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Research Article

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Predictors of CD4 cell count and Disclosure of HIV status among HIV-positive Adults under HAART in Amhara Region, North-west Ethiopia

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Abstract

Background: *There were an estimated 37.7 million people living with HIV in 2020. For more than two decades, HIV/AIDS has been a major health concern in Sub-Saharan African countries. The main objective of this study was identifying predictors associated with HIV disease disclosure status and CD4 cell count change among adults receiving HAART.*

Methods: *A retrospective cohort study design was conducted on 300 randomly selected HIV infected adults in the ART clinic at Felege Hiwot Hospital during the study period. Three different models were used for the data analysis namely; a generalized linear mixed-effects model for the longitudinal data, a binary logistic regression model for the binary outcome data, and joint modeling of the two responses linked through a random intercept. Quasi-Poisson mixed effect model was a final model to analyze longitudinal CD4 cell count data based on small AIC and BIC criteria with an unstructured covariance structure.*

Results: *The descriptive statistics showed that about 23.7% of the patients did not disclose their disease status to their families. The current study indicates that among the predictor variables, non-educated(β=-0.6185,p-value<0.01) , primary educated patients (β=-0.3687,p-value<0.01), employed HIV patients (β=0.3888,p-value<0.01), adherent patients(β=0.2274,p-value<0.01) and patients who did not social support(β= -0.1148, p-value=0.030) has significant effect for the variation of CD4 cell counts on HIV positive patients. Similarly, non-educated (AOR=0.000145, p-value<0.01), primary educated patients (AOR= 0.004413, p-value<0.01), employed HIV patients (AOR=3.4562, p-value=0.021), adherent patients (AOR=1.564, p-value<0.01) and patients who did not have social support (AOR=0.075, p-value= 0.0078) had significant effect for the variation of level of disclosure of HIV status. The correlation between CD4 cell count and disclosure of disease status was about 0.4607 which indicates a positive correlation between the two responses.*

Conclusions: *Significant variables for the variable of interest were were educational level, occupation, adherence, and social support, jointly affecting the two variables of interest among HIV-positive adult patients.*

Keywords: HIV Disease Disclosure Status, CD4 Cell Count, ART, Binary Logistic Regression Model, GLMM, Joint Model

1. Introduction

HIV continues to be a serious global public health problem for 36.7 million people to live with HIV, for 1.8 million new infections and 1 million people to be died from HIV related illnesses [1]. Among these, bout 19.4 million people are testified to live with HIV in Sub Sahran Africa [2].

The infection of HIV is the leading public health related problem in Ethiopia. Amhara region, one of the eleven regions in the country, accounts the highest number of people living with the HIV. In the region, overall incidence rate of new HIV infection is 6.9 per 1000 tested population [3].

Disclosing own HIV status is is one of the indicators of behavioural changes and crucial to reduce the tramsmission of the virus from infected to non-infected individuals. Disclosing the HIV status facilitates for CD4 cell count to be higher in number [4]. Hence, if HIV infected adult disclosed own HIV status, an individual can have high number of CD4 cell count [4]. Disclosure of the HIV status is one indicator of behavioural changes of the adults and this further leads to have high number of CD4 cell count.

Self-disclosure of the HIV disease status is generally have important effects on an individual's health, lower stress, and leads to better psychological relief [5]. In the case of HIV/

AIDS, individuals who disclose their HIV status are in a better health conditions in terms of reproductive choices as well as psychosocial readness [6].

