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Serological prevalence of Herpes Simplex Virus, Syphilis, and *H. pylori* co-infections amongst HIV-infected individuals receiving care in a secondary healthcare facility in Port Harcourt, Nigeria

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Abstract

Helicobacter pylori is a widespread pathogen that significantly contributes to dyspeptic disease and gastric cancer. There are conflicting prevalence patterns of *H. pylori* in HIV-1-infected patients. Although the interaction between HIV and *H. pylori* infection is not well investigated, previous studies have suggested a decreased prevalence of *H. pylori* and the limited effectiveness of eradication treatment in HIV-positive individuals. Therefore, this study aimed to describe the serological prevalence of HIV/HSV, HIV/Syphilis, and HIV/*H. pylori* co-infection among HIV-infected individuals receiving care in a secondary healthcare facility in Port Harcourt, Nigeria. In the study, 100 HIV-infected individuals were screened for HSV, syphilis and *H. pylori* co-infections. Co-infections were 0.0% for HIV/HSV, 0.0% for HIV/Syphilis and 58.0% for HIV/*Helicobacter pylori*. Higher prevalence of HIV/*H. pylori* co-infection occurred among the age group <20-40 (59.5%), males (59.5%), unemployed (100.0%), Ahaoda, Eleme and Etche LGAs, and high CD4 counts of 200-349 and >350 cells/µl (58.3%) compared to other categories. This study confirmed the absence of HSV and syphilis among these participants. It further indicated that co-infection of HIV/*H. pylori* were high (58.0%), although the underlying mechanisms remained unknown. However, the *H. pylori* co-infection in HIV-infected individuals was associated (P>0.05) with CD4+ cell counts and any socio-demographic variables evaluated. However, more studies are needed on these patients in Rivers State, Nigeria, to evaluate the infection rate further.

Keywords: Co-infections; HIV/HSV; HIV/Syphilis; HIV/*Helicobacter pylori*; The prevalence

1 Introduction

HIV infection is considered a challenge for public health in Nigeria and the globe, affecting the population since the 1980s. HIV is still a pandemic regardless of the progress in treatment and prevention over the years. Rivers State of Nigeria has witnessed a rising trend in HIV/AIDS infection (Tobin-West & Okeh, 2012). In HIV infection, a higher viral load often correlates with the severity of an active viral infection, indicating the failure of the immune system (Klatt et al., 2013). Destruction of the immune cells can lead to the loss of HIV-Specific immune response (WHO, 2007).

HIV became responsible for significant morbidity and mortality due to underlying immune suppression, which leads to life-threatening opportunistic infections (OIs) during the natural course of the disease (Solomon et al., 2018). OIs cause scientific articles particulate about 90% of HIV-related morbidity and mortality compared to 7.0% due to opportunistic

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cancers and 3% due to other causes (Yared et al., 2010). Co-infection is another challenge because it affects the rate at which the disease progress (Okonko et al., 2020a). Sexually transmitted co-infections pose a significant health threat to people with HIV/AIDS.

Herpes simplex type 2 (HSV-2) is a public health concern, particularly in developing countries, linked to an increased risk of HIV infection and transmission (Muhammad et al., 2021). HSV-2 co-infection is associated with increased genital HIV shedding, which may increase the transmissibility of HIV (Fleming & Wasserheit, 1999). HSV-1 and HSV-2 are ubiquitous. They rank among the most prevalent viral STDs (sexually transmitted illnesses) worldwide (Xu et al., 2006). They are now a significant health concern, confirmed by the epidemic of genital HSV and enhanced acquisition of HIV in association with HSV infections (Mbopi-Keou et al., 2000, 2002, 2003; Carr et al., 2006; Celum, 2004, 2005, 2008). Epidemiologic studies suggest synergy between HIV-1 and HSV-2 that facilitates the spread of both viruses, with HSV-2 increasing HIV-1 susceptibility and infectiousness (Freeman et al., 2006) and HIV-1 infection increasing HSV-2 reactivation frequency (Van de Perre et al., 2008). Viral STI and genital ulcer diseases, particularly HSV-2, are also linked to increased concentrations of HIV in blood plasma and genital fluids (Duffus et al., 2005). HSV-2 is implicated as a co-factor in HIV acquisition and transmission. It may contribute significantly to HIV infections by facilitating its spread among the low-risk population within a stable sexual relationship (Laith et al., 2008).

Conversely, HIV-induced immunosuppression alters the natural history of HSV leading to more severe HSV outbreaks and more frequent viral shedding in persons co-infected with HIV and HSV compared with those without HIV infection. The treatment of HSV can be more challenging in HIV-infected patients. In 2016, prediction showed that 491.5 million people worldwide had HSV type 2 infections (James et al., 2020). In Abuja, Nigeria, a study reported HSV-2 in 36.4 per cent of HIV-positive patients (Yunusa et al., 2019). In addition, HSV-2 substantially drove the spread of HIV in Sub-Saharan Africa (Looker et al., 2008, 2017). HSV-2 co-infection in HIV-positive patients is a risk factor for developing a secondary genital infection, which can cause death and morbidity among HIV patients and facilitate HIV transmission. However, the serological prevalence of HSV-2 co-infection among HIV patients is not commonly studied (Mohammad et al., 2018).

