Magnitude and Factors Affecting Virological Treatment Failure among HIV Reactive Adults from Selected Hospitals of North Shoa Zone, Amhara Region, Ethiopia

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Abstract

Background: Nowadays Human Immuno-deficiency Virus (HIV) is one of the devastating and prevalent viruses affecting the globe without a cure. Highly Active Antiretroviral Therapy (HAART) significantly reduced the morbidity and mortality of patients with HIV infection. Although there is increasing global use of antiretroviral therapy (ART) for the treatment of HIV/AIDs, the global trends in ART failure are growing. In developing countries including Ethiopia, particularly in our study settings, information related to the magnitude and correlates of virological treatment failure is scarce. Thus, this study aimed at assessing the magnitude of virological treatment failure and associated factors among HIV reactive adults at selected hospitals of North Shoa, Amhara Region, Ethiopia.

Methods: a facility-based cross-sectional study was conducted among 498 study participants who started their first-line HAART from August 2005 to December 2018. Data were collected from patients' charts and face-to-face interviews using a structured questionnaire. The bivariable analysis was executed to select candidate predictor variables at a p-value of less than 0.2.

Multivariable logistic regression (forward stepwise, conditional) analysis was used to identify factors associated with virologic failure at a significant level of 5%. Model adequacy check was done by Hosmer and Lemeshow (p = 0.57) and Naglkerke R Square (0.46) was calculated to express the variability of virological failure by predictors.

Result: More than half 290 (58.2%) of the study participants were females. The median age at ART initiation was 40 years with an interquartile range (IQR) of 15 years. The median duration of virologic failure since initiation of treatment was 96 months (IQR) of 72. The magnitude of virological treatment failure was 10.24% (95% CI: 7.57% - 12.91%). Poor ART drug adherence (AOR = 4.54; 95% CI: 2.09, 9.87), CD4 count less than 250 cell/µl (AOR = 24.88; 95% CI: 11.73, 52.81) and Poor Quality of Life (QoL) (AOR = 2.65; 95% CI: 1.12, 6.25) were independent predictors of virologic failure.

Conclusion: The magnitude of Virologic ART treatment failure in this study was relatively high. Poor ART drug adherence, patients' having lower CD4 count and poorer quality of life were predictors of treatment failure. Thus, an intervention programs that enriches patients' health-related quality of life should be implemented. Moreover, counseling that supplements the importance of drug adherence and reduction of risks that lower CD4 counts should be given emphasis which in turn helps to prevent first-line ART treatment failure.

Keywords: Adherence, First-line ART, virologic treatment failure, North Shoa, Ethiopia

Background

HIV continues to be a major global public health problem. In 2016, an estimated 36.7 million people living with HIV, among this 34.5 million were adults and 2.1 million were children, with a global HIV prevalence of 0.8% among adults. There were about 1.8 million new HIV infections - a decline from 2.1 million new infections in 2015. The majority of people living with HIV located in low and middle-income countries, with an estimated 25.5 million living in sub-

Saharan Africa. Among this group, 19.4 million are living in East and Southern Africa this year (1, 2). In 2016 around 1 million people died with AIDS-related illnesses compared to 1.9 million in 2005 and 1.5 million in 2010 (1, 3).

Globally, 20.9 million [18.4 million–21.7 million] people living with HIV were accessing antiretroviral therapy in June 2017. In 2016, around 53% [39–65%] of all people living with HIV had access to treatment. Some 54% [40–65%] of adults aged 15 years and older living with HIV had access to treatment. In eastern and southern Africa, 11.7 million people were accessing antiretroviral therapy, 60% [48–68%] of all people living with HIV in the region in 2016. In Ethiopia, 420 000, 59% [47%–73%] people were accessing antiretroviral therapy in 2016, among this 399000, 61% [49%–75%] adults aged 15 years and older living with HIV had access to treatment (1, 4).

WHO recommendation to "treat all" principles to reach a total of 36.7 million people who must be successfully maintained on treatment for life. The global expansion of antiretroviral therapy has been the primary contributor to a 48% decline in deaths from AIDS-related causes, from a peak of 1.9 million [1.7 million–2.2 million] in 2005 to 1.0 million [830 000 – 1 2 million] in 2016 (5, 6). With this scale-up of ART coverage, an increasing proportion of people initiating ART are likely to be infected with a virus that is resistant to one or more WHO-recommended first-line ARV drugs (7).