Disclosure of the HIV status facilitates other behaviors like strict combine antiretroviral therapy (food, time and medicatin) that may improve the management of HIV. Previous studies indicate that individuals who disclosed their disease status have better adherence to cART treatments [4]. Previously conducted studies, indicate that disclosure may increase opportunities to receive social support, which may help individuals cope and recover from physical illness, and decrease depressive symptoms due to HIV-related indications and finally leads to be cART adherent [4,7]. Disclosure of HIV status to all societies living around them is crucial for avoidance of HIV tramsmision and helps for good cART adherence [8]. Hence, the two responses namely CD4 cell count and combine antiretroviral therapy (cART) are highly correlated and one is the compeliment of the other. Previous studities indicate that HIV infected individuals who disclosed the HIV status are free from mental depression and stress to take his/her medication on time without fear of other individuals living together [9]. This further leads for the patients to have high number CD4 cell count [10]. This is why the joint predicters of the two resposes was initiated. A number of key issues may raised in the study of CD4 cell count and disclosure of HIV status determinants affecting jointly, and the development of interventions. Addressing these issues may provide valued information about which patients are most at risk for patients with low CD4 cell count and about how this can be improved. It is well known that patients hidden own disease status may not take treatment medication on time if he/ she is with another individual at a time around them and this further leads to be non-progressive in CD4 cell count [11]. Joint models are used to make analysis for the joint behavior of the two response variables at the same time [12]. Many previous studies have had joint models for repeated outcomes of longitudinal responses and time to event [13]. Such studies did not consider two longitudinal and correlated outcomes observed repeatedly from the same subject and lacked multivariate analysis of two observed results. Joint modeling between two repeated measures has benefits in reducing type I error rates in numerous tests with repeated observation on the same subject and advances efficiency in approximating the unknown parameters [14].

As far as an author's knowledge is concerned, no research has been conducted on the joint predictors of the two correlated longitudinal outcome variables in the study area.Therefore, the current investigation was conducted with objective of detecting the joint predicters of CD4 cell count and disclosure of HIV status. The result obtained in current investigation helps for health profetional to conducted health related education and to design interventional strategy.

2. Methods and Participants

2.1. Study Site and Population

The study was conducted at Felege-Hiwot Teaching and Specialized Hospital located in North-western Ethiopia, Amhara Region. The hospital is a referral hospital in which many patients refered from district hospitals in the region. The hospital has reginal laboratory where all HIV results in different district hospitals in the region are collected , processed and organized to send to Ministry of health. There are about 6 thousand HIV infected adults treated at the hospital whose enrollement was between September to Jun/2012. Among these, about 2 thousadns were under ART.

2.2. Study Design

A retrospective cohort study disgn was conducted to assess joint predictors of disclosure of HIV status and cART adherence among HIV infected adults enrolled in the first 10 months of 2012 and followed-up to June 2017. Both separate and joint models were used in data analysis.

2.3. Inclusion Criteria

Adult patients, whose ages were 15 years and above, enrolled in the first 10 months of 2012 and started cART in the hospital from September 2012 to June 2017 with a minimum of 2 follow-up visits at Felege-Hiwot Referral, Teaching and Specialized Hospital, were included under this study.

2.4. Sample Size and Sampling Technique

Out of the targete population, 300 were selected using stratified random sampling technique considering their residence area as strata using 95% level of confidence and 5% marginal error [15].

2.5. Data Quality and Analysis Strategy

The quality of the data was controlled by data controllers from ART section of the hospital. Traing about the way how to follow up the quality of data was given to data controllers by the Ministry of Health. Pilote test on the consistency research questions was conducted on 35 random samples and some modifications on the questionaries were made on the final data collection sheet.

2.6. Data Collection Tools and Extraction Procedures

Before the required data has been collected, there was adiscussion with the health staff at ART section in the hospital about the variables included in this investigation. The required data was extracted from each participants chart using data extraction format. The format was developed by an author in consultation with health staffs. Data analysis was conducted using Statistical System Analysis (SAS) software version 9.2.

2.7. Variables Under Investigation

2.7.1. Response Variable

The longitudinal response variables for current study were CD4 cell count and disclosure of the HIV status. The first response was count in nature and the second was binary in nature.

2.7.2. Predictor Variables

The independent variables for the two outcomes were age in years, gender (male, female), marital status (never married, married, widowed, divorced), Religion(Orthodox, Musilim, Others), Residence area(Rural, Urban), educational status (non-educated, primary, secondary, tertiary educated), WHO stages (stage1, stage2, stage3 and stage4), cART adherence(adheret, non-adherent), follow up times/visits. Functional status(ambulatory, bedridden, working), Opportunistic infection(yes, no) BMI(underweight, normal and overweight, Social discrimination(yes,

no), special support for patients disclosed the disease (yes, no), Homoglobin level and weight of patients.

