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SEROLOGICAL AND BEHAVIOURAL PROFILES OF EBV AND HIV COINFECTIONS IN TWO TERTIARY HEALTH FACILITIES IN RIVERS STATE, NIGERIA

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ABSTRACT

Epstein-Barr virus (EBV) is one of the opportunistic pathogens that affects HIV-infected individuals. Although the high prevalence of EBV has been well documented in Africa and some parts of Nigeria, data from Rivers State, Nigeria, remain sparse. This study aimed to determine the Epstein-Barr virus nuclear antigens and the behavioural characteristics of HIV-infected individuals in two tertiary hospitals in Rivers State, Nigeria. One eighty-two (182) individuals attending the Retroviral Clinics of UPTH and RSUTH in Rivers State, Nigeria were sampled and tested for antibodies specific for EBNA by IgM ELISA assays. Data were collected on seropositivity and various behavioural factors. The overall prevalence of IgM antibodies against EBV major immunodominant antigens (EBNA) was 20.9%. The findings indicate a significant association ($p < 0.05$) between certain behavioural characteristics, such as body piercing and tattooing, and the presence of EBV-IgG antibodies. The findings reveal a prevalence that emphasises the need to monitor EBV infection in all EBV-associated diseases in Nigeria routinely and suggest that targeted public health interventions addressing specific high-risk behaviours, such as tattooing and body piercing, could help mitigate co-infection impact.

INTRODUCTION

Epstein–Barr Virus (EBV) is a significant global human pathogen belonging to the herpesvirus family and is known to ubiquitously infect people worldwide (Irekeola et al., 2022), it is also known for its lifelong infections in humans responsible for 200 000 cancer cases annually across the globes (Fisher, 2008; Howley & DeMasi, 2008; Maeda et al., 2009; Jupp et al., 2013; Balfour, 2014; Tangye et al., 2017; Okonko & Egbogon, 2022; Okonko et al., 2020, 2022, 2023; Houen& Trier, 2021; Oketah et al., 2023). Epstein-Barr virus (EBV) is a ubiquitous virus that persistently infects more than 90% of adults in developed countries and essentially all individuals living in developing countries (Fisher, 2008; West, 2017; Irekeola et al., 2022). It is an oncogenic γ-herpes virus responsible for 200,000 lymphoma and carcinoma cases worldwide per year (Jupp et al., 2013; West, 2017). Although primary infection is usually subclinical, the virus remains latent in memory B cells. EBV is associated with infectious mononucleosis and

viral DNA and proteins are found in lymphoma cells (Fisher, 2008).

Despite its oncogenicity, EBV infection is usually harmless and >95% of the worldwide population carries EBV as a life-long asymptomatic infection (Jupp et al., 2013; West, 2017). EBV is also associated with approximately 30–40% of Hodgkin lymphomas, the most aggressive natural killer (NK) cell lymphomas and leukaemias, a subset of peripheral T cell lymphomas, and virtually all Burkitt lymphomas arising in malarial areas (Fisher, 2008). In developed countries, approximately 40% of HL are EBV-positive (Fisher, 2008).

EBV is a common virus with a worldwide distribution (Howley & DeMasi, 2008). More than 90% of individuals worldwide have been infected by the time they reach adulthood (Howley & DeMasi, 2008; West, 2017). It primarily affects individuals with weakened immune systems, such as those with HIV/AIDS, and is a major contributor to mortality and cancer development (Maeda et al., 2009; Balfour, 2014). EBV is etiologically linked to various malignancies, including nasopharyngeal carcinoma, extranodal nasal NK/T-cell lymphoma, endemic Burkitt's lymphoma, and classical Hodgkin's lymphoma, especially in HIV-infected patients (Thorley-Lawson & Gross, 2004; Adjei et al., 2008; Chen et al., 2015; Smatti et al., 2018). Nonetheless, EBV was the first virus to be recognized as a human tumour virus (Howley & DeMasi, 2008).

