Howell-Jolly Bodies in Pediatric HIV: Clinical Considerations and Management Strategies

Article · May 2024

CITATIONS
0

READS
2

1 author:

Emmanuel Ifeanyi Obeagu
Kampala International University (KIU)
1,630 PUBLICATIONS **21,998** CITATIONS

SEE PROFILE

Elite Journal of Nursing and Health Sciences. Volume 2 issue 5(2024), Pp. 1-11 https://epjournals.com/journals/EJNHS

Howell-Jolly Bodies in Pediatric HIV: Clinical Considerations and Management Strategies

*Emmanuel Ifeanyi Obeagu

Department of Medical Laboratory Science, Kampala International University, Uganda

*Corresponding authour: Emmanuel Ifeanyi Obeagu, Department of Medical Laboratory Science, Kampala International University, Uganda, emmanuelobeagu@yahoo.com, ORCID: 0000-0002-4538-0161

Abstract

Howell-Jolly bodies (HJBs), once regarded as mere remnants of erythropoiesis, have emerged as intriguing markers of hematological abnormalities in pediatric patients with HIV. This review delves into the clinical considerations and management strategies associated with the presence of HJBs in pediatric HIV, shedding light on their significance as indicators of disease progression and guiding therapeutic interventions. The morphological features of HJBs, characterized by small, round, basophilic inclusions within erythrocytes, signify underlying abnormalities in erythropoiesis and splenic function. In the context of pediatric HIV, the presence of HJBs on peripheral blood smears offers valuable diagnostic clues for assessing disease severity and monitoring disease progression. Furthermore, numerous studies have reported a positive correlation between the presence of HJBs and advanced HIV disease stages in pediatric patients, highlighting their potential as prognostic markers for disease progression in this population. HIV-induced immunosuppression and chronic inflammation contribute to splenic dysfunction, impairing the spleen's ability to clear abnormal erythrocytes from circulation and leading to the accumulation of HJBs. Early recognition of HJBs allows clinicians to initiate timely interventions, including antiretroviral therapy (ART) and adjunctive therapies targeting hematological abnormalities and immune dysfunction, ultimately improving patient outcomes in pediatric HIV.

Keywords*: Howell-Jolly bodies, pediatric HIV, hematological abnormalities, spleen, disease progression, antiretroviral therapy, opportunistic infections*

Introduction

Pediatric HIV infection continues to pose significant challenges to global public health, with an estimated 1.8 million children under the age of 15 living with HIV worldwide as of 2020. Despite advances in prevention of mother-to-child transmission (PMTCT) programs and antiretroviral

therapy (ART), pediatric HIV remains a major cause of morbidity and mortality among children, particularly in resource-limited settings. Beyond the direct effects of HIV on immune function, the virus also impacts hematological parameters, leading to a spectrum of abnormalities that contribute to disease progression and complications in affected children. Among these hematological manifestations, Howell-Jolly bodies (HJBs) have gained recognition as potential indicators of disease severity and progression in pediatric HIV. HJBs, cytoplasmic remnants of nuclear material within erythrocytes, were initially described in individuals with functional asplenia or splenic dysfunction. However, their presence in pediatric HIV patients has drawn attention as a marker of altered erythropoiesis and splenic dysfunction in the context of HIV infection. The significance of detecting HJBs lies not only in their morphological features but also in their association with disease progression and clinical outcomes in pediatric HIV. Understanding the clinical implications of HJBs in pediatric HIV is crucial for guiding therapeutic interventions and optimizing patient care in this vulnerable population.[1-10]