2.7.3. Impact of Dropouts on the Analysis

Patients who defaulted from cART treatment develops drug resistant virus and ultimately leads to bad response from the treatment and finaly resulted to be died. Missing obsevations were tested using logistic regression to assess the missing values were independent of the pastrsult.

2.8. Model Selection For Data Analysis

In this study the response variables were CD4 cell per cubic millimeter of blood and disclosure status of the HIV status. In model selection, the Kolmogorov-Smirnov test was used for model selection of CD4 cell count data analysis. In this regard, since the distribution was over dispersed, Poisson model can't be considered and negative Binomial and quasi-Poison models were compared and finally Quasi-Poisson was selected for data analysis of CD4 cell count. Covariance structures such as Independent (IND), Compound symmetry (CS), First-order Autoregressive (AR 1), Unstructured (UN), and Toeplitz(TOEP) were compared to select the one with the smallest AIC and BIC. In this Unstructured had smallest AIC and BIC selected for data analysis. Among the random effects, random intercept with random slope models were selected because of their smallest AIC and BIC values.

Similarly, to select the good model for data fit of binary response data, AIC and BIC were used and among the potential models the intercept and covariates had the smallest AIC and BIC and selected for binary response data analysis.

2.9. Parameter Estimation For Data Analysis

Maximum likelihood estimation is a well-established and well-respected method of estimation that has a variety of optimality properties and as such it is usually the default technique for estimating parameters. The maximum likelihood estimator (MLE) can be obtained by maximizing the joint probability (likelihood function) for values of the data. It includes both regression coefficient and the variance components, that is, both fixed-effects and random effects terms in the likelihood function and it treats β as fixed but unknown quantities when the variance component is estimated. Random-effects models can be fitted by maximization of the marginal likelihood, obtained by integrating out the random effects from conditional densities of the form:

Maximum likelihood estimation techniques were extensively utilized in joint models. If the underlying models are right, it gives a unified method to inference that generates valid and efficient inference. For both count and binary responses data, the maximum likelihood technique was based on the likelihood, which delivers more efficient estimates by maximizing this log likelihood function. The approximation to the integral using Laplace approximation methods was conducted (Maqutu, 2010) and (Huang et al., 2012).

2.10. Joint Model Diagnosis

After fitting a model, numerous methodologies are used to examine the model's appropriateness and adequacy. The goodness of fit of a model is a measure of how well it describes the response variable. When evaluating the goodness of fit, look at how closely the model's predicted values match the observed values. We need to assess the model goodness-of-fit and do some suitable model diagnostics after generating a final joint model using the model selection procedure outlined in the previous part. The most widely employed measurements of model goodness of fit would be Hosmer and Lemeshow test, and Deviance goodness of fit tests. These are formal tests of the null hypothesis that the fitted model is accurate, with higher p-values suggesting a better fit [15, 16].

3. Results

3.1. Descriptive Data Analysis

The socio-demographic characteristics of the patients are summarized in Table 1. Out of the total of 300 patients included in the study, 55% of the patients were female from these 77.57% of patients disclose their HIV status to their families, and from male patients 74.81% have disclose their disease status to their family members. Out of the total samples included in this study 59% of patients were unemployed, and 63.67% of patients were from urban areas. 43.33% of patients have only completed their first year of school, and the majority of patients are married (36%). From a total sample 57.33% were got social support from the community, and 86.67% identified as practicing an orthodox religion. The baseline characteristics of respondents are indicated in Table 1.

