MEDWIN PUBLISHERS
Committed to Create Value for Researchers

Haematology International Journal
ISSN: 2578-501X

Understanding Hypoxia in Pregnancy: A Comprehensive Overview

Emmanuel Ifeanyi Obeagu[1]* and Getrude Uzoma Obeagu[2]

[1]Department of Medical Laboratory Science, Kampala International University, Uganda

[2]School of Nursing Science, Kampala International University, Uganda

***Corresponding author:** Emmanuel Ifeanyi Obeagu, Department of Medical Laboratory Science, Kampala International University, Kampala, Uganda, Tel: +2348037369912; Email: emmanuelobeagu@yahoo.com; obeagu.emmanuel@kiu.ac.ug

Review Article

Volume 8 Issue 1

Received Date: February 13, 2024

Published Date: February 29, 2024

DOI: 10.23880/hij-16000237

Abstract

Hypoxia during pregnancy poses intricate challenges to both maternal and fetal well-being, demanding a nuanced exploration of its various dimensions. This comprehensive review consolidates the current state of knowledge on hypoxia in pregnancy, encompassing its forms, underlying mechanisms, implications, diagnostic approaches, management strategies, and global perspectives. The review highlights the multifaceted nature of hypoxia, incorporating insights into chronic and intermittent hypoxia, molecular and physiological mechanisms, potential complications, diagnostic tools, and management interventions. Furthermore, it addresses the lasting impact of maternal hypoxia on offspring development, emphasizing neurodevelopmental outcomes, cardiovascular health, and the risk of chronic diseases. The global perspective section underscores the importance of understanding regional disparities, socioeconomic factors, and healthcare access in addressing hypoxia during pregnancy on a global scale. The review concludes by identifying research gaps and advocating for multidisciplinary collaborations and innovative research approaches to advance our comprehension of hypoxia's complexities in pregnancy. Ultimately, this comprehensive overview aims to contribute to the enhancement of maternal-fetal healthcare by providing a holistic understanding of hypoxia in pregnancy.

Keywords: Hypoxia; Pregnancy; Maternal Health; Fetal Development; Mechanisms; Implications; Management

Abbreviations: IUGR: Intrauterine Growth Restriction; HIF: Hypoxia Inducible Factor; ROS: Reactive Oxygen Species; PlGF: Placental Growth Factor; SOD: Superoxide Dismutase.

Introduction

Pregnancy represents a dynamic physiological state wherein the maternal-fetal unit intricately balances numerous factors to support optimal fetal development. Central to this delicate equilibrium is the maintenance of adequate oxygen supply to meet the growing demands of the developing fetus. However, when this balance is disrupted, hypoxia - a condition characterized by inadequate oxygen levels – can ensue, presenting a substantial challenge to both maternal and fetal health [1-11]. Hypoxia during pregnancy is a complex phenomenon that can manifest in various forms, including chronic and intermittent patterns. These manifestations are closely tied to intricate molecular and physiological mechanisms, influencing vital processes such as oxygen transport and placental development. Consequently, maternal and fetal health may be compromised, leading to a spectrum of complications, including but not limited to preeclampsia, intrauterine growth restriction (IUGR), and gestational diabetes [12-20].

Given the critical implications of hypoxia in pregnancy, understanding its nuanced facets becomes imperative. This comprehensive review aims to provide an in-depth exploration of hypoxia during pregnancy, offering insights into its different forms, elucidating the underlying mechanisms, delineating potential complications, and examining current diagnostic and management strategies. Additionally, the review will address the lasting impact of maternal hypoxia on offspring development and underscore the importance of considering global perspectives and disparities in addressing this multifaceted challenge.