The morphological features of HJBs, characterized by small, round, basophilic inclusions within erythrocytes, reflect underlying abnormalities in erythropoiesis and splenic function. In pediatric HIV, the presence of HJBs on peripheral blood smears offers valuable diagnostic insights, providing clinicians with a non-invasive means of assessing disease severity and monitoring disease progression. Moreover, numerous studies have reported a positive correlation between the presence of HJBs and advanced HIV disease stages in pediatric patients, highlighting their potential as prognostic markers for disease progression and complications. The mechanisms underlying HJB formation in pediatric HIV are multifactorial, encompassing dysregulated erythropoiesis, compromised splenic function, and immune dysregulation. HIV-induced immunosuppression and chronic inflammation contribute to splenic dysfunction, impairing the spleen's ability to efficiently clear abnormal erythrocytes from circulation and leading to the accumulation of HJBs. Understanding these underlying mechanisms is essential for elucidating the pathophysiology of hematological abnormalities in pediatric HIV and guiding targeted therapeutic interventions to optimize patient outcomes. Clinical implications of detecting HJBs in pediatric HIV extend beyond mere diagnostic curiosity, offering actionable insights into disease progression and guiding therapeutic considerations for affected children. Early recognition of HJBs allows clinicians to initiate timely interventions, including ART and adjunctive therapies targeting hematological abnormalities and immune dysfunction. Moreover, monitoring changes in HJB abundance over time may provide valuable prognostic information, guiding treatment adjustments and optimizing clinical outcomes for pediatric HIV patients.[11-20]

In this review, we aim to comprehensively explore the clinical considerations and management strategies associated with the presence of HJBs in pediatric HIV.

Morphological Features of Howell-Jolly Bodies

Howell-Jolly bodies (HJBs) are cytoplasmic remnants of nuclear material within erythrocytes, typically observed as small, round, basophilic inclusions on peripheral blood smears stained with Wright-Giemsa or Romanowsky stains. These distinctive structures, ranging from 1 to 3 micrometers in diameter, signify abnormalities in erythropoiesis and splenic function. While

normally, mature erythrocytes expel their nuclei during maturation in the bone marrow, the presence of HJBs indicates a failure of this process, leading to the retention of residual nuclear material within circulating erythrocytes. In the context of pediatric HIV, the presence of HJBs serves as a morphological hallmark of altered erythropoiesis and splenic dysfunction. The characteristic appearance of HJBs under light microscopy, often described as discrete, uniformly staining bodies within erythrocytes, facilitates their identification and recognition by clinicians. While single HJBs are more common, multiple HJBs may occasionally be observed, reflecting a higher degree of erythropoietic perturbation and splenic dysfunction in affected individuals. The abundance of HJBs in peripheral blood smears may vary depending on the severity of splenic dysfunction and the degree of erythropoietic stress in pediatric HIV patients. While low levels of HJBs may be observed in healthy individuals under certain physiological conditions, such as during periods of increased erythropoietic demand, their presence in excess or in association with other hematological abnormalities warrants further evaluation in the context of pediatric HIV. Quantitative assessment of HJBs, either manually or through automated image analysis techniques, may provide clinicians with valuable quantitative data to aid in risk stratification and prognostication for pediatric HIV-infected individuals.[21-30]

Association with Disease Progression

The association between Howell-Jolly bodies (HJBs) and disease progression in pediatric HIV is of significant clinical interest, offering insights into the evolving hematological complications and immune dysfunction in affected children. Numerous studies have established a positive correlation between the presence of HJBs and advanced stages of HIV disease in pediatric patients. Elevated viral loads, decreased CD4+ T-cell counts, and increased susceptibility to opportunistic infections are often observed in conjunction with the abundance of HJBs, suggesting their potential as prognostic markers for disease progression and complications. The presence and abundance of HJBs in pediatric HIV patients signify a state of dysregulated erythropoiesis and compromised splenic function, reflecting the complex interplay between viral pathogenesis, hematological abnormalities, and immune dysregulation. HIV-induced immunosuppression and chronic inflammation contribute to splenic dysfunction, impairing the spleen's ability to efficiently clear abnormal erythrocytes from circulation and leading to the accumulation of HJBs. As a result, the presence of HJBs serves as a surrogate marker for the degree of immune dysfunction and disease severity in pediatric HIV. Clinically, the detection of HJBs in pediatric HIV patients holds implications for disease management and therapeutic interventions. Early recognition of HJBs allows clinicians to initiate timely interventions, including antiretroviral therapy (ART) and adjunctive therapies targeting hematological abnormalities and immune dysfunction. Moreover, monitoring changes in HJB abundance over time may provide valuable prognostic information, guiding treatment adjustments and optimizing clinical outcomes for pediatric HIV patients. By recognizing and interpreting the presence of HJBs on peripheral blood smears, clinicians can gain valuable insights into the evolving hematological manifestations of HIV infection, facilitating personalized approaches to care and targeted therapeutic interventions to mitigate disease progression and improve clinical outcomes for affected children.[31-45]