According to the WHO definition, ART failure is defined as clinically (New or recurrent clinical event), immunologically (CD4 count falls to the baseline) and virological failure (viral load above 1000 copies/ml based on two consecutive viral load measurements after 3 months with adherence support), after 6 months of Effective treatment (8). WHO's Report on HIV drug resistance (HIVDR) in 2017 demonstrates a steady increase in the prevalence of HIVDR in people initiating first-line ART since 2001, most notably in Southern and Eastern Africa. The prevalence of HIVDR in people initiating first-line ART was 6.8% in 2010, and estimates from recent nationally representative surveys show levels of HIVDR above 10% (5). Currently, WHO recommended first-line ART includes Tenofovir (TDF), Efavirenz (EFV) combined with Lamivudine(3TC), and Zidovudine (AZT) alternatives for TDF and Nevirapine (NVP), Dolutegravir (DTG)as alternatives for EFV (8).

78 The treatment of people with this first-line antiretroviral (ARV) drugs will inevitably be
79 accompanied by the emergence and transmission of drug-resistant virus. HIVDR limits treatment
80 options and may necessitate a switch to more expensive regimens (2nd line ART) which
81 associated with greater long-term toxicity. Moreover, significant population-levels of treatment
82 failure may lead to an increase in HIV/AIDS-related morbidity and mortality (8, 9).

83 In Ethiopia, 718,500 people were living with HIV/AIDS in 2016, of these, 653,412 were adults
84 and 65,088 were children under 15 years of age, adult HIV prevalence was 1.18 this year
85 (3). Antiretroviral Therapy (ART) service began in August 2003 with payment and free
86 ART launched in January 2005. Ethiopia has already adopted major strategies of WHO guidance
87 to meet the third 90 targets (90% of people on treatment are virally suppressed). In 2016 a total
88 of 420,000 people living with HIV were put on anti-retroviral treatment and virological
89 suppression rates were 51% at the national level (4, 10). Currently, patients on HAART are
90 monitored with viral load, immunological and clinical assessment among this viral load
91 monitoring is the gold standard method to diagnose ART failure. Though WHO's
92 recommendation to "treat all" living with HIV immediately after confirming HIV diagnosis that
93 helps to reduce morbidity levels and premature death and the continued expansion of ART
94 coverage, there were an increasing proportion of people on ART had HIV drug resistance
95 (HIVDR); like Pretreatment HIV drug resistance (PDR) and acquired HIV drug resistance
96 (ADR) to one or more of first-line ARV drugs (10, 11).

97 The human cost of HIVDR cannot be underestimated. HIV drug resistance associated with
98 increased mortality and reduced effectiveness of treatment regimens. So preventing, monitoring
99 and responding to HIVDR is therefore critical to maintaining current achievements, improving
100 patient outcomes, and guarantee the long term sustainability of care and treatment programs (7).
101 Studies have been conducted from different countries to identify the magnitude and factors
102 associated with first-line ART a failure like in low-income and middle-income countries, a
103 systematic review and meta-regression analysis, which indicate that the prevalence estimate of
104 first-line ART resistance in 2016 was 11% in southern Africa, 10.1% in eastern Africa, 7.2% in
105 western and central Africa, and 9.4% in Latin America and the Caribbean (12).

According to a study conducted in Tanzania, more than 50% of the patients on first-line ART were experiencing immunological failure. Another study conducted in the Tigray region in 2017 virological and immunological failure in the study area were 11.5% and 6.5%, respectively(13, 14), 29% in Colombia (15), 74% in Sweden (Hunduran) (16), 28% in China (17). However, in our study settings, studies which assess the association between virologic failure and health-related quality of life among ARV clients were scarce. Therefore, this study was aimed to assess the magnitude and predictors of virologic treatment failure among adult people with first-line ART.

