ISSN 2348-0319 International Journal of Innovative and Applied Research [2022]
(Volume 10, Issue 12)
01-06

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

INTERNATIONAL JOURNAL
OF INNOVATIVE AND APPLIED RESEARCH

REVIEW ARTICLE

UPDATE ON THE ROLES HUMAN IMMUNODEFICIENCY VIRUS INFECTION AND MALNUTRITION ON IMMUNITY

Emmanuel Ifeanyi Obeagu[1], Godfred Yawson Scott[2], Felix Amekpor[2] and Amaechi Chukwudi Ofodile[3]

1. Department of Medical Laboratory Science, Kampala International University, Uganda. https://orcid.org/0000-0002-4538-0161
2. Department of Medical Diagnostics, Kwame Nkrumah University of Science and Technology, Ghana.
3. Department of Medical Laboratory Science, Nnamdi Azikiwe University, Nnewi Campus, Anambra State, Nigeria.

Manuscript Info

Manuscript History
Received: 30 October 2022
Final Accepted: 01 December 2022
Published: December 2022

Keywords:
HIV, AIDS, MALNUTRITION, IMMUNITY.

Abstract

Human Immunodeficiency Virus (HIV) infection is a major public health threat to the existence of human beings especially to the developing countries like in Africa. Human Immunodeficiency Virus attacks the CD4 T cells thereby suppressing the immunity of the human host. There is high level of malnutrition in the developing countries due to poor economic status of many individuals with attendant immunodeficiency which affects the patients with HIV drastically for survival. Patients with HIV infection should maintain good nutritional status with improved immunity for increased life span and effectiveness in their works. A lot of commitment from the society is needed to encourage the patients with HIV to reduce the morbidity and mortality rates associated to HIV infection.

***Corresponding Author:-** **Emmanuel Ifeanyi Obeagu,** Department of Medical Laboratory Science, Kampala International University, Uganda. https://orcid.org/0000-0002-4538-0161

Introduction:-

Immunodeficiency is thought to be triggered predominantly worldwide by malnutrition. An intricate negative cycle involving the immune system, infectious illnesses, and malnutrition exists. The definition of malnutrition is the cellular imbalance between supply and demand for nutrients and energy to support growth, maintenance, and particular functions(Duggal et al., 2012). HIV and nutrition have a close connection and mutually beneficial relationship. HIV impairs the immune system, which promotes malnutrition, which further impairs the immune system and speeds up the progression of HIV infection into AIDS. Due to this body's inability to effectively fight infection, a malnourished person who contracts HIV is more likely to develop AIDS quickly than a well-nourished person because of this (Sicotte et al., 2014). It has been scientifically demonstrated that healthy eating enhances energy, boosts resistance to infectious diseases, and makes a person stronger and more effective (Obeagu et al. 2022; Odo et al., 2020; Madekwe et al., 2022). Wasting syndrome is characterized by a loss of more than 10% of the average body weight and the absence of any other known causes of wasting other from HIV infection (Alebel et al., 2022). Before a patient gets to this point, nutritional improvement efforts must be proceeded. Malnutrition causes immune system malfunction and increases the host's susceptibility to infections (Duggal et al., 2012).

Reduced appetite is one of the causes of malnutrition in HIV-infected individuals. This could be as a result of difficulty swallowing food as a result of infections like oral thrush or oesophagitis caused by Candida, a common opportunistic infection in HIV-infected individuals, as well as fever, medication side effects, or depression. Poor nutrient absorption may result from accompanying diarrhea brought on by bacterial infections like Salmonella or

Mycobacterium avium intercellular, viral infections like CMV or parasitic infections like Giardia, C. parvum, or due to nausea and vomiting brought on by drugs used to treat HIV or opportunistic infections (Brenchley & Douek, 2008).
Patients who have dementia associated to AIDS or neuropsychiatric impairment may find it difficult to take care of themselves, to remember to eat, or to put together healthy meals. If an HIV-positive adult becomes too ill to work and support their family's diet, nutritional effects may be observed even in homes with HIV-positive individuals(Duggal et al., 2012). Additionally, dietary consumption is inversely correlated with virus load, which suggests that viral replication either directly or indirectly reduces hunger. Malnutrition is prevalent and is thought to be a sign of a failing prognosis in HIV-positive individuals(Sashindran et al., 2020).

Human Immunodeficiency Virus (HIV)
When a closely related chimpanzee virus first infected humans in Central Africa during the first half of the 20th century that is where HIV-1 first emerged. HIV-1 began to spread throughout the world in the late 1970s, and AIDS was first identified in 1981.