Risk factors associated with EBV seropositivity include behaviours such as kissing, smoking, and sexual activity (Crawford et al., 2002; Higgins et al., 2007; Fisher, 2008; Anejo-Okopi et al., 2019; Okonko & Egbogon, 2022; Cookey et al., 2023; Innocent-Adiele et al., 2023). Risk has been estimated to be 2.5 and lasts up to 20 years after initial infection, suggesting a link with EBV or confounding due to socioeconomic class and late exposure to infections or hyperreactivity resulting from antigenic stimuli (Fisher, 2008). While numerous studies have focused on EBV serological assays (Nystad & Myrmel, 2007; Adjei et al., 2008; Trottier et al., 2012; Dowd et al., 2013; Suntornlohanakul et al., 2015; Smatti et al., 2018), fewer have examined EBV viremia, particularly among healthy blood donors (Hudnall et al., 2008; Sousa et al., 2011; Polz et al., 2014; Smatti et al., 2017, 2018). Research on EBV viremia in HIV-infected individuals remains limited.

Lymphoma and HIV are the most reported diseases associated with EBV in Nigeria (Irekeola et al., 2022). The presence of IgM antibodies against EBV Nuclear Antigen (EBNA) signals past infection and holds significant implications for immunocompromised individuals, such as those living with HIV (Okonko & Egbogon, 2022; Oketah et al., 2023; Okonko et al., 2023). However, the actual prevalence of EBV infection in diseased individuals in Nigeria remains unknown (Irekeola et al., 2022). These individuals are at a heightened risk for co-infections, complicating their clinical management and prognosis. Behavioural factors, including body modification practices and substance use, can affect the transmission and prevalence of viral infections. This study aims to estimate the prevalence of IgM antibodies against EBV major immunodominant antigens with the behavioural characteristics of HIV-infected individuals in two tertiary hospitals in Rivers State, Nigeria. By exploring the relationship between these behaviours and EBV IgM seropositivity, the study seeks to provide insights that could inform public health strategies to mitigate the impact of co-infections in this vulnerable population.

MATERIALS AND METHODS

Study Design and Setting

This cross-sectional study was conducted at the University of Port Harcourt Teaching Hospital (UPTH) and the Rivers State University Teaching Hospital (RSUTH), both in Port Harcourt, Rivers State, Nigeria.

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Study Population and Sample Size

The study included 182 HIV-infected individuals, with a representative sample from both UPTH and RSUTH using established the sample size determination formula (Charan& Biswas, 2013): $N = Z^2pq/d^2$. N is the desired sample size, P is the expected prevalence in the target population, q is 1-P, Z is the normal distribution =1.96; standard error, and d is the level of statistical significance (0.05). A P-value of 3.8% (3.8% [0.038] reported for Rivers State by NAIIS (2019) was used to represent maximum uncertainty. The demographic details relevant to this study were obtained. All HIV-infected patients were eligible for the study and minors and very sick HIV-infected individuals were excluded from the study.

Sample and Data Collection, Laboratory Diagnosis and Quality Control

Serological testing for IgM antibodies against EBV was performed, alongside a comprehensive survey on behavioural characteristics. Five millilitres of venous blood were collected aseptically from the participants into sterile ethylene-diamine-tetra-acetate (EDTA) bottles. The collected samples of blood were transported in a cold chain to the Virus & Genomics Research Unit of the Department of Microbiology, University of Port Harcourt, Nigeria and centrifuged at 1300 x g for 10 minutes. Plasma was used to detect the existence of antibodies EBV (ELISA; IgM antibodies to major viral immunodominant antigens; Dia. Pro, Milano, Italy), following the manufacturer's inserts. Washing was done automatically using an ELISA washer (ELx50, Biotek, USA). Plates were read using a spectrophotometric plate reader (ELx808i, Biotek, USA) at an absorbance of 450nm and 630nm.

