Longitudinal Episodes of Under nutrition and its Predictors among HIV Positive Adults in Public Hospitals, Guraghe Zone: Linear Mixed model

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Abstract

Background: More than one-fourth of adult HIV patients had malnutrition which has high risk of relapse after treatment. Hence, assessing the longitudinal episodes and its predictors has great importance. Therefore, this study was aimed to assess the longitudinal trends of under nutrition and its predictors among HIV positive adults attending Public Hospitals in southwest Ethiopia, 2019.

Methods: Longitudinal study with repeated measure was conducted among 519 randomly selected records of adult HIV clients who were on treatment. Malnutrition was assessed using the records of weight and height at different points of follow up (0, 6, 12, 18 and 24 months of ART follow up). Analysis of variance, analysis of covariance and spaghetti plot were done to compare the mean change in BMI across different repeated measures. To assess predictors of malnutrition episodes, linear mixed model was used considering fixed and random variables. Thus, parameter estimate, and p-value with 95% confidence interval was estimated via maximum likelihood method. From the model information criteria, Akaikes information criteria (AIC) were used to assess model fitness with smaller value as indicative of better model fit.

Results: a total of 480 records were reviewed with mean age of 36 years (± 9 years). A total of 354(73.8%) of clients mentioned that they got dietary counseling. While, 34.6% of them got nutritional support. Statistical significant increasing trend of mean BMI score across the five follow up intervals (F statistics = 13.9, p value = 0.0001) were observed. Being male (β = -0.72; P = 0.044), with problem of eating difficulty (β = -1.61; p = 0.0001), having anemia (β = -1.51; p = 0.003), shorter follow up interval (β = 0.04.; p = 0.129), not getting nutritional counselling (β = 0.63; p =0.32) and diarrheal disease (β = -0.04; p = 0.129) were negatively associated with improvement in BMI indices.

Conclusions: Improvement was seen in nutritional status after initiation of ART. Presence of eating disorder, anemia, not getting nutritional counseling, short follow interval were predictors of under nutrition. In addition to giving better nutritional counseling, the health professionals working in ART clinic should emphasize for early detection, and treatment of eating disorders, diarrheal disease and others.

Introduction

Acquire Immune Deficiency syndrome (AIDS) is the combination of different illness characterized by decreased immune system due to immune damage by Human Immune Virus (HIV) [1]. The critical points for better quality of life among HIV infected patients is to give a comprehensive HIV treatment, adherence support, counselling services and other concomitant cares. Moreover, in order to better control the viral replication and diminish the fast progresses during the course of AIDS, emphasizing the role of nutritional care and maintaining optimum nutrition is a major concern [2, 3].

World Health organization (WHO) recommends increased energy intake by 10% to maintain body weight in asymptomatic HIV-infected adults, by 20–30% for adults during periods of symptomatic disease or opportunistic infection and by about 30% during the recovery period [2]. This emphasizes the need for

integrated and focused nutritional care and counseling for adult clients throughout their follow up periods.

Malnutrition among adults with Human Immune Virus (HIV) infection is commonly seen as thinness or low Body mass index (BMI < 18.5 kg/m^2). Among the various nutritional assessment indices, BMI is the common indicator of the nutritional status of adult populations. BMI is a predictive of adverse treatment outcome [4]. It is evident that programs like nutritional supplementation for adult HIV clients greatly improve their nutritional status, along with Anti-Retroviral treatment (ART). But the presence of opportunistic diseases such as oral candidiasis and diarrhea are related to increased susceptibility to malnutrition and poor recovery from malnutrition [5].

Sub-Saharan Africa (SSA) is one of the regions with highest number of people living with HIV/AIDS, accounting about 69% of global AIDS epidemic [6]. Furthermore, the region is seriously affected by under nutrition, high food insecurity and other nutrition related problems [7].