The human immunodeficiency virus (HIV), which assaults and weakens the body's natural defense mechanism against illness and infection, is indeed the retrovirus that causes acquired immune deficiency syndrome, often known as AIDS.

The human immunodeficiency virus (HIV) preys on the immune system and erodes people's resistance to a variety of illnesses and cancers that healthy immune systems are better able to combat. Infected individuals eventually lose their immunological capacity as the virus kills and damages immune cells. CD4 cell count is commonly used to assess immune function (Ezimah,Uloaku et al., 2016; WHO et al., 2022).

Depending on the individual, acquired immunodeficiency syndrome (AIDS), the most advanced stage of HIV infection, might take many years to manifest. The emergence of certain tumors, infections, or other serious long-term clinical symptoms is what defines AIDS (WHO, 2022).

Infection with HIV affected 38 million individuals globally in 2019, including 1.8 million children under the age of 15. Globally, AIDS-related illnesses claimed the lives of roughly 690,000 individuals in 2019, down from 1.4 million in 2010 and 1.9 million in 2004. In 2019, 1.7 million people, including 150,000 children, acquired a new HIV infection, down from 3.4 million in 1996 (Obeagu et al. 2022; Okoroiwu et al., 2022; Obeagu et al., 2017).

Immunology of HIV
Both CD4+ and CD8+ T cells are important in controlling HIV infection. HIV infection stimulates production of cytokines such as TNFα, IL-6, IL-10, and IFNγ and a pool of activated target cells in the lymphoid tissue which paradoxically help in establishing and propagating HIV infection(Humbwavali et al., 2019). It has been observed that HIV-specific CD4+ T-cell responses were of high magnitude in individuals who were HIV infected but not showing progression over long periods (long-term nonprogressors)(Takarinda et al., 2017a). It has also been found that when discontinuation of antiretroviral therapy leads to loss of virologic control, HIV-specific CD4+ T cells are preferentially infected and depleted compared with the CD4+ T cells of other antigen specificities. Antiviral immunity involves both the arms of the immune system. The protective component of cell-mediated immunity involves the cytotoxic CD8 T-lymphocytes (Humbwavali et al., 2019).

Humoral immunity to HIV is expressed by neutralizing antibodies. Anti-HIV antibodies are able to bind cell-free virus and potentially prevent established infection in the challenged host(Sashindran et al., 2020). Neutralizing antibodies attaching to CD4 binding site of HIV have been identified which appear to prevent the virus from attaching to and infecting T cells. These are natural human antibodies—named VRC01, VRC02, and VRC03 which can neutralize over 90% of circulating HIV-1 isolates. Though HIV-specific humoral immune responses can be detected during primary infection, they mostly comprise low-avidity env specific IgG antibodies with little or no neutralizing activity. Significant neutralizing titers are believed to take place after chronicity has set in. HIV evolves various strategies to establish chronicity in the human body (Sashindran et al., 2020). These include viral latency, inhibition of antigen processing or presentation, mutations in viral epitopes, and rapid clonal exhaustion/deletion of the initially expanded virus-specific CD8+ CTL clones. Initial CTL responses cause downregulation of viremia and prevent disease progression, but later it induces the selection of virus mutants capable of escaping the immune response. HIV virions concentrate on the surface of follicular dendritic cells in the germinal centres of lymphoid

organs from where they are shed intermittently to establish a steady chronic state of infection of CD4+ T cells, and to a chronic inflammatory reaction that ultimately results in the destruction of lymphoid tissue (Sashindran et al., 2020).
Antiretroviral therapy (ART) results in a marked reduction of T-cell activation and apoptosis and helps to decrease naive T-cell consumption and restore their numbers (Humbwavali et al., 2019). Chronic HIV infection also causes immunological or direct virotoxic effects on gastrointestinal tract which shows blunted villi, crypt hyperplasia, and damaged epithelial barrier with increased permeability and malabsorption of bile acid and vitamin B12, microbial translocation, and enterocyte apoptosis (Takarinda et al., 2017b).

Malnutrition
It is known that good nutrition is a key driver in achieving a satisfactory level of human development.

Malnutrition, in all its forms, includes undernutrition, inadequate vitamins or minerals, overweight, obesity, and resulting diet-related noncommunicable diseases. 1.9 billion adults are overweight or obese, while 462 million are underweight (Humbwavali et al., 2019). Globally in 2020, 149 million children under 5 were estimated to be stunted (too short for age), 45 million were estimated to be wasted (too thin for height), and 38.9 million were overweight or obese. Around 45% of deaths among children under 5 years of age are linked to undernutrition(Takarinda et al., 2017b). These mostly occur in low- and middle-income countries.