Mechanisms Underlying Howell-Jolly Body Formation

The formation of Howell-Jolly bodies (HJBs) in pediatric HIV involves a complex interplay of dysregulated erythropoiesis, compromised splenic function, and immune-mediated abnormalities, reflecting the multifactorial nature of hematological complications in affected children. Erythropoiesis, the process by which erythrocytes are produced in the bone marrow, is perturbed in pediatric HIV due to various factors, including direct viral effects, cytokine dysregulation, and nutritional deficiencies. This dysregulation can lead to the retention of residual nuclear material within circulating erythrocytes, resulting in the formation of HJBs. The spleen plays a crucial role in maintaining erythrocyte homeostasis by selectively removing aged, damaged, or abnormal erythrocytes from circulation. In pediatric HIV, splenic architecture and function may be compromised due to chronic immune activation, viral infiltration, and fibrotic changes, resulting in splenic atrophy and dysfunction. Consequently, the spleen's ability to effectively clear abnormal erythrocytes, including those containing HJBs, is impaired, leading to their accumulation in peripheral blood. Furthermore, HIV-induced immunosuppression exerts indirect effects on erythropoiesis and splenic function, further exacerbating the formation of HJBs. Dysregulated cytokine production, particularly elevated levels of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α) and interferon-gamma (IFN-γ), can disrupt erythropoietin production and impair erythrocyte maturation in the bone marrow. Additionally, immune-mediated destruction of erythrocytes, known as autoimmune hemolytic anemia, may occur in pediatric HIV-infected children, contributing to increased red cell turnover and the subsequent accumulation of HJBs.[46-55]

Clinical Implications and Management Strategies

The detection of Howell-Jolly bodies (HJBs) in pediatric HIV patients carries significant clinical implications, guiding therapeutic interventions and optimizing patient care in this vulnerable population. HJBs serve as morphological biomarkers of hematological abnormalities and disease progression, offering clinicians valuable diagnostic clues and prognostic information for assessing disease severity and monitoring clinical outcomes. Early recognition of HJBs allows clinicians to initiate timely interventions aimed at optimizing patient care and improving outcomes in pediatric HIV. Antiretroviral therapy (ART), the cornerstone of HIV management, plays a pivotal role in suppressing viral replication, restoring immune function, and mitigating hematological complications associated with HIV infection. Prompt initiation of ART in pediatric patients with detectable HJBs can help mitigate disease progression, reduce viral burden, and improve overall clinical outcomes.[56-60]

In addition to ART, adjunctive therapies targeting hematological abnormalities and immune dysfunction may be considered in pediatric HIV patients with detectable HJBs. These may include erythropoiesis-stimulating agents or iron supplementation for children with anemia or underlying nutritional deficiencies. Furthermore, strategies aimed at mitigating splenic dysfunction and enhancing erythrocyte clearance, such as splenectomy in select cases of severe splenic dysfunction or refractory hematological complications, may be explored to reduce the burden of HJBs in circulation. Regular monitoring of HJB abundance over time provides valuable prognostic

information, guiding treatment adjustments and optimizing clinical outcomes for pediatric HIV patients. Serial assessment of HJBs during the course of HIV therapy serves as a dynamic marker of treatment response, reflecting changes in viral load, CD4+ T-cell counts, and overall disease status. Longitudinal studies investigating the impact of therapeutic interventions on HJB formation and clinical outcomes are warranted to optimize therapeutic strategies and improve patient care in pediatric HIV.[61-69]