Syphilis is among the most acute sexually transmitted infections (STIs) caused by the spirochete Treponema pallidum, which has been since the 15th century (Sule et al., 2010; Hussen & Tadesse, 2019). Syphilis infections have been a severe health issue facing our health sector for decades. During pregnancy, it is associated with disastrous health outcomes in the newborn (Hussen & Tadesse, 2019). Syphilis is associated with HIV shedding in blood plasma and the genital tract (Buchacz et al., 2005). It lowers cell counts and raises HIV viral load in HIV-infected patients with new syphilis infections (Buchacz et al., 2004). It also leads to changes in plasma HIV-1 RNA and CD4 + T-cell levels in people with HIV (PWH) with viraemia, although its effect in PWH on suppressive antiretroviral therapy (ART) is less clear (Chan et al., 2022).

Study results on the prevalence of syphilis in sub-Saharan Africa are highly erratic and contradictory (Hussen & Tadesse, 2019). However, the syphilis prevalence was estimated to be 3.7% in Congo (Agasa et al., 2003), 9.1% in Cameroon (Tagny et al., 2009, 2010), and 7.9% in Ghana (Adjei et al., 2003) while in Nigeria, it is estimated to be 19.3% in Abuja (Sule et al., 2010), 0.0%, 0.8%, 1.5% and 0.0%, respectively, in Ibadan (Okonko et al., 2012a, b, c, 2013), 6.6% and 1.5%, respectively, in Port Harcourt (Adewuyi-Oseni et al., 2019; Okonko et al., 2020b), and 1.7% in Uyo (Okonko et al., 2020c). Treponema pallidum, the syphilis-causing agent, cannot be stored at low temperatures (Sarkodie et al., 2016a, b).

Helicobacter pylori is among the most common chronic infections in the world, with a prevalence ranging from 35% in high-income countries (Zamani et al., 2018; Mesfun et al., 2022) to 79–90% in low-income countries (Asrat et al., 2004a; Hooi et al., 2017; Mesfun et al., 2022). The infection is mostly asymptomatic but can manifest as dyspeptic disease, malignant complications such as gastric and oesophagal cancer (Xie et al., 2013; Mesfun et al., 2022), and non-malignant complications, for example, iron-deficiency anaemia (Gravina et al., 2020; Mesfun et al., 2022).

Helicobacter pylori is a common infection contributes to gastric cancer and dyspeptic sickness (Mesfun et al., 2022). Globally, two-thirds of humans are infected with these *Helicobacter pylori* (*H. pylori*), a flagellated Gram-negative bacterium that brings peptic ulcer disease and others, mainly in ART-experienced HIV patients (Kiros et al., 2020). *H. pylori* infection is the primary etiologic factor of chronic gastritis and peptic ulcer in the general population. Gastrointestinal (GI) symptoms are frequent among patients infected with HIV and AIDS (Peterson, 1991). Gastric mucosa-associated lymphoid tissue (MALT) lymphoma, gastric adenocarcinoma, gastritis, and peptic ulcer disease (PUD) have all been linked to *Helicobacter pylori* (Sabbagh et al., 2019). With an estimated 87.7% prevalence rate, *H. pylori* are very common in Nigeria (Smith et al., 2022a). Only a small percentage of infected people eventually acquire PUD or gastric cancers; the majority of infected people (>80%) have asymptomatic chronic gastritis (Smith et al., 2019a).

Gastric erosion and ulcers were observed in 43.6% and 15.4% of Nigerians by Palamides et al. (2020), as opposed to 4.0% and 9.3% of South African patients, respectively. Also, 2.6% of Nigerian patients in the same study had stomach cancer from *H. pylori* (Smith et al., 2022b). *H. pylori* antibodies were detected in 44.0% of hospital attendees in Port Harcourt, Nigeria (Okonko et al., 2016), while 2.0% were HIV/*H. pylori* co-infection also occurred (Okonko & Barine, 2023). More recently, Ahaotu et al. (2023a, b) reported 20.0% and 38.0% among pregnant women and HIV patients, respectively, in Port Harcourt, Nigeria. *H. pylori* co-infection occurred in 26.2% of HIV patients in Calabar, Nigeria (Agbagwa et al., 2023).

Beyond the high frequency of *H. pylori* infection and its related clinical effects, the pathogen's ability to be effectively treated and eradicated in Nigeria is gravely endangered by its high levels of growing antibiotic resistance (Jolaiya et al., 2020; Smith et al., 2022a; Ahaotu et al., 2023a). Although the relationship between HIV and *H. pylori* infection is poorly understood, prior research has revealed that HIV-positive persons had lower *H. pylori* prevalence and poor success with eradication therapy (Asrat et al., 2004b; Mesfun et al., 2022). The necessity for an effective initial diagnosis, therapy, or monitoring of the eradication process is appropriate given the high incidence of *H. pylori* in Nigeria (Smith et al., 2019a, 2022a; Bordin et al., 2021; Ahaotu et al., 2023a). Because of this, this study aimed to describe the serological prevalence of HIV/HSV, HIV/Syphilis, and HIV/*H. pylori* co-infection among HIV-infected people getting care in a secondary healthcare facility in Port Harcourt, Nigeria.

