.2.1111
3. Deputy NP, Sharma AJ, Kim SY. Gestational Weight Gain - United States, 2012 and 2013. MMWR Morb Mortal Wkly Rep. 2015;64(43):1215–1220.
4. Johnson J, Clifton RG, Roberts JM, et al. Pregnancy outcomes with weight gain above or below the 2009 Institute of Medicine guidelines. Obstetrics and gynecology. 2013;121(5):969–975.
5. Magon N., Kumar P. Hormones in pregnancy. Niger. Med. J. 2012;53:179–183. doi: 10.4103/0300-1652.107549.
6. Obeagu, E. I., Hassan, A. O., Adepoju, O. J., Obeagu, G. U., & Okafor, C. J. (2021). Evaluation of Changes in Haematological Parameters of Pregnant Women Based on Gestational Age at Olorunsogo Road Area of Ido, Ondo State. Nigeria. Journal of Research in Medical and Dental Science, 9(12), 462-464.
7. Alum EU, Ugwu OPC, Aja PM, Obeagu EI, Inya JE, Onyeije PE, et al. Restorative effects of ethanolic leaf extract of Datura stramonium against methotrexate-induced hematological impairments, Cogent Food & Agriculture. 2023; 9:1, DOI: 10.1080/23311932.2023.2258774.https://doi.org/10.1080/23311932.2023.2258774
8. Obeagu EI, Bot YS, Obeagu GU, Alum EU, Ugwu OPC. Anaemia and risk factors in lactating mothers: a concern in Africa. International Journal of Innovative and Applied Research. 2023; **11**(02): 15-17. Article DOI: 10.58538/IJIAR/2012 DOI URL: http://dx.doi.org/10.58538/IJIAR/2012.
9. Ejike DE, Ambrose B, Moses DA, Karimah MR, Iliya E, Sheu OS, et al. Determination, knowledge and prevalence of pregnancy-induced hypertension/eclampsia among women of childbearing age at Same District Hospital in Tanzania. International Journal of Medicine and Medical Sciences. 2018; 10(2): 19-26.
10. Soma-Pillay P., Nelson-Piercy C., Tolppanen H., Mebazaa A. Physiological changes in pregnancy. Cardiovasc. J. Afr. 2016;27:89–94. doi: 10.5830/CVJA-2016-021.
11. Mensink G.B.M., Fletcher R., Gurinovic M., Huybrechts I., Lafay L., Serra-Majem L., Szponar L., Tetens I., Verkaik-Kloosterman J., Baka A., et al. Mapping low intake of micronutrients across Europe. Br. J. Nutr. 2013;110:755–773. doi: 10.1017/S000711451200565X.
12. Lips P., Cashman K.D., Lamberg-Allardt C., Bischoff-Ferrari H.A., Obermayer-Pietsch B., Bianchi M.L., Stepan J., El–Hajj F.G., Bouillon R. Current vitamin D status in European and Middle East countries and strategies to prevent vitamin D deficiency: A position statement of the European Calcified Tissue Society. Eur. J. Endocrinol. 2019;180:23–54. doi: 10.1530/EJE-18-0736.
13. Obeagu, E. I., Ezimah, A. C., &Obeagu, G. U. (2016). Erythropoietin in the anaemias of pregnancy: a review. Int J Curr Res Chem Pharm Sci, 3(3), 10-8.
14. Obeagu EI, Obeagu GU, Ezeonwumelu JOC, Alum EU, Ugwu OPC. Antioxidants and Pregnancy: Impact on Maternal and Fetal Health.Newport International Journal of Biological and Applied Sciences. 2023; 4 (1):17-25. https://doi.org/10.59298/NIJBAS/2023/1.3.11111.

15. Otten JJ, Pitzi Hellwig J, Meyers LD, Editors. Dietary reference intakes. The essential guide to nutrient requirements. Washington, DC: National Academies Press; 2006.
16. WHO. WHO Recommendations on Antenatal Care for a Positive Pregnancy Experience. WHO Press; Geneva, Switzerland: 2016.
17. Ekpono EU, Aja PM, Ibiam UA, Alum EU, Ekpono UE. Ethanol Root-extract of Sphenocentrumjollyanum Restored Altered Haematological Markers in Plasmodium berghei-infected Mice. Earthline Journal of Chemical Sciences. 2019; 2(2): 189-203. https://doi.org/10.34198/ejcs.2219.189203.
