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Original Research Article

Factors influencing the onset of tuberculosis in HIV-positive adults receiving highly active antiretroviral therapy in the coastal area of Kenya

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ABSTRACT

Background: Tuberculosis is one of the most common infectious diseases in patients with HIVAIDS. The purpose of this study was to determine the factors that influence the development of tuberculosis in HIV-positive patients who frequent public hospitals in coastal Kenya.
Methods: A retrospective study was conducted in a hospital environment with 600 HIV-positive adults undergoing highly active antiretroviral treatment (HAART) at 35 government hospitals in Mombasa County.
Results: The patient's age (AOR=1.120; 95% CI: 1.011-2.231), initial CD4 cell count (AOR=0.870; 95% CI: 0.710-0.940), individuals residing independently (AOR=1.200; 95% CI: 1.048-1.120), female patients undergoing treatment (AOR=0.775; 95% CI: 0.562-0.843), absence of opportunistic infections (AOR=0.862; 95% CI: 0.728-0.932), those who have not disclosed their HIV status (AOR=1.239; 95% CI: 1.081-2.339), patients living in rural areas (AOR=1.132; 95% CI: 1.030-1.451), individuals lacking formal education (AOR=1.120; 95% CI: 1.052-1.541), patients demonstrating poor adherence to treatment (AOR=1.221; 95% CI: 1.190-2.451), bedridden patients (AOR=1.222; 95% CI: 1.129-1.519), ambulatory patients (AOR=1.153; 95% CI: 1.090-1.263), and non-smokers (AOR=0.850; 95% CI: 0.681-0.932) were all significantly associated with the variable being studied.
Conclusions: Additionally, factors such as alcohol consumption, drug toxicity, and the initial clinical WHO stages significantly influenced the advancement of tuberculosis in HIV-positive individuals receiving treatment.

Keywords: HAART, HIV-positive people, TB development

INTRODUCTION

Considering that approximately 650,000 individuals perished in 2021 due to HIV-related factors.[1] HIV infection remains a major global public health concern. As per the World Health Organization (WHO) TB accounts for around 30% of the 690000 AIDS-related fatalities that take place worldwide according to the most recent data available.[2,3] For people living with HIV (PLHIV), tuberculosis remains the leading cause of mortality. In comparison to individuals without HIV, PLHIV face a 15-21 times greater risk of progressing to active tuberculosis. In 2021, the reported cases of tuberculosis rose to 6.4 million, although this figure remains lower than that recorded in 2019.[4] Research has established that HIV is a major risk factor, accounting for

almost 17% of TB cases in Kenya.[5] About 80% of all TB cases worldwide occur in Kenya, which ranks 15th out of 22 high-burden nations in terms of TB disease burden.[6] HIV increases the lifelong chance of developing tuberculosis.[7,8] Tuberculosis (TB) ranks as the primary cause of mortality and is the most common opportunistic infection affecting individuals living with HIV globally.[9] This assertion is supported by the findings of a study in Southern Ethiopia.[10,11] According to Kenya's Ministry of Health, the number of TB patients increased from 77,854 in 2021 to 90,841 in 2022. The absence of detection during the COVID-19 outbreak contributed to a little rise in tuberculosis fatalities in 2021. According to World Health Organisation projections, 47% of TB cases are currently being identified (CDR).[4] Medication was taken by 87% of patients in Kenya, yet 10.3% of TB/HIV patients getting ART passed away.[12] On the other hand, in Mombasa County, Kenya, 92.9% of TB/HIV patients were on antiretroviral therapy (ART) in 2019, while only 17% of patients were not on ART.[13] Prior research on TB treatment outcomes stratified by HIV status was not reported in the majority of these studies. Due to significant investments in HIV control and prevention or greater accessibility to ART for HIV-positive individuals, it is probable that the prevalence of TB and HIV has also changed over time.[14, 15]

