

## Anemia as a Prognostic Marker for Disease Progression in HIV Infection

**Emmanuel Ifeanyi Obeagu<sup>1</sup>, Getrude Uzoma Obeagu<sup>2</sup>, Esther Ugo Alum<sup>3,4</sup> and Okechukwu Paul-Chima Ugwu<sup>4</sup>**

<sup>1</sup>Department of Medical Laboratory Science, Kampala International University, Uganda.

<sup>2</sup>School of Nursing Science, Kampala International University, Uganda.

<sup>3</sup>Department of Biochemistry, Ebonyi State, Abakaliki, Ebonyi State, Nigeria

<sup>4</sup>Department of Publication and Extensions, Kampala International University, Uganda.

<sup>\*</sup>Corresponding author: Emmanuel Ifeanyi Obeagu, Department of Medical Laboratory Science, Kampala International University, Uganda.

E-mail:[emmanuelobeagu@yahoo.com](mailto:emmanuelobeagu@yahoo.com), [obeagu.emmanuel@kiu.ac.ug](mailto:obeagu.emmanuel@kiu.ac.ug)

ORCID: 0000-0002-4538-0161

---

### ABSTRACT

Anemia, a prevalent hematologic manifestation in individuals living with Human Immunodeficiency Virus (HIV) infection, has garnered considerable attention as a prognostic indicator for disease progression and adverse clinical outcomes. This abstract presents a comprehensive review elucidating the intricate relationship between anemia and the progression of HIV infection, incorporating epidemiological trends, underlying pathophysiological mechanisms, clinical implications, and prognostic significance. Despite advances in antiretroviral therapy (ART), anemia remains a frequent complication in HIV-infected individuals, posing substantial challenges to patient management. This paper aims to provide a nuanced understanding of anemia's role as a prognostic marker, surpassing its conventional characterization as a hematologic abnormality in the context of HIV infection. Anemia's role as a predictive marker for adverse clinical outcomes in HIV patients is explored, encompassing increased mortality rates, heightened risk of opportunistic infections, accelerated disease progression, and compromised quality of life. The review delves into its prognostic significance, shaping therapeutic decisions and prognostic assessments. This paper encapsulates the criticality of anemia as a prognostic marker for disease progression in HIV infection. Understanding its epidemiology, pathophysiological mechanisms, clinical implications, and prognostic significance is pivotal for informed clinical decision-making, prognostic assessments, and optimizing care paradigms in HIV management.

**Keywords:** Anemia, Prognostic Marker, Disease Progression and HIV

---

### INTRODUCTION

Human Immunodeficiency Virus (HIV) infection remains a significant global health challenge, affecting millions of individuals worldwide. While advances in antiretroviral therapy (ART) have substantially improved the management of HIV, hematologic abnormalities, particularly anemia, persist as prevalent complications among those living with the virus. Anemia, characterized by a reduction in red blood cell mass or hemoglobin levels, has emerged as a notable hematologic manifestation with implications extending beyond its

traditional definition, serving as a potential prognostic indicator for disease progression in HIV-infected individuals [1-10]. Anemia prevalence in HIV-infected populations has been extensively documented, displaying variations across disease stages, demographics, and geographical regions. Its significance lies not only in its frequency but also in its association with disease severity, morbidity, and mortality rates. Understanding anemia's complex interplay with the pathophysiology of HIV infection

is crucial for comprehensive patient care and prognostic assessments [11-21].

This paper aims to provide an extensive examination of anemia as a prognostic marker for disease progression in the context of HIV infection. It delves into the epidemiological trends, underlying pathophysiological mechanisms, clinical implications, and prognostic significance of anemia in HIV-infected individuals. By synthesizing existing research and clinical insights, this review seeks to elucidate the multifaceted role of anemia beyond its hematologic ramifications, emphasizing

#### **Epidemiology of Anemia in HIV**

The epidemiology of anemia in individuals living with Human Immunodeficiency Virus (HIV) represents a multifaceted landscape influenced by various factors, including disease progression, treatment regimens, demographics, and geographic disparities. Anemia, characterized by a decrease in red blood cell count or hemoglobin levels, is a prevalent hematologic complication among HIV-infected populations and remains a significant concern in HIV management [22-30]. Anemia exhibits varying prevalence rates across different stages of HIV infection. Studies indicate a higher prevalence of anemia in advanced stages of the disease, particularly among individuals with lower CD4 cell counts or higher viral loads. The prevalence of anemia tends to increase with disease progression, affecting a substantial proportion of patients, despite advancements in antiretroviral therapy (ART) [31-42]. Anemia's prevalence demonstrates variations across demographic groups and geographical regions. Certain demographic factors such as age, gender, and race/ethnicity contribute to differences in anemia rates among HIV-infected individuals. Additionally, disparities in anemia

#### **Pathophysiological Mechanisms**

The pathophysiological mechanisms contributing to anemia in individuals living with Human Immunodeficiency Virus (HIV) infection are multifactorial and involve intricate interactions between the virus, immune dysregulation, chronic

its potential as a valuable prognostic tool in HIV management. The multifactorial etiology of anemia in HIV, influenced by chronic inflammation, immune dysregulation, opportunistic infections, nutritional deficiencies, and bone marrow dysfunction, underscores the intricate relationship between the virus and hematologic abnormalities. Furthermore, anemia's prognostic value is explored, elucidating its association with adverse clinical outcomes, disease progression, and therapeutic responses, thus shaping the landscape of HIV care.