Characteristics	Category	Disclosure Status		Total (%)	CD4
		Disclosed	Not disclosed		Mean
Gender	Male	101	34	135 (45)	358.18
	Female	128	37	165 (55)	360.55
Residence	Rural	91	18	109 (36.33)	348.61
	Urban	138	53	191 (63.67)	365.64
Religion	Orthodox	194	66	260 (86.67)	357.97
	Muslin	18	2	20 (6.67)	307.59
	Other	17	3	20 (6.67)	439.42
Marital status	Never-married	78	16	94 (31.33)	372.58
	Married	80	28	108 (36)	355.29
	Widowed	29	11	40 (13.33)	349.03

	Divorced	42	16	58 (19.33)	365.36
Educational-level	No-education	25	34	59 (19.67)	228.52
	Primary	104	26	130 (43.33)	428.93
	Secondary	62	8	70 (23.33)	355.78
	Tertiary	38	3	41 (13.67)	367.31
Occupation	Unemployed	130	47	177 (59)	345.29
	Employed	99	24	123 (41)	377.64
Social support	No	61	67	128 (42.67)	243.88
	Yes	168	4	172 (57.33)	437.72

Table 1: Summery Statistics For Socio-Demographic Variables.

The clinical characteristics for PLWHA in Felege Hiwot Comprehensive Specialized Hospital are shown in Table 2. Out of 300 patients 32% of patients were not adhere their medication, and adherent patients have a higher number of CD4 cell mean (425.73) than non-adherent patients (225.33). When patients began ART, 23.3 % were in clinical stage I, 37.7 % were in clinical stage II, 20.3% were in clinical stage III, and the remaining were in clinical stage IV. Regarding BMI, 60.3% of the patients' body mass indices were normal, 24.7 % were underweight, and 15% were overweight. A total of 47.7 % of patients have opportunistic infections, and 25.3% of patients had TB infection. When we look at the patients' functional status, 72.3% of the patients were working functional status, 12.0% were bedridden, and 15.7% were ambulatory. The most common ART regimen at Felege Hiwot Comprehensive Specialized Hospital is TDF+3TC+EFV ART regimen which is accounted 47.7% of the total sample.

Characteristics	**Category**	**Disclosure**		**Total (%)**	**CD4**
		Disclosed	**Not Disclosed**		**Mean**
Adherence	Non-adhere	65	31	96 (32)	225.33
	Adhere	164	40	204 (68)	425.73
WHO-stage	Stage I	58	12	70 (23.33)	411.12
	stage II	85	28	113 (37.67)	405.08
	stage III	45	16	61(20.33)	329.81
	stage IV	41	15	56 (18.67)	236.37
ART regimen	AZT+3TC+NVP	8	3	11 (3.66)	326.79
	AZT+3TC+EFV	15	6	21 (7)	356.00
	TDF+3TC+EFV	119	24	143 (47.67)	390.31
	TDF+3TC+NVP	47	30	77 (25.67)	315.70
	TDF+3TC+DTG	40	8	48 (16)	350.28
TB status	Uninfected	171	53	224 (74.67)	404.59
	Infected	58	18	76 (25.33)	235.63
Opportunistic infection	No	124	33	157 (52.33)	374.27
	Yes	105	38	143 (47.67)	343.48
Body Mass Index	Under weight	43	31	74 (24.67)	401.41
	Normal	164	17	181 (60.33)	348.51
	Over weight	22	23	45 (15)	360.49
Functional status	Ambulatory	11	36	47 (15.67)	364.22
	Bedridden	20	16	36 (12)	434.71
	Working	198	19	217 (72.33)	343.75

Table 2: Summery Statistics For Clinical Variables.

The mean of baseline CD4 cell count and the standard deviation among HIV positive adult at Felege Hiwot Comprehensive Specialized Hospital were 357.3 and 323.4 respectively, and the mean age and the standard deviation of the patients were 34.30 and 11.15 respectively. The patients' viral loads were a mean of 8959.60 and a standard deviation of 35169.834 during the study period.

Out of the total sample, 76.3% of the patients disclosed their HIV disease status to their families at Felege Hiwot Comprehensive Specialized Hospital and the mean CD4 cell for all patients is 368.36 cells/mm3 with disclosed patients accounted for 493.54 cells/mm3 and non disclosed patients accounted 172.95 cells/mm3.

3.1. Exploring Individual Profile Plot

The result in this investigation indidicates that the individual profile plots of CD4 cell count change of HIV-infected patients over time varies within and between subjects . Hence, CD4 cell count slowly increases over time.