Methods

Study Area and Setting

Currently, there are eight public hospitals, one private hospital, and more than ten Health center that providing ART services in North Shoa zone. Among these eight public hospitals, four district hospitals started ART services recently. The study was conducted in high caseload health institutions; Debre Berhan referral hospital and Mehal Meda District hospital, both in north Shoa zone, Amhara region, Ethiopia. According to the monthly report of Debre Berhan hospital, as of December 2018, in Debre Berhan referral hospital ever enrolled HIV positive clients to chronic HIV care starting from September 2005-December 2018 is 5951, patients ever started on Highly Active Antiretroviral Therapy (HAART) is 3834 and total current on ART is 1712 among this who's age ≥18 years is 1651(F=1067, M=584)(18). In Mehal Meda Hospital the number of patients ever enrolled in HIV chronic care starting from September 2005-December 2018, is 1005, patients ever started on Highly Active Antiretroviral Therapy (HAART) is 767 and total current on ART is 448 among this who's age ≥18 years is 411 (F=246, M=165)(19).

Study Design and Period

A facility based cross-sectional study design was conducted among HIV-positive patients on HAART for ≥6 months to test the size of first-line ART failure and its associated factors from January 28/2019 - March 22/2019.

Source and study population

The source population was all human immunodeficiency virus (HIV) infected clients with age ≥18yrs who were on first-line Antiretroviral Therapy (ART) regimen in Debre Berhan referral Hospital and Mehal-Meda district Hospital. The study population were all HIV/AIDS clients who enrolled in the HAART program, who meet the inclusion criteria and available during the study period to get service from the ART unit.

Sample size determination and sampling procedure

The sample size is determined based on a single population proportion formula. The proportion of first-line Anti-retroviral Treatment Failure is taken from a study done in Ethiopia (14). Where, p = 0.115, confidence interval of 95% (Z $\frac{a}{2}$, critical value 1.96), with a marginal error of 4% and 10% non-response rate. The sample size (n) is calculated as; n= $\left(z\frac{a}{2}\right)^2 * \frac{p(1-p)}{d^2} = (1.96)^2 * \frac{0.115\ (1-0.115)}{(0.04\times0.04)^2}$ = 244 by considering 10% non-response rate, and multiplying it by a design effect of 2, the total sample size estimated was 538.

A cluster sampling technique was used to select hospitals. There are eight public hospitals in North Shoa Zone. Out of eight ART-site public hospitals, four hospitals were selected by the number of cases they have and late initiation of ART. Then, Debre Berhan referral hospital and Mehal-Meda district hospital were selected by a simple random sampling technique from four hospitals.

Finally, consecutive sampling technique was used to select 538 study participants from two HIV care center clinics, by allocating total sample size proportionally based on the number of clients/ patients they have.

154 **Operational definition**

155 **Adherence**: the extent to which a person's activities, taking medications, following corresponds
156 with accepting instructions from a health care provider (**20**).

157 **Good adherence:** if a client used greater than or equal to 95% adherence, that is, missing only 1
158 out of 30 doses or missing 2 from the 60 doses(8).

159 **Fair adherence:** if a client used 85-94% adherence, meaning, missing 2-4 doses out of 30 doses
160 or 4 to 9 doses from 60 doses(8).

161 **Poor adherence:** if a client used less than 85% adherence, that is, missing ≥5 doses out of 30
162 doses or more than 10 doses from 60 doses (8).

163 **Virological failure:** is considered in this study, if a patient has virological failure. That is viral
164 load above 1000 copies/mL based on two consecutive viral load measurements in 3 months, with
165 adherence support following the first viral load test (8).

166 **Immunological failure**: CD4 count at or below 250 cells/mm3 following clinical failure or
167 Persistent CD4 levels below 100 cells/mm3(8).

168 **Clinical failure**: New or recurrent clinical event indicating severe immunodeficiency after 6
169 months of effective treatment(8).

