ORIGINAL RESEARCH

Predictors of Virological Failure after Adherence-Enhancement Counseling among First-Line Adults Living with HIV/AIDS in Kombolcha Town, Northeast Ethiopia

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Background: HIV virological failure is a common challenging problem, even after adherence-enhancement counseling. However, there have been few studies on the determinants of virological failure after adherence-enhancement counseling among adult patients on antiretroviral therapy in Ethiopia in general, and there is variation across clients and settings for unknown reasons. Therefore, this study aimed to identify predictors of virological failure after adherence-enhancement counseling among adults living with HIV/AIDS.

Methods: A case–control study was conducted in the town of Kombolcha from January 1, 2019 to March 30, 2019 using simple random sampling for 338 participants. Data were collected through face-to-face interviews for social and personal characteristics and document review for clinical profiles. Descriptive statistics were used for frequency, proportions, and summary measures. Binary logistic regression analysis was carried out to identify the predictors of virological failure after adherence-enhancement counseling among adults. For multivariate logistic regression, $P<0.05$ was considered statistically significant. AORs are presented with 95% CIs.

Results: The odds of virological failure after adherence-enhancement counseling were higher following poor antiretroviral medication adherence (AOR 7.3, 95% CI 2.57–20.79) and for patients who had had a first high viral load (≥10,000 copies/mL, (AOR 5, 95% CI 1.86–13.56) and a history of opportunistic infection (AOR 3.7, 95% CI 1.11–8.44) compared with their counterparts.

Conclusion: Poor antiretroviral medication adherence during adherence-enhancement counseling session, first viral load ≥10,000 copies/mL, and recent history of opportunistic infection were predictors of virological failure. Therefore, efforts should be strengthened to improve adherence to antiretroviral medication, which helps to boost immunity and suppress viral replication.

Keywords: HIV/AIDS, adherence-enhancement counseling, virological failure, case–control, Ethiopia

Introduction

HIV virological failure is a detectable viral load >1,000 copies/mL on two consecutive viral load measurements 3–6 months apart with adherence support between measurements after at least 6 months of starting a new antiretroviral treatment (ART) regimen.[1,2] According to the current national guideline, two or more high viral load results (≥1,000 copies/mL) 3–6 months apart is considered the gold standard for treatment failure

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compared with immunological and clinical failure.[2] This failure induces a premature switch to second-line treatment without prioritizing determinants other than adherence.[3] Unlike first-line drugs, second-line drugs are more toxic and expensive,[4] and most are not in fixed-dose combinations[1] which is one of the factors in poor adherence.[5]

Poor adherence to ART is the most common reason for high viral load.[6] Common factors for high viral load other than poor adherence include drug resistance,[7] malabsorption, drug–drug interactions, drug-associated side effects,[8] and type of regimen,[9] and addressing these may be important in preventing virological failure. The current systematic review and meta-analysis shows that viral resuppression is >53% in patients with initial high viral loads.[10] Globally, virological failure after adherence-enhancement counseling is a public health problem, as >50% of antiretroviral users fail to achieve it.[11] Even local reports of virological failure after adherence-enhancement counseling show higher failure rates than global reports, though there has been limited reports on a national level.

Virological failure after adherence-enhancement counseling can lead to high mortality and morbidity.[12] On the other hand, virological failure after adherence-enhancement counseling causes low productivity and increases economic dependence, and social problems. Not controlling viral loads increases the rate of transmission,[13] which is a challenge in achieving an end to HIV/AIDS epidemics by 2030.[14]

Even though the WHO recommends enrolling all clients with high initial viral loads in adherence-enhancement counseling programs[1] and Ethiopia adopted this policy in 2017, with every client with high viral load receiving counseling on a monthly basis,[15] the impact of adherence-enhancement counseling in decreasing viral load is low. There have been a few studies on determinants of virological failure after adherence-enhancement counseling among adult patients on ART in Ethiopia in general, but there have been variations across clients and settings for for unknown reasons. As such, this study aimed to assess determinants of virological failure after adherence-enhancement counseling.