Ethiopia is one of the countries which has scaled up antiretroviral treatment (ART) over the past decade. From 2005 to 2015, there were several improvements in treatment coverage and other parameters. But, still significant challenges are in place, including concerns and equitable accesses of the nutritional cares for all [8]. As of 2017, there were an estimated 738,976 peoples living with HIV. Based on the latest national recommendations, all HIV confirmed clients should start ART immediately (after adherence support); and due to the fact that an increasing incident (new) cases of HIV among different segments of the population, makes the need for nutritional care and helping them to be well nourished become more important. This in turn makes the need to give nutritional assessment and nutritional care top priority in the program [1].

Maintaining good nutritional status is one of the most common proxy indicators for quality of life among HIV/AIDS patients. In addition, it is among one of the clinical targets to be achieved through ART follow up period. The study from eastern Ethiopia showed that 28.7% of HIV/AIDS patients had low Dietary diversity score [9].

Improving the health and well-being, provision of antiretroviral therapy and comprehensive long-term care (including nutritional care) to all people living with HIV is one of the 2021 global focus areas [10]. In one study, it has been shown that nutritional status of ART clients is associated with better CD4 recovery rate, reduced opportunistic infection rate (OI) [11, 12] and reduced risks of all-cause mortality [13]. Similarly, those underweight clients (prior to HAART), died of AIDS more than twice as rapidly (AHR = 2.04, 95% CI 1.03, 4.04) [14]. In addition, higher CD4 cell count and higher pre ART BMI are associated with higher immunity recovery at 12 months of ART initiation. Thus maintaining normal BMI among HIV adults is of first priority for the successful treatment [15]. Therefore, this longitudinal study considers BMI measurements taken at 0, 6 months, 12 months, 18 months and two years' after initiation of ART in order to get adequate and complete data.

Objectives Of The Study

General Objective

To assess the longitudinal episodes of under nutrition and its predictors among Adult clients on HAART attending Public Hospitals in Guraghe Zone, South west Ethiopia, 2019

Specific objectives

To determine the longitudinal episodes of malnutrition among Adult clients on HAART attending Public Hospitals in Guraghe Zone, South west Ethiopia, 2019

To identify the predictors of under nutrition episodes among Adult clients on HAART attending Public Hospitals in Guraghe Zone, South west Ethiopia, 2019

Methods And Materials

Study Area and Period

Guraghe zone is one of the administrative zones in southern nations and nationalist region. It has 13 districts and two town administrations. Wolkite town is the capital of Guraghe zone which is found 425 km and 158 km from Hawassa and Addis Ababa respectively on the way to Jimma. There are five hospitals with four governmental and one private (Non-governmental) hospital. There were about 3032 adult ART clients on HAART in the zone [16].

Study design

A longitudinal cross sectional study design using retrospective review of charts (of adult ART clients on HAART) was conducted. Data were collected on randomly selected records of adult HIV positive clients on ART (age >18 years), from randomly selected Hospitals in Guraghe zone, southern Ethiopia.

Eligibility Criteria

Records of adult HIV positive patients on ART (age >18 years at enrollment) from the selected Hospitals, who have at least two consecutive BMI records during the follow up period were included in the study. While, records with incomplete data on outcome measurement; nutritional status indicators (weight, height) at different time periods of repeated measurements were excluded from the study. Cases which transferred to other facilities (transfer outs), in which the full follow up information was not available were excluded. As BMI is not appropriate indicator for pregnant women, those records of pregnant women without MUAC record were also not considered.

Sample Size Determination

The sample size for the first specific objective was determined based on single population proportion formula using magnitude of under nutrition among adult ART clients (P) and margin of error, 5% at 95% confidence interval. Hence, by using the prevalence estimates of under nutrition 10.5% (BMI < 18.5 Kg/m2) [17] the sample size became 144.