Malnutrition has become an urgent global health issue, with undernutrition killing or disabling millions of children each year. Malnutrition also prevents millions more from reaching their full intellectual and productive potential In children, severe malnutrition accounts for approximately 1 million deaths annually 1, with approximately 20 million children under the age of five suffering from severe malnutrition (Bagilkar & Savadatti, 2015).

Sub-Saharan Africa is the only region in the world where the number of child deaths is increasing and in which food insecurity and absolute poverty are expected to increase. Children who are malnourished not only tend to have increased morbidity and mortality but are also more prone to suffer from delayed mental development, poor school performance and reduced intellectual achievement. Chronic malnutrition is usually measured in terms of growth retardation (Van de Poel et al., 2007). It is widely accepted that children across the world have much the same growth potential, at least to seven years of age. Environmental factors, diseases, inadequate diet, and the handicaps of poverty appear to be far more important than genetic predisposition in producing deviations from the reference. These conditions, in turn, are closely linked to overall standards of living and the ability of populations to meet their basic needs. Therefore, the assessment of growth not only serves as one of the best global indicators of children's nutritional status, but also provides an indirect measurement of the quality of life of an entire population (Van de Poel et al., 2007).

HIV and Malnutrition
HIV infection results in functionally defective metabolic ability at the individual level to absorb, store and utilize nutrients thus resulting in nutrient deficiencies, compromised immunity and increased risk of acquiring infectious diseases (Sashindran et al., 2020). Insufficient food intake, together or with malabsorption, result in further progression of HIV-disease, and the subsequent weight loss and severe malnutrition that ensue are significant predictors of Acquired Immune Deficiency Syndrome (AIDS) related morbidity and mortality. Despite the high global burden of HIV/AIDS, between 2010 and 2015 there has been more than a two-fold increase in the number of HIV-positive people receiving antiretroviral therapy (ART), which reached 10.3 million in eastern and southern Africa, the world’s most affected regions (Sashindran et al., 2020).

HIV/AIDS and malnutrition form a deadly duo with each one fuelling the other. Malnutrition increases susceptibility to infection by causing immune dysfunction in manifold ways. The depressed immune status can amplify HIV replication and accelerate progression of HIV disease to AIDS. Malnutrition increases the risk of death on initiation of ART in PLHA, and untreated HIV/AIDS puts individuals at risk for malnutrition (Takarinda et al., 2017b). The same is more acute in infants and children under 5 years of age. Untreated or advanced HIV/AIDS is again associated with a compromised immune status that makes these patients susceptible to opportunistic infections. Of these, tuberculosis is the most common and most debilitating one. Apart from TB, common infections like pneumonia, kala-azar, meningitis and malaria are also more common in these patients. Infections and the chronic low-grade inflammatory state perpetuated by HIV infection suppress appetite, increase catabolism of muscles and push patients towards malnutrition. Loss of strength means low earning capacity and loss of livelihood.

The social stigma of HIV fractures social and family bonds. All of them further push patients towards impoverishment and malnutrition (Takarinda et al., 2017b).
Malnutrition is a common complication of human immunodeficiency virus (HIV) infection and plays a significant and independent role in its morbidity and mortality. Malnutrition was one of the earliest complications of acquired immunodeficiency syndrome (AIDS) to be recognized. Unexplained weight loss is one of the most common initial AIDS-defining diagnoses to be reported to public health authorities (Babameto & Kotler, 1997).

Steady advances have been made in understanding the extent and composition of weight loss, the relevant pathogenic mechanisms, and the potential effects of nutritional therapies in HIV infection. Despite these advances, there are major limitations in the ability to provide effective nutritional support (Babameto & Kotler, 1997).

Impact of HIV and Malnutrition on the immunity
HIV and malnutrition result in a vicious cycle that eventually aims to lower the patient's immunity. Reduced CD4 and CD8 T-lymphocyte counts, delayed cutaneous sensitivity, decreased bactericidal capabilities (Alebel et al., 2022), and impaired serological response to vaccinations are all symptoms of both malnutrition and HIV. Findings indicated that 30–60% of HIV-infected adolescents who are asymptomatic had problems with lipid, protein, and carbohydrate absorption (Duggal et al., 2012). Micronutrient deficiencies cause many metabolic changes in the body in addition to perhaps affecting the invading virus' ability to replicate. This entails modifications in the metabolism of all the body's proteins, an increase in nitrogen loss from the urine, significantly increased liver protein synthesis, and elevated muscle tissue breakdown, all of which promote the growth of neutrophils, lymphocytes, and fibroblasts as well as the production of immunoglobulins and hepatic acute phase proteins, which are clinically manifested as fever(Alebel et al., 2022). Hypertriglyceridemia, enhanced hepatic de novo fatty acid synthesis, reduced peripheral lipoprotein lipase activity, hyperglycemia, insulin resistance, and increased gluconeogenesis are additional symptoms. Because of redistribution across the body and buildup in the liver, serum concentrations of iron and zinc drop precipitously (Duggal et al., 2012). The main intracellular antioxidant, glutathione, has been found to be decreased in infants with HIV infection, particularly in those who demonstrate development failure.