Methods
Study Setting, Area, and Design
An institution-based unmatched 1:1 case–control study design was employed. The study was conducted in Kombolcha town's ART health centers from January 1, 2019 to March 30, 2019. Kombolcha is located in northeast Ethiopia, about 378 km from Addis Ababa and 494 km from the capital of the region — Bahirdar. There were 4,322 ART clients in the town, of which 1,148 were in Kombolcha 05 health center and 3,174 clients were in Kombolcha 03 health center (October 2018 SmartCare report). There was a total of 418 ART clients with initial high viral load undergoing adherence-enhancement counseling sessions in the study period (October 2018 high viral load register).

Population
Adult clients with high viral load results on first-line ART enrolled for adherence-enhancement counseling for 3–6 months, with complete adherence-enhancement counseling sessions and a second viral load measurement. Cases were adult clients on first-line ART whose second plasma viral load result was ≥1,000 copies/mL within 3–6 months after completing adherence-enhancement counseling. Controls were adult clients on first-line ART with second plasma viral load <1,000 copies/mL within 3–6 months after completing adherence-enhancement counseling.

Sample-Size Determination
The sample size was determined using Epi Info 7.2 StatCalc by taking current BMI as a key predictor of virological failure after adherence-enhancement support, which reulted in a large sample size to be the minimum for the current study.[16] Assumptions were 95%) confidence, 80% power, and 1:1 control:case ratio, with 40% control exposure. Finally, the sample size derived was 306, and then by adding a 10% contingency, the final sample size was 338.

Participants and Data Collection
Two ART public health institutions were included in the study. Medical charts of adult clients who had completed adherence-enhancement counseling were included. A separate list of adults with completed adherence-enhancement counseling from September 2016 to August 2018 was extracted from the high viral load register at ART clinics in the facilities for cases and controls. On each separate list for cases and controls, simple random sampling was carried out using a lottery method based on medical record numbers. After interviews had been conducted, charts of these clients were reviewed during visits to the health facilities for

drug refills. The data-collection tool was developed from national ART guidelines, adherence-enhancement counseling tools, and the literature.[2] A supervisor was checked the data daily for completeness and consistency before submission for data entry.

Data Management and Analysis

Data were entered into Epi Data 3.1 and exported to Stata 14 for cleaning and analysis. Descriptive statistics were computed using frequencies, proportions, and summary statistics, such as means and ± SD. Hosmer–Lemeshow and omnibus tests were conducted to test necessary assumptions and model fitness for binary logistic regression, respectively. Bivariable logistic regression was run to identify determinants of virological failure after adherence-enhancement counseling, and variables with $P<0.2$ were entered into a multivariate binary logistic regression model. On multivariable logistic regression, $P<0.05$ was considered statistically significant, are with 95% CIs presented.

Ethical Considerations

Before undertaking the investigation, ethical clearance was obtained from the Ethical Review Committee of Wollo University, College of Medicine and Health Sciences. Consent letters were also obtained from Kombolcha Town Health Office and the health facilities. All participants were informed about the risks, benefits, and their full right to withdraw or refuse the study at any time. Adults and parents/legal guardians of clients under the age of 18 years provided written informed consent. Privacy and confidentiality of information given by each respondent were guaranteed through anonymity. Data were collected as per the Declaration of Helsinki, and data accessibility was limited to third parties.

Result

Sociodemographic Characteristics

A total of 338 HIV positive adults (169 cases and 169 controls) participated in this study. The mean age of the cases and the controls was 35±6 years) and 37±6 years, respectively. In sum, 95 (56.8%) of cases and 99 (57.9%) of controls were females, 96 (56.8%) cases and 99 (58.6%) controls currently married. More than three-quarters (130, 77.5%; 137, 80.5%) of cases and controls were urban dwellers, respectively. A majority of (70, 41.4%; 75, 44.4%) had primary school education

among cases and controls, respectively. Regarding occupation, 38 (22.5%) cases and 33 (19.5%) controls were farmers (Table 1).