Even if mixed models have become the most popular method for analyzing repeated measures and longitudinal data; validated power and sample size methods exist only for a limited class of mixed models [19]. The appropriate sample size for the second specific objective was calculated by using significance level of 5%, at 95% Confidence level, with time interval of half a year, power of 80 %. By taking the larger sample size calculated using OR = 2.47, percent of unexposed with outcome (17.08 %), Type I error =5% [20], the sample size became 236. While, adding 5% loss of data and design effect of 2, the final sample size became 519.

Sampling Procedures

Out of the four public hospitals in Guraghe zone, two hospitals were randomly selected and included in the study. Out of the four hospitals, two hospitals were randomly selected with the fact that they are almost the similar regarding ART care (similar protocol) and patient characteristics. Then using the average five years' adult ART case load of the two selected hospitals, the sample size was allocated proportionally. The records were selected using simple random sampling technique, by computer random number generator (using Open Epi software). The corresponding unique ART number (medical record number) of randomly selected clients' record was used to retrieve the clients' medical card from ART register.

Data Collection Methods and Procedure

Structured and cross checked data abstraction format was used to collect data from the client's record at different periods of retrospective follow-up. The check list included information on relevant socio-demographic characteristics, weight, height, and treatment related issues. The data were collected by trained health professionals with basic skills and experience in ART documentation (intake form, follow up form and other medical records). Considering the total adult ART case load, the six Bsc nurses and public health officers with their supervisors were assigned to each selected hospital and collected the data. The primary outcome of this study is client's repeated BMI score at different periods of follow up.

Study Variables

Dependent Variable of the study was Episodes of malnutrition among adults (Repeated measures) while the independent Variables included age, sex, employment status, functional status, nutritional therapy, ART adherence, baseline CD4, WHO stage, Cotrimoxazole prophylaxis, INH prophylaxis, Co morbidities, ART regimen, Presence of care giver, Opportunistic diseases, presence of eating problems and Gastro intestinal symptoms

Operational Definitions

According World Health Organization (WHO), malnutrition in this study was defined as low body mass index below 18.5 kg/m^2 (< 18.5 kg/m^2) which refers to under nutrition while those with BMI above 18.5 kg/m2 was considered as normal. Thus those with BMI < 16 (as severe malnutrition), 16 to 16.9 kg/m2 (moderate malnutrition) while those with BMI between 17 to 8.5 kg/m^2 are defined as mild malnutrition or thinness [4].

Eating problems: for this study patients were considered as having eating problems, if they developed at least one of eating or swallowing difficulties due to oral hairy Leukoplakia, oral candidiasis, esophageal candidiasis or if they had loss of appetite at the time of the most current study period.

Data quality control

Two days training was given to the data collectors and supervisors before the actual data collection. Principal investigators and supervisors monitored and check the daily progresses. The information collected were cross checked with different sources (intake forms, ART register and ART chronic follow up form). Supervisors cross checked sample of daily collected data for correctness against the medical record or the ART register. Then reasonable feedback were given for the data collectors. The data were entered in to Epi data software and was restricted by legal values and other parameters to minimize errors. The data were entered by two independent data entry clerks and then cross checked for possible errors of data entry. Additionally, to keep the data quality, data from the medical records and the register were also crosschecked.

Data processing and analysis

The raw data were entered in to Epi-Data software version 3.1 and exported to SPSS version 25 for analysis. Data were presented in frequency, percentages, tables, and graphs. Nutritional status indicator for adults (BMI) was calculated by using compute command as weight divided by height in metre squared. Then the nutritional status was categorized in to under nutrition (below 18.5 kg/m2) and Normal (above or equal to 18.5 kg/m2) [4]. To assess the longitudinal episodes of malnutrition and its correlates, linear mixed model with random effect was done for repeated measure. In the meantime, the correlation between measurements of BMI was assessed. Thus, BMI score was considered as linear variable for linear mixed model. Spaghetti plot (with times of follow up on the X axis and the BMI score on the Y axis) was used to see the linear or curved pattern of the BMI scores. Multivariable random effects linear mixed models was fitted to estimate differences in BMI cell with respect to different factors (predictors). Maximum likelihood (ML) was used to estimate the parameter, as it considers both fixed and random factors. Under random effect model, parameter estimate with 95% Confidence Interval (CI) was calculated wit t and p value. Akaikes information criteria (AIC) was used to assess model fitness; with smaller value considered as complex in estimating parameter estimates. P-value of less than 0.05 used as cut off point to declare statistical significance.

