

Determinants of Opportunistic Infections Among HIV-Positive Patients on HAART in Debre Berhan Referral Hospital, North Shoa Zone, Ethiopia, 2020: A Case–Control Study

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Abrham Shitaw Tewachew¹
Wassie Negash Mekonnen²
Abinet Dagnaw Mekuria²
Yosef Eshetie Amare³

¹Department of Medicine, Institute of Medicine and Health Sciences, Debre Berhan University, Debre Berhan, Ethiopia; ²Department of Public Health, Institute of Medicine and Health Sciences, Debre Berhan University, Debre Berhan, Ethiopia; ³Department of Biomedical Sciences, Institute of Medicine and Health Sciences, Debre Berhan University, Debre Berhan, Ethiopia

Introduction: Opportunistic infections are an illness that exists more frequently and is more severe in people with HIV. In HIV/AIDS patients, opportunistic infections still cause morbidity and mortality even after the era of highly active antiretroviral therapy (HAART) and most patients die as direct or indirect complications of opportunistic infections. This study was aimed to identify the determinants for the occurrence of opportunistic infections in HIV-positive patients having HAART follow-up in DBRH, Debre Berhan, Ethiopia.

Methods: A total of 339 study subjects were involved under institution-based unmatched case–control study design and simple random sampling technique. A pre-tested structured questionnaire was used for data collection. Data were entered using Epidata version 3.1 and analyzed for descriptive and logistic regression models by SPSS version 21. A *P*-value of less than 0.05 was considered as statistically significant.

Results: After adjusting potential confounders, drinking alcohol (AOR=3.12, 95% CI: 1.07–9.06), BMI <18.5 (AOR= 3.36, 95% CI: 1.49–7.55), previous history of opportunistic infections (AOR= 2.96, 95% CI: 1.51–5.8) were independent predictors of opportunistic infections in people living with HIV/AIDS on HAART.

Conclusion: In this study, the poor clinical and biochemical status, and behavioral factors were being the predictors of the occurrence of opportunistic infections. HIV/AIDS patients must be assessed and screened for opportunistic infections.

Keywords: opportunistic infections, HIV/AIDS, HAART, CD4, Debre Berhan, Ethiopia

Introduction

Human Immunodeficiency Virus (HIV) related opportunistic infections (OIs) have been defined as infections that are more frequent or more severe because of HIV-mediated immunosuppression.^{1–5}

HIV infection and OIs have bi-directional relationships.^{6–10} Having HIV weakens the immune system and causes the risk of developing opportunistic infections. On the other hand, OIs can affect the natural history of HIV/AIDS infection by causing reversibly boosting viral load that speed up HIV progression and increases its transmission.^{2,3,11–13}

OIs are the leading causes of morbidity and mortality among HIV-infected individuals.³ It affects different body parts such as mainly the nervous, gastrointestinal, respiratory systems, and the skin. The occurrence and type of opportunistic infections depend on the level of immunity. For example, in the early stage, milder

Correspondence: Yosef Eshetie Amare
Department of Biomedical Sciences,
Institute of Medicine and Health Sciences,
Debre Berhan University, Debre Berhan,
Ethiopia
Tel +251910966364
Email yophy2006@gmail.com

infections such as herpes zoster and skin infections would occur. However, lethal infections such as central nervous system toxoplasmosis (CNS toxoplasmosis) and cryptococcal meningitis exist later with severe immunosuppression. Pneumonia and tuberculosis (TB) might occur in either early or later stages of HIV/AIDS infection.^{12,14–16}

Ethiopia is a country with a large percentage of HIV-infected population with a total of 737,186 population living with HIV where the occurrence of opportunistic infection is considered as minor infections until they present with life-threatening complications.⁵

Most of the states in Ethiopia have an HIV prevalence of 1% and more. For example, Gambella, Addis Ababa, Dire Dawa, and Harari have an HIV prevalence of 4.8%, 3.4%, 2.5%, 2.4%, respectively.¹¹

In developing countries including Ethiopia, immediate determinants for opportunistic infections on HAART receiving patients are not studied well; though several studies on the prevalence and associated factors of OIs were investigated in the general population. The occurrence of opportunistic infections in HIV patients who started treatment with HAART and its determinant factors are not fully understood and opportunistic infections remain the main causes of morbidity, mortality, and deterioration of clinical conditions in patients with HIV. Therefore, it is quite essential to see the determinants of opportunistic infections to minimize potential challenges. Health planners, researchers as well as clinicians will also get important insights from this work.