2 Material and methods

2.1 Study Area

In the Port Harcourt metropolis' secondary healthcare facility, where people with HIV can receive care, this study was carried out. As the sole major metropolis in the state, the Port Harcourt metropolis is very crowded. In the city, only December and January fall under the category of the dry season. Port Harcourt experiences less of the harmattan, which impacts many towns in West Africa due to its meteorological characteristics. With an average rainfall of 370 mm, September is the wettest month in Port Harcourt. With an average annual rainfall of 20 mm, December is typically the driest month of the year. The city experiences very stable temperatures throughout the year with little seasonal change. In the city, typical average temperatures range from 25 to 28 degrees Celsius (Mbakwem-Aniebo et al., 2012a, b).

2.2 Study Design

In order to establish the prevalence of the herpes simplex virus, syphilis, and *H. pylori* among HIV patients seeking care, blood samples were obtained from HIV-positive people at a secondary health care facility in Port Harcourt, Nigeria.

2.3 Ethical Consideration

The Military Hospital in Port Harcourt, Rivers State, Nigeria, granted ethical approval from its ethics committee. Before samples were taken and processed, everyone who participated gave informed consent.

2.4 Study Population

One hundred (100) HIV-infected individuals accessing care at a secondary healthcare facility in Port Harcourt, Nigeria, were enrolled on this study from September 2021 to November 2022. The socio-demographic data were collected from their medical registers. The information obtained was stratified as presented in Figures 2-6. Every HIV-positive patient who was not on any form of antibiotics and who gave their consent was included in the study. At the same time, the exclusion criterion was based on no consent and being too weak. Patients with missing information were also eliminated.

2.5 Sampling techniques, sample collection, preparation and storage

Using a random sampling technique, blood was drawn from patients who tested positive for HIV at a secondary healthcare facility in Port Harcourt, Nigeria. Clinic records were consulted for socio-demographic information pertinent to the study. Five millilitres (5 ml) of blood from each patient were obtained, and plasma was separated by centrifugation at 3000rpm for 10 minutes and stored at -20^{0}C until further analysis. Samples were identified with codes in order to avoid misinterpretation of results.

2.6 Serological Analysis of HSV, Syphilis and anti-*Helicobacter pylori*

HIV antibodies were re-screened using the sequential algorithm of rapid HIV tests. According to the manufacturer's instructions, sera were also tested for HSV, Syphilis and *H. pylori* utilizing a commercially available ELISA kit made by the Italian company DIA.PRO in Milan.

2.7 Data Analysis

Statistical Package for Social Sciences (SPSS) 20.0 was used to analyze and report the results. The difference between the number of samples that tested positive and the number of samples that were screened, multiplied by 100, was used to determine seropositivity. The correlations between the individuals' socio-demographic factors were determined using the Chi-square test. The threshold for statistical significance was fixed at $P < 0.05$.

3 Results

3.1 Population characteristics

After analyzing the 100 HIV-infected individuals accessing care at a secondary healthcare facility in Port Harcourt, the socio-demographics, age, sex, occupation, Local Government Areas (LGA) and CD4 counts were presented in Figures 2-6. The age ranges between 20 and 70. (Figure 2). The most significant age groupings, with 74.0% of the population, were those aged 20 to 40. Also, 58.0% of the people in the study were males, making up the majority (Figure 3). Their CD4 count ranged from 20 - 1514 cells/µl. The majority (39.0%) of the population had CD4 <200 cells/µl (Figure 6).

3.2 Prevalence of Co-infections amongst PLWHIV

The overall co-infections from the research were 58.0% for HIV/ *H. pylori*, 0.0% for HIV/HSV, and 0.0% for HIV/Syphilis, as shown in Figure 1. The overall HIV/*H. pylori* were determined as 58.0%.

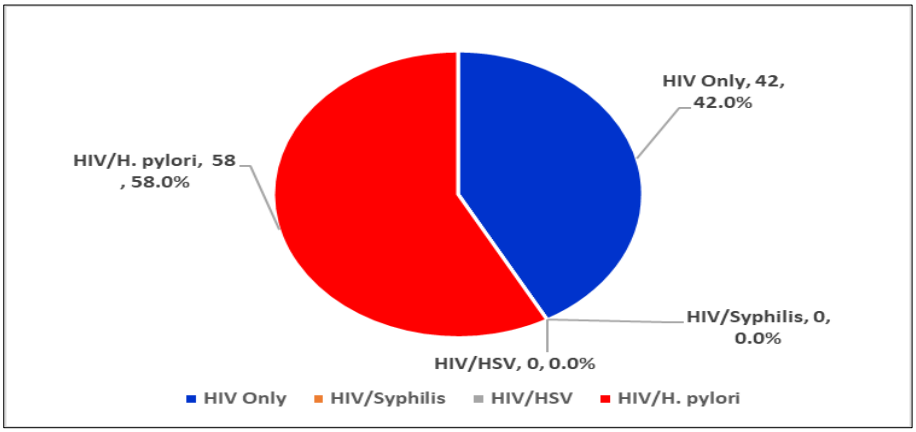

Figure 1 HIV Co-infections with HSV, Syphilis and *H. pylori*

3.3 Age-Related HIV/ *Helicobacter pylori* Co-infection

Figure 2 illustrates that a higher HIV/*H. pylori* co-infection occurred in the age group <20-40 (59.5%) compared to age groups 41-70 (53.8%); however, this distinction lacked statistical significance ($p = 0.62$).