Ethical consideration

Formal ethical clearance was obtained from the University's Institutional Ethical Review committee and letter of cooperation was taken from the university to the zonal health office and to the respective hospitals sequentially. Before the data collection, informed consent was obtained (after full explanations of the study procedure) from the respective hospital managers. Then during the actual data collection all hard copy and softcopy data were under full protection in the hands of the investigators. The collected data were not used for other purposes than the study's primary objectives. Client's confidentiality was also kept.

Results

In this study, a total of 480 client records were retrieved with overall retrieval rate of 92.4%. The mean age was 36 years (± 9 years). About three fourth (74.2%) aged between 25 to 44 years' and nearly two third (62.7%) were females. More than one third (35.2%) attended no formal education and nearly two fifth (39.2%) were married. One thirds (33.3%) reported that they were engaged in private works. More than one fifth (23.3%) of client's come for follow up from outside the hospitals' catchment area (Table 1).

Table 1
Shows Adult ART client characteristics in public Hospitals, Guraghe Zone, Southwest Ethiopia, 2019

Characteristics		Frequency	Percent (%)
Age in years	15–24 years	33	6.9
	25–34 years	164	34.2
	35–44 years	193	40.2
	>= 45 years	90	18.8
Sex	Male	179	37.3
	Female	301	62.7
Educational status	No formal education	169	35.2
	Primary	229	47.7
	Secondary	73	15.2
	Tertiary and above	9	1.9
Marital status	Married	188	39.2
	Single	80	16.7
	Divorced	122	25.4
	Widowed	90	18.8
Employment status	Government	62	12.9
	private	160	33.3
	Not employed*	258	53.8
Client resides with in catchment area	Yes	368	76.7
	No	112	23.3

Client's Treatment related characteristics

Nearly nine out of ten (88.1%) clients disclosed their HIV status to their friends, parents or others (Fig. 1).

It is reported that, nearly three fourth (73.8%) of clients got dietary counseling; however, only about one third (34.6%) of the clients got any additional nutritional supplementation during the course of ART treatment. About 230 (47.9%) of clients had history of any eating disorders; loss of appetite (83.9%), swallowing difficulty (23.5%), nausea and vomiting (45.7%). In addition, any of the opportunistic infections were reported in about 275 clients; pneumonia (32.7%), Tuberculosis (19.6%), and diarrheal

diseases (38.2%). Additionally, 73 (15.2%) and 17 (3.5%) of clients had reported to have symptoms of oral candidiasis and Esophageal candidiasis respectively (Table 2).

Table 2
Clinical characteristics of Adult ART clients in Guraghe Zone, Southwest Ethiopia, 2019

Variable		Number	Percent (%)
Dietary counseling	Yes	354	73.8
	No	126	26.3
Nutritional support	Yes	166	34.6
	No	269	56.0
	Not stated	45	9.4
Eating problem	Yes	230	47.9
	No	250	52.1
Opportunistic disease	Yes	275	57.3
	No	205	42.7
Pneumonia	Yes	90	32.7
	No	185	67.3
Tuberculosis	Yes	54	19.6
	No	221	80.4
Diarrhea	Yes	105	38.2
	No	170	61.8
Oral candidiasis	Yes	73	15.2
	No	405	84.4
Esophageal candidiasis	Yes	17	3.5
	No	456	95.0
Baseline functional status	Working	277	57.7
	Ambulatory	135	28.1
	Bedridden	28	5.8

Baseline characteristics of ART clients

During the start of the ART program, more than two out of five clients were in WHO stage III and above. Nearly two third (63%) of the clients were working actively while, 6.4% of clients were bedridden. The vast

majority of clients were reported to took prophylactic treatments; INH (90.2%), and CPT (91.3%). However, only 11% had received fluconazole therapy. Anemia was reported only in 10.4% of the clients (Table 3).