Data management and analysis

Data was validated for inclusiveness and entered into SPSS version 20 for evaluation. Chi-square analysis was fit to identify dynamics related to HIV and EBV infections. A P-value ≤ 0.05 was considered to be statistically significant.

RESULTS

Behavioural Features of the Study Participants

One hundred and eighty-two (182) HIV-infected individuals participated in this study, with 91 individuals from the University of Port Harcourt Teaching Hospital (UPTH) and 91 from the Rivers State University Teaching Hospital (RSUTH). The ages of the participants ranged from 4 to 73 years, with an average age of 37.6 years. Specifically, participants at UPTH ranged from 9 to 73 years (average age: 39.2 years), while those at RSUTH ranged from 4 to 73 years (average age: 36.1 years). Behavioural determinants assessed included tattoos, tribal marks, blood oaths, body piercing, intravenous drug use (IDU), living and sharing facilities with IDUs, sharing sharp objects, social/healthcare work, sharing toothbrushes, sharing hair shaving materials, first intercourse with a spouse, and having multiple sexual partners. Among the participants, 32 (23.1%) had tattoos, while 140 (76.9%) did not. Tribal marks were present in 34 (18.7%) participants, and 148 (81.3%) had no tribal marks. Only 2 (1.1%) participants had a history of blood oaths, whereas 180 (98.9%) did not. Body piercing was reported by 33 (18.1%) participants, and 149 (81.9%) had no such history. None of the participants were intravenous drug users, shared facilities with IDUs, or shared sharp objects. Eight (4.4%) participants were social or healthcare workers, while 174 (95.6%) were not. First intercourse with a spouse was reported by 17 (9.3%) participants and 44 (24.2%) had more than one partner (Table 1).

Overall Seropositivity of EBV Major Immunodominant Antigens in HIV-Infected Individuals in Rivers State, Nigeria

Among the 182 HIV-infected individuals studied, 38 (20.9%) tested positive for EBV IgM antibodies against major immunodominant antigens (EBNA). The

seropositivity rate was 24.2% at UPTH and 17.6% at RSUTH (Table 1).

Seropositivity of anti-IgM antibodies against EBNAas relates to behavioural features

Table 1 presents the EBV IgM seropositivity rates with various behavioural characteristics. Participants with tattoos showed a higher prevalence of seropositivity (34.4%), and those with body piercings had an even higher rate (48.5%). There were notable differences in seropositivity between the two hospitals, with RSUTH showing higher overall rates over UPTH (27.8% vs 25.0%). The presence of tattoos was significantly associated with higher EBV IgM seropositivity ($p<0.05$). Similarly, individuals with tribal marks had higher seropositivity (26.5%) compared to those without (19.6%), and this association was statistically significant ($p<0.05$). For blood oaths, all individuals with a history of blood oaths (100%) tested positive, while those without such a history had a lower seropositivity rate (20.0%), indicating a significant relationship ($p<0.05$). Participants with body piercings had a higher seropositivity rate (48.5%) compared to those without (14.8%), also showing a significant relationship ($p<0.05$). In terms of IDU, living with IDUs, sharing sharp objects, or sharing toothbrushes, no significant differences in seropositivity rates were found, as no participants reported these behaviours. However, the sharing of hair-shaving materials was associated with a higher seropositivity rate (100%) compared to those without this history (16.0%), indicating a significant relationship ($p<0.05$). Participants who had their first sexual intercourse with a spouse had a higher seropositivity rate (47.1%) compared to those who did not (18.2%), showing a significant relationship ($p<0.05$). Having multiple sexual partners was also associated with higher seropositivity (31.8%) compared to those with one partner (17.4%), which was statistically significant ($p<0.05$). Healthcare workers had a significantly higher seropositivity rate (75.0%) compared to non-healthcare workers (18.4%) ($p<0.05$) (Table 1).