3.2. Exploring Mean Profile Plot

In current study, CD4 cells rose from the beginning (6th) month up to the 36th month, started to decline up to the 42th month, and then began to climb fast up to the final month of the visit (60th).

3.3. Separate Analysis of CD4 Cell Count Data

A multivariate analysis of the generalized linear mixed effect model (Table 9) displayed that age, time, baseline CD4 cell, weight, disclosure, educational level, occupation, adherence, WHO stage, social support, TB status, opportunistic infection, baseline viral load, functional status, and the interaction effect of follow up time and educational level variables were significantly associated with the log of expected CD4 cell count change of HIV infected adults at 5% level of significance. The estimated subject-specific variability was statistically significant. The amount of variability among patients due to the effect of visiting time was 0.000467 and the correlation was -0.6241, this indicates that there is a negative correlation between the intercept and slope (visiting time).

Effect	Category	Estimates	Std Errors	95% CI		P-Value
				Lower	Upper	
Intercept		4.8756	0.2106	4.4611	5.2901	<.0001
Gender (ref=male)	Female	-0.01569	0.05324	-0.1202	0.08882	0.7682
Age		-0.00744	0.002359	-0.01207	-0.00281	0.0017*
Time		0.005296	0.001347	0.002646	0.007946	0.0001*
Baseline CD4		0.000526	0.000092	0.000346	0.000707	<.0001*
Weight		0.00470	0.002080	0.000621	0.008788	0.0240*
Baseline viral load		-0.001345	0.000012	-0.0279	-0.00603	<.0001*
Disclosure(ref=not disclosed)	Disclosed	0.5084	0.06781	0.3753	0.6415	<.0001*
Educational level (ref=Tertiary)	No-education	-0.3720	0.1115	-0.5909	-0.1530	0.0009*
	Primary	-0.2567	0.09359	-0.4404	-0.07301	0.0062*
	Secondary	-0.4044	0.09764	-0.5960	-0.2127	<.0001*
Occupation(ref=unemployed)	Employed	0.2062	0.04958	0.003036	0.4089	<.0001*
Adherence(ref= non-adhere)	Adhere	0.1339	0.06400	0.008248	0.2595	0.0368*
WHO stage(ref- stage IV)	Stage I	0.5712	0.09709	0.3806	0.7618	<.0001*
	Stage II	0.4268	0.08560	0.2588	0.5949	<.0001*
	Stage III	0.2478	0.08388	0.08310	0.4124	0.0032*
BMI(ref=under weight)	Normal Over weight	0.07015 0.1709	0.07390 0.1539	-0.07493 -0.1312	0.2152 0.4729	0.3428 0.2672
TB status(ref=uninfected)	Infected	-0.2035	0.06066	-0.3226	-0.08443	0.0008*
Opp infection (ref=yes)	No	0.3001	0.05507	0.1920	0.4082	<.0001*
Functional status(ref=working)	Ambulatory	0.07860	0.08187	-0.08212	0.2393	0.3373
	Bedridden	0.1807	0.07225	0.03884	0.3225	0.0126*
Social support (ref=yes)	No	-0.1981	0.05567	-0.3073	-0.08878	0.0004*
V-Time*Educational level (ref=Tertiary)	V-Time*0 V-Time*1 V-Time*2	-0.00012 0.005965 0.01208	0.004475 0.004101 0.004185	-0.00890 -0.00209 0.003865	0.008670 0.01402 0.02030	0.9795 0.1462 0.0040*
Random effect		Estimates	Std errors			P-value
Intercept(b_{oi}) Time(b_{1i}) Cor(b_{oi},b_{1i})		0.2687 0.000467 -0.6241	0.02547 0.000043			<.0001 <.0001

Note: b_{oi} *and* b_{1i} are the intercept and slope of the random effect of the model respectively and *indicates that variables that are significant at 5% of significance level

Table 3: Parameter Estimates of CD4 Cell Count Including Disclosure As A Linear Predictor.