prevalence exist among diverse geographic locations, often influenced by socioeconomic factors, access to healthcare, and nutritional status [43-56]. Anemia in HIV patients is associated with increased morbidity and mortality rates. It serves as a predictor of disease progression and is linked to a higher risk of opportunistic infections, reduced quality of life, and adverse clinical outcomes. The presence of anemia exacerbates the burden of HIV-related complications and impacts overall health status [57-61]. While ART has significantly improved HIV management, it does not completely eliminate anemia. However, studies suggest a potential reduction in anemia prevalence among individuals receiving effective ART. Nevertheless, certain antiretroviral medications may contribute to or exacerbate hematologic abnormalities, warranting careful consideration in treatment selection [62-65]. Addressing anemia in the HIV population poses challenges in clinical management. Anemia not only impacts overall health but also presents challenges in optimizing treatment responses, adherence to therapy, and long-term outcomes.

inflammation, hematopoiesis, and various comorbidities [66]. Persistent immune activation and chronic inflammation triggered by HIV infection play a pivotal role in anemia. Pro-inflammatory cytokines, including tumor necrosis

factor-alpha (TNF- $\alpha$ ), interleukin-6 (IL-6), and interferon-gamma (IFN- $\gamma$ ), disrupt erythropoiesis, inhibit red blood cell production, and contribute to the development of anemia [67]. HIV-associated bone marrow alterations and dysfunctions affect erythropoiesis, leading to inadequate red blood cell production. Suppressed bone marrow activity, impaired maturation of erythroid precursors, and decreased response to erythropoietin contribute to anemia development in HIV patients [68]. HIV viral proteins, particularly Tat and gp120, disrupt erythropoiesis and promote apoptosis of erythroid progenitor cells, contributing to decreased red blood cell production [69]. Coexisting conditions and nutritional deficiencies prevalent in HIV-infected individuals, such as iron, vitamin B12, and folate deficiencies, exacerbate

#### **Clinical Implications and Prognostic Significance**

The clinical implications and prognostic significance of anemia in the context of Human Immunodeficiency Virus (HIV) infection are substantial, encompassing various adverse outcomes, disease progression, treatment responses, and overall patient well-being [72]. Anemia in HIV-infected individuals is associated with a spectrum of adverse clinical outcomes. It serves as a predictor of increased morbidity, including a higher risk of opportunistic infections, hospitalizations, and progression to AIDS-defining illnesses. Anemic patients often experience reduced quality of life due to symptoms such as fatigue, weakness, and decreased exercise tolerance [73]. Anemia has been identified as an independent predictor of accelerated disease progression in HIV-infected individuals. Studies suggest a correlation between lower hemoglobin levels and faster disease progression, leading to poorer clinical outcomes and increased mortality rates. Anemia appears to be associated with increased mortality risk, especially in advanced stages of HIV infection. Anemia's impact extends to treatment responses and adherence to

anemia. These deficiencies, either due to malabsorption, increased utilization, or poor dietary intake, impair erythropoiesis and worsen anemia in HIV patients [70]. Certain antiretroviral medications, notably zidovudine (AZT) and other nucleoside reverse transcriptase inhibitors (NRTIs), are associated with bone marrow suppression and can exacerbate anemia. Drug-related effects on erythropoiesis contribute to hematologic abnormalities observed in HIV-infected individuals undergoing specific ART regimens [71]. Coinfections and opportunistic infections prevalent in HIV patients, such as chronic viral hepatitis, mycobacterial infections, and parasitic infections, contribute to anemia through multifaceted mechanisms including chronic inflammation, direct hematological effects, and increased erythrocyte destruction.

antiretroviral therapy (ART). Patients with anemia may exhibit poorer responses to therapy, delayed immune recovery, and reduced virological suppression. Moreover, anemia can complicate ART regimens, potentially affecting treatment adherence and tolerability. Anemia serves as a valuable prognostic marker for disease severity and overall HIV progression. Lower hemoglobin levels or the presence of anemia may indicate more advanced disease stages, guiding clinical assessments and prognostic evaluations. Anemia's presence or severity can predict clinical outcomes, including increased hospitalizations, progression to AIDS-related complications, and decreased survival rates. Monitoring hemoglobin levels and anemia status may aid in prognostic assessments and informing treatment decisions. Beyond clinical parameters, anemia significantly impacts patients' quality of life, contributing to fatigue, diminished physical functioning, and impaired daily activities. Addressing anemia is crucial not only for clinical management but also for improving patients' overall well-being.

#### **Role in Antiretroviral Therapy**

Anemia's role in the context of Antiretroviral Therapy (ART) among

individuals living with Human Immunodeficiency Virus (HIV) is

multifaceted, influencing treatment outcomes, adherence, and therapeutic considerations. Understanding how anemia interacts with ART is crucial for optimizing HIV management strategies [74]. While ART significantly improves immune function and reduces HIV-associated morbidity, its impact on anemia varies among different antiretroviral regimens. Some ART medications, particularly certain nucleoside reverse transcriptase inhibitors (NRTIs) like zidovudine (AZT), have been associated with bone marrow suppression, potentially exacerbating anemia. Conversely, effective viral suppression achieved through ART may indirectly alleviate anemia by reducing chronic inflammation and improving overall health. Anemia can serve as a predictive marker for ART response and treatment outcomes. Patients presenting with anemia at the initiation of ART may exhibit altered responses to therapy, potentially affecting virological suppression and immune recovery. Monitoring anemia alongside viral load assessments provides insights into treatment responses and helps tailor therapeutic strategies [71]. Anemia's presence can impact ART adherence and tolerance. Patients experiencing anemia-related symptoms, such as fatigue or reduced physical endurance, might face