Methods

Study Area

The study was conducted in Debre Berhan Referral Hospital (DBRH) which is located 130kilometers north of Addis Ababa. It was established in 1929 E.C. It is giving curative health care services for more than 2.8 million people (from North Shewa, Oromia, and neighboring Afar regions). The Hospital gives emergency, inpatient, outpatient, delivery, and specialized services. The antiretroviral therapy (ART) clinic is one of the departments in the outpatient case team of the hospital.

The ART clinic has its separate outpatient department (OPD) room, follow-up room, adherence counseling room, and a separate waiting area. The clinic gives follow-up service for diagnosed HIV patients. It also gives clinical care for HIV-exposed children and enrolled them in the follow-up if HIV is confirmed after clinical and laboratory evaluation.

The clinic has one physician, four clinical nurses trained on treatment and follow-up of patients with HIV, four adherence counselors, two data clerks, and two pharmacists. It also has job aids (for drug dosing, for diagnosing and handling of drug side effects), updated national treatment guidelines, registration books, reporting formats, and inter and intra-facility patient transferring slips. Two thousand one hundred and forty-eight clients had follow-ups in the unit in the 2018/19 fiscal year.

Study Design and Period

The hospital-based unmatched case–control study was carried out from February 2020 – March 2020 to see determinant factors of opportunistic infections in HIV-infected patients who received HAART and who have at least one of the disease-defining illnesses for opportunistic infections. HIV infected patients on HAART who does not have any of the disease-defining illness for opportunistic infections were taken as controls.

Source Population

All HIV-positive patients who are on HAART were the source population of the study.

Study Population

All HIV-positive patients who follow in the ART follow-up clinic, and admitted to the wards of DBRH in the study period were taken as the study population.

Inclusion Criteria

Cases were defined as all HIV/AIDS patients with known opportunistic infection who followed their treatment in the hospital. And, controls were defined as all HIV patients with no opportunistic infection who followed their treatment in the hospital.

Exclusion Criteria

Critical patients who were not able to respond to the interview.

Determination of Sample Size

Epi Info™ statistical program was used to calculate the sample size using unmatched case–control formula. One of the determinants of opportunistic infections (controls exposed 46.1%, an OR of 1.974) was taken¹⁷ with the assumptions of 5% margin of error, two-sided confidence level 95%, and 80% power of the test, finally, the total sample size was 339 (113 cases and 226 controls).

Sampling Technique

A consecutive sampling method was applied for cases and simple random sampling was used to select controls from patients attending the ART clinic for follow-up and who are admitted to the medical wards.

Study Variables

The research variables were selected after a thorough literature review was conducted and variables of interest were selected and customized to the study. We measured socio-demographic characteristics such as; age, sex, marital status, educational status, and occupation as independent variables. Also, variables measured in the study were behavioral factors (alcohol use, cigarette smoking, khat chewing, drug adherence). Individual clinical related factors (Baseline CD4 count, prophylaxis for OIs). The occurrence of opportunistic infections was taken as a dependent variable.

Operational Definitions

Cases: HIV patients on HAART who developed opportunistic infections any time after the start of the treatment and diagnosed at the time of interview such as Herpes Zoster, Bacterial Pneumonia, Pulmonary Tuberculosis, EPTB, Candidiasis, Aphthous Ulcer, PCP, CNS Toxoplasmosis, Cryptococcal meningitis, Chronic diarrhea, Kaposi's Sarcoma, Lymphoma, Cervical cancer.

Control: HIV infected patients on HAART who does not have any of the disease defining illness for opportunistic infections (Herpes Zoster, Bacterial Pneumonia, Pulmonary Tuberculosis, EPTB, Candidiasis, Aphthous Ulcer, PCP, CNS Toxoplasmosis, Cryptococcal meningitis, chronic diarrhea, Kaposi's sarcoma, Lymphoma, Cervical cancer).

Good adherence: >95% (<2 doses of 30 doses or <3 doses of 60 doses missed); Fair adherence: between 85% and 94% (3–5 dose of 30 doses or 3–9 dose of 60 doses is missed); Poor adherence: <85% (≥ 6 doses out of 30 doses or >9 doses out of 60 doses missed) as documented by ART physician.

Working: able to perform usual work in or out of the house; Ambulatory: able to perform activities for daily living; Bedridden: not able to perform activities of daily living.

Data Collection Process

Data was collected by 4 trained nurses who are working in the ART clinic. Data were collected with a pretested interviewer-administered questionnaire to collect the socio-demographic

and behavioral factors. Other data regarding the clinical conditions of patients were collected from the medical registry of the patients and registered in a form that was formulated to collect data.