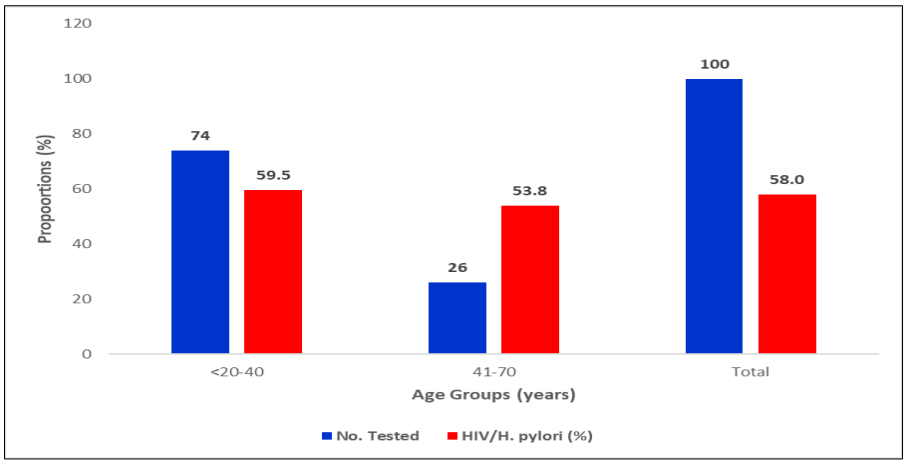

Figure 2 HIV/*H. pylori* concerning age

3.4 Sex-Related HIV/ *Helicobacter pylori* Co-infection

A higher HIV/*H. pylori* co-infection occurred in males (59.5%) than their female counterparts (56.9%); however, this distinction lacked statistical significance (p = 0.79). This result is represented in Figure 3.

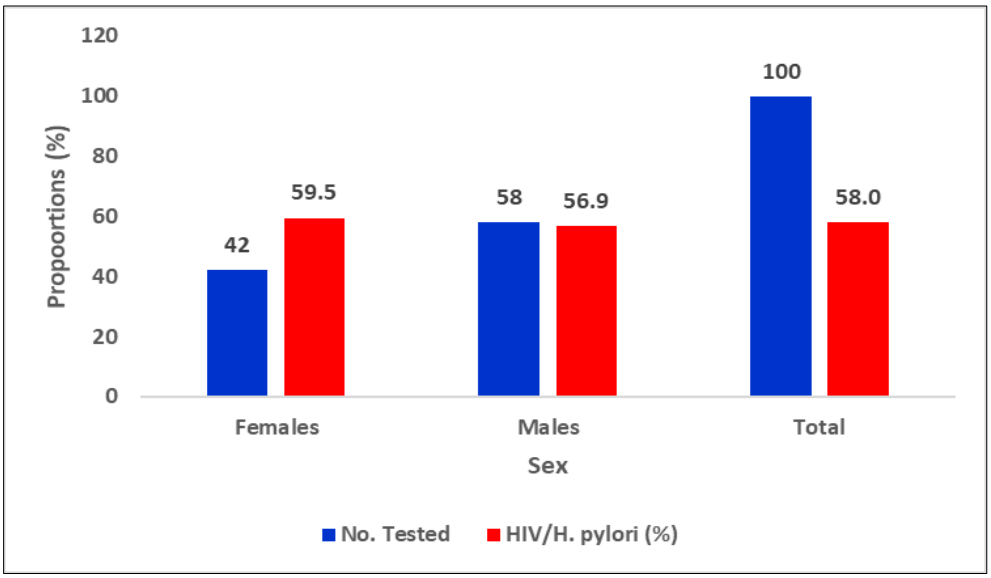

Figure 3 HIV/*H. pylori* concerning sex

3.5 Occupation-Related HIV/ *Helicobacter pylori* Co-infection

A higher HIV/*H. pylori* co-infection (100.0%) occurred among the unemployed compared to other occupational groups with various prevalence rates (Figure 4). However, this distinction lacked statistical significance (p = 0.26).