Mechanisms of Hypoxia in Pregnancy

Hypoxia during pregnancy involves intricate molecular and physiological mechanisms that significantly impact maternal health, placental function, and fetal development. Conditions like anemia or respiratory disorders impair oxygen-carrying capacity. Diminished oxygen delivery to the fetus, affecting organ development and function. Hypoxia induces alterations in placental blood flow and vascular development. Hypoxia triggers the activation of HIF, a transcription factor regulating genes involved in oxygen homeostasis. Hypoxia induces the generation of reactive oxygen species (ROS). Hypoxia stimulates immune responses, leading to inflammation. Prolonged inflammation may contribute to placental dysfunction and adverse pregnancy outcomes. Hypoxia alters endothelial function in maternal and placental blood vessels. Hypoxia influences epigenetic modifications, altering gene expression patterns. Epigenetic changes in the fetus may impact long-term health outcomes. Hypoxia influences the expression of placental microRNAs. Hypoxia disrupts mitochondrial function, impacting energy production. Impaired cellular respiration and ATP production affect overall cellular function. Fetal tissues activate adaptive responses to withstand periods of oxygen deprivation [21-35].

Implications for Maternal and Fetal Health

Hypoxia during pregnancy introduces a myriad of implications for both maternal and fetal health, spanning a spectrum of complications that can significantly impact the course and outcome of gestation. Hypoxia is a recognized contributor to the development of preeclampsia, characterized by hypertension, proteinuria, and systemic inflammation. Hypoxia may contribute to insulin resistance and the development of gestational diabetes, affecting maternal metabolic health. Hypoxia disrupts nutrient and oxygen supply to the fetus, leading to IUGR. IUGR is associated with an increased risk of neurodevelopmental delays in offspring. Hypoxia-induced stress can trigger premature uterine contractions, leading to preterm birth. Preterm infants born under hypoxic conditions may face respiratory challenges due to underdeveloped lungs. Hypoxia alters blood flow within the placenta, affecting nutrient exchange. Placental dysfunction may contribute to conditions such as placental abruption and placenta previa [36-45].

Hypoxia-induced preeclampsia may have long-term implications, increasing the risk of maternal hypertension post-pregnancy. Fetal exposure to hypoxia may contribute to an increased risk of cardiovascular diseases in later life. Hypoxia during critical periods of fetal brain development may lead to cognitive impairments in offspring. Increased risk of behavioral disorders and neurodevelopmental issues in children exposed to maternal hypoxia. The physiological stress induced by hypoxia may contribute to maternal stress and anxiety during pregnancy. Hypoxia-related complications may influence the risk of postpartum depression. Maternal hypoxia, particularly in the context of gestational diabetes, may increase the risk of metabolic syndrome in both mothers and offspring. Fetal exposure to hypoxia may program an increased susceptibility to chronic diseases, such as diabetes and cardiovascular disorders [47-52].

Diagnostic Approaches and Biomarkers

Accurate and timely diagnosis of hypoxia during pregnancy is crucial for effective management and intervention strategies. Various diagnostic approaches and biomarkers offer valuable insights into the oxygenation status of both the mother and the developing fetus Assessing blood flow velocity in maternal and fetal vessels provides insights into placental perfusion and potential hypoxic conditions [53,54]. Offers detailed visualization of maternal and fetal anatomy, aiding in the identification of structural abnormalities and potential oxygenation issues. Monitoring maternal hemoglobin levels helps identify anemia, a condition contributing to oxygen transport deficiencies. Non-invasive measurement of maternal oxygen saturation levels aids in identifying hypoxia. Reduction in Placental Growth Factor (PlGF) levels may indicate placental dysfunction associated with hypoxia. Monitoring glucose levels is crucial, especially in the context of gestational diabetes linked to hypoxia. Analyzing fetal cfDNA in maternal blood allows for the detection of chromosomal abnormalities, providing indirect insights into oxygenation issues. Combining assessments such as fetal heart rate, amniotic fluid volume, and fetal movements provides a comprehensive evaluation of fetal well-being. Monitoring maternal complaints such as shortness of breath or fatigue can offer valuable clinical information. Conditions like respiratory disorders or pre-existing anemia may increase the risk of maternal hypoxia. Assessing placental vascularization and blood flow patterns aids in identifying abnormalities associated with hypoxia. Elevated MDA levels indicate increased oxidative stress associated with hypoxia. Changes in SOD activity may reflect the antioxidant response to hypoxia-induced oxidative stress.