Data Quality Control

Every questionnaire was coded for specific patients. The completeness of data was checked in a daily manner by the principal investigator. Double entry was done to ensure the maximum level of completeness. The principal investigator communicated and checked the data collection process, gave feedback and correction to ensure the completeness, accuracy, and clarity of the collected data were checked carefully. Timely corrections were made when there were confusions during the data collection process. Data coding, entering, verifying, and cleaning was performed with due care.

Data Analysis

Epidata version 3.1 and SPSS version 21 statistical software were employed for data entry and analysis, respectively. Summary values were obtained by computing descriptive statistics. The association of independent and dependent variables was determined using bivariate analysis. A p-value less than 0.05 at a 95% confidence interval was taken statistically significant difference. Then, variables that had a p-value less than 0.2 in the bivariate analysis were further subjected to multivariate logistic regression to identify predictors of developing opportunistic infections using the odds ratio as a measure of associations between variables. Tables and charts were computed using Ms-Excel-2013.

Results

Sociodemographic Characteristics of Participants

Three hundred and thirty-nine study subjects (113 cases and 226 controls) were involved in this research. Of the total 339 study participants, 141 (41.6%) were male and 198 (58.4%) were female as presented in Table 1. The median age of the respondents was found to be 40.51 \pm 11.413 with the minimum being 15 years old and the maximum 74 years old.

The majority (81.1%) of the study participants were urban dwellers while 18.9% of them are from rural areas. Regarding educational status, 33.6% completed secondary school while 24.2% had no formal education. Participants who completed a college diploma and above were 64 (18.8%). Of the study

Table 1 Sociodemographic Characteristics of People Living with HIV Who Had a Follow-Up in Debre Berhan Referral Hospital, 2020

Variables		Cases (n=113)		Controls (n=226)		Total	
		Freq (n)	Percentage (%)	Freq (n)	Percentage (%)	Freq (n)	Percentage (%)
Sex	Male	41	36.28	100	44.24	141	41.59
	Female	72	63.71	126	55.75	198	58.40
Age	≤18	3	2.655	6	2.65	9	2.65
	18–29	19	16.81	26	11.50	45	13.27
	30–39	37	32.74	76	33.62	113	33.33
	40–60	51	45.13	105	46.46	156	46.01
	≥60	3	2.65	13	5.75	16	4.72
Marital Status	Single	26	23	29	12.83	55	16.22
	Married	40	35.39	105	46.46	145	42.77
	Divorced	30	26.54	62	27.43	92	27.13
	Widowed	17	15.04	30	13.27	47	13.86
Occupation	Unemployed	32	28.31	46	20.35	78	23
	Farmer	11	9.73	36	15.92	47	13.86
	Private Worker	22	19.46	35	15.48	57	16.81
	Government Employee	21	18.58	53	23.45	74	21.82
	Daily Laborer	24	21.23	52	23.00	76	22.41
	Student	3	2.65	4	1.77	7	2.065
Residence	Urban	91	80.53	184	81.41	275	81.12
	Rural	22	19.46	42	18.58	64	18.87
Educational status	No formal education	30	26.54	52	23	82	24.18
	Primary	27	23.89	52	23	79	23.30
	Secondary	45	39.82	69	30.53	114	33.62
	College Diploma	3	2.65	28	12.38	31	9.14
	Degree and above	8	7.08	25	11.06	33	9.73

participants, 48.7% live in their own house where 40.1% live in rented houses while 10.3% live with relatives and 3 respondents live in the street. Of households, 96.1% have <5 people living in the same house, while the rest 3.9% have between 6 and 10 people living in the same house. The mean monthly income was 2621.60±2724.7 ETB with the minimum being 500 and the maximum 15,000.

Behavioral Characteristics

Of the 339 study participants, 53 of them take alcohol while being on HAART whereas 286 participants do not take any alcohol while on Medications. Five respondents smoke a cigarette while 334 respondents were not smokers while being on HAART. Twenty-one respondents chew Khat whereas 318 participants had no use of khat while on medications. From the cases, 91.15% had no use of khat while on HAART where only 8.85% had use of Khat while on medications (Table 2).

Clinical Characteristics

Out of the 339 study participants, 41 had a diagnosed chronic illness. From chronic illnesses, hypertension takes 46.3% followed by diabetes mellitus which accounts for 19.5%. Lung diseases account for 9.8%, neurologic disorders account for 12.2% of chronic illnesses while cardiac diseases, renal diseases, and mental disorders account for 4.9%, 4.9%, and 2.4%, respectively (Figure 1).