3.4. Separate Analysis of Disclosure of HIV- Status

The separate analysis of disclosure of HIV status is indicated in Table 4. The parameter estimation during this time was conducted using Fisher Scoring.

Parameter	Estimate(β)	Std Error	Wald Chi-Square	AOR (95% CI)	P - value
Intercept	7.9518	2.3303	11.6437	2840.68	0.0006
Gender (ref= Male)					
Female	0.4089	0.5060	0.6530	1.505(0.558, 4.058)	0.4190
Age	-0.00764	0.0252	0.0923	0.992(0.945, 1.043)	0.7613
Residence (ref= urban)					
Rural	1.6283	0.5891	7.6402	5.095(1.606, 16.166)	0.0057*
Religion (ref= other)					
Muslim Orthodox	0.1374 -0.6328	1.7229 1.3128	0.0064 0.2324	1.147(0.039, 33.586) 0.531(0.041, 6.961)	0.9364 0.6298
Functional Status (ref= working)					
Ambulatory Bedridden	-3.1760 -2.5810	0.6291 0.6625	25.4842 15.1787	0.042(0.012, 0.143) 0.076(0.021, 0.277)	<.0001* <.0001*
Marital Status (ref= widowed)					
Divorced Married Never-married	-0.0197 -0.5365 2.1233	0.7997 0.8232 0.8597	0.0006 0.4247 6.0999	0.981(0.205, 4.700) 0.585(0.116, 2.936) 8.358(1.550, 45.070)	0.9804 0.5146 0.0135*
Educational Level (ref= tertiary)					
No-education Primary Secondary	-4.7875 -2.1073 -1.2588	1.4062 1.1223 1.2050	11.5901 3.5254 1.0913	0.008(0.001, 0.131) 0.122(0.013, 1.097) 0.284(0.027, 3.013)	0.0007* 0.0604 0.2962
Occupation (ref= Unemployed)					
Employed	1.3311	0.6687	3.9628	3.785(1.071, 13.80)	0.0465*
Social Support (ref=Yes)					
No	-4.0866	0.7587	29.0080	0.017(0.004, 0.074)	<.0001*

Note:*indicates that variables that are significant at 5% of significance level

Table 4: Parameter Estimates of Disclosure of HIV Status Considering CD4 Cell Count As Linear Predictor.

Table 4 indicates that residence, marital status, educational level, occupation, social support and functional status variables in the model significantly associated with disclosure of HIV-status in the separate analysis.

3.5. Joint Model Analysis for Binary and Count Data

The joint data analysis for the two response variable namely CD4 cell count and disclosure status of HIV–disease is indicated in Table 5. In Table 5, it is indicated that among the predictors educational level, occupation, adherence, and social support significantly affected the change of CD4 cell count and disclosure of disease status jointly. The correlation between CD4 cell count and disclosure of disease status was about 0.4607 which indicates a positive correlation between the two responses.

Level of education was of the predictor variables for the two responses. Hence, comparing non-educated with tertiary educated HIV-positive patients, the expected CD4 cell count of non-edicated patients was decreased by 0.6185 cells/ MM3 of blood and the odds of exposed the disease status was decreased by 0.000145given the other covariates constant(β=-0.6185,p-value<0.01) and (AOR=0.000145, p-value<0.01) respectively. Similarly, the expected CD4 cell count of primary educated patients was decreased by 0.3687(β=-0.3687,p-value<0.01) and the odds of disclosed the disease was decreased by 0.004413 (AOR= 0.004413, p-value<0.01) as compared to tertiary educated patients, given the other covariates constant.

Occupation of HIV-positive adults also significantly and jointly affected the two response variables. The expected number of CD4 cell count for employed HIV–positive individuals was increased by 0.3888 as compared to unemployed ones(β=0.3888,p-value<0.01) and the odds of being disclosed the disease status of employeed HIV-positive individuals was 3.4562 times that of unemployed ones(AOR=3.4562, p-value=0.021) given the other covariates constant.