Management Strategies

The effective management of hypoxia during pregnancy involves a multifaceted approach aimed at optimizing maternal and fetal outcomes. Strategies encompass lifestyle modifications, pharmacological interventions, and close monitoring to address the underlying causes and mitigate potential complications. Administration of supplemental oxygen to mothers experiencing hypoxia helps improve maternal oxygenation and fetal well-being. Encouraging moderate exercise, under medical supervision, promotes cardiovascular health and oxygen transport. Addressing iron-deficiency anemia enhances oxygen-carrying capacity. Promoting a diet rich in nutrients supports overall maternal health and fetal development. Treating conditions such as asthma or sleep apnea improves respiratory function and reduces the risk of hypoxia. Effectively managing pre-existing conditions like diabetes and hypertension is crucial to minimize the impact of hypoxia. Monitoring fetal growth, amniotic fluid levels, and placental function through regular ultrasounds helps detect complications early. Continuous fetal heart rate monitoring during labor provides real-time information on fetal oxygenation [53].

Managing maternal hypertension associated with hypoxia helps reduce the risk of complications. In cases of severe anemia, erythropoiesis-stimulating agents may be considered to enhance red blood cell production. In certain cases, hyperbaric oxygen therapy may be considered to increase oxygen delivery to tissues. Tight glucose control is essential for managing gestational diabetes and reducing the risk of associated hypoxia. In cases of severe hypoxia or complications such as preeclampsia, the timing of delivery may be carefully considered to minimize risks to both mother and fetus. Close monitoring of fetal heart rate patterns during labor aids in identifying signs of distress. Provides direct information on fetal oxygenation during labor and guides clinical decision-making. Monitoring maternal health post-delivery to address any residual effects of hypoxia. Ensuring appropriate neonatal care for infants exposed to hypoxic conditions, including respiratory support if needed. Providing information to mothers about the importance of adherence to prescribed medications, lifestyle modifications, and regular antenatal visits. Recognizing and addressing maternal stress or anxiety associated with hypoxia, offering support services as needed [55].

Impact of Hypoxia on Offspring Development

Hypoxia during pregnancy can exert lasting effects on offspring development, influencing various physiological and neurological aspects. The intricate interplay between maternal oxygenation status and fetal development contributes to a spectrum of consequences that extend beyond the prenatal period. Prenatal exposure to hypoxia may contribute to cognitive deficits and learning disabilities in offspring. Offspring exposed to maternal hypoxia may face an elevated risk of cardiovascular diseases later in life. Prenatal hypoxia has been linked to an increased likelihood of developing hypertension. Children born to mothers who experienced hypoxia during pregnancy may be more prone to respiratory issues, including asthma. Maternal hypoxia, especially in the context of gestational diabetes, may program offspring for an increased risk of developing diabetes. Hypoxia-induced changes in DNA methylation and histone modifications may influence gene expression patterns in offspring. Offspring may be at an increased risk of anemia and iron deficiency due to impaired oxygen transport mechanisms. Maternal hypoxia can disrupt thyroid function, potentially affecting the offspring's metabolic and developmental processes. Changes in the adrenal gland function may influence the offspring's stress response and overall endocrine health. Offspring exposed to hypoxia may exhibit alterations in immune function, potentially leading to an increased susceptibility to infections. Hypoxia-associated immune changes may contribute to the development of allergic conditions in offspring. Prenatal hypoxia may contribute to developmental delays, affecting motor skills and cognitive milestones. Increased risk of speech and language impairments in children exposed to hypoxia during gestation. Hypoxia-induced mitochondrial dysfunction may impact cellular energy production, potentially affecting multiple organ systems in offspring [56].

Global Perspectives and Disparities

Hypoxia during pregnancy is a global health concern, and its impact varies across regions, populations, and socioeconomic strata. Understanding the global perspectives and disparities associated with maternal hypoxia is crucial for implementing targeted interventions and improving outcomes for vulnerable populations. Pregnant women residing at high altitudes face increased exposure to chronic hypoxia due to lower oxygen levels. This geographical factor contributes to unique challenges and health considerations. Despite lower inherent hypoxic stress, regions with limited access to healthcare resources may experience disparities in addressing and managing maternal hypoxia. Disparities in healthcare infrastructure and access contribute to varying levels of awareness, diagnosis, and management of hypoxia during pregnancy. Socioeconomic factors influence nutritional status, contributing to variations in maternal anemia and, consequently, hypoxia [57].