Of the 339 study participants, 123 (36.2%) of study participants had a previous history of opportunistic infections while the other 63.7% had no history of opportunistic infections. Of the cases, 59.3% had a previous history of opportunistic infections while only 24.7% of controls had a history of opportunistic infections (Figure 2).

Categorizing participants based on the Body Mass Index (BMI), the majority of respondents have a baseline BMI of 18.5–24.9, which is normal weight. About 113 respondents were underweight who have a baseline BMI of less than 18.5 (Figure 3).

Table 2 Behavioral Factors of People Living with HIV Who Had a Follow-Up in Debre Berhan Referral Hospital, 2020

Variables		Cases (n=113)		Controls (n=226)		Total	
		Freq (n)	Percentage (%)	Freq (n)	Percentage (%)	Freq (n)	Percentage (%)
Alcohol intake	Yes	28	24.78	25	11.062	53	15.63
	No	85	75.22	201	88.938	286	84.37
Smoking	Yes	4	3.54	1	0.442	5	1.47
	No	109	96.46	225	99.558	334	98.53
Khat Chewing	Yes	10	8.85	11	4.867	21	6.19
	No	103	91.15	215	95.133	318	93.81

Out of the 339 participants, 237 have a recent CD4 count of 350 and above followed by 54 participants who have a CD4 count of 201–349. Thirty-seven participants have a CD4 count of 50–200 while the rest 11 participants have a CD4 count of <50 (Figure 4).

Out of 339 study participants, 292 took or completed Isoniazid prophylaxis while the rest 47 did not take tuberculosis prophylaxis. Moreover, 222 participants took Cotrimoxazole prophylaxis and 117 participants did not take Cotrimoxazole prophylaxis (Table 3).

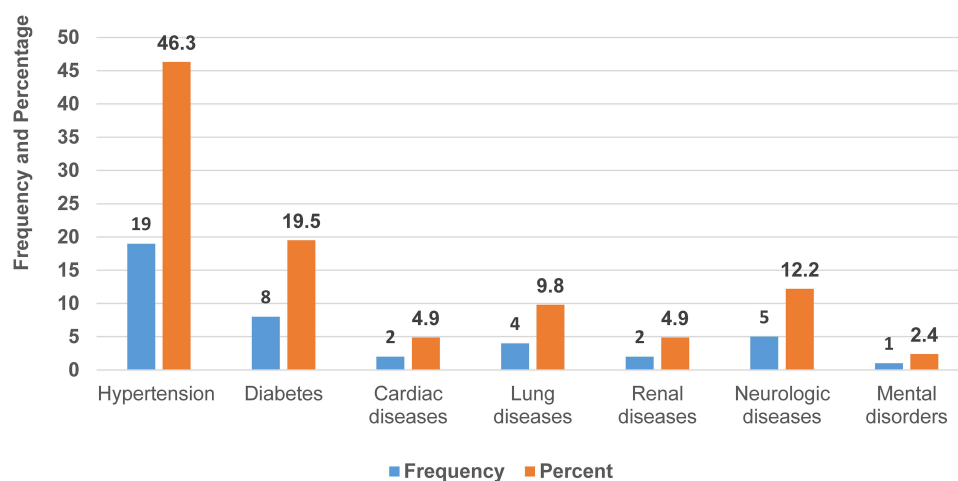
Associated Factors with the Occurrence of Opportunistic Infections

In the bivariate analysis, marital status, alcohol intake, drug adherence, taking Isoniazid prophylaxis, recent CD4 count, recent hemoglobin status, current body mass index, previous history of opportunistic infections, history of opportunistic infection in the family or household were significantly associated with developing an opportunistic infection (Table 4).

Divorced and widowed participants are 2.13 times higher risk to develop OIs than participants who married to 95% CI (1.17–3.891). But Age, sex, educational status, and occupation have no association with the development of opportunistic infection.

Study participants who drink alcohol while on HAART medications are 2.64 times more likely to develop opportunistic infections than those who do not drink alcohol with 95% CI (1.45–4.8). HIV patients who had poor drug adherence are at 10.3 times higher risk of getting an opportunistic infection than those patients with good adherence 95% CI (3.36–31.9).