Kenya's HIV testing policy changed over time from provider-initiated testing and counselling (PITC) to self-initiated voluntary counselling and testing.[16,17] Based on new scientific evidence supporting the benefits of a "test and treat" approach and the WHO's recommendation, Kenya has changed its policy in 2016 to begin antiretroviral therapy (ART) as soon as an HIV diagnosis is made, regardless of CD4 count.[18,19] A very high level of continuous ART adherence is necessary to reduce viral replication, improve immunological and clinical outcomes, and both.[20] Antiretroviral therapy non-adherence is one of the main challenges facing the HIV management plan. Isoniazid preventive therapy (IPT) for PLHIV to protect against TB was recommended by WHO and implemented in Kenya from 2015.[21,22]

A variety of research has identified risk factors, including living environment, education level, job type, co-existing health issues, HIV status disclosure, CD4 count, substance abuse, and social support, that are linked to the adherence of PLWHIV to their ART.[23-25] If HIV patients fail to adhere to their medication regimen, they might face several negative consequences. Non-adherence has been identified as a key risk factor for the development of ART treatment failure.[26]

Although research on the progression of tuberculosis among HIV-positive individuals in Kenya has been conducted, there are no studies in the region that thoroughly examine the risk factors for tuberculosis and HIV co-infection in patients with complete data. To best of our knowledge, there has been no recent research across the region examining the factors that affect the emergence of tuberculosis in individuals with HIV who are undergoing HAART in the study area.

Consequently, the aim of this research was to examine the factors that affect the progression of tuberculosis in HIV patients receiving treatment at 35 government hospitals in the area. The results of this investigation are expected to serve as a valuable resource for enhancing the knowledge of planners, decision-makers, and implementers of HIV/TB programs.

METHODS

Study area

The study was carried out in Mombasa County which has a network of health facilities including the referral hospital (Coast General Teaching and Referral Hospital), sub-county hospitals, health centres and dispensaries as well as private healthcare facilities. The population is steadily growing due to rural-urban migration and immigration from unstable countries. Tuberculosis and HIVAIDS are the leading causes of deaths in the area representing 50%.

Study population

A longitudinal retrospective study was conducted across 35 government hospitals, involving 600 randomly selected individuals who were HIV-positive and have initiated their treatment in the coastal region of Kenya. The sites purposely selected to represent the Kenya Essential Package for Health levels 2-5. The research took place from August 2020 to April 2023. The selection framework included 54,361 HIV-positive individuals who were followed up at each of the 35 government hospitals following the commencement of HAART.

Inclusion and exclusion criteria

This study included all HIV-positive persons aged 15 years and above who began therapy at least six months after starting HAART enrolled within the first five months of 2020 and had a complete record of clinical and sociodemographic information. Patients under the age of 15 or without complete medical records were not included in the current study.

Variables under study

The occurrence of TB in adults with HIV undergoing HAART was the key variable. The patients' age in years, sex, job status, education level, marital status (living alone or with a partner), WHO clinical stages I, II, III, and IV, initial baseline CD4 count, functional status (working, bedridden, or ambulatory), smoking behavior, alcohol consumption, adherence to medication, disclosure of their illness to others living with them, susceptibility to other diseases, drug toxicity, and depression at the

beginning of treatment were all recognized as predictive indicators.

The clinical stages I, II, III, and IV defined by the World Health Organization reflect the status of the viruses and potential results. The fourth stage is the most challenging; hence, greater attention should be directed towards it at this time.

Sample size estimation

Using Cochran's formula, the sample size was determined considering the proportion of TB occurrence at a 95% confidence level with a 5% margin of error. In this case the formula was

$$n_{\frac{1}{4}} = \frac{z^2 pq}{e^2}$$

Where n is the necessary sample size for the entire target population z is the critical value chosen for the desired level of confidence p is the estimated proportion of an attribute that is present in the population q=1-p and e is the desired degree of precision. After calculation of the sample size for the whole population, a proportional random sampling technique was used in the demonstration of random samples from the study population in each of the governmental hospitals in the region. Samples were randomly selected considering the charts in each hospital belonging to each patient. Hence, a total of 600 randomly selected patients were considered for this study.