18. Ifeanyi OE. A review on pregnancy and haematology. Int. J. Curr. Res. Biol. Med. 2018; 3(5): 26-28.
19. Obeagu EI, Ali MM, Alum EU, Obeagu GU, Ugwu OPC, Bunu UM. An Update of Aneamia in Adults with Heart Failure. INOSR Experimental Sciences. 2023; 11(2):1-16. https://doi.org/10.5281/zenodo.7791916
20. Obeagu EI, Nimo OM, Bunu UM, Ugwu OPC, Alum EU. Anaemia in children under five years: African perspectives. Int. J. Curr. Res. Biol. Med. 2023; (1): 1-7. DOI: http://dx.doi.org/10.22192/ijcrbm.2023.08.01.001.
21. Kominiarek MA, Rajan P. Nutrition Recommendations in Pregnancy and Lactation. Med Clin North Am. 2016 Nov;100(6):1199-1215. doi: 10.1016/j.mcna.2016.06.004. PMID: 27745590; PMCID: PMC5104202.
22. Ifeanyi OE, Uzoma OG. An update on Anaemia, Iron, Folic acid and Vitamin B 12 in Pregnancy and Postpartum. Int. J. Curr. Res. Med. Sci, 2018; 4(5): 62-70.
23. O'Brien E.C., Kilbane M.T., McKenna M.J., Segurado R., Geraghty A.A., McAuliffe F.M. Calcium intake in winter pregnancy attenuates impact of vitamin D inadequacy on urine NTX, a marker of bone resorption. Eur. J. Nutr. 2017;57:1015–1023. doi: 10.1007/s00394-017-1385-3.
24. Hofmeyr G.J., Lawrie T., Atallah Á.N., Torloni M.R. Calcium supplementation during pregnancy for preventing hypertensive disorders and related problems. Cochrane Database Syst. Rev. 2018;10:001059. doi: 10.1002/14651858.CD001059.pub5.
25. Buppasiri P., Lumbiganon P., Thinkhamrop J., Ngamjarus C., Laopaiboon M., Medley N. Calcium supplementation (other than for preventing or treating hypertension) for improving pregnancy and infant outcomes. Cochrane Database Syst. Rev. 2015;2:CD007079. doi: 10.1002/14651858.CD007079.pub3.
26. Spätling L., Classen H.G., Kisters K., Liebscher U., Rylander R., Vierling W., Von Ehrlich B., Vormann J. Supplementation of Magnesium in Pregnancy. J. Pregnancy Child Health. 2017;4:1–6. doi: 10.4172/2376-127X.1000302.
27. Morton A. Hypomagnesaemia and pregnancy. Obstet. Med. 2018;11:67–72. doi: 10.1177/1753495X17744478.
28. Supakatisant C., Phupong V. Oral magnesium for relief in pregnancy–induced leg cramps: A randomized controlled trial. Matern. Child Nutr. 2015;11:139–145. doi: 10.1111/j.1740-8709.2012.00440.x.
29. Aja, P. M., Nwobasi, C. S., Alum, E. U., Udeh, S.M.C., Edwin, N., Orinya, O.F., Abara, P.N. and Aloke, C. Mineral and Proximate Compositions of Nauclae latifolia Root bark from Abakaliki, Ebonyi State Nigeria. International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS), 2017; **6 (2):** 375-382.
30. Ibiam UA, Alum EU, Aja PM, Orji OU, Nwamaka NN, Ugwu OPC. Comparative analysis of chemical composition of Buchholzia coriacea ethanol leaf-extract, aqueous and ethylacetate fractions. Indo Am J Pharm Sci. 2018; 5(7):6358- 69. doi: 10.5281/zenodo.1311171.
31. Alum EU, Oyika MT, Ugwu OPC, Aja PM, Obeagu EI, Egwu CO, Okon MB. Comparative analysis of mineral constituents of ethanol leaf and seed extracts of Datura stramonium. IDOSR JOURNAL OF APPLIED SCIENCES. 2023d; **8**(1):143-151. https://doi.org/10.59298/IDOSR/2023/12.1.7906.