170 **Data collection tool and procedure**

171 Data collection was conducted by using a structured questionnaire and structured checklist to
172 collect data from patient follow-up form, ART register, and the electronic database for ART
173 program. Relevant clinical data such as CD4 count, clinical stage, HAART regimen, and drug
174 adherence status were extracted from participants' medical charts. Data on supply disruptions of
175 HIV-commodities like ART regimens were interviewed by the clients and from existing
176 registers. In addition, all selected sampled clients who come to ART follow-up clinics were
177 interviewed to collect socio-demographic information and drug adherence level. The

178 questionnaire was prepared in the English language and translated into Amharic and back to
179 English to confirm the consistency questionnaire and checklist. Data were collected by two
180 health information technology (HIT) personnel's that have diploma and experience in managing
181 ART data. Two data collectors and two supervisors (BSC nurses) were trained for half a day
182 about the aims of the study, the contents of tool, and how to collect the data before the data
183 collection. Health-related Quality of Life (HRQoL) of the clients was measured to quantify
184 multidimensional components of health perceived by clients in the past two weeks prior to data
185 collection and includes; physical, mental, emotional, and social domains (21). The tool is known
186 as WHOQOL-HIV BREF and developed by the World Health Organization; Mental Health
187 Department. The questions are measured in 5-scales and we tested the reliability in our context
188 (Cronbach $\alpha = 0.727$).

189 Data Processing and Analysis.

190 The data were checked for completeness and consistency during data collection. The data also
191 cleaned during data entry into EPI info version 3.5.1 and has been transported into SPSS version
192 20. Data exploration technique was used to check the inconsistency and detect outliers in the
193 dataset. Normality test was performed by using Shapiro-Wilk (P-Value > 0.05), Kolmogorov-
194 Smirnova (P-Value > 0.05), and visual inspection of Q-Q Plot, P-P Plot, and
195 Histogram. Descriptive statistics were used to express variables in terms of tables, percentages,
196 and frequencies. The bivariable binary logistic regression was used to select predictor variables
197 at a cut off points (< 0.2). Logistic regression assumptions (sample size
198 and multicollinearity test) were used to check whether variables have satisfied the rules in
199 regression or not. Variance Inflation Factor (VIF) > 10 was used to declare the presence and
200 absence of multicollinearity. Forward stepwise conditional logistic regression analysis was
201 used to determine the independent predictors of virologic failure. To calculate the measures of
202 association, Adjusted Odds Ratio (AOR) with its 95% Confidence Interval (CI) at 5% level of
203 significance was used. The model fitness test was performed by Hosmer and Lemeshow test
204 (p=0.573) and model summary was done by Naglkerke R square (0.461) which express the
205 variability of virologic treatment failure in terms of CD4 counts, Quality of Life and ART
206 treatment drug adherence.

207 **Result**

208 **Socio-demographic characteristics of patients**

209 A total of 498 HIV infected individuals on first-line ART regimens were voluntarily participated
210 in this study with a response rate of 92.5%. The rest clients were refused to participate in the
211 study due to unwillingness. More than half 290 (58.2%) of the study participants were female.
212 The median age of the participants was 40 with an interquartile range of (IQR = 15). Regarding
213 the educational level, 80 (16.1%) of the study participants had no formal education, 209 (42%) of
214 them completed primary school, 86 (17.3%) completed college or university. Seventy-six
215 (15.3%) were government employees and 230 (46.2%) of them were self-employed. Two-
216 hundred sixty-one (52.4%) of the study participants had a monthly income above 1000 per
217 month (Table 1).

218 Table 1. Socio-demographic characteristics of the respondents in Debre-Berhan referral hospital
219 and Mehal-Meda hospital, North Showa Zone, April/2019. (n=498)

Variable	Frequency	Percent
Sex		
Female	290	58.2
Male	208	41.8
Age(year)		
18-30	68	13.7
31-45	264	53.0
46-60	142	28.5
>60	24	4.8
Religion		
Orthodox	465	93.4
Muslim	19	3.8
Protestant	14	2.8
Employment		
Employed full time	76	15.3
Unemployed	103	20.7

Self-employed	230	46.2
Farmer	89	17.9
Level of education		
Not educated	80	16.1
Elementary	209	42.0
Secondary	123	24.7
College and above	86	17.3
Residence		
Urban	418	83.9
Rural	80	16.1
Monthly income		
<=500	82	16.5
501-100	155	31.1
>1000	261	52.4