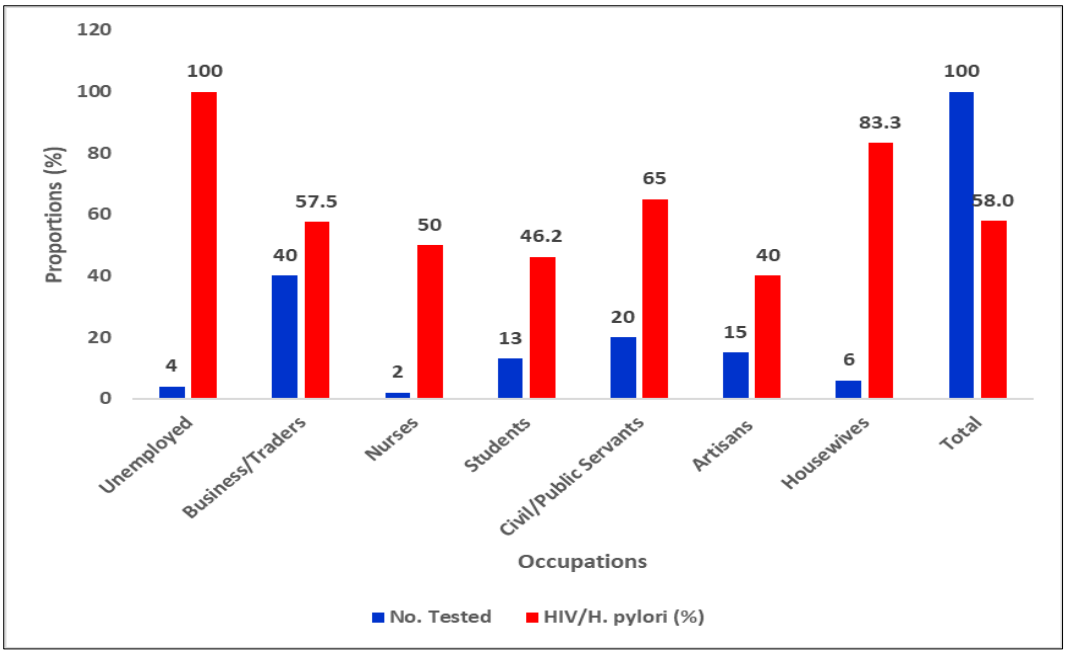

Figure 4 HIV/*H. pylori* concerning Occupations

3.6 HIV/*H. pylori* concerning LGA

Higher seropositivity of HIV/*Helicobacter pylori* co-infection occurred in 3 local government areas of Rivers State (Ahoada, Eleme and Etche) with a co-infection rate of 100.0% compared to other local government areas with various prevalence rates (Figure 5) however, this distinction lacked statistical significance (p = 0.60).

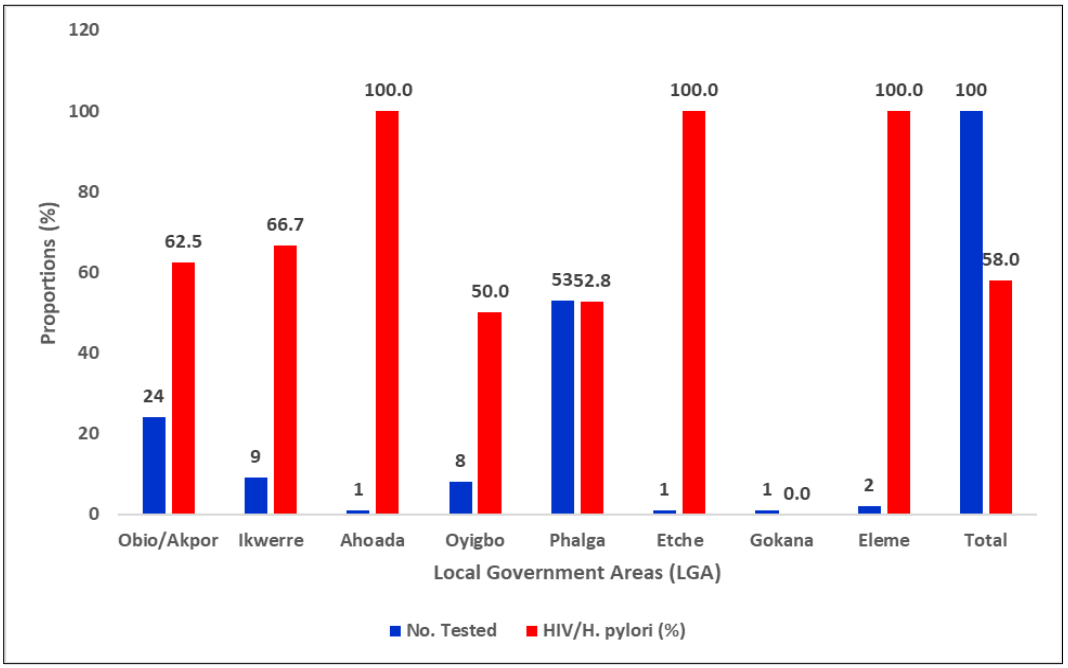

Figure 5 HIV/*H. pylori* concerning Local Government Areas (LGA)

3.7 CD4 counts-Related HIV/ *Helicobacter pylori* Co-infection

A higher HIV/*H. pylori* co-infection rate of 58.3% occurred in those with CD4 counts 200-349 and >350 cells/µl compared to CD4 counts <200 cells/µl (Figure 6); however, this distinction lacked statistical significance (p = 0.57).