Patients who do not take Isoniazid prophylaxis for tuberculosis are 3 times more likely to develop opportunistic infections with 95% CI (1.55–5.46) than patients who are taking prophylaxis for tuberculosis. Taking Cotrimoxazole prophylaxis has a preventive relation for opportunistic infection with COR 0.7 with 95% CI (0.44–1.13).

**Figure 1** Summary of chronic illnesses among HIV patients on HAART in Debre Berhan Referral Hospital, 2020.

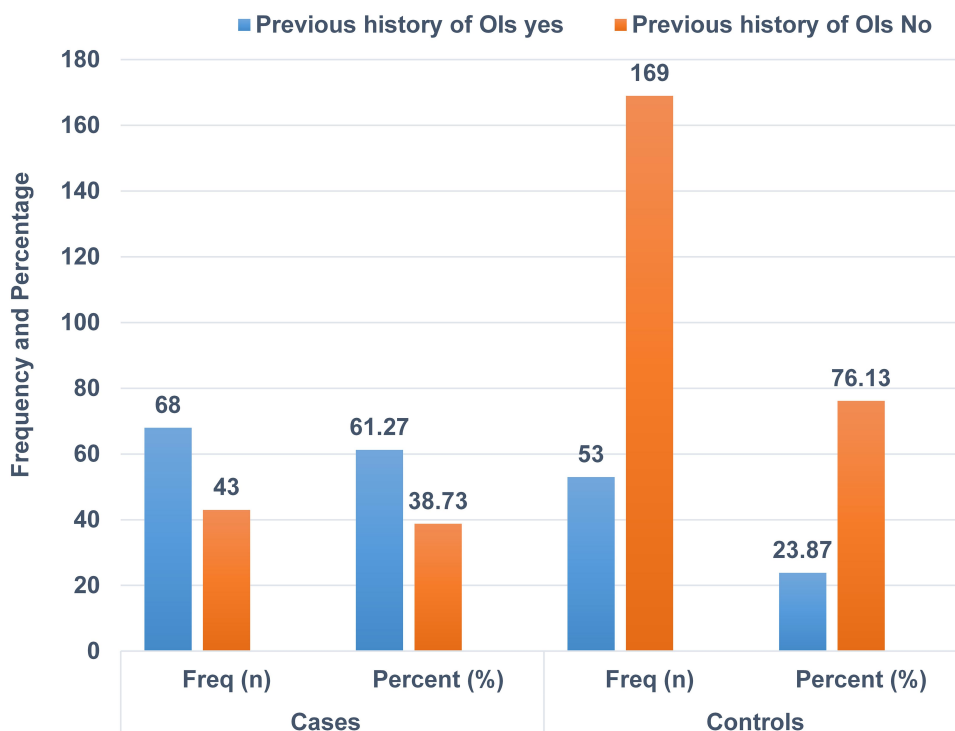


Figure 2 Previous history of opportunistic infections among people living with HIV who had follow-up in Debre Berhan Referral Hospital, 2020.

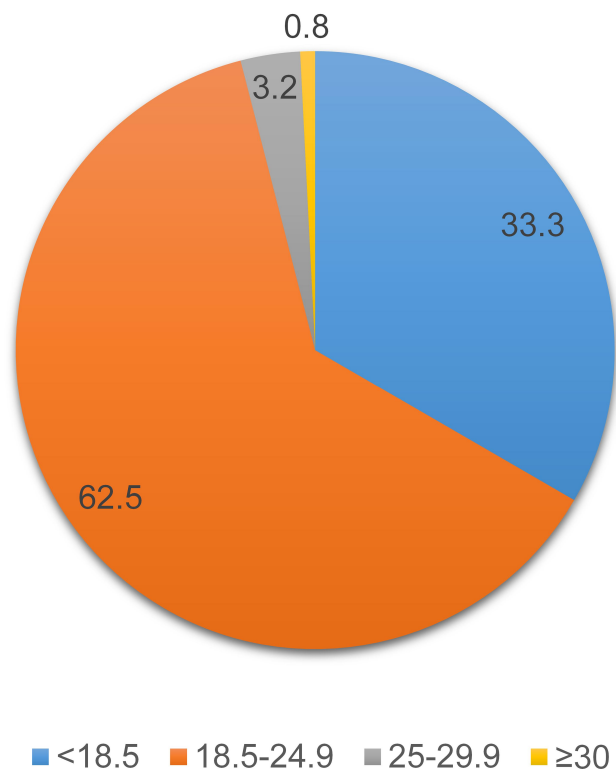


Figure 3 BMI category among HIV patients on HAART in Debre Berhan Referral Hospital, 2020.