Data collection procedures

From August 2020 to April 2023, a random selection of the medical professionals employed in the ART department of each of the 35 hospitals was made in order to gather pertinent data. The variables used in this study were specified in detail and provided to the data collectors.

Collection of sputum and blood samples

A specialist doctor connected to the TB clinic performed the required clinical and diagnostic assessments. A diagnosis was reached by combining the results of laboratory testing imaging investigations and clinical observations.

The initial sputum was subjected to Ziehl-Neelsen (ZN) staining in the peripheral laboratory for standard Acid-fast (AFB) direct smear microscopy in order to confirm the diagnosis of tuberculosis in suspected patients. Another sputum specimen was taken, and sent each week to the Central Reference Laboratory (CRL) for culture.

Blood samples for HIV testing were delivered using sterile EDTA tubes from the vacutainer brand.

Isolation of and identification of Mycobacterium tuberculosis

Mycobacteria were isolated from sputum specimens using standard procedures. Participants with three negative culture results were deemed to be TB-free, whereas those with at least one positive culture (MGIT and/or LJ) were deemed to have TB. Suspects with culture-negative sputa but ZN-smear-positive sputa were considered smear-negative pulmonary tuberculosis cases.

Molecular tests of active TB

Molecular tests were used to diagnose and test for tuberculosis when patients were being watched for drug adherence. Molecular diagnostics can detect TB cases that are either unreported or undetected at each visit by offering precise, timely outcomes, comprising rapid drug susceptibility testing. The care provided to TB patients might enhance due to this. Numerous molecular tests are currently being created and assessed for the identification of tuberculosis. Certain tests are meant for reference laboratories, while others are created for point-of-service and remote healthcare environments. This resulted in the creation, production, and utilization of a new wave of TB molecular assays in the present study. Assessments for HIV and tuberculosis co-infection, patient weights, viral suppression, and CD4 cell count were performed on each patient who came to the hospital for a follow-up in order to ascertain the clinical treatment outcomes. Similarly, TB was detected and tested for using molecular testing. This task was finished by laboratory technicians, who are employed in the medical field. The entire set of recorded data on HIV/AIDS patients were considered during data analysis. laboratory molecular tests, supplemental forms, TB drugs record forms, and patients' cards were examined during data collection. The quality of data was pre-tested using a standard data collection tool and trained data collectors.

Data management and analysis

Data analysis was conducted utilizing SAS software version 9.4. Descriptive statistics were used to assess normality, the existence of outliers, and the absence of observations. Creating a multivariate regression model required taking into account all variables in the bivariate analysis that had a p value below 0.05. The elements affecting tuberculosis (TB) development in people with HIV were subsequently analyzed through the binary logistic regression model. In the data analysis, the crude odds ratio (COR), the adjusted odds ratio (AOR), and their 95% confidence intervals were calculated.

RESULTS

Base characteristics of the respondents

A total of six hundred (600) individuals with HIV were included in the study, with 54.2% being male and 45.8%

female. Most of the participants (55.3%) were not residing with their partners, 71.1% were educated, 65.3% had a viral load that was not suppressed, and 81.8% of them lived in urban areas. Most of them (80.0%) were in a working position. Among the individuals, 32 percent (33.3%) chose not to inform their family members about their HIV positive status. As per the clinical stages defined by the WHO, 36.7% were classified as stage IV, 34.3% as stage III, 15.5% as stage II, and 13.5% as stage I. During enrollment, 20% of the patients presented with baseline HIV/TB co-infection. Among the subjects, 31.7% were smokers, 25% experienced opportunistic diseases, and 36.7% consumed alcohol (Table 1). The typical (median) weight of the individuals under care in this study was 58 kg (IQR: 52, 64), while the mean age of the patients was 35.67 years (SD=10.7 years). Every patient exhibited a baseline CD4 cell count of 134 cells/mm^3 (median) (IQR: 113, 180).

Table 1: Baseline socio-demographic and clinical variables (n=600).