32. Jouanne M, Oddoux S, Noël A, Voisin-Chiret AS. Nutrient Requirements during Pregnancy and Lactation. Nutrients. 2021 Feb 21;13(2):692. doi: 10.3390/nu13020692. PMID: 33670026; PMCID: PMC7926714.
33. Aja P.M., Ugwu O. P. C., Ekpono E. U., Mbam M. L., Alum E. U. and Ibere J. B. Proximate and Mineral Compositions of Phoenix dactylifera (Fruit Sold in Hausa Quarter Abakaliki, Ebonyi State, Nigeria. IDOSR Journal of Scientific Research. 2017; **2(1):** 53-65.
34. Offor, C. E., Uche, S. O., Alum, E. U., Ezeani, N. N. and Nwangwu, S. C. Determination of Mineral Contents of Blighia unijugataLeaves. Journal of Research in Pharmaceutical Science, 2015; **2 (10):** 01-03.
35. Maxfield L., Crane J.S. Zinc Deficiency. StatPearls Publishing; Treasure Island, FL, USA: 2020. [(accessed on 27 December 2020)]. Available online: https://www.ncbi.nlm.nih.gov/books/NBK493231
36. Ota E., Mori R., Middleton P., Tobe-Gai R., Mahomed K., Miyazaki C., Bhutta Z. Zinc supplementation for improving pregnancy and infant outcome. Cochrane Database Syst. Rev. 2015;2015:CD000230. doi: 10.1002/14651858.CD000230.pub5.
37. Aoki C, Imai K, Owaki T, Kobayashi-Nakano T, Ushida T, Iitani Y, Nakamura N, Kajiyama H, Kotani T. The Possible Effects of Zinc Supplementation on Postpartum Depression and Anemia. Medicina (Kaunas). 2022 May 29;58(6):731. doi: 10.3390/medicina58060731. PMID: 35743994; PMCID: PMC9230907.

38. Argyridis S. Folic acid in pregnancy. Obstet. Gynaecol. Reprod. Med. 2019;29:118–120. doi: 10.1016/j.ogrm.2019.01.008. [
39. Patel KR, Sobczyńska-Malefora A. The adverse effects of an excessive folic acid intake. Eur. J. Clin. Nutr. 2016;71:159–163. doi: 10.1038/ejcn.2016.194.
40. Allen L. Encyclopedia of Human Nutrition. Elsevier BV; Amsterdam, The Netherlands: 2013. Pregnancy: Nutrient Requirements; pp. 61–67.
41. Rumbold A., Ota E., Hori H., Miyazaki C., Crowther C. Vitamin E supplementation in pregnancy. Cochrane Database Syst. Rev. 2015;9:CD004069. doi: 10.1002/14651858.cd004069.pub3.
42. EFSA NDA Panel (EFSA Panel on Dietetic Products, Nutrition and Allergies) Scientific Opinion on dietary Reference Values for vitamin A. EFSA J. 2015;13:4028. doi: 10.2903/j.efsa.2015.4028.
43. Alum EU, Aja W, Ugwu OPC, Obeagu EI, Okon MB. Assessment of vitamin composition of ethanol leaf and seed extracts of Datura stramonium. Avicenna J Med Biochem. 2023; 11(1):92-97.doi:10.34172/ajmb.2023.2421.
44. Uraku AJ, Igwenyi IO, Alum E, Orji OU. Assessment of nutritional value of Culcasia scandens P. Beauv leaves. Adv Biomed Pharm. 2016;3(2):115-9. doi: 10.19046/abp. v03i02.06.
45. Aja PM, Uzuegbu UE, Opajobi AO, Udeh SM, Alum EU, Ominyi MC, et al. Amino acid profile, vitamin and reducing sugar compositions of ethanol fruit-extract of Phoenix dactylifera (date fruit) sold in Abakaliki, Ebonyi state, Nigeria. Int J Biol Pharm Allied Sci. 2017;6(2):349-62.
46. Ogbanshi ME, Ebenyi LN , Ominyi MC, Nwali BU, Edwin N, Ugadu AF & Alum EU. Comparative Evaluation of Nutritional and Toxicological Implication of Consumption of Wild Fishes from Ebonyi River and Fishes Cultured in Concrete Pond with Different Feed Formulations, International Journal of Basic and Clinical Toxicology, November 2022; 1 (2): 1-7.https://sbctnigeria.org/articles/0c1a6ef2-06b3-4413-8e3d-fc516cc4736b.pdf.