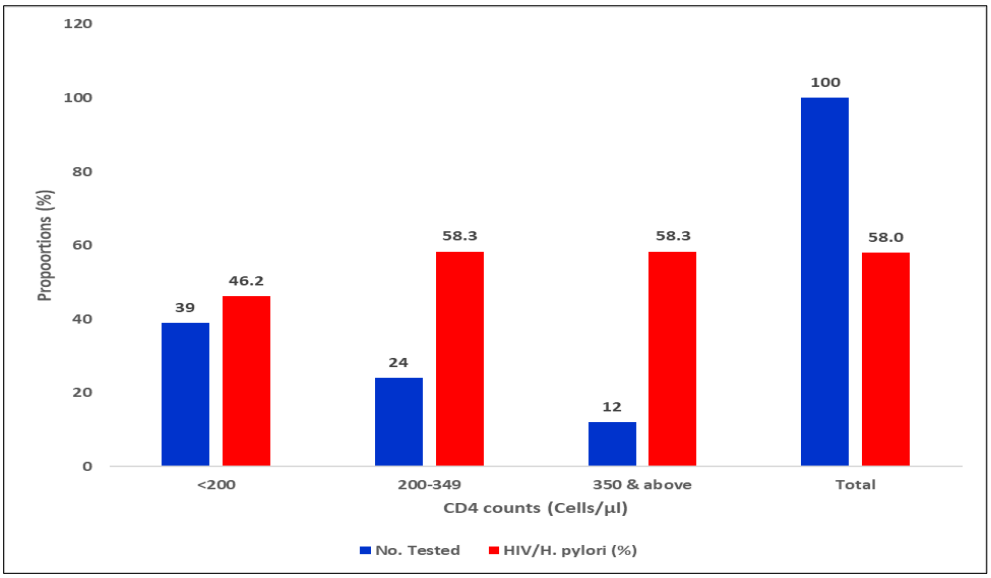

Figure 6 HIV/*H. pylori* concerning CD4 counts

4 Discussion

In order to assess the prevalence of co-infection with the herpes simplex virus, syphilis, and *H. pylori* among HIV-positive people seeking treatment in a secondary healthcare facility in Port Harcourt, Nigeria, this study was conducted. Studies reveal that while access to ART has improved over time, the percentage of patients with HIV who are also infected with STIs has grown (Scheer et al., 2001). Regular STI screening can be done during clinical visits to assess blood plasma virus load in response to HIV treatment. The standard of care is to routinely test viral load for persons on ART every three to four months to detect viral rebound before establishing drug resistance, even though treatment guidelines are frequently altered (Volberding & Deeks, 2010).

Over time, more diagnostic tests have been available to identify antibodies to herpes simplex virus types 1 and 2 (HSV-1 & HSV-2). However, among different worldwide populations, their performance traits could differ (Aldisi et al., 2018). In this study, the overall prevalence of HSV among HIV-infected individuals was zero per cent, which contrasts with co-infection rates of 2.4% found in a study of high-risk groups in India (Rahman et al., 2000), 2.8% for IgM and 99.4% for IgG antibodies in a study conducted in Nigeria (Okonko et al., 2015; Okonko & Cookey, 2015), 6.1% in Northern Nigeria (Muhammad et al., 2021) and the 2.2% reported for IgM and 51.1% reported for IgG antibodies in our previous studies in Nigeria (Okonko et al., 2023a, b). Due to the low prevalence of HIV in the research location, it is also lower than the value discovered in a study done in Ibadan, Nigeria. In Lokoja, Nigeria, a different study (Kolawole et al., 2016) found a rate of 61.6%, more significant than the information in this article. The transmission of HSV may be reduced by antiviral agents, decreasing virus shedding and virus load (Celum, 2004), which could be a standing factor of correspondence with 0.0% prevalence.

Syphilis and HIV have the same mode of transmission and risk factors (Mutagoma et al., 2016). Control of syphilis remains a challenge (Arando et al., 2019). In this study, the overall prevalence is 0.0%. This observation agrees with Nnoruka & Ezeoke's (2005) finding of a 2.1% prevalence incidence of co-infection with HIV and syphilis in the Nigerian state of Enugu. The study prevalence is also lower compared to other studies of 2.63% prevalence reported in the urban areas of Akwa Ibom State, Nigeria (Opone et al., 2020) and 2.0% HIV-infected subjects (Okonko et al., 2020c).

The frequency of syphilis among pregnant women and commercial sex workers in Nigeria ranged from 0.125% to 4.1%, according to the findings of different epidemiological investigations (Bakare et al., 2002). Although the prevalence of maternal syphilis decreased from 3.2% in 2013 to 1.4% in 2016 (Adeyinka et al., 2018), the rate of syphilis infection in Nigeria is lower compared to other countries in the West African sub-region. For example, the syphilis-seroprevalence rate of 11.0%, 20.0%, and 23.8% have been reported in Ghana, Sierra Leone, and Senegal, respectively (Adjei et al., 2006). The 0.0% reported in the present study is lower than the 0.8% reported by Okonko et al. (2012b) in Ibadan, Nigeria. Additionally, this frequency was lower than the 0.1% recorded in earlier research done in Port Harcourt (Ejele et al., 2005), the 0.3% reported in Eritrea (Siraj et al., 2018), the 2.9% pooled prevalence in sub-Saharan Africa (Hussen & Tadesse, 2019) and the 1.7% reported in Enugu (Chukwurah & Nneli, 2005). The present findings deviated from

findings agreed with other previous studies. Okonko et al. (2012a & 2013) reported no co-infections of HIV/syphilis and HIV-HBV-HCV-syphilis infections. Hussain et al. (2006) also reported that none were co-infected with HIV—HCV, HBV—syphilis, or HCV/syphilis. Although the percentage of patients with co-infections is zero in their studies, the combination of HIV/syphilis is a dangerous coexistence. It may have a detrimental effect on the patient and the treatment outcome.

The prevalence of HIV/syphilis (6.6%) recorded in Port Harcourt is higher than the 0.0% reported in the current study, which is lower (Adewuyi-Oseni et al., 2019). This prevalence was discovered to be lower than the 2.61% reported in Ile-Ife research (Salawu et al., 2010), the 3.1% recorded in Calabar studies (Okoroiwu et al., 2018), and the 7.5% reported in Ghana studies (Adjei et al., 2003). The differing healthcare systems, test methodologies, and risk variables in the various study locations may all contribute to the disparity in prevalence. They may be to blame for the discrepancy in prevalence. Individual risk of contracting syphilis indeed depends on lifestyle choices. Being a nosocomial infection, syphilis can be spread by unscreened blood during transfusion (Nwabuisi et al., 2005).