Recent CD4 count has a significant association with the occurrence of opportunistic infections with patients who have a recent CD4 count of $<200\text{cells}/\mu\text{L}$ are 6.5 times more likely to develop opportunistic infections 95% CI (3.-32–12.78) than patients who have a recent CD4 count of $\geq 200\text{cells}/\mu\text{L}$. Patients with recent hemoglobin of $<10\text{mg}/\text{dl}$ are 12 times riskier to develop opportunistic infection compared to patients who have recent hemoglobin of $\geq 10\text{mg}/\text{dl}$ with 95% CI (3.49–43). Body mass index has a significant association with opportunistic infection with patients who have a body mass index of <18.5 are 6.4 times more likely to develop an opportunistic infection with 95% CI (3.65–11.14) than patients who have a recent body mass index of ≥ 18.5 .

Patients who had a previous history of opportunistic infections are 4.4 times riskier to develop opportunistic infections with 95% CI (2.73–7.15) than patients who had no previous opportunistic infections. The odds of developing opportunistic infections is 4 times higher in patients who had an opportunistic infection in the family or household with 95% CI (1.023–16.9).

The alcohol intake, the body mass index, and the previous history of opportunistic infections were found to be

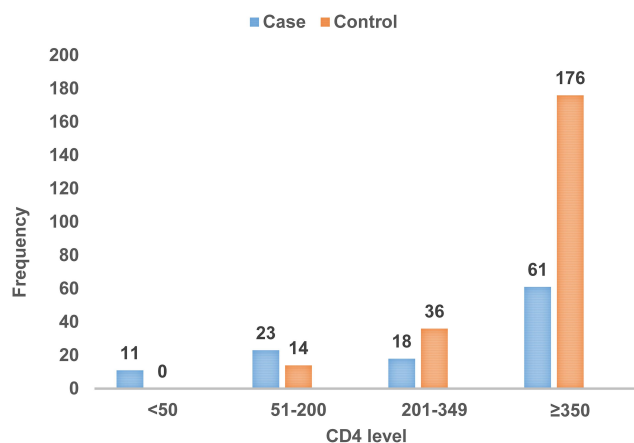


Figure 4 CD4 count of cases and controls in HIV patients on HAART in Debre Berhan Referral Hospital, 2020.

the final independent variables significantly associated with OIs in logistic regression analysis (Table 5).

Patients who drink alcohol were 3.12 times more likely to develop an opportunistic infection than those who do not drink alcohol (AOR= 3.12, 95% CI: 1.07–9.06).

Body mass index has a significant association with opportunistic infection with patients who have a body mass index of <18.5 are 3.36 times higher risk to develop opportunistic infection (AOR= 5.7, 95% CI: 1.49–7.55) than patients who had a recent body mass index of ≥18.5.

The odds of developing opportunistic infections is 3 times higher in patients who had a previous opportunistic infection (AOR= 2.96, 95% CI: 1.51–5.8) than patients who had no previous opportunistic infections.

Discussion

This case–control study has identified several determinant factors for the occurrence of opportunistic infections among HIV-infected people enrolled on HAART in

Debre Berhan referral hospital. The Isoniazid preventive therapy and drinking alcohol while on HAART were found to be independent risk factors for opportunistic infections in this study. The advanced conditions of patients such as being underweight was also associated with the incidence of opportunistic infections.

The study revealed more females are infected with opportunistic infections than their male counterparts. Even though there is no statistically significant association, it is consistent with other studies in Debre Markos, Bahir Dar, Gondar, and Addis Ababa, which founded a more female population infected with opportunistic infections.^{17–20} This may be explained by the higher prevalence of HIV in females than males. It may also be explained by the anatomical characteristics of females which makes them the recipient of genital secretions during sexual intercourse.

This study revealed that educational status has no association with the occurrence of opportunistic infections which are in agreement with studies done in Addis Ababa and Bahir Dar,^{18,21} but inconsistent with other studies that concluded an association between educational status and opportunistic infections.^{17,19,22} This might be explained by larger literate study participants in our study as the mainstream of respondents were from the metropolitan area.

Even though smoking has an established role in the development of opportunistic infections, especially tuberculosis; however, this study has not shown such findings. This could be due to the low prevalence of smoking in our study area. And also, there could be a social desirability bias in which individuals might deny despite they are being smokers.