Name of variables	Categories	Frequency	Percentage
Gender	Male	325	54.2
	Female	275	45.8
Marital status	Living with partner	268	44.7
	Living without partner	332	55.3
Level of education	Not educated	170	28.3
	Educated	430	71.7
Viral suppression	Suppressed	208	34.7
	Unsuppressed	392	65.3
Baseline clinical WHO stages	Stage I	81	13.5
	Stage II	93	15.5
	Stage III	206	34.3
	Stage IV	220	36.7
Place of residence	Rural	109	18.2
	Urban	491	81.8
HIV status of the partner	Negative	56	9.3
	Not applicable	114	19
	Positive	205	34.2
	Unknown	225	37.5
Functional status	Ambulatory	100	16.7
	Bed ridden	20	3.3
	Working	480	80
HIV and TB co-infection at enrollment	Negative	480	80
	Positive	120	20
Alcohol intake	No	380	63.3
	Yes	220	36.7
HIV status disclosure	Disclosed	400	66.7
	Not disclosed	200	33.3
Smoking Status	No	410	68.3
	Yes	190	31.7
Opportunistic status	No	450	75
	Yes	150	25

Clinical outcome during highly active antiretroviral therapy

As indicated in Table 2 below, the clinical outcome factors throughout therapy (follow-ups) were also documented at each visit. Of the patients, about 66.9% were virally unsuppressed, 77.2% were in working status, 60.8% were not adhering to treatment, 23% did not reveal their HIV status to their living companions, 56.1% had opportunistic infections, and 55.4% had medication toxicity. By the conclusion of the research period, 39.7% of the HIV patients had co-infected HIV and TB. As a result, at the final visits (the trial period conclusion), the initial HIV/TB co-infection rate of 6% was raised to 39.7%.

Table 2: Clinical outcome during HAART (end of study period) n=408.

Name of variables	Categories	Frequency	Percentage
Viral suppression	Suppressed	135	33.1
	Unsuppressed	273	66.9
Clinical WHO stages	Stage I	83	20.3
	Stage II	84	20.6
	Stage III	132	32.4
	Stage IV	109	26.7
Partner HIV status	Negative	38	9.3
	Not applicable	85	20.8
	Positive	133	32.6
	Unknown	152	37.3
Functional status	Ambulatory	68	16.7
	Bed ridden	25	6.1
	Working	315	77.2
HIV and TB co-infection at enrollment	Negative	246	60.3
	Positive	162	39.7
Adherence status	Adherent	160	39.2
	Non-adherent	248	60.8
HIV status disclosure	Disclosed	314	77
	Not disclosed	94	23
Opportunistic status	No	179	43.9
	Yes	229	56.1
Drug toxicity	No	182	44.6
	Yes	226	55.4

Multivariate findings for TB/HIV co-infection

Table 3 below shows the key predictors of the variable of interest in the multivariate analysis. The development of TB in individuals with HIV was greatly affected by age. Maintaining all other factors constant, the average likelihood of developing tuberculosis rose by 12.2% for each additional year of age (AOR=1.120; 95% CI: 1.011-2.231, p<0.01). When all other variables are held constant, the anticipated probability of developing TB in HIV-positive individuals decreased by 11.2% for each additional cell/mm^3 increase in baseline CD4 cell count (AOR=0.887; 95% CI: 0.710-0.940, p<0.01). For people with HIV, marital status had a significant impact on the development of tuberculosis. As a result, when all other variables were controlled, HIV patients who lived alone had a 21.2% greater likelihood of developing TB compared to those who lived with partners (AOR=1.200; 95% CI: 1.048-1.120, p=0.018).

The patients' sex also significantly influenced the variable of interest. When all other variables remained unchanged, the expected risks of developing tuberculosis in female HIV patients were 21.4% lower compared to their male counterparts (AOR=0.755; 95% CI: 0.562-0.843, p=0.020)

The status of HIV/TB co-infection was significantly influenced by opportunistic connections with other diseases. With all other variables held constant, individuals not affected by opportunistic infections had a 13.5% reduced likelihood of developing TB compared to those who were unscrupulous with other health conditions (AOR=0.862; 95% CI: 0.728-0.932, p=0.030). In comparison to patients who informed their household members about their illness status, those who did not had a 24% increased likelihood of developing tuberculosis (AOR=1.019, 95% CI: 1.081-2.339, p=0.003)."