Disparities in health literacy levels among pregnant women impact their understanding of the importance of prenatal care, including the management of conditions leading to hypoxia. Access to antenatal education programs varies globally, influencing the capacity of pregnant women to adopt preventive measures. Regions with high levels of air pollution contribute to environmental hypoxia, potentially exacerbating maternal respiratory conditions and increasing the risk of hypoxia-related complications. Climate-related events, such as extreme weather conditions and natural disasters, can disrupt healthcare infrastructure and exacerbate hypoxia risks. Cultural preferences and reliance on traditional medicine may impact the acceptance and utilization of modern healthcare interventions for managing hypoxia. Stigmatization and misconceptions surrounding maternal health may deter women from seeking timely care, leading to delayed interventions [58].

Disparities in food security contribute to variations in maternal nutrition, influencing the prevalence of anemia and hypoxia during pregnancy. Access to and adherence to iron supplementation programs may vary, impacting maternal hemoglobin levels. Disparities in the availability and accessibility of antenatal care services affect the early detection and management of conditions contributing to hypoxia. Variations in the availability of emergency obstetric care services impact the response to acute hypoxia-related complications during labor and delivery. Governmental commitment to healthcare infrastructure and maternal health programs significantly influences the quality of care and outcomes related to maternal hypoxia. Variations in national policies and their implementation contribute to disparities in maternal health outcomes. Regions with a high burden of infectious diseases may experience compounded health challenges, impacting maternal health and exacerbating hypoxia-related risks. Disparities in women's empowerment and autonomy influence decision-making regarding maternal healthcare, affecting the likelihood of timely interventions for hypoxia-related conditions [58].

Conclusion

Hypoxia during pregnancy represents a complex challenge with far-reaching implications for maternal and fetal health. Understanding the mechanisms underlying hypoxia during pregnancy is crucial. From oxygen transport alterations and placental insufficiency to oxidative stress and epigenetic modifications, these intricate pathways offer opportunities for targeted interventions. Evolving diagnostic approaches, including imaging techniques, blood markers, and biomolecular assessments, provide a more nuanced understanding of maternal and fetal oxygenation status. Early and accurate diagnosis is fundamental for effective management.

References

1. Obeagu EI, Agreen FC (2023) Anaemia among pregnant women: A review of African pregnant teenagers. J Pub Health Nutri 6 (1): 138.
2. Obeagu EI, Ezimah AC, Obeagu GU (2016) Erythropoietin in the anaemias of pregnancy: a review. Int J Curr Res Chem Pharm Sci 3(3): 10-18.
3. Obeagu EI, Adepoju OJ, Okafor CJ, Obeagu GU, Ibekwe AM, et al. (2021) Assessment of Haematological Changes in Pregnant Women of Ido, Ondo State, Nigeria. J Res Med Dent Sci 9(4): 145-148.
4. Obeagu EI, Obeagu GU (2023) Sickle Cell Anaemia in Pregnancy: A Review. International Research in Medical and Health Sciences 6(2): 10-13.
5. Jakheng SP, Obeagu EI (2022) Seroprevalence of human immunodeficiency virus based on demographic and risk factors among pregnant women attending clinics in Zaria Metropolis, Nigeria. J Pub Health Nutri 5(8): 137.
6. Obeagu EI, Obeagu GU, Chukwueze CM, Ikpenwa JN, Ramos GF (2022) Evaluation of Protein C, Protein S and Fibrinogen of Pregnant Women with Malaria in Owerri Metropolis. Madonna University journal of Medicine and Health Sciences 2(2): 1-9.
7. Obeagu EI, Ikpenwa JN, Chukwueze CM, Obeagu GU (2022) Evaluation of protein C, protein S and fibrinogen of pregnant women in Owerri Metropolis. Madonna University Journal of Medicine and Health Sciences 2(1): 292-298.
8. Obeagu EI, Obeagu GU, Adepoju OJ (2022) Evaluation of haematological parameters of pregnant women based on age groups in Olorunsogo road area of Ido, Ondo state. J Bio Innov 11(3): 936-941.
9. Obeagu EI (2022) An update on utilization of antenatal care among pregnant Women in Nigeria. Int J Curr Res Chem Pharm Sci 9(9): 21-26.
10. Okoroiwu IL, Obeagu EI, Obeagu GU (2022) Determination of Clot Retraction in Preganant Women Attending Antenatal Clinic in Federal Medical Centre Owerri Nigeria. Madonna University Journal of Medicine And Health Sciences 2(2): 91-97.
11. Obeagu EI, Hassan AO, Adepoju OJ, Obeagu GU, Okafor