Drinking alcohol was significantly associated with OIs. Patients who drink alcohol have 3 times more risk of

Table 3 Isoniazid and Cotrimoxazole Prophylaxis Status Among People Living with HIV Who Had a Follow-Up in Debre Berhan Referral Hospital, 2020

Variables		Cases (n=113)		Controls (n=226)		Total	
		Freq (n)	Percentage (%)	Freq (n)	Percentage (%)	Freq (n)	Percentage (%)
Isoniazid Prophylaxis	Yes	87	76.991	205	90.71	292	86.136
	No	26	23.009	21	9.29	47	13.864
Cotrimoxazole Prophylaxis	Yes	68	60.177	154	68.14	222	66.667
	No	45	39.823	72	31.86	117	34.513
Adherence to HAART	Good	80	70.796	207	91.59	287	84.661
	Fair	17	15.044	15	6.64	32	9.440
	Poor	16	14.159	4	1.77	20	5.900

Table 4 Summary of Bivariate Analysis of Associated Factors with Opportunistic Infections in HIV Patients on HAART, Debre Berhan, Ethiopia, 2020

Variable		Cases	Control	COR (95% CI)	p-value
Sex	Male	41	100	1	0.161
	Female	72	126	0.72 (0.451–1.142)	
Age	≤18	3	6	1	0.622
	18–29	19	26	0.68 (0.152–3.088)	
	30–39	37	76	1.02 (0.243–4.337)	
	40–60	51	105	1.02 (0.47–4.283)	
	>60	3	13	2.16 (0.334–14.05)	
Marital Status	Married	40	105	1	0.297
	Single	26	29	1.52 (0.68–3.4)	
	Widowed/divorced	47	92	2.13 (1.17–3.891)	
Residence	Urban	91	184	1	0.844
	Rural	22	42	1.06 (0.60–1.88)	
Alcohol consumption	Yes	28	25	2.64 (1.45–4.80)	0.001*
	No	85	201	1	
Smoking	Yes	4	1	8.52 (0.912–74.7)	0.06
	No	109	225	1	
Khat Chewing	Yes	10	11	1.89 (0.78–4.61)	0.157
	No	103	205	1	
Drug Adherence	Good	80	207	1	0.057
	Fair	17	15	3.52 (0.965–12.9)	
	Poor	16	4	10.3 (3.36–31.9)	
Isoniazid Prophylaxis	Yes	26	21	1	0.001*
	No	87	205	2.91 (1.55–5.46)	
Cotrimoxazole Prophylaxis	Yes	68	154	1	0.147
	No	45	72	0.70 (0.44–1.13)	
Recent CD4 Count (cells/ μ L)	<200	34	14	6.517 (3.32–12.78)	0.001*
	≥ 200	79	212	1	
Hgb status (mg/dl)	<10	16	3	12.26 (3.49–43.0)	0.001*
	≥10	97	223	1	
Recent Body mass index	<18.5	50	25	6.38 (3.655–11.14)	0.001*
	≥18.5	63	201	1	
Prev history of OIs	Yes	67	56	4.42 (2.731–7.15)	0.001*
	No	46	170	1	
History of OIs in Household	Yes	6	3	4.16 (1.023–16.9)	0.046*
	No	107	223	1	

Note: *Statistically significant on bivariate analysis p-value less than 0.05.

Abbreviations: COR, crude odds ratio; CI, confidence interval; 1, reference.

developing opportunistic infections compared to non-alcoholics that is in agreement with previous cross-sectional studies done in Ethiopia.^{18,20} It might be explained by alcoholics tend to have other behavioral factors that can result in skipping of drugs that further

affect the adherence to ART medications which will, in turn, hinder immunity against opportunistic infections. Additionally, more alcohol consumption also might contribute to have higher HIV viral load thereby suppresses immunity.²³

Table 5 Summary of Multivariate Analysis of Associated Factors with Opportunistic Infections in HIV Patients on HAART, Debre Berhan, Ethiopia, 2020