Holding all other variables constant, HIV patients residing in rural areas had a 13.5% increased likelihood of developing TB compared to their urban counterparts (AOR=1.132; 95% CI: 1.030-1.451, p=0.05). The variable of interest being examined was significantly influenced by education. When controlling for all other variables, the anticipated risks of acquiring tuberculosis were 12.5% greater for uneducated individuals compared to educated ones (AOR=1.120; 95% CI: 1.052-1.541, p=0.013).

Medication adherence had a significant impact on the progression of TB in individuals with HIV. Consequently, in relation to patients who followed their treatment, those who did not had a 22.5% increased likelihood of contracting tuberculosis (AOR=1.221; 95% CI: 1.190-2.451, p=0.014). The functional state of HIV-positive individuals had a significant impact on their risk of contracting tuberculosis. With all other variables constant, the expected risks of contracting TB for bedridden HIV patients and those with compromised

functional status were 22.3% greater than for individuals who are employed (AOR=1.222; 95% CI: 1.129-1.519, p=0.021). For HIV patients with ambulatory functional status, the expected likelihood of developing TB was also 15.6% greater than for those with working status, when all other variables remained constant (AOR=1.153; 95% CI: 1.090-1.263, p value =0.001).

When all other factors were held constant, individuals with HIV who did not smoke had a 14.6% reduced likelihood of contracting TB compared to smokers (AOR=0.850; 95% CI: 0.681-0.932, p=0.001). Likewise, when all other variables remained unchanged, patients who abstained from alcohol had a 12.6% reduced likelihood of developing TB compared to those who consumed it (AOR=0.871: 95% CI: 0.732-0.970, p=0.002). As previously noted, significant elements like WHO clinical stages and medication toxicity significantly influence the progression of tuberculosis in individuals with HIV.

Table 3: Multivariate findings for TB/HIV co-infection.

Parameters	COR	95% COR	COR p value	AOR	95% COR	P value
Age (years)	1.022	(1.011, 1.231)	0.003*	1.120	(1.011,2.231)	0.01*
Baseline CD4 cell count	0.011	(0.013, 0.213)	<0.001*	0.870	(0.710, 0.940)	0.01*
Marital status (Ref. =With partner)						
Without partners	1.96	(1.14, 3.25)	0.005*	1.209	(1.048,1.120)	0.018*
Sex (Ref.=Male)						
Female	0.015	(0.012,0.224)	<0.101	0.775	(0.562, 0.843)	0.020*
Infected with Opportunistic illness (Ref.=yes)						
No	0.131	(0.060, 0.233)	0.002*	0.862	(0.728, 0.932)	0.030*
Presence of mental depression/stress (Ref.=yes)						
No	0.021	(0.002, 1.345)	0.063	1.019	(0.227. 1.780)	0.052
Disclosure of the HIV status to individuals residing together (Ref.=yes)						
No	1.230	(1.001,0.40)	0.003	1.239	(1.081, 2.339)	0.003*
Residence area (Ref.=Urban)						
Rural	1.116	(1.011, 1.126)	0.046*	1.132	(1.030, 1.451)	0.05*
Level of education (Ref.=educated)						
Not-educated	1.024	(1.013,1.208)	<0.021*	1.120	(1.052,1.541)	0.013*
Adherence to HAART (Ref.= adherent)				H		
Non-adherence	1.035	(1.005, 1.649)	< 0.018*	1.221	(1.190, 2.451)	0.014*
Functional status (Ref.= working)						
Confined to bed	1.424	(1.190, 1.551)	0.024*	1.222	(1.129, 1.519)	0.021*
Ambulatory	1.013	(1.929, 1.452)	0.001*	1.153	(1.090, 1.263)	0.001*
Smoking status (Ref. =yes)						
No	0.223	(0.020,0.431)	<0.001*	0.850	(0.681, 0.932)	0.001*
Alcohol consumption (Ref.= yes)						
No	0.124	(0.012,0.330)	0.003*	0.871	(0.732, 0.970)	0.002*
Drug toxicity (Reference=no)						
Yes	1.062	(1.029,1.220)	0.001*	1.073	(1.061, 1.142)	0.002*
Baseline clinical stages (Ref.=Stage IV)						
Stage I	0.234	(0.014, 0.553)	0.034*	0.250	(0.042, 0.340)	0.013*
Stage II	0.136	(0.031, 0.211)	0.032*	0.122	(0.089, 0.338)	0.002*
Stage III	0.103	(0.020, 1.230)	0.031*	0.085	(0.016, 0.141)	0.013*