Baseline clinical characteristics of patients

The majority, 434 (87.1%) of study participants were working by their functional status and 482 (96.8%) of participants had hemoglobin measurement of greater or equal to 10 mg/dl at the start of HAART. The median CD4 count was 184 cell/µl (IQR=182) and TB infection was confirmed in 138 (27.7%) since the start of HAART. Moreover, 190 (38.2%) and 91 (18.3%) of study participants had started treatment with Tonofovir- Lamivudine–Efavirenz, and Zidovudine-Lamivudine-Efavirenz regimen, respectively. In addition, one hundred sixteen (23.3%) of them have a history of malnutrition and 125 (25.1%) of the participants were non-adhered to their medication (Table 2).

239

240 **Table 2.** Baseline and follow up characteristics of HIV/AIDS clients on antiretroviral therapy in

241 Debre-Berhan referral hospital and Mehal-Meda hospital, North Shoa Zone, April/2019 (n=498).

Variable	Category	Frequency (%)
Baseline first-line HAART regimen	D4T+3TC+NVP	67(13.5)
	D4T+3TC+EFV	32(6.4)
	AZT+3TC+NVP	82(16.5)
	AZT+3TC+EFV	91(18.3)
	TDF+3TC+EFV	190(38.2)
	TDF+3TPC+NV	36(7.2)
Baseline WHO stages	I	398(79.9)
	II	70(14.1)
	III	30(6.0)
Baseline hemoglobin level	<10	16(3.2)
	≥10	482(96.8)
History of TB	Yes	138(27.7)
	No	360(72.3)
Functional status	Working	434(87.1)
	Ambulatory	60(12.0)
	Bed-ridden	4(0.8)
Baseline CD4 results	≤100	107(21.5)
	101-350	306(61.4)
	351-500	45 (9)
	≥501	40 (8)
Time on ART (months)	6-48	95 (19.1)
	49-72	105 (21.1)
	73-156	298 (59.8)
ART drug Adherence	Good	373 (74.9)
	Fair and Poor	125 (25.1)
BMI	Undernourished	116 (23.3)
	Well-nourished	382 (76.7)

242 **The magnitude of first-line ART virologic failure**

243 The magnitude of virologic failure (≥ 1000 RNA copies per ml) was found in 51 (10.24%; 95%

244 CI: 7.57%, 12.91%). Since the start of HAART, 43 (8.63%) of them encountered virologic

245 failure within 73-156 months (Table3).

246

247 **Table 3:** Treatment failure after initiation of HAART in HIV/AIDS clients in Debre-Berhan

248 referral hospital and Mehal-Meda hospital, North Shoa Zone, April/2019 (n=498).

Variable	Categories	Frequency (%)
Immunologic failure	Yes	47 (9.4)
	No	451 (90.6)
Virologic failure	Yes	51 (10.2)
	No	447 (89.8)
Months from ART initiation	6-48	3 (5.88)
	49-72	5 (9.8)
	73-156	43 (84.4)

249 **Factors associated with virologic treatment failure**

250 After conducting bivariable analysis on predictor variables with a p-value ≤ 0.2, then

251 multivariable logistic regression analysis has been conducted to control the effects of socio-

252 demographic, behavioral, and clinical factors. Then, poor ART drug adherence (AOR = 4.54;

253 95% CI: 2.09, 9.87), people who had CD4 counts less than 250 cell/µl (AOR = 24.88; 95% CI:

254 11.73, 52.81) and PLWHA who had poor quality of life (QoL) (AOR = 2.65; 95% CI: 1.12,

255 6.25) were found statistically associated with first-line ART virologic treatment failure **(Table**

256 **4).**

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263 **Table 4:** Bivariable and Multivariable Logistic Regression analysis of selected factors of

264 virologic failure in Debre Berhan and Mehal-Meda hospitals, North Shoa Zone, 2019 (n=498).