Seropositivity of EBV IgM relating to their Behavioural characteristics in respective hospitals (UPTH and RSUTH)

Table 1 details the seropositivity rates of anti-IgM antibodies against EBV with various behavioural characteristics at both UPTH and RSUTH. At UPTH, the highest EBV IgM seropositivity was associated with tattoos (25.0%), tribal marks (38.1%), body piercings (53.3%), first intercourse with a spouse (57.1%), having multiple sexual partners (38.9%), and healthcare working experience (100.0%). A similar pattern was observed at RSUTH, where the highest seropositivity rates were seen among participants with tattoos (27.8%), body piercings (44.4%), first intercourse with a spouse (40.0%), multiple sexual partners (26.9%), and healthcare working experience (66.7%). However, tribal marks had a higher seropositivity rate at UPTH (38.1%) compared to RSUTH (7.7%) (Table 1). For participants who did not report certain behavioural characteristics, seropositivity was higher at UPTH for those with no history of sharing sharp objects (24.2% vs. 17.6%), IDU (24.2% vs. 17.6%), living and sharing facilities with IDUs (24.2% vs. 17.6%), and sharing toothbrushes (24.2% vs. 17.6%). The same proportions were observed for participants who reported a history of blood oaths and sharing hair-shaving materials, with 100% seropositivity in both hospitals (Table 1). Overall, higher seropositivity of anti-IgM antibodies against EBV was noted among HIV-infected individuals at UPTH compared to RSUTH, except for the history of tattooing (Table 1).

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Table 1: EBV IgM Seropositivity as relates to the behavioural characteristics in respective hospitals

		Overall		UPTH		RSUTH	
Behavioural Characteristics	**Classes**	**No Tested (%)**	**No Positive (%)**	**No Tested (%)**	**No Positive (%)**	**No Tested (%)**	**No Positive (%)**
Tattoo	No	140 (76.9)	27(19.3)	67(47.9)	16(23.9)	73(52.1)	11(15.1)
	Yes	32(23.1)	11(34.4)	24(75.0)	6(25.0)	18(25.0)	5(27.8)
Tribal Mark	No	148(81.3)	29(19.6)	70(47.3)	14(20.0)	78(52.7)	15(19.2)
	Yes	34(18.7)	9(20.5)	21(61.8)	8(38.1)	13(38.2)	1(7.7)
Blood Oaths	No	180(98.9)	36(20.0)	90(50.0)	21(23.3)	90(50.0)	15(16.7)
	Yes	2(1.1)	2(100.0)	1(50.0)	1(100.0)	1(50.0)	1(100.0)
Body Piercing	No	149(81.9)	22(67.1)	76(51.0)	14(18.4)	73(49.0)	8(11.4)
	Yes	33(18.1)	16(48.5)	15(45.5)	8(53.3)	18(54.5)	8(44.4)
Intravenous Drug Users (IDUs)	No	182(100.0)	38(20.9)	91(50.0)	22(24.2)	91(50.0)	16(17.6)
	Yes	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Living with and Sharing Facilities with IDUs	No	182(100.0)	38(20.9)	91(50.0)	22(24.2)	91(50.0)	16(17.6)
	Yes	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Sharing Sharp Objects	No	182(100.0)	38(20.9)	91(50.0)	22(24.2)	91(50.0)	16(17.6)
	Yes	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Sharing of tooth brush	No	182(100.0)	38(20.9)	91(50.0)	22(24.2)	91(50.0)	16(17.6)
	Yes	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Sharing of hair shaving materials	No	175(96.2)	31(17.7)	88(50.3)	19(21.6)	87(49.3)	12(13.8)
	Yes	7(3.8)	7(100.0)	3(42.9)	3(100.0)	4(57.1)	4(100.0)
First intercourse with spouse	No	165(90.7)	30(18.2)	84(50.9)	18(21.4)	81(49.1)	12(14.8)
	Yes	17(9.3)	8(47.1)	7(41.2)	4(57.1)	10(58.8)	4(40.0)
Having a partner other than one	No	138(75.8)	24(17.4)	73(52.9)	15(20.5)	65(47.1)	9(13.8)
	Yes	44(24.2)	14(31.8)	18(40.9)	7(38.9)	26(59.1)	7(26.9)
Healthcare Working Experience	No	174(95.6)	6(13.4)	89(51.1)	20(22.5)	85(48.9)	12(14.1)
	Yes	8(4.4)	6(75.0)	2(25.0)	2(100.0)	6(75.0)	4(66.7)
Total		**182(100.0)**	**38(20.9)**	**91(50.0)**	**22(20.9)**	**91(50.0)**	**16(17.6)**