#### **Implications for Health Policy Makers**

The implications of understanding the relationship between anemia and Human Immunodeficiency Virus (HIV) infection have significant relevance for health policymakers. Addressing anemia in the context of HIV involves multifaceted considerations that can guide policy formulation and healthcare strategies:

#### **Guidelines and Recommendations:**

Health policymakers can develop or update guidelines that emphasize comprehensive hematological monitoring, including regular assessments of hemoglobin levels and other relevant parameters, in HIV care protocols. These guidelines can integrate recommendations for managing anemia, addressing its impact on treatment responses and patient outcomes.

challenges adhering to complex ART regimens. Moreover, specific ART medications associated with anemia-related side effects may affect treatment adherence, necessitating careful consideration in regimen selection. Management of anemia within the context of ART involves tailored approaches aimed at optimizing treatment outcomes. Strategies include nutritional interventions, iron supplementation, erythropoietin-stimulating agents (ESAs), and judicious adjustments in ART regimens to mitigate anemia-related adverse effects while maintaining viral suppression. Regular monitoring of hematologic parameters, including hemoglobin levels, is essential during ART to assess the impact of treatment on anemia and guide therapeutic decisions. Longitudinal assessments enable healthcare providers to evaluate treatment responses, manage hematologic complications, and optimize patient care. Tailoring ART regimens based on individual patient characteristics, including their anemia status, comorbidities, and tolerability, is crucial. Personalized treatment approaches that consider both viral suppression and hematologic health are essential for optimizing treatment efficacy and minimizing adverse effects.

#### **Healthcare Resource Allocation:**

Policymakers need to allocate resources effectively to ensure access to diagnostic tools, laboratory tests, and treatment modalities necessary for managing anemia in HIV-infected individuals. This includes ensuring access to a diverse range of antiretroviral medications with varying hematological profiles to mitigate anemia-related complications.

#### **Education and Training Programs:**

Policymakers can advocate for educational initiatives targeting healthcare providers to raise awareness about anemia's significance in HIV care. Educational programs can focus on enhancing providers' understanding of anemia monitoring, interpretation of hematologic

parameters, and appropriate interventions within the context of HIV management.

**Research and Surveillance Initiatives:** Supporting research programs aimed at elucidating the impact of anemia on treatment outcomes, disease progression, and overall health in HIV-infected populations is crucial. Policymakers can allocate funding for longitudinal studies and surveillance programs that investigate the relationship between anemia and HIV, providing valuable insights for evidence-based policymaking.

**Integrated Care Models:** Encouraging integrated care models that incorporate hematologic assessments as an integral part of HIV care can improve patient outcomes. Policymakers can promote collaborative efforts between hematologists, infectious disease specialists, primary care providers, and other healthcare professionals to ensure holistic care that addresses both viral suppression and hematological health.

In conclusion, the intersection between anemia and Human Immunodeficiency Virus (HIV) infection presents a complex landscape with far-reaching implications for patient care, treatment strategies, and overall health outcomes. The multifaceted relationship between anemia and HIV, characterized by its prevalence, pathophysiological mechanisms, clinical implications, and prognostic significance, underscores the need for comprehensive approaches in HIV management. Anemia, prevalent among individuals living with HIV, serves as more than a hematological abnormality; it emerges as a prognostic marker for disease progression and adverse clinical outcomes. Its association with increased morbidity, accelerated disease progression, and diminished quality of life emphasizes its clinical significance in the context of HIV care. The clinical implications of anemia extend

**Equitable Access to Care:** Policymakers play a vital role in advocating for equitable access to comprehensive HIV care, ensuring that marginalized or underserved populations have access to effective treatments addressing anemia and other hematologic complications associated with HIV.

**Policy Support for Research and Development:** Advocating for policies that incentivize research and development of novel therapies, diagnostic tools, and interventions targeting anemia in HIV is crucial. Encouraging innovation in this field can lead to improved treatment modalities and better outcomes for individuals living with HIV.

By addressing anemia's implications within HIV care through policy initiatives, policymakers can contribute significantly to optimizing treatment strategies, improving patient outcomes, and advancing comprehensive care paradigms for individuals living with HIV.

## CONCLUSION

beyond its hematological manifestations, influencing treatment responses, antiretroviral therapy (ART) adherence, and overall prognosis in HIV-infected individuals. Anemia's role as a predictive marker for disease severity, treatment responses, and clinical outcomes underscores its value in guiding therapeutic decisions and prognostic assessments.

Policymakers, healthcare providers, and researchers play pivotal roles in addressing anemia within the context of HIV care. Comprehensive policies, integrated care models, resource allocation, educational initiatives, and support for research are imperative for optimizing treatment strategies, ensuring equitable access to care, and advancing evidence-based practices in managing anemia among individuals living with HIV.

## REFERENCES

1. Chinedu K, Takim AE, Obeagu EI, Chinazor UD, Eloghosa O, Ojong OE, Odunze U. HIV and TB co-infection among patients who used Directly Observed Treatment Short-course centres in Yenagoa, Nigeria. *IOSR J Pharm Biol Sci.* 2017;12(4):70-5.
2. Offie DC, Obeagu EI, Akueshi C, Njab JE, Ekanem EE, Dike PN, Oguh DN. Facilitators and barriers to