Behavioral and Clinical Characteristics

Among the participants, 70 (41.4%) cases and 55 (32.5%) controls reported consistent use of condoms before initial high viral load. Most respondents (146, 86.4%; 143, 84.6%) were nonsmokers among cases and controls, respectively. A majority(153, 90.5%; 151%, 89.9) were not drinking among cases and controls, respectively. Khat chewers numbered 53 (31.4%) and 53 (31.4) in cases and controls, respectively. Regarding disclosure status and partner's HIV status, 145 (85.8%) and 102 (60.4%) cases and 140 (84.3%) and 93 (55%) controls had disclosed their HIV status and HIV-positive partner, respectively. A majority of respondents — 149 (88.2%) cases and 145 (85.8%) controls — had no hospital-admission

Table 1 Sociodemographic Characteristics of Adult First-Line ART Clients With VF After Adherence-Enhancement Counseling in Kombolcha, Northeast Ethiopia, May 2019

	Cases, n (%)	Controls, n (%)
Sex		
Male	73 (43.2)	71 (42.1)
Female	96 (56.8)	98 (57.9)
Age, years		
18–30	59 (34.9)	35 (20.7)
>31–45	97 (57.4)	104 (61.5)
>45	13 (7.7)	30 (17.8)
Marital status		
Single	41 (24.3)	25 (14.8)
Married	96 (56.8)	99 (58.6)
Separated/divorced/widowed	32 (18. 9)	45 (26.6)
Residence		
Rural	38 (22.5)	33 (19.5)
Urban	131 (77.5)	136 (80.5)
Education		
No formal education	52 (30.8)	38 (22.5)
Primary school	70 (41.4)	75 (44.4)
Secondary school	34 (23.1)	44 (26)
College and above	13 (7.7)	12 (7.1)
Occupation		
Government employee	13 (7.7)	16 (9.5)
Farmer	38 (22.5)	33 (19.5)
Daily laborer	32 (18.9)	39 (23.1)
Merchant	24 (14.2)	24 (14.2)
Private work	62 (36.7)	57 (33. 7)

history. In sum, 41 (24.3%) cases and 58 (34.3%) controls had a history of antiretroviral drug discontinuation (Table 2).

Antiretroviral Medication–Related Characteristics

Over half (93, 55.4%) the cases and 28 (16.5%) of the controls had poor adherence to treatment during adherence-enhancement sessions, while 63 (37.5%) of the cases and nearly a third (57,33. 5%) of the controls had been on highly active ART ≥10 years. Among patients, 69 (41.1%) cases and 50 (29.4%) controls had a history of opportunistic infections. Of those with an initial high viral load, 116 (69%) cases 51 (30%) controls had an initial

Table 2 Behavioral and Clinical Characteristics of Adult First-Line ART Clients with VF After Adherence-Enhancement Counseling in Kombolcha, Northeast Ethiopia, 2019

	Controls, n (%)	Cases, n (%)
Cigarette smoking		
Yes	23 (13.6)	26 (15.4)
No	146 (86.4)	143 (84.6)
Alcohol drinking		
Yes	16 (9.5)	18 (10.7)
No	153 (90.5)	151 (89.9)
Khat chewing		
Yes	53 (31.4)	53 (31.4)
No	116 (68.6)	116 (68.6)
Disclosure status		
Yes	145 (85.8)	140 (84.3)
No	24 (14.2)	29 (17.2)
Partner HIV status		
Positive	102 (60.4)	93 (55)
Negative	30 (17.8)	29 (17.5)
Currently single	37 (21.9)	47 (27.8)
Condom utilization		
Yes	70 (41.4)	55 (32.5)
No	99 (58.6)	114 (67.5)
Hospital-admission history		
Yes	20 (11.8)	24 (14.3)
No	149 (88.2)	145 (85.8)
History of drug discontinuation		
Yes	41 (24.3)	58 (34.3)
No	128 (75.7)	111 (65.7)