Determining the burden and the risk factors for acquiring this infection may be crucial to containing it and its sequelae in Port Harcourt, Nigeria. Many gastrointestinal (GI) tract disorders, including gastritis, peptic ulcer disease, and gastric cancer, have been linked to *Helicobacter pylori* (*H. pylori*) (Bello et al., 2018). The study aimed to identify *Helicobacter pylori* among HIV-positive people in Port Harcourt, Nigeria. Infection with *H. pylori* is prevalent in underdeveloped nations (Lee et al., 2003). In this study, 58.0% of the 100 HIV patients tested had *Helicobacter pylori* seropositivity. The high incidence rates previously reported in Nigeria and other underdeveloped nations are lower than this (Lee, 2003; Chen et al., 2014; Bello et al., 2018). This disagrees with the 72.1% of *H. pylori* infection reported by Chen et al. (2014), the 44.4% reported by Okosigha (2014) in Port Harcourt, the 44.0% reported by Barine (2014) and Okonko et al. (2016) in Port Harcourt, and the 81.7% reported by Bello et al. (2018) in Kano, Nigeria. However, it is higher than the 12.7% reported by Jemikalajah and Okogun (2014) in Warri, Nigeria, the 2.0% HIV/*H. pylori co*-infection observed in Port Harcourt, Nigeria (Okonko & Barine, 2023), the 20.0% and 38.0% reported by Ahaotu et al. (2023a, b) in Port Harcourt, Nigeria, the 26.2% reported by Agbagwa et al. (2023) in Calabar, Nigeria.

Depending on the time, place, and population, the prevalence of *H. pylori* infection among HIV-positive people ranges from 10.0 to 81.7% (Nkuize et al., 2010; Fialho et al., 2011; Bello et al. (2018). A prevalence of 58.0% was found in this investigation. Similarly, the prevalence percentage was also determined to be 73.0% by Ndububa et al. (2001) in Ile-Ife, South-west Nigeria and other studies reported from Iran (Kafil et al., 2011), India (Nkuize et al., 2010), Ghana (Sarfo et al., 2015), two studies of Nigeria (Ejilude et al., 2011; Anejo-Okopi et al., 2016) and other parts of Ethiopia (Teka et al., 2015), which was 69.7, 33, 51.5, 46.8, 47.4 and 64.2%, respectively.

The prevalence rates for *H. pylori* reported in other Nigerian research do not match the rates found in this study. In developing countries, 70.0%-90.0% of the population harbour *H. pylori*, which is mainly acquired during childhood (Bello et al., 2018). In developed countries, the prevalence is lower, ranging from 30.0% to 40.0% (Saad & Chey, 2008). An earlier study in 2009 from the exact centre by Tijjani and Umar (2008) reported 81.0% prevalence. In another study from Gombe (Mustapha et al., 2011), *H. pylori* prevalence was 77.1%, while Ndububa et al. (2001) in Ile-Ife reported prevalence rates of 73.0%. Nigerian prevalence rates are similar to those reported in studies in South Africa (Kidd et al., 1999) and Kenya (Kimang'a et al., 2010), which reported, respectively, rates of 66.0% and 94.0%. Malu et al. (2000) in Jos found a prevalence of 87.0%, while Aboderin et al. (2007) reported 73.0% in the South-West. Studies from many African countries reported similar prevalence rates of 91.7% in Egypt (El Dine et al., 2008), 97.0% in Gambia (Secka et al., 2011), and 75.4% in Ghana (Baako & Darko, 1996).

In the age group of 20 to 40, HIV/*Helicobacter pylori* were more common (59.5%) than those of 41-70 years (53.8%). This observation agrees with Zhu et al. (2014), who reported that more 30-39-year-olds than other age groups have *H. pylori infection*. It agrees with Efere (2019) and Agbagwa et al. (2023), who have an increased prevalence in the age group 26-30 years. It also agrees with Ahaotu et al. (2023a), who reported a higher frequency in pregnant women in Port Harcourt who are between the ages of 20 and 29. It agrees with Kolawole et al. (2021), who also found no relationships between age and *H. pylori* infection in their study. However, this result disagrees with that of Okosigha (2014) in Port Harcourt, who reported lower seropositivity in children (ages 1-18 years). Moreover, Kooffreh-Ada et al. (2019) showed that *H. pylori* infection is relatively common in Calabar, Nigeria, between the ages of 40 to 60. It also disagrees with Ahaotu et al. (2023b), who reported a higher prevalence among HIV-positive people in the age group 40-49 years in Port Harcourt. In addition, in disagreement with the report of Joav et al. (2004), who found a similar situation.

Also, a higher HIV/*Helicobacter pylori* co-infection occurred in males (59.5%) compared to their female counterparts (56.9%). This result can be attributable to stress and family responsibility, among other factors. Abdollahi et al. (2014)

tried to match the cases and controls regarding gender to minimize the result of socioeconomic status and found no discernible difference in serum anti-*H. pylori* distribution between two groups. It agrees with Ahaotu et al. (2023b), who reported a higher co-infection among males than females in Port Harcourt. The observation in this study disagrees with Efere (2019), and According to Agbagwa et al. (2023), there were more females than males affected in Calabar. Chukwuma et al. (2020) also discovered that the seroprevalence of *H. pylori* was mainly in females.