Table 3
Baseline clinical characteristics of Adult ART clients, Southwest Ethiopia, 2019

Parameters		Number	Percent (%)
WHO clinical stage	WHO stage I	115	24.0
	WHO stage II	163	34.0
	WHO stage III	170	35.4
	WHO stage IV	32	6.7
Functional status	Working	277	63.0
	Ambulatory	135	30.7
	bedridden	28	6.4
INH prophylaxis	Yes	433	90.2
	No	47	9.8
CPT Prophylaxis	Yes	438	91.3
	No	42	8.8
Fluconazole	Yes	53	11.0
	No	427	89.0
Anemia	Yes	50	10.4
	No	430	89.6

A total of 43 (10%) of clients had Virological failure in the course of ART follow up. A total of 401 (83.5%) ART clients were on TDF-3TC-EFV HAART regimen. Regarding the treatment outcomes of clients; nearly three fourth (74%) were on regular ART follow ups, where as 13% were Transfer outs and 7% were dead (Fig. 2).

The median pre ART follow up was three months with average chronic ART follow up interval of three months. Regarding the total months on ART ranges from two to above hundred months of follow up periods. At the start of their chronic follow up, with mean hemoglobin level of 13.5 g/dl (± 1.8 g/dl). About 455 (94.8%) were reported to had good adherence to the treatment (Fig. 3).

Trends of Malnutrition

The homogeneity of variance for BMI of ART clients was full filled (Leaven statistics = 0.474, p value = 0.755). In addition, statistically significant increasing trend of mean BMI score were observed across the five follow up intervals (F statistics = 13.9, p value = 0.0001). The BMI of clients were recorded at start of ART, 6 months, 12 months, 18 months and 24 months during the course of follow ups.

Using normal plot and klomogrove Sminirove test for normality of serial BMI measurements; the BMI follows approximate normally distributed, with minimum of 9 and maximum of 36 kg/m^2.

Predictors of BMI: Linear Mixed Effect

The data follows approximate normal distribution, since it involves repeated measurements of weight and height at start of ART and every six month till two years. The data measurements at each follow up periods were highly correlated with correlation coefficient (r) of above 0.9. Furthermore the data were not independent, as it involves multiple measurements; violating the basic assumption of general linear regression. Thus, linear mixed model with random intercept model was fitted with Information criteria (Alkaiks's Information Criteria).

Significant improvements in BMI score of ART client's was observed after ART initiation ($P < 0.0001$). Accordingly, the mean BMI score at 24 months is better than the previous follow up periods. ART clients who were male (mean difference (MD) = -0.73)) and from rural area (MD = -0.19) had lower BMI score than their counterparts. For each year a person lives, the mean BMI of ART clients showed statistically non-significant decline by 0.025. ART clients who got nutritional support in the course of HIV treatment showed to improve their BMI ($\beta = 0.28$, p value = 0.32). Clients with recent history of eating problems were reported to had lower BMI scores as compared to clients without eating problems ($\beta = -1.26$; P value $\leq$ 0.0001).

Similarly clients with recorded opportunistic Infection (OI) had lower BMI score than those who have at one OIs ($\beta = -1.06$; P value ≤ 0.0001). Importantly, longer pre ART follow up periods resulted in improved BMI scores of ART clients ($\beta = 0.023$; P value = 0.067). ART clients who were in advanced WHO stage and with working functional status had higher BMI score than their counter parts. Clients who had good adherence to ART follow ups showed to have higher BMI than those who had poor adherence ($\beta = 0.68$; P value = 0.51). The presence of anemia had shown to decrease the BMI of ART clients by 1.3 ($\beta = -1.31$; P value = 0.001) (Table 4).