Variable		Cases	Control	COR (95% CI)	AOR (95% CI)
Sex	Male	41	100	1	2 (0.937–4.27)
	Female	72	126	0.72 (0.451–1.142)	
Marital Status	Married	40	105	1	0.57 (0.20–1.62) 0.95 (0.342–2.64)
	Single	26	29	1.52 (0.68–3.4)	
	Widowed/divorced	47	92	2.13 (1.17–3.891)	
Alcohol consumption	Yes	28	25	2.64 (1.45–4.80)	3.12 (1.07–9.06)*
	No	85	201	1	
Smoking	Yes	4	1	8.52 (0.912–74.7)	1.63 (0.05–5.1)
	No	109	225	1	
Drug Adherence	Good	80	207	1	1.135 (0.23–5.52) 1.08 (0.16–6.99)
	Fair	17	15	10.3 (3.36–31.9)	
	Poor	16	4	3.52 (0.965–12.9)	
Isoniazid Prophylaxis	Yes	26	21	1	0.87 (0.323–2.35)
	No	87	205	2.91 (1.55–5.46)	
Cotrimoxazole Prophylaxis	Yes	68	154	1	1.593 (0.77–3.26)
	No	45	72	0.70 (0.44–1.13)	
CD4 Count (cells/ μ L)	<200	34	14	6.517 (3.32–12.78)	1.31 (0.42–4.0)
	\geq 200	79	212	1	
Hgb status (mg/dl)	<10	16	3	12.26 (3.49–43.0)	1.66 (0.22–12.5)
	\geq 10	97	223	1	
Body mass index	<18.5	50	25	6.38 (3.655–11.14)	3.36 (1.49–7.55)*
	\geq 18.5	63	201	1	
Prev history of OIs	Yes	67	56	4.42 (2.731–7.15)	2.96 (1.51–5.8)**
	No	46	170	1	
History of OIs in Household	Yes	6	3	4.16 (1.023–16.9)	0.99 (0.11–8.3)
	No	107	223	1	

Note: *Statistically significant on multivariate analysis p-value less than 0.05; **statistically significant on multivariate analysis p-value less than 0.001.

Abbreviations: AOR, adjusted odds ratio; COR crude odds ratio; CI, confidence interval; HH, household; OI, opportunistic infection; 1, reference.

Patients having a hemoglobin level of <10mg/dl have a higher risk of developing OIs than those patients having a hemoglobin level >12.5mg/dl. This study is similar to another study.¹⁷ But, in contrast with other studies done in Dawro, Addis Ababa, Debre Markos, and North-western Ethiopia.^{20–22,24}

Malnutrition is also an independent factor for developing opportunistic infections. Low body mass index is strongly associated with active OIs where the odds of developing an opportunistic infection in malnourished patients are 3.3 times higher than well-nourished individuals, which is similar to other reports from Addis Ababa, Northeast Ethiopia and Eastern Ethiopia.^{17,20,22,24} This could be because of the

opportunistic infection could lead to malnutrition and anemia through a loss of appetite and pain during swallowing, and increased metabolic rate and malabsorption. Conversely, malnutrition can exacerbate immune deficiency and cause the development of opportunistic infections in patients with HIV.

The previous history of opportunistic infection was found to be independently associated with almost a 3 times higher rate of occurrence of opportunistic infections. This could be due to an already suppressed immune system that has poor resistance to opportunistic infections. Opportunistic infections can also decrease the immunity against other opportunistic infections and predispose a person to multiple illnesses at a time.

The case-control study design of this work might produce possible limitations in that it could only show associations. The temporal relationships and causations are not able to infer by a case-control study design. Moreover, time on HAART and HIV diagnosis date is limited for this study.

Conclusion

The study identified alcohol consumption, lower BMI, and previous history of OIs as predictors of higher opportunistic infection among HIV-positive people who are on HAART. Behavioral factors like poor drug adherence are also potential risk factors for opportunistic infections. The poor clinical and biochemical status were attributed for independent predictors of the existence of opportunistic infections.

Abbreviations

AIDS, Acquired Immune Deficiency Syndrome; AOR, Adjusted Odds Ratio; ART, Anti-Retroviral Treatment; ARV, Anti-Retrovirus; BMI, Body Mass Index; CD4, Cluster of Differentiation 4; CI, Confidence Interval; CNS, Central Nervous System; COR, Crude Odds Ratio; DBRH, Debre Berhan Referral Hospital; HAART, Highly Active Anti-Retroviral Treatment; HIV, Human Immune Deficiency Virus; OI, Opportunistic Infections; OPD, Out Patient Department; PCP, Pneumocystis carinii pneumonia; SPSS, statistical package for social science; TB, Tuberculosis; WHO, World Health Organization.

Ethics Approval and Consent to Participate

Ethical approval was obtained from the College of Health Science Institutional Review Board, Debre Berhan University. Full information was given to participants on the purpose and significance of the study. The informed and written consent was then obtained from all participants and it was conducted following the declaration of Helsinki.²⁵ Parental informed consent was obtained for the participants under the age of 18 years old.

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Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of

data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

Disclosure

The authors declared no conflicts of interest in this work.

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