DISCUSSION OF FINDINGS

The findings of this study reveal significant associations between certain behavioural characteristics and the presence of EBV IgM antibodies among HIV-infected individuals in Rivers State, Nigeria. The observed prevalence of EBV IgM seropositivity (20.9%) aligns with previous studies conducted in similar populations in Nigeria (Okonko et al., 2020; Irekeola et al., 2022), underscoring the widespread nature of EBV infection among immunocompromised individuals. Okonko et al. (2020) reported 22.0% in Abakaliki, Ebonyi State, Nigeria and Irekeola et al. (2022) reported pooled prevalence of EBV infection in Nigeria to be 20.3%. However, Cookey et al. (2023) and Okonko et al. (2023) reported somewhat different in Port Harcourt, Nigeria where 3.2% and 3.1% prevalence were respectively, reported.

Behavioural risk factors and seropositivity, including kissing (Balfour et al., 2013a; Chen et al., 2015; Anejo-Okopi et al., 2019; Okonko et al., 2022,2023; Oketah et al., 2023),

smoking habit (Levine et al., 2012; Chen et al., 2015; Anejo-Okopi et al., 2019) and sexual activity (Anejo-Okopi et al., 2019), have been connected ($p < 0.05$) with the EBV seropositivity (Chen et al., 2015). The data in this present study showed a notably higher seropositivity rate among individuals with tattoos and those who engaged in body piercing. This suggests that body modification practices may be significant risk factors for EBV infection in this population. The higher prevalence among tattooed individuals could be attributed to the use of non-sterile equipment or unregulated tattooing practices, which are common in various parts of Nigeria. Similarly, the association with body piercing points to potential exposure to contaminated instruments, especially in informal settings where sterilization protocols may not be rigorously followed.

The absence of seropositivity among intravenous drug users (IDUs) and those sharing sharp objects, toothbrushes, or hair-shaving materials is noteworthy. While these practices are well-documented risk factors for bloodborne infections, the lack of observed cases in this study could reflect the small sample size or the possibility that these behaviours are less prevalent or less openly reported in the study population. The finding that all individuals who reported sharing hair-shaving materials were seropositive warrants further investigation, as it may indicate a high-risk behaviour not adequately captured in broader surveys. Statistically, significant relationships ($p < 0.05$) occurred between certain behaviours and EBV IgM seropositivity. Higher seropositivity was associated ($p < 0.05$) with tattoos, tribal marks, blood oaths, body piercing, sharing hair-shaving materials, first sexual intercourse with a spouse, having multiple sexual partners, and healthcare working experience. This is consistent with the findings by Chen et al. (2015) in Taiwan, who observed that only one-quarter of the participants had clinical appearances of infectious mononucleosis, permeating sexual intercourse as a substantial possibility factor for their seroconversion. This suggests that EBV can be disseminated via sexual activity (Crawford et al., 2002; Thomas et al., 2006).

The study highlights the role of specific behaviours in the transmission and prevalence of EBV among HIV-infected individuals. The higher prevalence of seropositivity among those with tattoos and body piercings suggests potential pathways for co-infection. These results align with previous studies that have identified body modification practices as risk factors for viral infections (Okonko et al., 2022, 2023).