Table 3 Antiretroviral Medication-Related Characteristics of Adult First-Line ART Clients With VF After Adherence-Enhancement Counseling in Kombolcha, Northeast Ethiopia, 2019

	Controls, n (%)	Cases, n (%)
Opportunistic infection before first HVL		
Yes	119 (70.4)	100 (59.2)
No	50 (29.6)	69 (40.8)
ARV doses per day		
One	81 (47.9)	73 (43.2)
Two	88 (52.1)	96 (56.8)
Initial high viral load		
1,000–9,999	50 (29.6)	117 (69.2)
≥10,000	119 (70.4)	52 (30.8)
ARV regimen during EAC		
Azt-based	47 (27.8)	71 (42.5)
Tdf-based	122 (72.2)	96 (57.5)
Missed ARV doses		
Yes	22 (13)	29 (17.2)
No	147 (87)	140 (82.8)
BMI		
>18.5	102 (60.4)	92 (54.4)
16–18.49	58 (34.3)	71 (42)
<16	1 (0.6)	3 (1.8)
≥18.5	8 (4.7)	3 (1.8%)
Adherence during EAC		
Good	141 (83.45)	76 (45)
Poor	28 (16.6)	93 (55)

load ≥ 10,000 copies/mL. Over half the cases (88, 52.1%) and controls 96 (56.8%) were receiving twice-daily antiretroviral drug doses. Regarding the history of missing antiretroviral drug doses during adherence-enhancement counseling, 22 (13%) and 29 (17.2%) were missing their doses in cases and controls, respectively (Table 3).

Predictors of Virological Failure

The bivariable logistic regression analysis showed that age, marital status, education, type of antiretroviral regimen, ART-medication adherence during adherence-enhancement counseling, history of opportunistic infections (within 2 years before first high viral load), depression status, first high viral load value, ART discontinuation, and condom utilization were associated with virological failure after adherence-enhancement counseling (P<0.2, Table 4).

Table 4 Predictors of Adult First-Line ART Clients With VF After Adherence-Enhancement Counseling in Kombolcha, Northeast Ethiopia, 2019

	Cases n (%)	Controls n (%)	COR (95% CI)	AOR (95% CI)
Marital status				
Single	41 (24.3)	25 (14.8)	1	1
Married	96 (56.8)	99 (58.6)	0.59 (0.18–4.20)	0.77 (0.19–3.11)
Other	32 (18.9)	45 (26.6)	0.43 (0.06–2.20)	0.31 (0.05–1.79)
Education				
No formal education	52 (30.8)	38 (22.5)	1	1
Primary school	70 (41.4)	75 (44.4)	0.68 (0.24–1.64)	0.77 (0.14–4.37)
Secondary school	34 (23.1)	44 (26)	0.56 (0.13–1.43)	1.02 (0.14–7.06)
College and above	13 (7.7)	12 (7.1).	0.79 (0.47–7.84)	0.60 (0.04–8.24)
Condom utilization				
Yes	55 (32.5)	70 (41.4)	0.68 (0.94–2.28)	0.82 (0.22–3.07)
No	114 (67.5)	99 (58.6)	1	1
History of drug discontinuation				
Yes	58 (34.3)	41 (24.3)	1.63 (0.92 4.97)	1.87 (0.89–4.71)
No	111 (65.7)	128 (75.7)	1	1
Opportunistic infections before first HVL				
Yes	119 (70.4)	100 (59.2)	1.6 (1.01–10.74)	3.1 1.11–8.44)***
No	50 (29.6)	69 (40.8)	1	1
Depression				
No	149 (88.2)	159 (94.1)	0.46 (0.87–6.07)	0.63 (0.48–7.21)
Yes	20 (11.8)	10 (5.9)	1	1
ARV regimen				
Tdf-based	96 (57.5)	122 (72.2)	1	1
Azt-based	73 (42.5)	47 (27.8)	2.33 (0.94–7.85)	1.66 (0.98–6.33)
First high VL				
1,000–9,999	50 (29.6)	117 (69.2)	1	1
≥10,000	119 (70.4)	52 (30.8)	5.35 (1.33–7.04)	5 (1.86–13.56)***
Adherence during EAC				
Good	76 (45)	141 (83.45)	1	1
Poor	93 (55)	28 (16.6)	6.16 (1.30–23.91)	7.3 (2.57–20.79)***

Note: ***$P<0.05$.