Reactive oxygen molecules and pro-oxidant cytokines are released by activated phagocytic cells during infectious diseases (Schwarz, 1996), which increases the need for antioxidant vitamins like vitamin E and C, as well as -carotene, and minerals like zinc, copper, manganese, and selenium, which are required to produce antioxidant enzymes . Antioxidant deficiencies lead to increasing oxidative stress, which in turn causes T cells to apoptose, compromising cell-mediated immunity and possibly promoting HIV replication. Reactive oxygen radicals have been found to enhance HIV replication in cell cultures by activating the nuclear transcription factor cell gene, whilst other antioxidants have been demonstrated to suppress HIV replication (Evans et al., 2013).

The oxidative burst could also boost the viral load in bodily fluids including cervicovaginal secretions and seminal fluid, increasing infectivity. The immune system and susceptibility of the unborn or young breast-fed child may be impacted by maternal micronutrient deficiencies(Duggal et al., 2012), which may also increase the viral load in blood, cervicovaginal secretions, and breast milk. These factors contribute to utero, intrapartum, and postnatal mother-to-child HIV transmission, respectively(Duggal et al., 2012). HIV infection worsens nutritional deficiencies and increases cellular oxidative stress in those who are already malnourished. This alters the way that transcription factors like NF-kB work and helps HIV spread and replicate. Despite the fact that HIV only targets a small subset of T-lymphocyte subtypes, AIDS-related malnutrition can trigger the onset of NAIDS as a result of proinflammatory cytokines.

Deficits in particular micronutrients may also tend to support the host while supplements boost the virus. For instance, retinoid-cultured monocytes have increased HIV replication (Alebel et al., 2022). Similar to this, the zinc-binding zinc finger structures of the HIV nucleocapsid protein. This might suggest that consuming a lot of zinc speeds up HIV replication. The role of iron in HIV infection is more complicated because iron is crucial for healthy immunological function, as well as being a pro-oxidant and perhaps promoting replication, as has been demonstrated in laboratory tests using a U-shaped curve (Colecraft, 2008). Antioxidants impede the oxidative burst, which is thought to be crucial for the bactericidal abilities of phagocytes, despite the fact that they reduce HIV replication. As a result, they may potentially encourage opportunistic infections(Duggal et al., 2012).

Children who are malnourished die more frequently, primarily from infections. When compared to children of the same age who were well fed, children with severe acute malnutrition had a 12-fold increased chance of

dying(Sashindran et al., 2020). Malnourished children are at an even higher risk of death from HIV infection. In addition to immunological considerations, malnourished children are more likely to die. These include limited electrolyte absorption from the stomach, impaired renal concentration capacity, thus puts the child at potential danger for dehydration, poor renal function owing to decreased muscle mass, and finally impaired cardiovascular function that can lead to heart failure(Sicotte et al., 2014).

Conclusion:-

Human immunodeficiency virus attacks the CD4 T cells thereby suppressing the immunity of the human host. There is high level of malnutrition in the developing countries due to poor economic status of many individuals with attendant immunodeficiency which affects the patients with HIV drastically for survival. A lot of commitment of nth society is needed to encourage the patients with HIV to reduce the morbidity and mortality rates associated to HIV infection.