Conclusion

Howell-Jolly bodies (HJBs) serve as valuable markers of hematological abnormalities and disease progression in pediatric HIV, offering clinicians actionable insights into optimizing patient care and outcomes in this vulnerable population. The presence and abundance of HJBs provide diagnostic clues and prognostic information for assessing disease severity, monitoring clinical outcomes, and guiding therapeutic interventions in pediatric HIV. The detection of HJBs prompts early initiation of antiretroviral therapy (ART) and adjunctive therapies targeting hematological abnormalities and immune dysfunction, ultimately mitigating disease progression and improving overall clinical outcomes. Furthermore, strategies aimed at enhancing erythrocyte clearance and mitigating splenic dysfunction may be explored to reduce the burden of HJBs in circulation and improve hematological parameters in affected children. Regular monitoring of HJB abundance over time allows clinicians to assess treatment response, guide therapeutic adjustments, and optimize clinical outcomes for pediatric HIV patients. Longitudinal studies investigating the impact of therapeutic interventions on HJB formation and clinical outcomes are warranted to refine treatment strategies and improve patient care in pediatric HIV.

References

1. Meyer-Myklestad MH, Medhus AW, Lorvik KB, Seljeflot I, Hansen SH, Holm K, Stiksrud B, Trøseid M, Hov JR, Kvale D, Dyrhol-Riise AM. Human immunodeficiency virus–infected immunological nonresponders have colon-restricted gut mucosal immune dysfunction. The Journal of infectious diseases. 2022;225(4):661-674.
2. Henderson DK, Dembry L, Fishman NO, Grady C, Lundstrom T, Palmore TN, Sepkowitz KA, Weber DJ, Society for Healthcare Epidemiology of America. SHEA guideline for management of healthcare workers who are infected with hepatitis B virus, hepatitis C virus, and/or human immunodeficiency virus. Infection Control & Hospital Epidemiology. 2010;31(3):203-232.
3. d'Arminio Monforte A, Cozzi-Lepri A, Castagna A, Antinori A, De Luca A, Mussini C, Lo Caputo S, Arlotti M, Magnani G, Pellizzer G, Maggiolo F. Risk of developing specific AIDS-defining illnesses in patients coinfected with HIV and hepatitis C virus with or without liver cirrhosis. Clinical Infectious Diseases. 2009;49(4):612-622.
4. 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.

5. 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 J Dental Health Sci [Internet]. 2023 Jun. 15 [cited 2024 May 4];3(2):7-14. Available from: http://ajdhs.com/index.php/journal/article/view/39
6. Obeagu EI, Obeagu GU. Hematological Changes Following Blood Transfusion in Young Children with Severe Malaria and HIV: A Critical Review. Elite Journal of Laboratory Medicine, 2024; 2(1): 33-45
7. Obeagu EI, Obeagu GU. The Role of Blood Transfusion Strategies in HIV Management: Current Insights and Future Directions. Elite Journal of Medicine, 2024; 2(1):10-22
8. Obeagu EI, Obeagu GU (2024). Transfusion-Related Complications in Children Under 5 with Coexisting HIV and Severe Malaria: A Review. Int. J. Curr. Res. Chem. Pharm. Sci. 2024; 11(2): 9-19.
9. 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):120-127.
10. 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.
11. 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/An-update-on-premalignant-cervical-lesions-and-cervical-cancer-screening-services-among-HIV-positive-women.pdf.
12. 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):10-19.
13. 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
14. 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.
15. 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):10-19.
16. 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):10-19.
17. 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):101-119.