CJ (2021) Evaluation of Changes in Haematological Parameters of Pregnant Women Based on Gestational Age at Olorunsogo Road Area of Ido, Ondo State. Journal of Research in Medical and Dental Science 9(12): 462-464

12. Anyiam AF, Obeagu EI, Obi E, Omosigho PO, Irondi EA, et al. (2022) ABO blood groups and gestational diabetes among pregnant women attending University of Ilorin Teaching Hospital Kwara State Nigeria. International Journal of Research and Reports in Hematology 5(2): 113-121.

13. Obeagu EI (2023) Gestational Thrombocytopaenia. J Gynecol Women's Health 25(3): 556163.

14. Jakheng SP, Obeagu EI, Abdullahi IO, Jakheng EW, Chukwueze CM, et al. (2022) Distribution Rate of Chlamydial Infection According to Demographic Factors among Pregnant Women Attending Clinics in Zaria Metropolis, Kaduna State Nigeria. South Asian Journal of Research in 13(2): 26-31.

15. Obeagu EI, Ogbonna US, Nwachukwu AC, Ochiabuto O, Enweani IB, et al. (2021) Prevalence of Malaria with Anaemia and HIV status in women of reproductive age in Onitsha Nigeria. Journal of Pharmaceutical Research International 33(4): 10-19.

16. Obeagu EI, Abdirahman BF, Bunu UO, Obeagu GU (2023) Obsterics characteristics that effect the newborn outcomes. Int J Adv Res Biol Sci 10(3): 134-143.

17. Obeagu EI, Ogunnaya FU (2023) Pregnancy induced Haematological Changes a Key to Marternal and Child Health. European Journal of Biomedical 10(8): 42-43.

18. Okamgba OC, Nwosu DC, Nwobodo EI, Agu GC, Ozims SJ, et al. (2017) Iron Status of Pregnant and Post-Partum Women with Malaria Parasitaemia in Aba Abia State Nigeria. Annals of Clinical and Laboratory Research 5(4): 206-207.

19. Eze RI, Obeagu EI, Edet FN (2021) Frequency of Rh Antigen C And c among pregnant women in Sub-Urban area in Eastern Nigeria. Madonna Uni J Med Health Sci 1(1): 19-30.

20. Obeagu EI, Ofodile AC, Okwuanaso CB (2023) A review of urinary tract infections in pregnant women Risks factors. J Pub Health Nutri 6(1): 26-35.

21. Obeagu EI, Obeagu GU, Musiimenta E (2023) Postpartum haemorrhage among pregnant women Update on risks factors. Int J Curr Res Med Sci 9(2): 14-17.

22. Obeagu EI, Obeagu GU, Ogunnaya FU (2023) Deep vein thrombosis in pregnancy A review of prevalence and risk factors. Int J Curr Res Chem Pharm Sci 10(8): 14-21.

23. Jakheng SP, Obeagu EI, Jakheng EW, Uwakwe OS, Eze GC, et al. (2022) Occurrence of Chlamydial Infection Based on Clinical Symptoms and Clinical History among Pregnant Women Attending Clinics in Zaria Metropolis, Kaduna State Nigeria. International Journal of Research and Reports in Gynaecology. 5(1): 98-105.