- retention in HIV care among HIV infected MSM attending Community Health Center Yaba, Lagos Nigeria. *Journal of Pharmaceutical Research International*. 2021;33(52B):10-9.
3. Nwovu AI, Ifeanyi OE, Uzoma OG, Nwebonyi NS. Occurrence of Some Blood Borne Viral Infection and Adherence to Universal Precautions among Laboratory Staff in Federal Teaching Hospital Abakaliki Ebonyi State. *Arch Blood Transfus Disord*. 2018;1(2).
  4. Ifeanyi OE, Uzoma OG, Stella EI, Chinedum OK, Abum SC. Vitamin D and insulin resistance in HIV sero positive individuals in Umudike. *Int. J. Curr. Res. Med. Sci*. 2018;4(2):104-8.
  5. Ifeanyi OE, Leticia OI, Nwosu D, Chinedum OK. A Review on blood borne viral infections: universal precautions. *Int. J. Adv. Res. Biol. Sci*. 2018;5(6):60-6.
  6. Obeagu EI, Obarezi TN, Omeh YN, Okoro NK, Eze OB. Assessment of some haematological and biochemical parameters in HIV patients before receiving treatment in Aba, Abia State, Nigeria. *Res J Pharma Biol Chem Sci*. 2014; 5:825-30.
  7. Obeagu EI, Obarezi TN, Ogbuabor BN, Anaebo QB, Eze GC. Pattern of total white blood cell and differential count values in HIV positive patients receiving treatment in Federal Teaching Hospital Abakaliki, Ebonyi State, Nigeria. *International Journal of Life Science, Biotechnology and Pharama Research*. 2014; 391:186-9.
  8. Obeagu EI. A Review of Challenges and Coping Strategies Faced by HIV/AIDS Discordant Couples. *Madonna University journal of Medicine and Health Sciences*. 2023; 3 (1): 7-12.
  9. Oloro OH, Obeagu EI. A Systematic Review on Some Coagulation Profile in HIV Infection. *International Journal of Innovative and Applied Research*. 2022;10(5):1-1.
  10. Nwosu DC, Obeagu EI, Nkwuocha BC, Nwanna CA, Nwanjo HU, Amadike JN, Ezemma MC, Okpomeshine EA, Ozims SJ, Agu GC. Alterations in superoxide dismutase, vitamins C and E in HIV infected children in Umuahia, Abia state. *International Journal of Advanced Research in Biological Sciences*. 2015;2(11):268-71.
  11. Shen Y, Wang Z, Lu H, Wang J, Chen J, Liu L, Zhang R, Zheng Y. Prevalence of anemia among adults with newly diagnosed HIV/AIDS in China. *PLoS One*. 2013;8(9): e73807.
  12. Obeagu EI, Malot S, Obeagu GU, Ugwu OP. HIV resistance in patients with Sickle Cell Anaemia. *NEWPORT INTERNATIONAL JOURNAL OF SCIENTIFIC AND EXPERIMENTAL SCIENCES (NIJSES)*. 2023;3(2):56-9.
  13. Ifeanyi OE, Obeagu GU. The Values of CD4 Count, among HIV Positive Patients in FMC Owerri. *Int. J. Curr. Microbiol. App. Sci*. 2015;4(4):906-10.  
[https://www.academia.edu/download/38320134/Obeagu\\_Emanuel\\_Ifeanyi\\_and\\_Obeagu\\_Getrude\\_Uzoma.EMMA2.pdf](https://www.academia.edu/download/38320134/Obeagu_Emanuel_Ifeanyi_and_Obeagu_Getrude_Uzoma.EMMA2.pdf).
  14. Obeagu EI, Okeke EI, Anonde Andrew C. Evaluation of haemoglobin and iron profile study among persons living with HIV in Umuahia, Abia state, Nigeria. *Int. J. Curr. Res. Biol. Med*. 2016;1(2):1-5.
  15. Alum EU, Ugwu OP, Obeagu EI, Okon MB. Curtailing HIV/AIDS Spread: Impact of Religious Leaders. *Newport International Journal of Research in Medical Sciences (NIJRMS)*. 2023;3(2):28-31.
  16. Obeagu EI, Obeagu GU, Paul-Chima UO. Stigma Associated With HIV. *AIDS: A Review. Newport International Journal of Public Health and Pharmacy (Nijpp)*. 2023;3(2):64-7.
  17. Alum EU, Obeagu EI, Ugwu OP, Aja PM, Okon MB. HIV Infection and Cardiovascular diseases: The