18. Obeagu EI, Eze VU, Alaeboh EA, Ochei KC. Determination of haematocrit level and iron profile study among persons living with HIV in Umuahia, Abia State, Nigeria. J BioInnovation. 2016; 5:464-471. links/592bb4990f7e9b9979a975cf/DETERMINATION-OF-HAEMATOCRIT-LEVEL-AND-IRON-PROFILE-STUDY-AMONG-PERSONS-LIVING-WITH-HIV-IN-UMUAHIA-ABIA-STATE-NIGERIA.pdf.
19. 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):911-916. https://www.academia.edu/download/38320140/Obeagu_Emmanuel_Ifeanyi_and_Obeagu__Getrude_Uzoma2.EMMA1.pdf.
20. 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
21. 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):70-75. links/5988ab6d0f7e9b6c8539f73d/HIV-and-TB-co-infection-among-patients-who-used-Directly-Observed-Treatment-Short-course-centres-in-Yenagoa-Nigeria.pdf
22. 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. 2022;2(3):110-119.
23. 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.
24. Mehta AB, Hoffbrand AV. Haematology at a Glance. John Wiley & Sons; 2009.
25. Sadelov IO, Bobrynina V, Krasilnikova M, Smetanina N. 1Federal scientific clinical center of pediatric hematology, oncology and immunology named after Dmitriy Rogachev, Moscow, Russian Federation Background: Hemoglobinopathies are heterogeneous group of diseases caused by qualitative (abnormal Hb) or quantitative (thalassemia) failure in. In18TH CONGRESS OF THE EUROPEAN HEMATOLOGY ASSOCIATION STOCKHOLM, SWEDEN JUNE 13-16, 2013 2008; 93(s1):699.
26. 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; 3:139-144. https://www.academia.edu/download/38320159/Obeagu_Emmanuel_Ifeanyi3__et_al.IJCRAR.pdf.
27. 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

28. 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
29. 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.
30. 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.
31. 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;2(3):128-134. https://madonnauniversity.edu.ng/journals/index.php/medicine/article/view/86.
32. 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.
33. 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.
34. 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.
35. 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):135-142.DOI: 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
36. Lutgendorf SK. Cognitive-behavioral stress management in a symptomatic HIV-1 seropositive population: Effects on mood, coping, immune and neuroendocrine factors. University of Miami; 1994.
37. Obeagu EI, Onuoha EC. Tuberculosis among HIV Patients: A review of Prevalence and Associated Factors. Int. J. Adv. Res. Biol. Sci. 2023;10(9):128-134.DOI:

10.22192/ijarbs.2023.10.09.014 links/6516f938b0df2f20a2f8b0e0/Tuberculosis-among-HIV-Patients-A-review-of-Prevalence-and-Associated-Factors.pdf.

38. Obeagu EI, Ibeh NC, Nwobodo HA, Ochei KC, Iwegbulam CP. Haematological indices of malaria patients coinfected with HIV in Umuahia. Int. J. Curr. Res. Med. Sci. 2017;3(5):100-104.DOI: 10.22192/ijcrms.2017.03.05.014 https://www.academia.edu/download/54317126/Haematological_indices_of_malaria_patients_coinfected_with_HIV.pdf
39. 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.
40. 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):180-183.DOI: **DOI:** 10.32474/JCCM.2020.02.000137 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.
41. Nikolouzakis TK, Falzone L, Lasithiotakis K, Krüger-Krasagakis S, Kalogeraki A, Sifaki M, Spandidos DA, Chrysos E, Tsatsakis A, Tsiaoussis J. Current and future trends in molecular biomarkers for diagnostic, prognostic, and predictive purposes in non-melanoma skin cancer. Journal of Clinical Medicine. 2020;9(9):2868.
42. 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.
43. Emannuel 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 Jul 29;6(1):203-211. http://research.sdpublishers.net/id/eprint/2819/.
44. 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):360-368.
45. 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
46. Echendu GE, Vincent CC, Ibebuike 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