24. Okorie HM, Obeagu EI, Eze EN, Jeremiah ZA (2018) Assessment of some haematological parameters in malaria infected pregnant women in Imo state Nigeria. Int J Curr Res Biol Med 3(9): 1-14.

25. Onyenweaku FC, Amah HC, Obeagu EI, Nwandikor UU, Onwuasoanya UF (2017) Prevalence of asymptomatic bacteriuria and its antibiotic susceptibility pattern in pregnant women attending private ante natal clinics in Umuahia Metropolitan. Int J Curr Res Biol Med 2(2): 13-23.

26. Okoroiwu IL, Chinedu-Madu JU, Obeagu EI, Vincent CC, Ochiabuto OM, et al (2021) Evaluation of Iron Status Haemoglobin and Protein Levels of Pregnant Women in Owerri Metropolis. Journal of Pharmaceutical Research International 33(27A): 36-43.

27. Obeagu EI, Njar VE, Obeagu GU (2023) Infertility Prevalence and Consequences. Int J Curr Res Chem Pharm Sci 10(7): 43-50.

28. Emeka OOR, Ibeh NC, Obeagu EI, Okorie HM (2021) Evaluation of levels of some inflammatory cytokines in preeclamptic women in owerri. Journal of Pharmaceutical Research International 33(42A): 53-65.

29. Obeagu EI, Faduma MH, Uzoma G (2023) Ectopic Pregnancy A Review. Int J Curz Res Chem Pharm 10(4): 40-44.

30. Obeagu EI, Gamade SM, Obeagu GU (2023) The roles of Neutrophils in pregnancy. Int J Curr Res Med Sci 9(5): 31-35.

31. Eze R, Obeagu EI, Nwakulite A, Okoroiwu IL, Vincent CC, et al. (2021) Evaluation of Copper Status and Some Red Cell Parameters of Pregnant Women in Enugu State South Eastern Nigeria. Journal of Pharmaceutical Research International 33(30A): 67-71.

32. Obeagu EI, Obeagu GU (2023) Molar Pregnancy Update of prevalence and risk factors. Int J Curr Res Med Sci 9(7): 25-28.

33. Obeagu EI, Bunu UO (2023) Factors that influence unmet need for family planning. International Journal of

Current Research in Biology and Medicine 8(1): 23-27.

34. Ibebuike JE, Ojie CA, Nwokike GI, Obeagu EI, Nwosu DC, et al. (2017) Barriers to utilization of maternal health services in southern senatorial district of Cross Rivers state Nigeria International Journal of Advanced Multidisciplinary Research 4(8): 1-9.

35. Emannuel G, Martin O, Peter OS, Obeagu EI, Daniel K (2023) Factors Influencing Early Neonatal Adverse Outcomes among Women with HIV with Post Dated Pregnancies Delivering at Kampala International University Teaching Hospital Uganda. Asian Journal of Pregnancy and Childbirth. 6(1): 203-211.

36. Okorie HM, Obeagu EI, Eze EN, Jeremiah ZA (2018) Assessment of coagulation parameters in malaria infected pregnant women in Imo state, Nigeria. International Journal of Current Research in Medical Sciences 4(9): 41-49.

37. Obeagu EI, Obeagu GU (2023) Postpartum haemorrhage among women delivering through spontaneous vaginal delivery Prevalence and risk factors. Int J Curr Res Chem Pharm Sci 10(8): 22-26.

38. Obeagu E, Eze RI, Obeagu EI, Nnatuanya IN, Dara EC (2022) Zinc Level in Apparently Pregnant Women In Urban Area. Madonna University journal of Medicine and Health Sciences 2(1): 134-148.

39. Ogomaka IA, Obeagu EI (2021) Malaria in Pregnancy Amidst Possession of Insecticide Treated Bed Nets (ITNs) in Orlu LGA of Imo State, Nigeria. Journal of Pharmaceutical Research International. 33(41B): 380-386.

40. Obeagu EI, Ogunnaya FU, Obeagu GU, Ndidi AC (2023) Sickle Cell Anaemia: A Gestational Enigma. European Journal of Biomedical and Pharmaceutical Sciences 10(9): 72-75.