The expected number of CD4 cell count for adherent HIV-

positive adults was increased by 0.2274 as compared to non-adherent patients(β=0.2274,p-value<0.01 and the odds of being disclosed the disease status of adherent patients was increased by 56% as compared to non-adherent ones(AOR=1.564, p-value<0.01), given that the health conditions constant.

Social support had significant role for the variation of CD4 cell count and the exposed level of the disease status. Comparing those HIV-positive individuals who did not get social support with those who got social support, the expected number of CD4 cell count for individuals who did not get social support was decreased by 0.1148 cells /mm3 of blood as comapared to those of who got social support(β=-0.1148, p-value=0.030) and the odds of being disclosed the disease status of individuals who did not get social support was decreased by 92.5% as compared to individuals who got social support(AOR=0.075, p-value= 0.0078), given the other covariates constant.

Parameters	**CD4 Cell Count Outcome**			**Disclosure Status Outcome**		
	Estimate	**Std error**	**P-value**	**AOR**	**Std error**	**P-value**
Intercept	5.0658	0.1526	<.0001	0.2124	3.1354	0.6214
Age	-0.00417	0.002122	0.0059*	1.1429	0.04852	0.0597
Time	0.007219	0.000674	<.0001*	1.723	0.5643	<.0001*
Baseline CD4	0.0379	0.00542	<.0001*	1.0013	0.001583	0.4211
Educational level (ref=Tertiary)						
No-education	-0.6185	0.1097	<.0001*	0.0001	1.1200	<.0001*
Primary	-0.3687	0.09477	0.0001*	0.0044	0.8201	0.0029*
Secondary	-0.2693	0.08320	0.0012*	2.5403	0.2350	0.0274*
Occupation (ref=unemployed)						
Employed	0.3888	0.07032	<.0001*	3.4562	0.2701	0.0218*
Adherence (ref= non-adhere)						
Adhere	0.2274	0.05203	<.0001*	1.564	0.9334	0.0003*
WHO stage (ref- stage IV)						
Stage I	0.3709	0.08991	<.0001*	4.6306	1.7376	0.3778
Stage II	0.2661	0.07863	0.0007*	0.5770	1.4230	0.6743
Stage III	0.1514	0.07539	0.0447*	0.98453	1.3192	0.9906
Social support (ref=yes)						
No	-0.1148	0.05295	0.0303*	0.0755	0.6707	0.0078*
TB status (ref=uninfected)						
Infected	-0.2991	0.07015	<.0001*	1.5752	2.1284	0.8310
Opportunistic infection (ref=yes)						
No	0.3062	0.07242	<.0001*	1.6487	1.4173	0.7243
BMI (ref=under weight)						
Normal	0.1412	0.06088	0.0205 *	0.4942	1.2089	0.0509
Over weight	0.3441	0.1196	0.0041*	0.4448	2.2669	0.7208
Functional status(working)						
Ambulatory	-0.01528	0.06393	0.8112	0.0145	0.2780	0.0009*
Bedridden	-0.00987	0.06255	0.8746	0.0334	0.1128	0.0023*
Variance component	**Estimates**		**Std Error**		**95% CI**	
Var. R.I (CD4 cell)	0.1270		0.01099		(0.1005, 0.14)	
Var. R.I (Disclosure)	12.9709		0.5508		(9.6734, 17.85)	
Corr. between the R.I	0.4607					

Note:*indicates that variables that are significant at 5% of significance level

Table 5: Parameter Estimate and Standard Errors Under the Joint Modeling Analysis

4. Discussion

Follow-up visits have significant effect on the two response variables namely, CD4 cell count and disclose of the disease status. Hence, as patients' visiting time incrase, their corresponding CD4 cell count also increase and they encouraged to disclose the disease status. The potential reason for this might be the proper follow-up leads for being medication adherent and this further leads to good health progressions like increase of CD4 cell count. The health related education given at each visiting time also encourages the patients to disclose the disease status [17,18].

Educated HIV positive adults have higher number of CD4 cell count and they have more probability to disclose the disease status as compared to none or less educated patients. This might occur because as patients become more educated, they may have better care of their health and may have disclosed their disease status to family members, to take their medication properly on time and they may have enough understanding about ART, for this reason, the CD4 cell count change[19,20]. This findings is supported by many other studies [21-23].