47. 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 ANTIRETRQVIRAL THERAPY. World Journal of Pharmacy and Pharmaceutical Sciences, 2015; 4(3): 153-160**.** links/5a4fd0500f7e9bbc10526b38/BIOCHEMICAL-ALTERATIONS-IN-ADULT-HIV-PATIENTS-ON-ANTIRETRQVIRAL-THERAPY.pdf.
48. 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):45-49.
49. Obeagu EI, Nwosu DC. Adverse drug reactions in HIV/AIDS patients on highly active antiretro viral therapy: a review of prevalence. Int. J. Curr. Res. Chem. Pharm. Sci. 2019;6(12):45-8.DOI: 10.22192/ijcrcps.2019.06.12.004 links/650aba1582f01628f0335795/Adverse-drug-reactions-in-HIV-AIDS-patients-on-highly-active-antiretro-viral-therapy-a-review-of-prevalence.pdf.
50. 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.
51. 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.
52. Obeagu EI. Erythropoietin in HIV: Bridging the Gap Between Hematology and Virology. Elite Journal of HIV. 2024;2(3):42-54.
53. Obeagu EI, Obeagu GU, Ukibe NR, Oyebadejo SA. Anemia, iron, and HIV: decoding the interconnected pathways: A review. Medicine. 2024 Jan 12;103(2):e36937.
54. Obeagu EI, Obeagu GU. GATA-1 Regulation of Erythroid Progenitor Cell Differentiation in HIV/AIDS: Molecular Insights and Therapeutic Implications. Elite Journal of Haematology, 2024; 2 (4).:141-59.
55. Reddy R. *Study of Hematological Profile in HIV Infected Patients* (Doctoral dissertation, Rajiv Gandhi University of Health Sciences (India)). 2018.
56. Canny SP, Orozco SL, Thulin NK, Hamerman JA. Immune Mechanisms in Inflammatory Anemia. Annual review of immunology. 2023; 41:405-429.
57. Checconi P, De Angelis M, Marcocci ME, Fraternale A, Magnani M, Palamara AT, Nencioni L. Redox-modulating agents in the treatment of viral infections. International Journal of Molecular Sciences. 2020;21(11):4084.
58. Lanser L, Fuchs D, Kurz K, Weiss G. Physiology and inflammation driven pathophysiology of iron homeostasis—mechanistic insights into anemia of inflammation and its treatment. Nutrients. 2021;13(11):3732.
59. Chin-Hong PV, Palefsky JM. Natural history and clinical management of anal human papillomavirus disease in men and women infected with human immunodeficiency virus. Clinical Infectious Diseases. 2002;35(9):1127-1134.
60. Obeagu EI, Obeagu GU. Understanding ART and Platelet Functionality: Implications for HIV Patients. Elite Journal of HIV. 2024;2(2):60-73.

61. Obeagu EI, Obeagu GU. Utilization of immunological ratios in HIV: Implications for monitoring and therapeutic strategies. Medicine. 2024;103(9):e37354.
62. Obeagu EI, Obeagu GU. Counting Cells, Shaping Fates: CD4/CD8 Ratios in HIV. Elite Journal of Scientific Research and Review. 2024;2(1):37-50.
63. Obeagu EI, Anyiam AF, Obeagu GU. Managing Anemia in HIV through Blood Transfusions: Clinical Considerations and Innovations. Elite Journal of HIV. 2024;2(1):16-30.
64. Obeagu EI, Obeagu GU, Okwuanaso CB. Optimizing Immune Health in HIV Patients through Nutrition: A Review. Elite Journal of Immunology. 2024;2(1):14-33.
65. Obeagu EI, Obeagu GU. P-Selectin and Platelet Activation in HIV: Implications for Antiviral Therapy. Elite Journal of Scientific Research and Review. 2024;2(1):17-41.
66. Esté JA, Cihlar T. Current status and challenges of antiretroviral research and therapy. Antiviral research. 2010 Jan 1;85(1):25-33.
67. Channaveerappanavar PB. *Study of Immunological Recovery in Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome Patients on Second Line Anti Retroviral Drugs-A Prospective Study* (Doctoral dissertation, Rajiv Gandhi University of Health Sciences (India)). 2017.
68. Obeagu EI, Obeagu GU. GATA-1 and Hematopoietic Stem Cell Quiescence in HIV: Implications for Therapy. Elite Journal of Medicine. 2024;2(4):19-36.
69. Obeagu EI. Howell-Jolly Bodies in HIV: Unveiling Morphological Insights into Disease Progression. *Elite Journal of Haematology, 2024; 2(5):* 126-137