In this study, a higher prevalence of *Helicobacter pylori* was seen in the unemployed compared to other occupational groups. Similar findings were made in Denmark by Steffen et al. in 1996, who discovered that a decline in socioeconomic position increased the probability of chronic *H. pylori* infection. It supports the assertion made by Smith et al. (2018) that an *H. pylori* infection is unrelated to a person's line of work. This finding conflicts with Ahaotu et al. (2023b), who claimed that traders had a higher prevalence. Low socioeconomic class individuals are more likely to have low levels of education, inadequate health education, and a greater propensity to reside in environments that increase the risk of faecal contamination of water and food (Bello et al., 2018). In order to reduce the impact of socioeconomic status on their findings, Abdollahi et al. (2014) attempted to match the cases and controls related to residency and educational level status. They discovered no significant variation in the distribution of serum anti-*H. pylori* between the two groups. Efere (2019) and Agbagwa et al. (2023), who indicated a higher frequency among students than other occupational categories in Calabar, Nigeria, disagree with the findings of this study. According to Bello et al. (2018), having an *H. pylori* infection is more likely if you belong to a lower social level.

Compared to other local government districts, Ahaoda, Eleme, and Etche showed a higher prevalence of *Helicobacter pylori*. The crowdedness and environmental variables connected to these three local government regions may be to blame. Infection with *H. pylori* is substantially correlated with crowding. (Bello et al., 2018). Similarly, numerous investigations conducted in Nigeria by Etukudo et al. (2012) and Olufemi et al. (2015) revealed that the prevalence of *H. pylori* infection increased with household size. As risk factors for *H. pylori* infection, Khalifa et al. (2010) also reported increased household contact, sharing of beds, and crowded households. According to a study by Torres et al. (1998), living conditions are a critical factor in how likely someone is to become infected with *H. pylori*.

Compared to people with CD4 counts under 200 cells/µl, those with CD4 counts between 200 and 349 and >350 cells/µl had a greater prevalence of HIV/*H. pylori* co-infection (58.3%). It agrees with Akhiani et al. (2002), who concluded that there had been a decline in HIV-positive subjects with decreasing CD4+ cell counts. Furthermore, it supports the findings of Efere (2019) and Agbagwa et al. (2023), who found that in Calabar, Nigeria, those with CD4+ cell counts >350 cells/µl had a higher prevalence than people with lower CD4 counts.

Summarily, in this investigation, the prevalence of HIV/HSV, HIV/Syphilis, and HIV/*H. pylori* coinfections was determined to be 0.0%, 0.0%, and 58.0%, respectively. Ages <20-40 years, males, and the unemployed had a higher prevalence of HIV/ *H. pylori* co-infections than their counterparts in other categories. From the LGA of the study, Ahoada, Eleme, and Etche had the most common occurrence of HIV/ *H. pylori* co-infections. CD4 counts were not a factor in all HIV co-infections studied. The results revealed that HIV-infected individuals in Port Harcourt, Nigeria, did not harbour HIV/HSV and HIV/syphilis co-infections that would otherwise remain undiagnosed if no screening existed. This study achieved its objectives of detecting the zero prevalence of HIV/HSV and HIV/syphilis co-infection and a high co-infection rate with HIV and *H. pylori* among HIV-positive people in Port Harcourt, Nigeria.

The fact that this study is retrospective is one of its limitations since virological markers were not examined because of the cross-sectional design. However, compared to comparable studies conducted in other areas, our findings are reliable and demonstrate the potential public health impact of HIV/Co-infections in Port Harcourt, Rivers State. The findings also demonstrate the potential public health effects of HSV among HIV-positive people in Nigeria, where anti-HSV testing is not routinely done, particularly given the possibility of neonatal transmission. Particularly in people with HIV infection, there will be limited effectiveness in eliminating *H. pylori*. Since science has always aimed to improve the world, understanding the dangers of HSV infection will help gather the fields that urgently need epidemiological data while enhancing the lives of those at risk and the community at large.

5 Conclusion

Further evidence from this study supports the lack of HIV/HSV and HIV/Syphilis co-infections among HIV-positive patients getting care in Port Harcourt, Nigeria. It also said that the prevalence of HIV/*H. pylori* co-infection is high. The research also revealed that *H. pylori* infection is widespread among HIV-positive people and may pose a severe public health threat in Port Harcourt, Nigeria, although the underlying causes are unknown. The results of this study represent the sixth documented prevalence of HIV/*H. pylori* co-infection in Port Harcourt, Nigeria, and they serve as a baseline for more in-depth investigations into HIV/*H. pylori* co-infection in the South-South region of Nigeria. However, more

research is required to fully assess the infection rate among these HIV-positive people in Rivers State, Nigeria. Further research is required to understand the underlying mechanisms of HIV/*H. pylori* co-infection.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors claim that there are no conflicting interests.

Statement of ethical approval

All authors declare that all experiments have been examined and approved by the University of Port Harcourt and the Military Hospital Research Ethics committees. Therefore, the study follows the ethical standards in the 1964 Declaration of Helsinki.

Statement of informed consent

All authors declare that informed consent was obtained from all participants included in the study.

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