- obnoxious Duos. Newport International Journal of Research in Medical Sciences (NIJRMS). 2023;3(2):95-9.
18. Ibebuike JE, Nwokike GI, Nwosu DC, Obeagu EI. A Retrospective Study on Human Immune Deficiency Virus among Pregnant Women Attending Antenatal Clinic in Imo State University Teaching Hospital. *International Journal of Medical Science and Dental Research*, 2018; 1 (2):08-14. <https://www.ijmsdr.org/published%20paper/li1i2/A%20Retrospective%20Study%20on%20Human%20Immune%20Deficiency%20Virus%20among%20Pregnant%20Women%20Attending%20Antenatal%20Clinic%20in%20Imo%20State%20University%20Teaching%20Hospital.pdf>.
  19. Obeagu EI, Okwuanaso CB, Edoho SH, Obeagu GU. Under-nutrition among HIV-exposed Uninfected Children: A Review of African Perspective. *Madonna University journal of Medicine and Health Sciences*. 2022 ;2(3):120-7.
  20. Obeagu EI, Alum EU, Obeagu GU. Factors associated with prevalence of HIV among youths: A review of Africa perspective. *Madonna University journal of Medicine and Health Sciences*. 2023;3(1):13-8. <https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/93>.
  21. Obeagu EI. A Review of Challenges and Coping Strategies Faced by HIV/AIDS Discordant Couples. *Madonna University journal of Medicine and Health Sciences*. 2023;3(1):7-12. <https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/91>.
  22. Obeagu EI, Obeagu GU. An update on premalignant cervical lesions and cervical cancer screening services among HIV positive women. *J Pub Health Nutri*. 2023; 6 (2). 2023;141:1-2. [links/63e538ed64252375639dd0df](https://doi.org/10.59298/IAAJB/2023/3.2.23310)
  23. Ezeoru VC, Enweani IB, Ochiabuto O, Nwachukwu AC, Ogbonna US, Obeagu EI. Prevalence of Malaria with Anaemia and HIV status in women of reproductive age in Onitsha, Nigeria. *Journal of Pharmaceutical Research International*. 2021;33(4):10-9. [/An-update-on-premalignant-cervical-lesions-and-cervical-cancer-screening-services-among-HIV-positive-women.pdf](https://doi.org/10.59298/IAAJB/2023/3.2.23310).
  24. Omo-Emmanuel UK, Chinedum OK, Obeagu EI. Evaluation of laboratory logistics management information system in HIV/AIDS comprehensive health facilities in Bayelsa State, Nigeria. *Int J Curr Res Med Sci*. 2017;3(1): 21-38.DOI: [10.22192/ijcrms.2017.03.01.004](https://doi.org/10.22192/ijcrms.2017.03.01.004)
  25. Obeagu EI, Obeagu GU, Musiimenta E, Bot YS, Hassan AO. Factors contributing to low utilization of HIV counseling and testing services. *Int. J. Curr. Res. Med. Sci*. 2023;9(2): 1-5.DOI: [10.22192/ijcrms.2023.09.02.001](https://doi.org/10.22192/ijcrms.2023.09.02.001)
  26. Obeagu EI, Obeagu GU. An update on survival of people living with HIV in Nigeria. *J Pub Health Nutri*. 2022; 5 (6). 2022;129. [links/645b4bfcf3512f1cc5885784/An-update-on-survival-of-people-living-with-HIV-in-Nigeria.pdf](https://doi.org/10.59298/IAAJB/2023/3.2.23310).
  27. Offie DC, Obeagu EI, Akueshi C, Njab JE, Ekanem EE, Dike PN, Oguh DN. Facilitators and barriers to retention in HIV care among HIV infected MSM attending Community Health Center Yaba, Lagos Nigeria. *Journal of Pharmaceutical Research International*. 2021;33(52B):10-9.
  28. Obeagu EI, Ogbonna US, Nwachukwu AC, Ochiabuto O, Enweani IB, Ezeoru VC. Prevalence of Malaria with Anaemia and HIV status in women of reproductive age in Onitsha, Nigeria. *Journal of Pharmaceutical Research International*. 2021;33(4):10-9.
  29. Odo M, Ochei KC, Obeagu EI, Barinaadaa A, Eteng UE, Ikpeme M, Bassey JO, Paul AO. TB Infection

- Control in TB/HIV Settings in Cross River State, Nigeria: Policy Vs Practice. *Journal of Pharmaceutical Research International*. 2020;32(22):101-9.
30. Obeagu EI, Eze VU, Alaebob EA, Ochei KC. Determination of haematocrit level and iron profile study among persons living with HIV in Umuahia, Abia State, Nigeria. *J BioInnovation*. 2016;5:464-71. [links/592bb4990f7e9b9979a975cf/DETERMINATION-OF-HAEMATOCRIT-LEVEL-AND-IRON-PROFILE-STUDY-AMONG-PERSONS-LIVING-WITH-HIV-IN-UMUAHIA-ABIA-STATE-NIGERIA.pdf](https://doi.org/10.59298/IAAJB/2023/3.2.23310).
  31. Chaparro CM, Suchdev PS. Anemia epidemiology, pathophysiology, and etiology in low-and middle-income countries. *Annals of the new York Academy of Sciences*. 2019;1450(1):15-31.
  32. Ifeanyi OE, Obeagu GU. The values of prothrombin time among HIV positive patients in FMC owerri. *International Journal of Current Microbiology and Applied Sciences*. 2015;4(4):911-6. [https://www.academia.edu/download/38320140/Obeagu\\_Emanuel\\_Ifeanyi\\_and\\_Obeagu\\_Getrude\\_Uzoma2.EMMA1.pdf](https://www.academia.edu/download/38320140/Obeagu_Emanuel_Ifeanyi_and_Obeagu_Getrude_Uzoma2.EMMA1.pdf).
  33. Izuchukwu IF, Ozims SJ, Agu GC, Obeagu EI, Onu I, Amah H, Nwosu DC, Nwanjo HU, Edward A, Arunsi MO. Knowledge of preventive measures and management of HIV/AIDS victims among parents in Umuna Orlu community of Imo state Nigeria. *Int. J. Adv. Res. Biol. Sci.* 2016;3(10): 55-65.DOI; [10.22192/ijarbs.2016.03.10.009](https://doi.org/10.22192/ijarbs.2016.03.10.009)
  34. Chinedu K, Takim AE, Obeagu EI, Chinazor UD, Eloghosa O, Ojong OE, Odunze U. HIV and TB co-infection among patients who used Directly Observed Treatment Short-course centres in Yenagoa, Nigeria. *IOSR J Pharm Biol Sci*. 2017;12(4):70-5. [links/5988ab6d0f7e9b6c8539f73d/HIV-and-TB-co-infection-among-patients-who-used-Directly-](https://doi.org/10.59298/IAAJB/2023/3.2.23310)
  35. Oloro OH, Oke TO, Obeagu EI. Evaluation of Coagulation Profile Patients with Pulmonary Tuberculosis and Human Immunodeficiency Virus in Owo, Ondo State, Nigeria. *Madonna University journal of Medicine and Health Sciences* ISSN: 2814-3035. 2022;2(3):110-9.
  36. Nwosu DC, Obeagu EI, Nkwocha BC, Nwanna CA, Nwanjo HU, Amadike JN, Elendu HN, Ofoedeme CN, Ozims SJ, Nwankpa P. Change in Lipid Peroxidation Marker (MDA) and Non enzymatic Antioxidants (VIT C & E) in HIV Seropositive Children in an Urban Community of Abia State. Nigeria. *J. Bio. Innov.* 2016;5(1):24-30. [links/5ae735e9a6fdcc5b33eb8d6a/CHANGE-IN-LIPID-PEROXIDATION-MARKER-MDAAND-NON-ENZYMATIC-ANTIOXIDANTS-VIT-C-E-IN-HIV-SEROPOSITIVE-CHILDREN-IN-AN-URBAN-COMMUNITY-OF-ABIA-STATE-NIGERIA.pdf](https://doi.org/10.59298/IAAJB/2023/3.2.23310).
  37. Igwe CM, Obeagu IE, Ogbuabor OA. Clinical characteristics of people living with HIV/AIDS on ART in 2014 at tertiary health institutions in Enugu, Nigeria. *J Pub Health Nutri.* 2022; 5 (6). 2022;130. [links/645a166f5762c95ac3817d32/Clinical-characteristics-of-people-living-with-HIV-AIDS-on-ART-in-2014-at-tertiary-health-institutions-in-Enugu.pdf](https://doi.org/10.59298/IAAJB/2023/3.2.23310).
  38. Ifeanyi OE, Obeagu GU, Ijeoma FO, Chioma UI. The values of activated partial thromboplastin time (APTT) among HIV positive patients in FMC Owerri. *Int J Curr Res Aca Rev*. 2015; 3:139-44. [https://www.academia.edu/download/38320159/Obeagu\\_Emanuel\\_Ifeanyi3\\_et\\_al.IJCRAR.pdf](https://www.academia.edu/download/38320159/Obeagu_Emanuel_Ifeanyi3_et_al.IJCRAR.pdf).
  39. Obiomah CF, Obeagu EI, Ochei KC, Swem CA, Amachukwu BO. Hematological indices o HIV seropositive subjects in Nnamdi Azikiwe University teaching