The differences in seropositivity rates between UPTH and RSUTH suggest potential impacts of varying healthcare practices, patient demographics, and regional factors. UPTH's higher overall seropositivity rate may reflect a larger catchment area or differences in the socio-economic status of patients, influencing both exposure to risk factors and access to healthcare services. The observed variations underscore the need for localized public health strategies that consider the specific contexts of different healthcare facilities. The association between body modification practices and EBV infection suggests a need for regulatory oversight and public education on safe practices. Educational campaigns should emphasize the importance of sterile techniques and the risks associated with informal tattoo and piercing establishments (Okonko et al., 2022, 2023). Healthcare providers should be trained to recognize and address the unique risks faced by individuals with these behavioural characteristics, including offering regular screenings for co-infections like EBV.

The study's limitations include its cross-sectional design, which precludes establishing causality, and the reliance on self-reported data, which may be subject to bias. Despite these limitations, the study confirms earlier research indicating high EBV seroprevalence in Nigeria.

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CONCLUSION

This study identified a significant prevalence of anti-EBV IgM antibodies (20.9%) against EBV major immunodominant antigens among HIV-infected individuals in Rivers State, Nigeria. It provides valuable insights into the relationship between behavioural characteristics and EBV IgM seropositivity in this population. The findings reveal a prevalence that emphasises the need to monitor EBV infection in all EBV-associated diseases in Nigeria routinely and suggest that targeted public health interventions addressing specific high-risk behaviours, such as tattooing and body piercing, could help mitigate the impact of co-infections.

REFERENCES

Adjei, A.A., Armah, H.B., Gbagbo, F., Boamah, I., Adu-Gyamfi, C. &Asare, I. (2008). Seroprevalence of HHV-8, CMV, and EBV among the general population in Ghana, West Africa. *BioMed Central Infectious Diseases*, 8,111

Anejo-Okopi, J., Julius O. O., Adamu, N., Ogbonna, J., Adetunji, J., & Ikwulono, O. G. (2019). Epstein-Barr Virus Capsid Antigen (EBV-VCA) IgM Antibodies among HIV Infected Individuals in Jos, Nigeria. *Trends Journal of Sciences Research*, 4(3), 99-104.

Balfour, H. H., Jr, Odumade, O. A., Schmeling, D. O., Mullan, B. D., Ed, J. A., Knight, J. A., Vezina, H. E., Thomas, W., &Hogquist, K. A. (2013). Behavioral, virologic, and immunologic factors associated with acquisition and severity of primary Epstein-Barr virus infection in university students. *Journal of Infectious Diseases*, 207(1), 80–88.

Balfour, H. H. (2014). Progress, prospects, and problems in Epstein-Barr virus vaccine development. *Current Opinion in Virology*, *6*, 1-5.

Charan, J.& Biswas, T. (2013). How to calculate sample size for different study designs in medical research? *Indian Journal of Psychological Medicine*,*35*(2), 121–126.

Chen, C. Y., Huang, K. Y., Shen, J. H., Tsao, K. C., & Huang, Y. C. (2015). A large-scale seroprevalence of Epstein-Barr virus in Taiwan. *PloS one*, *10*(1), e0115836.

Cohen JI (2000) Epstein-Barr virus infection. *N Engl J Med*, 343: 481–492.

Cookey, T. I., Jonah, J., Adim, C. C., Okonko, B. J., Innocent-Adiele, H. C. &Okonko, I. O. (2023). Epstein Barr virus nuclear antigens among University Students in Port Harcourt, Nigeria. *International Journal of Science and Technology Research Archive, 04(01), 113–120*

Crawford, D. H., A. J., Swerdlow, C. Higgins, K., McAulay, N., Harrison, H., Williams, K., Britton, & K. F. Macsween. (2002) Sexual history and Epstein-Barr virus infection. *Journal of Infectious. Diseases.* 186:731-736.

Dowd JB, Palermo T, Brite J, McDade TW, & Aiello A. (2013) Seroprevalence of Epstein-Barr virus infection in U.S. children ages 6–19, 2003–2010. *PLoS One* 8: e64921.