*Stands for statistically significant variable (p<0.05); COR, crude odds ratio; AOR, adjusted odds ratio.

DISCUSSION

A major risk to public health is tuberculosis, which remains the leading cause of HIV-related diagnoses.[4,27] As a result, we performed this retrospective record review to identify TB predictors among HIV-positive adults in Kenya's coastal region. In this study, the likelihood of HIV patients co-infecting with TB increases with patient age. Older adults may be less likely to take their medications as prescribed, which could result in drug-resistant co-infection by tuberculosis (TB). Studies conducted elsewhere are comparable to this one.[28] According to earlier research, Patients experience a decrease in CD4 cell count as they age, increasing their susceptibility to other infectious diseases.[29] the outcome is consistent. It also concurred with a study in Kenya that showed age as a risk factor is independently associated with pulmonary tuberculosis and might play a role in the

progression of tuberculosis infection into disease.[30]

With a high initial CD4 cell count at the beginning of treatment, patients are less likely to encounter additional infectious diseases due to the abundance of white blood cells and the reduction in viral loads. This indicates that antiretroviral therapy inhibits HIV replication and rebuilds immunity. In theory, patients who start treatment with higher CD4 cell counts have a lower risk of contracting tuberculosis (TB) in individuals living with HIV/AIDS.[31]

The body's defensive system against different opportunistic infections often decreases as the CD4 cell count falls. According to results from another research, patients who began taking their drugs with a CD4 cell count of at least 200 cells/ml had a twofold higher chance of having tuberculosis than those who had a count of less than 200 cells/ml.[32] Similar findings were seen in other earlier study.[33] In another study, majority of the respondents with CD4+ cells <200 reported having constitutional symptoms in 70.5% of cases and night sweats in 79.5% of cases. Patients with CD4+T counts between 200 and 500 cells/mm3 also often had weight loss (21.8%) and a prolonged fever (23.1%).[34]

According to the findings of our study, a person's marital status significantly affects their risk of developing tuberculosis in the context of HIV/AIDS. Living with a partner lowers the risk of contracting other co-infections because HIV-positive patients are more likely to stick with their treatment. Cohabiting patients can support one another in taking their medications on time by helping each other. Further, this reduces the risk of tuberculosis in adults with HIV infection.

This outcome aligns with another research, but it contrasts with other earlier studies.[33.35] This opposing result indicates that patients living with partners partake in frequent sexual activity, leaving them susceptible to multiple infectious diseases.

We found that gender significantly influenced the occurrence of tuberculosis among individuals with HIV. Consequently, women infected with HIV were less prone to develop tuberculosis. This result aligns with another research conducted in a different location.[35] The possible reason could be that female HIV patients are more likely to be medication adherents by virtue of their acquaintance on taking pills for family planning as compared to males.