- hospital (NAUTH), Nnewi. *Ann Clin Lab Res.* 2018;6(1):1-4. [links/5aa2bb17a6fdccd544b7526e/Haematological-Indices-of-HIV-Seropositive-Subjects-at-Nnamdi-Azikiwe.pdf](https://doi.org/10.59298/IAAJB/2023/3.2.23310)
40. Omo-Emmanuel UK, Ochei KC, Osuala EO, Obeagu EI, Onwuasoanya UF. Impact of prevention of mother to child transmission (PMTCT) of HIV on positivity rate in Kafanchan, Nigeria. *Int. J. Curr. Res. Med. Sci.* 2017;3(2): 28-34. DOI: [10.22192/ijcrms.2017.03.02.005](https://doi.org/10.22192/ijcrms.2017.03.02.005)
  41. Aizaz M, Abbas FA, Abbas A, Tabassum S, Obeagu EI. Alarming rise in HIV cases in Pakistan: Challenges and future recommendations at hand. *Health Science Reports.* 2023;6(8): e1450.
  42. Obeagu EI, Amekpor F, Scott GY. An update of human immunodeficiency virus infection: Bleeding disorders. *J Pub Health Nutri.* 2023; 6 (1). 2023;139. [links/645b4a6c2edb8e5f094d9bd9/An-update-of-human-immunodeficiency-virus-infection-bleeding.pdf](https://doi.org/10.22192/ijcrms.2017.03.02.005).
  43. Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca F, Peña-Rosas JP, Bhutta ZA, Ezzati M. Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995-2011: a systematic analysis of population-representative data. *The Lancet Global Health.* 2013;1(1): e16-25.
  44. Obeagu EI, Scott GY, Amekpor F, Ofodile AC, Edoho SH, Ahamefula C. Prevention of New Cases of Human Immunodeficiency Virus: Pragmatic Approaches of Saving Life in Developing Countries. *Madonna University journal of Medicine and Health Sciences.* 2022 Dec 20;2(3):128-34. [https://madonnauniversity.edu.ng](https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/86)
  45. Walter O, Anaebo QB, Obeagu EI, Okoroiwu IL. Evaluation of Activated Partial Thromboplastin Time and Prothrombin Time in HIV and TB Patients in Owerri Metropolis. *Journal of Pharmaceutical Research International.* 2022:29-34.
  46. Odo M, Ochei KC, Obeagu EI, Barinaadaa A, Eteng EU, Ikpeme M, Bassey JO, Paul AO. Cascade variabilities in TB case finding among people living with HIV and the use of IPT: assessment in three levels of care in cross River State, Nigeria. *Journal of Pharmaceutical Research International.* 2020;32(24):9-18.
  47. Jakheng SP, Obeagu EI. Seroprevalence of human immunodeficiency virus based on demographic and risk factors among pregnant women attending clinics in Zaria Metropolis, Nigeria. *J Pub Health Nutri.* 2022; 5 (8). 2022;137. [links/6317a6b1acd814437f0ad268/Seroprevalence-of-human-immunodeficiency-virus-based-on-demographic-and-risk-factors-among-pregnant-women-attending-clinics-in-Zaria-Metropolis-Nigeria.pdf](https://doi.org/10.22192/ijcrms.2017.03.02.005).
  48. Obeagu EI, Obeagu GU. A Review of knowledge, attitudes and socio-demographic factors associated with non-adherence to antiretroviral therapy among people living with HIV/AIDS. *Int. J. Adv. Res. Biol. Sci.* 2023;10(9):135-42. DOI: [10.22192/ijarbs.2023.10.09.015](https://doi.org/10.22192/ijarbs.2023.10.09.015) [links/6516faa61e2386049de5e828/A-Review-of-knowledge-attitudes-and-socio-demographic-factors-associated-with-non-adherence-to-antiretroviral-therapy-among-people-living-with-HIV-AIDS.pdf](https://doi.org/10.22192/ijarbs.2023.10.09.015)
  49. Obeagu EI, Onuoha EC. Tuberculosis among HIV Patients: A review of Prevalence and