Fisher, S.G. (2008). Lymphomas. In: *International Encyclopedia of Public Health*, Pp. 176-186

Higgins, C. D., Swerdlow, A. J., Macsween, K. F., Harrison, N., Williams, H., McAulay, K., Thomas, R., Reid, S., Conacher, M., Britton, K., & Crawford, D. H. (2007). A study of risk factors for acquisition of Epstein-Barr virus and its subtypes. *The Journal of Infectious Diseases*, *195*(4), 474–482.

Houen, G. & Trier, N. H. (2021). Epstein-Barr virus and Systemic Autoimmune Diseases. *Frontiers in immunology, 11*, 587380.

Howley, P. M. & DeMasi, J. (2008). Infectious Agents and Cancer. In The Molecular Basis of Cancer (Third Edition), pp. 67-89

Hudnall, S. D., Chen, T., Allison, P., Tyring, S. K., & Heath, A. (2008). Herpesvirus prevalence and viral load in healthy blood donors by quantitative real-time

polymerase chain reaction. *Transfusion*, *48*(6), 1180–1187.

Innocent-Adiele, H. C., Okorare, B. O. &Okonko, I. O. (2023). Seropositivity of Epstein-Barr Virus Immunoglobulin G Among Health Care Workers in Port Harcourt, Nigeria. *International Journal of Multidisciplinary Research and Technology*, 4(3): 25-31

Irekeola, A. A., Eare, E. N. S., Wada, Y., Mohamud, R., Mat Lazim, N., Yean, C. Y., &Shueb, R. H. (2022). Prevalence of EBV infection in 1157 diseased cohorts in Nigeria: A systematic review and meta-analysis. *Indian Journal of Medical Microbiology*, *40*(3), 420–426.

Jupp, R., Ritchie, A., Robinson, M., Broadhurst, A. & Mills, J. (2013). Epstein-Barr Virus Assemblin. In: *Handbook of Proteolytic Enzymes* (Third Edition), 3, 3552-3554.

Levine, H., Balicer, R. D., Rozhavski, V., Halperin, T.&Shreberk, M. (2012). Seroepidemiology of Epstein Barr Virus and cytomegalovirus among Israeli male young adults. *Annals of Epidemiology*, 22: 783-788.

Maeda, E., Akahane, M. &Kiryu, S. (2009). Spectrum of Epstein–Barr virus-related Diseases: a Pictorial Review. *Japanise Journal of Radiology*, 27 (1), 4 – 19.

Nigeria HIV /AIDS Indicator and Impact Survey (NAIIS, 2019). National Summary Sheets- Preliminary Findings. Federal Ministry of Health (FMoH) and the National Agency for the Control of AIDS (NACA), Pp. 1-5.

Nystad, T.W. & Myrmel, H. (2007). Prevalence of primary versus reactivated Epstein-Barr virus infection in patients with VCAIgG-, VCAIgM- and EBNA-1-antibodies and suspected infectious mononucleosis. *Journal of Clinical Virology*, 38:292–297.

Oketah, E. N., Cookey, T. I., Okonko, B. J., Adim, C. C., Onu, E. N., Frank-Peterside, N. & Okonko, I. O. (2023). Epstein Barr Virus Nuclear Antigen and Sociodemographic characteristics of HIV-infected individuals in two tertiary health facilities in Rivers State, Nigeria. *Scientia Africana*, 22 (3), 319-330

Okonko, I. O., Makinde, T. S., Okonko, B. J. & Ogbu, O. (2020). Immunological and epidemiological evaluation of EBV infections among HIV-1 infected individuals in Abakaliki, Nigeria supports the potential use of neutrophils as a marker of EBV in HIV disease progression and as useful markers of immune activation. *Journal of Immunoassay and Immunochemistry*, 41 (2): 158-170