We found out that patients who reveal their HIV status to relatives may enhance their treatment adherence. This also enables people to take their medication promptly and without anxiety or shame. This likewise safeguards individuals from different infectious diseases. Consequently, individuals who have revealed their HIV status face a reduced risk of acquiring tuberculosis. The results align with previous studies.[36]

Our findings revealed that patients' residential neighborhood had a substantial impact on the prevalence of tuberculosis in people living with HIV/AIDS. Typically, rural patients receive HIV treatment after their CD4 cell counts are down and they are unable to recover from their HIV status, putting them vulnerable to additional infections. This outcome is consistent with prior investigations.[37]

The current study demonstrated that educational level is a predictor of TB in HIV patients. Knowledgeable HIV patients are likely to be well-versed in managing their medication and may have lived with the virus for a longer period of time. Thus, compared to less educated patients, HIV patients with greater education have a lower risk of developing tuberculosis The results are similar to those of another study.[37] It is contrary to study carried out in Ethiopia.[38]

We found that failure to adhere to HAART increases the risk of drug resistance, death, relapse, and persistent infection, posing a significant challenge for tuberculosis management. Ambulatory patients face a greater risk of developing tuberculosis than those who are employed during the initial stages of HAART. This study also discovered that both bedridden and ambulatory patients had a higher likelihood of developing tuberculosis than individuals who were employed. This is supported by a study done in another region.[39]

In this study, alcohol and smoking significantly accelerated TB progression. Previous research suggests that drinking and smoking are risk factors for TB in HIV-positive patients.[40] A Kenyan study indicated that smokers have a 2.16 times higher chance of contracting tuberculosis than nonsmokers, even after controlling for other characteristics.[30]

Our findings shows that drug toxicity significantly contributes to the progression of tuberculosis in individuals with HIV. Care for patients who have undergone drug toxicity might not lead to betterment or advancement. Moreover, this puts the patient at risk of contracting other infectious illnesses such as tuberculosis that are drug-resistant.[41] It is widely recognized that the occurrence of TB in individuals with HIV is frequent in stage four.[42]

Due to several reasons levels of drug toxicity vary greatly between developed and developing nations due to several factors. Older, more toxic medications including nevirapine (NVP), zidovudine (AZT), and stavudine (d4t) may cause HAART-related drug toxicity in impoverished countries, particularly in Sub-Saharan Africa.[40] Drug toxicity may lead to patients discontinuing therapy, increasing their risk of contracting other infectious diseases such as tuberculosis.

Our results indicates that patients in the 1st and 2nd

WHO clinical stages had a lower likelihood of developing TB than those in the 4th WHO clinical stages. This aligns with findings from other research conducted in different locations. It is widely recognized that the onset of TB in individuals with HIV is frequent in stage four.[41] It is well documented that development of TB in HIV-positive people is common in stage four which is an important predictor.[34,42]

Public health implications

The findings of this study are an essential source of information for program planners and policy makers creating different tuberculosis control initiatives. Health care providers working in the TB/HIV control and prevention units in Kenya's coastal region will also benefit from the study's findings. The study also offers guidance for future intervention research.

Before extrapolating results, it is important to consider the limitations of this study. The study participants who had incomplete data were not included in the analysis. This could give the TB incidence a fictitious or exaggerated appearance. Furthermore, because this research was done in a hospital, HIV-positive individuals who are not receiving care (at the community level) are not included in it. Additionally, because the study's focus was solely on adults, results might not be mirrored in pediatric patient groups.

CONCLUSION

The occurrence of tuberculosis in HIV-positive patients was significantly correlated with a number of patient characteristics, including age, baseline CD4+T cell count, marital status, gender, presence of opportunistic infections, HIV disclosure status, education level, compliance level, patient functional status, smoking and alcohol consumption status, and WHO HIV clinical stages.

Treatment adherence and HIV status disclosure were related with a lower risk of TB development.

Nevertheless, the age of patients, consumption of alcohol, smoking habits, and the existence of other opportunistic illnesses were closely linked to the occurrence of tuberculosis in adults living with HIV/AIDS.

Recommendations

Counselling recommendations to address patients with low treatment compliance, older patients, those infected with HIV and other opportunistic infections, and patients with lower educational backgrounds. Smokers and individuals who consume alcohol ought to be educated in a similar way individuals in WHO clinical stage IV who are susceptible to tuberculosis should be given targeted care.

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