Variables	**Virologic treatment failure**		**COR, 95% CI**	**p-value**	**AOR, 95% CI**
Age(years)	No	Yes			
<30 years	57	11	1.88 (0.913,3.877)	0.087	-
≥ 30 years	390	40	1		
Monthly Income					
<1500 ETB	262	35	1.545 (0.830,2.873)	0.170	-
≥ 1500 ETB	185	16	1		
Living area					
Urban	379	39	1		
Rural	68	12	1.715(0.855, 3.442)	0.129	-
ART adherence					
Good	385	25	1		1
Poor	62	26	6.458 (3.505,11.89)	<0.001	**4.54 (2.09, 9.87)**
Current BMI					
<18.5	96	15	1		
≥18.5	351	36	1.523(0.801, 2.899)	0.152	-
WHO stage of HIV/AIDS					
Stage I	442	42	18.94 (6.07, 59.11)	<0.001	-
Stage II & III	5	9	1		
Current CD4 count					
<250 cell/µl	25	34	33.76 (16.62, 68.88)	<0.001	**24.88 (11.73, 52.81)**
≥ 250 cell/µl	422	17	1		1
Quality of life					
Poor	237	42	4.15 (1.97, 8.73)	<0.001	**2.65 (1.12, 6.25)**
Good	210	09	1		1

265 **Discussion**

266 The identification and management of virological ART treatment failure is a key challenge for
267 HIV programs in resource-limited settings. ART treatment failure is a serious emerging threat to
268 the global scale-up of HIV treatment access and staying with this failing first-line therapy is
269 associated with an increased risk of morbidity and mortality (22). This study
270 particularly designed to determine the magnitude of virologic treatment failure (10.24%)
271 and identify the predictors of virologic failure (Poor ART drug adherence, CD4 count less
272 than 250cell/µl and clients' whose poor quality of life).

273 The size of virological treatment failure was 10.24% (51/498). This finding was consistent with
274 the study conducted in guinea 13.7% (23) and Bahir Dar 10.7% (24). However, when compared
275 with other studies, for instance, a study conducted in coastal Kenya (24, 6%)
276 (25), Debre Markos hospital (21%) (26), Colombia (29%) (15), Sweden, Honduran (74%) (16),
277 and China (28%) (17), it was low. This discrepancy may be due to most clients on first-line ART
278 treatment failure shift to second-line ART. This 10.2% virological treatment failure indicated
279 that first-line ART treatment may not be effective, as WHO recommends changing their first-line
280 ART regimen if levels of Non-nucleoside reverse-transcriptase inhibitor (NNRTI) pretreatment
281 HIV drug resistance (PDR) reach 10% (27), so further investigation is needed on
282 pretreatment HIVDR to NNRTIs.

283 The current study showed that ART treatment adherence was the independent reason for
284 the virologic treatment failure and patients with poor ART drug adherence were 4.5 times at
285 higher risk of developing treatment failure compared to patients with good ART drug adherence.
286 This finding is consistent with a systematic review conducted in Ethiopia (28). Medication
287 adherence has an opportunity for best viral suppression, immune recovery, and as a result clinical
288 benefit will be gained. Thus, successful ART treatment requires all medications should be taken
289 as per prescribed by the physicians (health care service giver). However, this result contradicts
290 from studies done in the Tigray region of northern Ethiopia, Gondar and Felege-Hiwot Referral
291 Hospitals (14, 29, 24). These variations may be related to the type of data collection method. In
292 our study, the data on adherence were collected from one-month recall self-reported missed
293 doses, and not directly collecting from the patients' charts.

294 Another predictor variable which has a significant association with virological failure
295 was CD4 count. Individuals who have CD4 count less than 250 cell/µl were 24 times more likely
296 to develop virological failure than their counterparts (AOR = 24.88; 95% CI: 11.449, 52.81).
297 This result was in line with studies conducted in different parts of the world; University of
298 Gondar Hospital (AOR = 9.03; 95% CI: 4.40, 18.50) (30), Zewditu Memorial Hospital (AOR =
299 2.67; 95% CI: 1.29, 5.51) (31), a multi-center study conducted at three selected Hospitals
300 Northwest Ethiopia (AHR = 2.0; 95% CI: 1.20, 3.50) (32), and Felege-Hiwot Hospital (AOR =
301 8.63; 95% CI: 3.32, 22.42) (24). Since ART treatment provides opportunities for viral load
302 suppression, recovery of immunity, and a client gets clinical benefits. Thus, all individuals taking

303 ART drugs are expected to take all medications as prescribed. As a consequent, the number
304 of CD4 counts increases and helps in the success of immunological treatment.