41. Ifeanyi OE, Uzoma OG (2018) A review on erythropietin in pregnancy. J Gynecol Womens Health 8(3): 1-4.

42. Ifeanyi OE (2018) A review on pregnancy and haematology. Int J Curr Res Biol Med 3(5): 26-28.

43. Nwosu DC, Nwanjo HU, Obeagu EI, Ibebuike JE, Ezeama MC, et al. (2015) Changes in liver enzymes and lipid profile of pregnant women with malaria in Owerri, Nigeria. International Journal of Current Research and Academic Review 3(5): 376-383.

44. Ibebuike JE, Ojie CA, Nwokike GI, Obeagu EI, Nwosu DC, Nwanjo HU, Agu GC, Ezenwuba CO, Nwagu SA, Akujuobi AU. Factors that influence women's utilization of primary health care services in Calabar Cros river state, Nigeria. Int J Curr Res Chem Pharm Sci 4(7): 28-33.

45. Eze R, Ezeah GA, Obeagu EI, Omeje C, Nwakulite A (2021) Evaluation of iron status and some haematological parameters of pregnant women in Enugu, South Eastern Nigeria. World Journal of Pharmaceutical and Medical Research 7(5): 251-254.

46. Elemchukwu Q, Obeagu EI, Ochei KC (2014) Prevalence of Anaemia among Pregnant Women in Braithwaite Memorial Specialist Hospital (BMSH) Port Harcourt. IOSR Journal of Pharmacy and Biological Sciences 9(5): 59-64.

47. Akandinda M, Obeagu EI, Katonera MT (2022) Non Governmental Organizations and Women's Health Empowerment in Uganda: A Review. Asian Research Journal of Gynaecology and Obstetrics 8(3): 12-16.

48. Vidya S, Sunil K, Shango PEJ, Emmanuel IO, Emmanuel WJ, et al. (2022) Occurrence of Chlamydial Infection Based on Clinical Symptoms and Clinical History among Pregnant Women Attending Clinics in Zaria Metropolis, Kaduna State, Nigeria. International Journal of Research and Reports in Gynaecology 5(3): 98-105.

49. Gamde MS, Obeagu EI. Iron Deficiency Anaemia: Enemical To Pregnancy. European Journal of Biomedical 10(9): 272-275.

50. Emeka OOR, Ibeh NC, Obeagu EI, Okorie HM. Evaluation of levels of some inflammatory cytokines in preeclamptic women in owerri. Journal of Pharmaceutical Research International 33(42A): 53-65.

51. Emeka OOR, Ibeh NC, Obeagu EI, Okorie HM. Studies of Some Haemostatic Variables in Preeclamptic Women in Owerri, Imo State, Nigeria. Journal of Pharmaceutical Research International 33(42B): 39-48.

52. Obeagu EI, Obeagu GU (2023) Sickle Cell Anaemia in Pregnancy: A Review. International Research in Medical and Health Sciences 6(2): 10-13.

53. Obeagu EI, Obeagu GU, Igwe MC (2023) The Silent Threat: Hypoxia and Maternal Health Implications. Int J Curr Res Med Sci ;9(11): 8-15.

54. Figueras F, Gratacos E (2014) Update on the diagnosis and classification of fetal growth restriction and proposal of a stage-based management protocol. Fetal diagn ther 36(2): 86-98.

55. Chang KJ, Seow KM, Chen KH (2023) Preeclampsia: Recent Advances in Predicting, Preventing, and Managing the Maternal and Fetal Life-Threatening Condition.

International Journal of Environmental Research and Public Health 20(4): 2994.

56. Wang B, Zeng H, Liu J, Sun M (2021) Effects of prenatal hypoxia on nervous system development and related diseases. Frontiers in neuroscience 15: 755554.

57. Shaw S, Ghosh D, Kumar U, Panjwani U, Kumar B (2018) Impact of high altitude on key determinants of female reproductive health: a review. International journal of biometeorology 62(11): 2045-2055.

58. Moore LG (2021) Hypoxia and reproductive health: reproductive challenges at high altitude: fertility, pregnancy and neonatal well-being. Reproduction 161(1): F81-F90.