Table 4
Predictors of BMI of adult ART clients in South west Ethiopia

Time (follow up)	No of subjects	Parameter	se	sig	95% CI	
Intercept	479	20.85	0.14	.000	20.57	21.12
0 month	477	-1.39	0.10	.000	-1.59	-1.20
6 month	476	− .77	0.09	.000	− .95	− .59
12 month	445	− .46	0.07	.000	− .60	− .31
18 month	396	− .20	0.05	.000	− .28	− .10
24 months of ART	479	Reference value				
Age in Years		-0.025	0.01	0.067	− .068	.002
Sex	Male	− .730	.26	0.05	-1.25	− .246
	Female	0	0			
Residence	Rural	− .192	.254	.450	− .69	.307
	Urban	0	0			
Live with in catchment area	Yes	− .031	.29	.917	− .608	.547
	No	0	0			
Disclosure status	Yes	− .597	.384	.120	-1.35	.157
	No	0	0			
Get nutritional support	Yes	.283	.282	.316	− .27	.837717
	No	0	0			
Eating problem	Yes	-1.26	.243	.000	-1.74	− .780
	No	0	0			
Presence of OIs	Yes	-1.06	.247	.000	-1.55	− .574
	No	0	0			
Pre ART follow up	In months	.023	.012	.067	− .0016	.047
Total ART follow up	In months	− .017	.004	.000	− .025	− .008
Follow up interval	In months	.045	.019	.020	.007	.082
Functional status	Working	1.88	.509	.000	.884	2.88
	Ambulatory	.394	.533	.460	− .653	1.44
	Bedridden	0	0			
WHO stage	WHO stage 1	3.023	.501	.000	2.04	4.00
	WHO stage 2	1.48	.484	.002	.528	2.43
	WHO stage 3	.295	.483	.541	− .653	1.24
	WHO stage 4	0	0			
Adherence	Good	.679	1.03	.510	-1.34	2.70
	Fair	-1.71	1.20	.156	-4.07	.654
	Poor	0	0			
Anemia	Yes	-1.31	.403	.001	-2.10	− .516
	No					
INH	Yes	.865	.417	.039	.0456	1.68
	No	0	0			
Fluconazole	Yes	− .821	.395	.039	-1.60	− .044
	No	0	0			

Up on fitting a linear mixed effect random intercept model using information criteria with smaller value; sex, nutritional support, having eating problem, diarrhea disease, anemia and follow up interval were important predictors for BMI (Table 5). The addition of diarrheal disease to the model significantly improved the model fitness ($P < 0.05$). For model fitness, Akaike's Information Criterion (AIC) value was used and compared for each model in back ward regression model. The model fitness has improved from AIC value of 8698 to better model of 4995.228. Male ART clients had significantly lower BMI as compared to females ($\beta = -0.72$; $P = 0.044$). In addition, clients who got nutritional counseling during the course of ART ($\beta = 0.63$) and those clients without any of the eating problems ($\beta = -1.61$) had higher BMI scores than their counter parts. The presence of diarrhea shown to decrease the BMI score of client's even if, it is

not statistically significant. Clients diagnosed with anemia had significantly lower BMI as compared to non-anemic (β = -1.51; p = 0.003). Furthermore each months of follow up interval is associated with improvement in BMI of the clients (β = 0.04; p = 0.129) (Table 5).