Medication adherent HIV positive adults have higher number of CD4 cell count and such patients disclosed their disease status to family members more likely as compared to non-adherent HIV patients. This may be the case that using ART regularly improves adherence to healthcare services (with an emphasis on HIV status disclosure), which in turn raises awareness of HIV-positive status disclosure [24-26]. This result is also consistent with the result obtained from previous researches [27-30].

Occupation of HIV-positive adults also significantly and jointly affects the two response variables. The expected number of CD4 cell count for employed HIV–positive individuals is by far better as compared to unemployed ones. This result is consistent with another previously conducted researches [31-34]. The potentional reason for this might be the fact that imployed patients have better means of income for daily consumption of inviduals [35]. The disclosing of the disease status of employeed HIV-positive individuals is better than as compared to non-employed patients. The potential reason for this might be the fact that employed patients are forced to disclose the disease to get work leave or permission to be free from their regular work with payment [36].

The number of CD4 cell count for adherent HIV-positive adults is better as compared to non-adherent patients. This is the reason that seriesly adherent patients show good progress in reducing viral loads and increase of CD4 cell counts [37]. Similarly, the odds of being disclosed the disease status of adherent patients is by far better as compared to non-adherent patients. Patients who disclosed their disease status can adhere the medication on time with irrispect of any other body living with them [38,39].

This finding showed that participants who got social support from the community are better in CD4 cell count and such patients have high probable of disclosing their disease status to their families than those who had not get social support. The potential reason for this may be the fact that such patients might have good HIV medication (adherence), and they are not fear stigma and discrimination in disclosing the disease status. This result was also consistent with the result obtained from previous researches [40,42]

5. Conclusion

In this study about 76.3% of the patients disclosed their HIV disease status to their families at Felege Hiwot Comprehensive Specialized Hospital, with the remaining 23.7% of the patients are not disclosed their disease status and the mean CD4 cell for all patients is 368.36 cells/mm^3 with disclosed patients accounted for 493.54 cells/mm^3 and non disclosed patients accounted 172.95 cells/mm^3.

This study revealed that about 76.3% of the patients disclosed their HIV disease status to their families at Felege Hiwot Comprehensive Specialized Hospital, Which is more than a study conducted by [35] which is 43.1% of the patients disclosed their disease status.

This study showed that CD4 cell count was a positive relationship with visiting time. This study also indicates that age and baseline CD4 cell count have significant effect on the variables of interest. Hence, as age of patients increased, CD4 cells count decreased but as baseline CD4 cells count increase, current CD4 cell count also increase. This result was consistent with another study [33] From the longitudinal sub-model, age, time, baseline CD4, educational level, occupation, adherence, WHO stage, social support, TB status, opportunistic infection, body mass index were significantly related to the change of CD4 cell count.

In this study, binary logistic regression model was used for a dichotomous outcome data for HIV disease status disclosure. In Hosmer and Lemeshow test statistics to check the overall model adequacy the model are good fit to the data well. From the binary sub model educational level, occupation, adherence, social support, and functional status were significantly related with disclosure of disease status of HIV/AIDS patients.

The association between the log of CD4 cell count and disclosure of disease status at random intercept was positively correlated. The parameters estimates of the separate and joint models are approximately similar to each other but not identical.

As recommendation, patients should be adhere to their prescribed HIV medication properly on time, and disclose their disease status without fearing stigma and discrimination to the community this may helps to increase their CD4 cell count. Bahir Dar health center and Felege Hiwot Comprehensive Specialized Hospital managements should give health-related education for the infected patients to disclose their HIV disease status this may help to decrease stigma and discrimination and the patients are taking their medicine on time.

The family members should give social support to the infected patients, and the government should work on education this may help to improve their CD4 cell count and increase the prevalence of disclosure of the disease status. The authors also recommended that further studies of this nature include other important variables that are not included in this study like income of the patients and many other covariates.

Declarations

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