- Associated Factors. *Int. J. Adv. Res. Biol. Sci.* 2023;10(9):128-34. DOI: [10.22192/ijarbs.2023.10.09.014](https://doi.org/10.22192/ijarbs.2023.10.09.014) <https://www.iaajournals.org/links/6516f938b0df2f20a2f8b0e0/Tuberculosis-among-HIV-Patients-A-review-of-Prevalence-and-Associated-Factors.pdf>.
50. Obeagu EI, Ibeh NC, Nwobodo HA, Ochei KC, Iwegbulam CP. Haematological indices of malaria patients coinfecting with HIV in Umuahia. *Int. J. Curr. Res. Med. Sci.* 2017;3(5):100-4. DOI: [10.22192/ijcrms.2017.03.05.014](https://doi.org/10.22192/ijcrms.2017.03.05.014) [https://www.academia.edu/download/54317126/Haematological\\_indices\\_of\\_malaria\\_patients\\_coinfected\\_with\\_HIV.pdf](https://www.academia.edu/download/54317126/Haematological_indices_of_malaria_patients_coinfected_with_HIV.pdf)
51. Jakheng SP, Obeagu EI, Abdullahi IO, Jakheng EW, Chukwueze CM, Eze GC, Essien UC, Madekwe CC, Madekwe CC, Vidya S, Kumar S. 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 Microbiology.* 2022;13(2):26-31.
52. Viola N, Kimono E, Nuruh N, Obeagu EI. Factors Hindering Elimination of Mother to Child Transmission of HIV Service Uptake among HIV Positive Women at Comboni Hospital Kyamuhunga Bushenyi District. *Asian Journal of Dental and Health Sciences.* 2023 ;3(2):7-14. <http://ajdhs.com/index.php/journal/article/view/39>.
53. Okorie HM, Obeagu Emmanuel I, Okpoli Henry CH, Chukwu Stella N. Comparative study of enzyme linked immunosorbent assay (Elisa) and rapid test screening methods on HIV, Hbsag, Hcv and Syphilis among voluntary donors in. Owerri, Nigeria. *J Clin Commun Med.* 2020;2(3):180-83. DOI: [10.32474/JCCM.2020.02.000137](https://doi.org/10.32474/JCCM.2020.02.000137) <https://www.iaajournals.org/links/5f344530458515b7291bd95f/Comparative-Study-of-Enzyme-Linked-Immunosorbent-Assay-ELISA-and-Rapid-Test-Screening-Methods-on-HIV-HBsAg-HCV-and-Syphilis-among-Voluntary-Donors-in-Owerri-Nigeria.pdf>.
54. Ezugwu UM, Onyenekwe CC, Ukibe NR, Ahaneku JE, Onah CE, Obeagu EI, Emeje PI, Awalu JC, Igbokwe GE. Use of ATP, GTP, ADP and AMP as an Index of Energy Utilization and Storage in HIV Infected Individuals at NAUTH, Nigeria: A Longitudinal, Prospective, Case-Controlled Study. *Journal of Pharmaceutical Research International.* 2021;33(47A):78-84.
55. Emmanuel G, Martin O, Peter OS, Obeagu EI, Daniel K. 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.* 2023;6(1):203-11. <http://research.sdpublishers.net/id/eprint/2819/>.
56. Igwe MC, Obeagu EI, Ogbuabor AO, Eze GC, Ikpenwa JN, Eze-Stephen PE. Socio-Demographic Variables of People Living with HIV/AIDS Initiated on ART in 2014 at Tertiary Health Institution in Enugu State. *Asian Journal of Research in Infectious Diseases.* 2022;10(4):1-7.
57. Vincent CC, Obeagu EI, Agu IS, Ukeagu NC, Onyekachi-Chigbu AC. Adherence to Antiretroviral Therapy among HIV/AIDS in Federal Medical Centre, Owerri. *Journal of Pharmaceutical Research International.* 2021;33(57A):360-8.
58. Igwe MC, Obeagu EI, Ogbuabor AO. Analysis of the Factors and Predictors of Adherence to Healthcare of People Living with HIV/AIDS in Tertiary Health Institutions in Enugu State. *Madonna University journal of Medicine and Health Sciences.* 2022;2(3):42-57. <https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/75>.