References:-

1. Alebel, A., Demant, D., Petrucka, P., & Sibbritt, D. (2022). Effects of undernutrition on opportunistic infections among adults living with HIV on ART in Northwest Ethiopia: Using inverse-probability weighting. PLOS ONE, 17(3)
2. Arpadi, S. (2022). Growth failure in HIV Growth failure in HIV -infected children.
3. Babameto, G., & Kotler, D. P. (1997). MALNUTRITION IN HIV INFECTION. Gastroenterology Clinics, 26(2):393–415.
4. Bagilkar, V., & Savadatti, B. (2015). A descriptive study on Malnutrition. Asian Journal of Nursing Education and Research, 5.
5. Brenchley, J. M., & Douek, D. C. (2008). HIV infection and the gastrointestinal immune system. Mucosal Immunology, 1(1):23–30.
6. Humbwavali, J. B., Giugliani, C., Nunes, L. N., Dalcastagnê, S. V., & Duncan, B. B. (2019). Malnutrition and its associated factors: A cross-sectional study with children under 2 years in a suburban area in Angola. BMC Public Health, 19(1),
7. Colecraft, E. (2008). HIV/AIDS: Nutritional implications and impact on human development. Proceedings of the Nutrition Society, 67(1): 109–113.
8. Duggal, S., Chugh, T. D., & Duggal, A. K. (2012). HIV and Malnutrition: Effects on Immune System. Clinical and Developmental Immunology. 784740.
9. Evans, D., McNamara, L., Maskew, M., Selibas, K., van Amsterdam, D., Baines, N., Webster, T., & Sanne, I. (2013). Impact of nutritional supplementation on immune response, body mass index and bioelectrical impedance in HIV-positive patients starting antiretroviral therapy. Nutrition Journal, 12(1): 111.
10. Ezimah,Uloaku, A.., Obeagu, E.I., Ezimah, C.O., Ezimah, A. and Nto , N.J. (2016). Diarrhoeal diseases of acquired immunodeficiency syndrome stimulate more depletion of total antioxidant status. Int. J. Adv. Multidiscip. Res. 3(4): 23–25
11. Madekwe, C.C., Madekwe, C.C. and Obeagu, E.I (2022). InequalityofmonitoringinHuman Immunodeficiency Virus,TuberculosisandMalaria. Madonna University Journal of Medicine and Health Science. 2 (3):6-15
12. Obeagu, E. I., Okwuanaso, C. B., Edoho, S. H., & Obeagu, G. U. (2022). Under-nutrition among HIV-exposed Uninfected Children: A Review of African Perspective. Madonna University Journal of Medicine and Health Sciences ISSN: 2814-3035, 2(3), 120-127.
13. Obeagu EI, Onyenweaku FC, Nwobodo HA, Ochei KC, Ochiabuto OMTB. (2017) Impact of HIV and Hepatitis Vvirus Coinfection on selected Haematological Markers of the patients in Umuahia, Abia State, Nigeria. Annals of Clinical and Laboratory Research.5:2.
14. Obeagu, E.l. and Obeagu, G.U. (2015). Effect of CD4 counts on coagulation parameters among HIV positive patients in federal medical centre, Owcrri, Nigeria. International Journal of Current Research in Biosciences and Plant Biology. 2:45-49.
15. Odo, M., Ochei, K. C., Obeagu, E. I., Barinaadaa, A., Eteng, U. E., Ikpeme, M., Bassey, J. O., & Paul, A. O. (2020). TB Infection Control in TB/HIV Settings in Cross River State, Nigeria: Policy Vs Practice.Journal of Pharmaceutical Research International,32(22), 101-109.
16. Okoroiwu, I. L., Obeagu, E. I., Anaebo, Q. B. N. and Walter, O. (2022). Evaluation of Activated Partial Thromboplastin Time and Prothrombin Time in HIV and TB Patients in Owerri Metropolis. Journal of Pharmaceutical Research International, 34(3A), pp. 29-34. doi: 10.9734/jpri/2022/v34i3A35560.

17. Sashindran, V. K., Thakur, R., Sashindran, V. K., & Thakur, R. (2020). Malnutrition in HIV/AIDS: Aetiopathogenesis. In Nutrition and HIV/AIDS - Implication for Treatment, Prevention and Cure. IntechOpen. https://doi.org/10.5772/intechopen.90477
18. Schwarz, K. B. (1996). Oxidative stress during viral infection: A review. Free Radical Biology and Medicine, 21(5): 641–649.
19. Sicotte, M., Langlois, É. V., Aho, J., Ziegler, D., & Zunzunegui, M. V. (2014). Association between nutritional status and the immune response in HIV + patients under HAART: Protocol for a systematic review. Systematic Reviews, 3(1): 9.
20. Takarinda, K. C., Mutasa-Apollo, T., Madzima, B., Nkomo, B., Chigumira, A., Banda, M., Muti, M., Harries, A. D., & Mugurungi, O. (2017a). Malnutrition status and associated factors among HIV-positive patients enrolled in ART clinics in Zimbabwe. BMC Nutrition, 3(1), 15.
21. Van de Poel, E., Hosseinpoor, A. R., Jehu-Appiah, C., Vega, J., & Speybroeck, N. (2007). Malnutrition and the disproportional burden on the poor: The case of Ghana. International Journal for Equity in Health, 6(1):21.