47. World Health Organization . WHO Antenatal Care Recommendations for a Positive Pregnancy Experience. Nutritional Interventions Update: Vitamin D Supplements During Pregnancy. World Health Organization; Geneva, Switzerland: 2020.
48. Offor CE, Ugwu Okechukwu PU, Alum Esther U. Determination of ascorbic acid contents of fruits and vegetables. Int J Pharm Med Sci. 2015;5(1):1-3. doi: 10.5829/ idosi.ijpms.2015.5.1.1105.
49. Alum EU, Ibiam UA, Ugwuja EI, Aja PM, Igwenyi I.O, Offor CE, et al. Antioxidant Effect of Buchholziacoriacea Ethanol Leaf Extract and Fractions on Freund's Adjuvant-induced Arthritis in Albino Rats: A Comparative Study. SlovenianVeterinary Research. 2022; 59 (1): 31–45. doi: 10.26873/svr-1150-2022.
50. Uti DE, Ibiam UA, Omang WA, Udeozor PA, Umoru GU, Nwadum SK, et al. Buchholzia coriacea Leaves Attenuated Dyslipidemia and Oxidative Stress in Hyperlipidemic Rats and Its Potential Targets In Silico. Pharmaceutical Fronts. 2023; 05(03): e141-e152. DOI: 10.1055/s-0043-1772607.
51. Rumbold A., Crowther C. Vitamin C supplementation in pregnancy. Cochrane Database Syst. Rev. 2005;9:CD004072. doi: 10.1002/14651858.cd004072.pub2.
52. I.O. Igwenyi, O. Dickson, I.P. Igwenyi, P.C. Ugwu Okechukwu, N. Edwin and **E.U. Alum.** (2015). Properties of Vegetable Oils from Three Underutilized Indigenous Seeds. Global Journal of Pharmacology, **9** (4): 362-365. DOI: 10.5829/idosi.gjp.2015.9.4.10157.
53. Wenstrom KD. The FDA's new advice on fish: it's complicated. American journal of obstetrics and gynecology. 2014;211(5):475–478. e471.
54. Fujimura S, Yoshinaga J. Risk and Benefit of Decreasing Seafood Consumption in Japan-Docosahexaenoic Acid, Methylmercury and Infant IQ. Foods. 2023 Apr 17;12(8):1674. doi: 10.3390/foods12081674. PMID: 37107468; PMCID: PMC10137566.
55. Makrides M, Gibson RA, McPhee AJ, Yelland L, Quinlivan J, Ryan P. Effect of DHA supplementation during pregnancy on maternal depression and neurodevelopment of young children: a randomized controlled trial. JAMA : the journal of the American Medical Association. 2010;304(15):1675–1683.
56. Tahir MJ, Haapala JL, Foster LP, Duncan KM, Teague AM, Kharbanda EO, McGovern PM, Whitaker KM, Rasmussen KM, Fields DA, et al. Higher Maternal Diet Quality during Pregnancy and Lactation Is Associated with Lower Infant Weight-For-Length, Body Fat Percent, and Fat Mass in Early Postnatal Life. Nutrients. 2019;11:632. https://doi.org/10.3390/nu11030632.
57. Martorell R: Improved Nutrition in the First 1000 Days and Adult Human Capital and Health. Am J Hum 2017, 29:doi:https://doi.org/10.1002/ajhb.22952.

58. Biswas T, Townsend N, Magalhaes RS, Islam MS, Hasan MM, Mamun A. Current Progress and Future Directions in the Double Burden of Malnutrition among Women in South and Southeast Asian Countries. Curr Dev Nutr. 2019;3:nzz026.
59. Sharifirad GR, Tol A, Mohebi S, Matlabi M, Shahnazi H, Shahsiah M. The effectiveness of nutrition education program based on health belief model compared with traditional training. J Edu Health Promot. 2013;2:15.
60. Otoo G, Adam Y. Effect of nutrition education with an emphasis on consumption of iron-rich foods on hemoglobin levels of pregnant women in Ghana. FASEB J. 2016;30:410.412.