59. Madekwe CC, Madekwe CC, Obeagu EI. Inequality of monitoring in Human Immunodeficiency Virus, Tuberculosis and Malaria: A Review. *Madonna University journal of Medicine and Health Sciences*. 2022;2(3):6-15.  
<https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/69>
60. Echendu GE, Vincent CC, Ibebuikwe J, Asodike M, Naze N, Chinedu EP, Ohale B, Obeagu EI. Weights Of Infants Born to HIV Infected Mothers: A Prospective Cohort Study in Federal Medical Centre, Owerri, Imo State. *European Journal of Pharmaceutical and Medical Research*, 2023; 10(8): 564-568
61. Nwosu DC, Nwanjo HU, Okolie NJ, Ikeh K, Ajero CM, Dike J, Ojiegbe GC, Oze GO, Obeagu EI, Nnatunanya I, Azuonwu O. Biochemical Alterations in Adult HIV Patients on Antiretroviral Therapy. *World Journal of Pharmacy and Pharmaceutical Sciences*, 2015; 4(3): 153-160.  
[links/5a4fd0500f7e9bbc10526b38/BIOCHEMICAL-ALTERATIONS-IN-ADULT-HIV-PATIENTS-ON-ANTIRETROVIRAL-THERAPY.pdf](https://www.iaajournals.org/links/5a4fd0500f7e9bbc10526b38/BIOCHEMICAL-ALTERATIONS-IN-ADULT-HIV-PATIENTS-ON-ANTIRETROVIRAL-THERAPY.pdf).
62. Obeagu EI, Obeagu GU. Effect of CD4 Counts on Coagulation Parameters among HIV Positive Patients in Federal Medical Centre, Owerri, Nigeria. *Int. J. Curr. Res. Biosci. Plant Biol.* 2015;2(4):45-9.
63. Obeagu EI, Nwosu DC. Adverse drug reactions in HIV/AIDS patients on highly active antiretroviral therapy: a review of prevalence. *Int. J. Curr. Res. Chem. Pharm. Sci.* 2019;6(12):45-8. DOI: [10.22192/ijcrps.2019.06.12.004 links/650aba1582f01628f0335795/Adverse-drug-reactions-in-HIV-AIDS-patients-on-highly-active-antiretro-viral-therapy-a-review-of-prevalence.pdf](https://www.iaajournals.org/links/650aba1582f01628f0335795/Adverse-drug-reactions-in-HIV-AIDS-patients-on-highly-active-antiretro-viral-therapy-a-review-of-prevalence.pdf).
64. Obeagu EI, Scott GY, Amekpor F, Obeagu GU. Implications of CD4/CD8 ratios in Human Immunodeficiency Virus infections. *Int. J. Curr. Res. Med. Sci.* 2023;9(2):6-13. DOI: [10.22192/ijcrms.2023.09.02.002 links/645a4a462edb8e5f094ad37c/Implications-of-CD4-CD8-ratios-in-Human-Immunodeficiency-Virus-infections.pdf](https://www.iaajournals.org/links/645a4a462edb8e5f094ad37c/Implications-of-CD4-CD8-ratios-in-Human-Immunodeficiency-Virus-infections.pdf).
65. Obeagu EI, Ochei KC, Okeke EI, Anode AC. Assessment of the level of haemoglobin and erythropoietin in persons living with HIV in Umuahia. *Int. J. Curr. Res. Med. Sci.* 2016;2(4):29-33.  
[links/5711c47508aeebe07c02496b/Assessment-of-the-level-of-haemoglobin-and-erythropoietin-in-persons-living-with-HIV-in-Umuahia.pdf](https://www.iaajournals.org/links/5711c47508aeebe07c02496b/Assessment-of-the-level-of-haemoglobin-and-erythropoietin-in-persons-living-with-HIV-in-Umuahia.pdf).
66. Vishnu P, Aboulafia DM. Haematological manifestations of human immune deficiency virus infection. *British journal of haematology*. 2015;171(5):695-709.
67. d'Ettorre G, Paiardini M, Ceccarelli G, Silvestri G, Vullo V. HIV-associated immune activation: from bench to bedside. *AIDS research and human retroviruses*. 2011;27(4):355-64.
68. Gibellini D, Clò A, Morini S, Miserocchi A, Ponti C, Re MC. Effects of human immunodeficiency virus on the erythrocyte and megakaryocyte lineages. *World Journal of Virology*. 2013;2(2):91.
69. Pascutti MF, Erkelens MN, Nolte MA. Impact of viral infections on hematopoiesis: from beneficial to detrimental effects on bone marrow output. *Frontiers in immunology*. 2016; 7:364.
70. Huibers MH, Bates I, McKew S, Allain TJ, Coupland SE, Phiri C, Phiri KS, Boele van Hensbroek M, Calis JC. Severe anaemia complicating HIV in Malawi; Multiple co-existing aetiologies are associated with high mortality. *PLoS One*. 2020;15(2): e0218695.
71. Kufel WD, Hale CM, Sidman EF, Orellana CE, Miller CD. Nucleoside

- reverse transcriptase inhibitor (NRTI) associated macrocytosis. *Int. J. Virol. AIDS.* 2016; 3:18.
72. Willig A, Wright L, Galvin TA. Practice paper of the Academy of Nutrition and Dietetics: Nutrition intervention and human immunodeficiency virus infection. *Journal of the Academy of Nutrition and Dietetics.* 2018;118(3):486-98.
73. Duffy C, Kenga DB, Gebretsadik T, Maússe FE, Manjate A, Zaqueu E, Fernando HF, Green AF, Sacarlal J, Moon TD. Multiple concurrent illnesses associated with Anemia in HIV-infected and HIV-exposed uninfected children aged 6-59 months, hospitalized in Mozambique. *The American journal of tropical medicine and hygiene.* 2020;102(3):605.
74. Joseph B, Nair PM, Nanda A. Effects of naturopathy and yoga intervention on CD4 count of the individuals receiving antiretroviral therapy-report from a human immunodeficiency virus sanatorium, Pune. *International Journal of Yoga.* 2015;8(2):122.

**CITE AS: Anemia as a Prognostic Marker for Disease Progression in HIV Infection (2023). Emmanuel Ifeanyi Obeagu, Getrude Uzoma Obeagu, Esther Ugo Alum and Okechukwu Paul-Chima Ugwu. IAA Journal of Biological Sciences 11(1):33-44. <https://doi.org/10.59298/IAAJB/2023/3.2.23310>**