Okonko, I. O.& Egbogon, J. A. (2022). Plasma Immunoglobulin-G (IgG) against Epstein Barr virus Nuclear Antigens among university students in Port Harcourt, Nigeria. *Biotechnology* 21(3), 110-119

Okonko, I. O., Adim, C. C., Innocent-Adiele, H. C., Cookey, T. I. & Okonko, B. J. (2022). Seroprevalence of Epstein Barr IgG antibody among patients presenting at a tertiary hospital in Port Harcourt, Nigeria. *International Journal of Multidisciplinary Research Updates*, 04(01), 001–007

Okonko, I. O., Oyasope, S. S., Enya, E. & Awanye A. M. (2023). Detection of Epstein-Barr Nuclear Antigen (EBNA) IgM among healthcare workers in some selected hospitals in Rivers State, Nigeria. *World Journal of Biology Pharmacy and Health Sciences*, 15(01), 060–065

Polz, D., Podsiadło, Ł., Stec, A.& Polz-Dacewicz, M. (2014). Prevalence of EBV genotypes in Polish, Taiwanese and Arabic healthy students and association between genotypes and 30-bp deletion in the LMP-1 gene phylogenetic analysis. *Pol. J. Microbiology* 63(1):105–109.

Santpere G, Darre F, Blanco S, Alcami A, Villoslada P, Mar Albà M, et al. (2014). Genome-wide analysis of wild-type Epstein-Barr virus genomes derived from healthy individuals of the 1,000 genomes project. *Genome Biology & Evolution*, 6(4):846–60.

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Smatti MK, Yassine HM, AbuOdeh R, AlMarawani A, Taleb SA, Althani AA, et al. (2017). Prevalence and molecular profiling of Epstein Barr virus (EBV) among healthy blood donors from different nationalities in Qatar. *PLoS One*, 12(12):e0189033.

Smatti, M. K., Al-Sadeq, D. W., Ali, N. H., Pintus, G., Abou-Saleh, H., &Nasrallah, G. K. (2018). Epstein-Barr Virus Epidemiology, Serology, and Genetic Variability of LMP-1 Oncogene Among Healthy Population: An Update. *Frontiers in Oncology*, *8*, 211.

Sousa H, Silva J, Azevedo L, Pinto-Correia AL, Catarino R, Pinto D, et al. (2011). Epstein-Barr virus in healthy individuals from Portugal. *Acta Med Port*, 24(5):707–12.

Suntornlohanakul R, Wanlapakorn N, Vongpunsawad S, Thongmee T, Chansaenroj J, Poovorawan Y. (2015). Seroprevalence of anti-EBVIgG among various age groups from KhonKaen Province, Thailand. *Asian Pac J Cancer Prevention*, 16(17):7583–7.

Tangye, S.G., Palendira, U. & Edward, E.S.J. (2017). Human immunity against EBV—lessons from the clinic. *Journal of Experimental Medicine*, 214 (2), 269-283

Thorley-Lawson, D.A., & Gross, A. (2004). Persistence of the Epstein-Barr virus and the origins of associated lymphomas. *New England Journal of Medicine* 350(13):1328–37.

Thomas, R., Macsween, K., Mcaulay, K., Clutterbuck, D., Anderson, R., Reid, S., Higgins, C., Swerdlow, A., Harrison, N., Williams, H., & Crawford, D. (2006). Evidence of shared Epstein-Barr viral isolates between sexual partners, and low-level EBV in genital secretions. *Journal of Medical Virology*, 78, 1204-1209.

Trottier, H., Buteau, C., Robitaille, N., Duval, M., Tucci, M., &Lacroix, J. (2012). Transfusion-related Epstein-Barr virus infection among stem cell transplant recipients: a retrospective cohort study in children. *Transfusion* 52(12):2653–63.

West, M. J. (2017). Chromatin reorganisation in Epstein-Barr virus-infected cells and its role in cancer development. *Current Opinion in Virology*, 26, 149-155