305 Health-Related Quality of Life (HRQoL) was another independent predictor variable
306 for virologic treatment failure. Clients with poor Quality of Life were 2.6 times more likely to
307 develop virologic failure than clients with good (QoL) (AOR = 2.65; 95% CI: 1.12, 6.25).
308 Maintaining and improving the quality of life among people in ART follow up clinics is
309 regarded as the most important component of HIV/AIDS care and treatment even though this
310 concept is not given emphasis in developing countries where resources are scarce. Similar
311 finding was observed in a study done in Ethiopia where immunologic treatment failure was
312 associated with health-related quality of life among people infected with HIV/AIDS (33). Since
313 measuring the quality of life of people with HIV/AIDS consisted of several dimensions
314 (physical, psychological, independence, social, environmental, and spiritual), stakeholders
315 should work on the betterment of the quality of life among people on HAART. As the result
316 indicated 56.02% (51.65%, 60.40%) of the clients' quality of life was compromised by
317 the disease (HIV/AIDS) and related complications. Thus, this significant number of clients needs
318 their health-related quality of life to be changed.

319 **Strength and limitations of the study**

320 Since the study was conducted in health facilities taking a representative sample, the results can
321 be generalized to health facilities in North Shoa Zone of Amhara Region, Ethiopia. But, the
322 results are interpreted with limitations. First, due to the cross-sectional nature of the study
323 design, we could not establish the temporal relationship between virological failure and its
324 predictors. Recall and social desirability bias where the participants may not respond correctly
325 for some sensitive questions due to memory loss and social norms. To reduce such systematic
326 errors, during data collection period data collectors tried to explain the importance of honest
327 response. Moreover, smaller frequency in certain categories of predictor variables
328 may reduce the precision of the measure of association. Thus, the use of this study finding for
329 any concern should be accounted in consideration having these inherent limitations of the study.

330 **Conclusion**

The magnitude of virological failure in this study was relatively high. Poor ART drug adherence, CD4 counts less than 250 µl/ml and poor health-related quality of life were found to be significant predictors of virologic treatment failure. Thus, Early ART failure detection is one of the most important key improvement areas of the health care providers with close follow up of the patients. Moreover, interventions that enhance the quality of life of clients on ART should be established. Behavior change communication on the benefits of good ART drug adherence should be strengthened which in turn expected to reduces the risks of the decrement of CD4 counts.

List of Acronyms and abbreviation

ADR: Acquired HIV drug resistance; ART: Antiretroviral Therapy; ARV: Anti-retroviral HAART: Highly Active Antiretroviral Therapy; HIV/AIDS: Human Immune Deficiency Virus/Acquired Immune Deficiency Syndrome; HIVDR: HIV drug resistance; PDR: Pretreatment HIV drug resistance; PLHIV: People Living with HIV; TDR: Transmitted HIV drug resistance

Declarations

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354 **Competing interest**

355 The authors declare that they have no competing interest.

356 **Availability of data**

357 The data used to support the findings of this study are included in this manuscript.

358 **Consent for publication**

359 All authors agree to publish this article at AIDS RESEARCH AND THERAPY journal; part of
360 Springer Nature.

361 **Authors' contribution**

362 All stated authors have participated in this research project: BTD and BS conceptualized,
363 designed the study including data analysis, and manuscript writing; AD and EAB drafted the
364 manuscript and critically reviewed the manuscript. All authors read and approved the final
365 version of the manuscript.

366 **Ethics approval and consent to participate**

367 Ethical clearance was obtained from Debre Berhan University, College of Health Sciences, and
368 Ethical Review Committee. Official letter was submitted to Debre Berhan Comprehensive
369 Specialized Hospital and Mehal- Meda Hospital to inform and support data collection process.
370 Verbal informed consent was gained from the study participants by explaining the potential
371 benefits of the study. Moreover, participants were told that they can stop interview at any point
372 during data collection if they are uncomfortable and if they don't want to give answer for a
373 particular question.

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