After adjustment for possible effects of confounding variables, poor ART-medication adherence during adherence-enhancement counseling, first viral load ≥10,000 copies/mL, and history of opportunistic infection (within 2 years before high viral load) were significantly associated with virological failure. The likelihood of developing virological failure was 7.3-fold higher among patients with poor ART-medication adherence during adherence-enhancement counseling than those with good adherence (AOR 7.3, 95% CI 2.57–20.79). Patients who had had a first viral load >10,000 copies/mL were five times as likely to have virological failure as those with a first viral load <10,000 copies/mL (AOR 5, 95% CI 1.86 –13. 56). The odds of developing virological failure were found to be 3.7 times higher among subjects with a history of opportunistic infections than their counterparts (AOR 3.7, 95% CI, 1.11–8.44, Table 4).

Discussion

Regarding determinants of virological failure after adherence-enhancement counseling, the current study revealed that patients who had recent opportunistic infections, first high viral load ≥10,000, and poor adherence to ART medication during adherence-enhancement counseling were found to have

increased odds of virological failure after adherence-enhancement counseling ([Table 4](#)).

Nonadherence to antiretroviral drugs in adult ART clients on adherence-enhancement counseling was a predictor of virological failure. This finding is similar to studies conducted at Gondar University Referral Hospital,[6] Debre Markos Referral Hospital,[17] and Dessie and Woldia referral hospitals,[18] Ethiopia and Zimbabwe,[19] where subjects who had good adherence were more likely to achieve viral load suppression. Survival studies conducted in southwestern Uganda showed that virological failure rates were significantly higher among participants who reported adherence <90% than those who reported good adherence >95%.[9] It is grossly apparent that poor adherence to antiretroviral medication reduce treatment response due to suboptimal drug concentration and increases viral replication, which leads to virological failure. This may be due to the fact that individuals missing three or more doses of ART drugs per month are at increased risk of drug resistance and reduced immunity. This in turn results in a loss of opportunity to suppress viral replication and leads to virological failure.

This study also reflected that the odds of developing virological failure were higher among HIV-positive adults receiving adherence-enhancement counseling with a history of opportunistic infections than those who did not report such a history. In agreement with this finding, a study conducted in Uganda[20] showed that risk of virological failure was increased among participants who had had opportunistic infections. As patients' immuno status declined, the rate of viral replication increases compared to immunocompetent counterparts. Clients with compromised immunity are more vulnerable to opportunistic infections, which sustain the vicious cycle of immunity and viral replication.[21]

The other variable found to be an independent predictor of virological failure was first viral load ≥10,000 copies/mL. This finding is supported by a study conducted in Zimbabwe, where viral load 1,000–5,000 copies/mL) was more associated with viral suppression than viral load >5,000 copies/mL.[19] Higher viral loads show that the virus replicates easily and is resistant to antiretroviral drugs, and patients face different opportunistic infections.[7] High viral loads consume body nutrients, emaciating clients on ART and exposing the to further complications.

Conclusion

Poor ART-medication adherence during adherence-enhancement counseling, first viral load ≥10,000 copies/

mL, and a recent history of opportunistic infections are known to be positive determinants of virological failure. This study highlights the need for more commitment and effort from all stakeholders to sustain the long-term efficacy of highly active ART, thereby achieving the ambitious target of 2020 and sustainable development goal to end the HIV epidemic by 2030.

Disclosure

The authors declare that they have no competing interests.

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