Table 5
Linear mixed model with random intercept for predictors of BMI among adult ART clients, Southwest Ethiopia, 2019

Predictor variables		β	se	P value	95% CI
Sex	Male	-0.72	0.58	0.044	-1.4–0.02
	Female				
Nutritional counseling	Yes	0.63	0.63	0.32	0.61–1.86
	No				
Eating Problem	Yes	-1.61	0.45	.000	-2.50–0.71
	No				
Diarrheal disease	Yes	0.27	0.37	0.455	-0.45–1.0
	No				
Anemia	Yes	-1.51	0.49	0.003	-2.48 - -0.53
	No				
Follow up interval in months		0.04	0.02	0.129	-0.01–0.08

Table 6
Type III test for estimation of fixed effect parameter estimate

Source	Denominator df	F	Sig.
Intercept	265.535	2680.023	.000
Sex	265.518	4.114	.044
Nutritional Counselling	265.235	.994	.320
Eating Problem	265.445	12.539	.000
Diarrhea	265.632	.561	.455
Anemia	265.941	9.306	.003
Follow up interval	264.995	2.316	.129

Discussion

The findings of this study showed that, there is a significant improvement in nutritional status indicator (BMI) of ART clients after the start of ART treatment. Thus, the mean BMI score has been increased from 19.5 kg/m^2 (during the start of ART) to 20.7 kg/m^2 at two years of ART follow ups (F statistics = 13.9, p value = 0.0001). Similarly, on cohort of HIV clients on ART showed that significant improvements in BMI (by about 3%) [21]. Nutritional status is one core indicator for quality of life and effectiveness of care for HIV clients [2, 3]. Thus early initiation of ART for HIV positive clients is one important contributor for the improvement of nutritional status. Additionally, this study found that nearly three fourth of the clients has got dietary counseling and about 94.8% of adults had good adherence. Thus, the quality of care and the adherence level of clients are found to be good; so that, the HAART therapy will be effective in controlling the viral replication and improving the CD4 counts of clients. Furthermore, the significantly lower number of number of clients with treatment/virological failure supports the scenario [12, 22].

In contrary, other study showed that the BMI of HIV-infected women did not significantly change over the period of follow up [23]. BMI gains were slower among HIV-infected participants of 40 years or less (P < 0.001) [24]. Data from Inter agency HIV study on about 1100 HIV positives following HAART initiation; the median BMI change (per 5 years) was 0.21 kg/m^2 (90% CI: -1.33, 0.42) for those with normal pre HAART

BMI, 0.39 kg/m^2 (90% CI: 0.15, 0.66) for overweight, 0.31 kg/m^2 (90% CI: − 0.18,0.67). The result showed that there is persistent increase in the BMI score of the patients [25].

However, the mean BMI score was found to be marginal. A significant number of clients had under nutrition at enrollment. This might be due to the fact that about 47.9% had any of the eating problems and 57.5% had opportunistic diseases. In addition, the level of nutritional support for clients was also found to be low (34.6%). In one of the hospitals, about one fourth (25.2%) of adults reported to have BMI below 18.5 kg/m ^{2}. Furthermore, greater that three fourth of clients (79%) were found to be food insecure. Studies from southern part of Ethiopia revealed that nearly one third of adults (32.5%) were under nourished [18] and 12.3% (95% CI: 9.5–15.0%) had malnutrition (BMI below 18.5 kg/m^2) [20]. Similarly, a study from Botswana showed that 28.5% of adults had under nutrition [26].

Also, the mean dietary diversity score (DDS) was 4, which is below the minimum [27]. While other study showed that 28.7% of HIV/AIDS patients had low DDS [9]. Thus, the aforementioned factor and study area context makes ART clients vulnerable to malnutrition; even if, there is significant improvement after ART enrollment. This is greatly linked to an increased estimated energy need of 10% in asymptomatic HIV-infected adults, by 20–30% in adults during periods of symptomatic disease or opportunistic infection and by about 30% during the recovery period to maintain body weight [2].

Up on fitting random intercept linear mixed model for predictors of nutritional status, being male (β = -0.72; P = 0.044), with problem of eating difficulty (β = -1.61; p = 0.0001), having anemia (β = -1.51; p = 0.003), shorter follow up interval ((β = 0.04; p = 0.129), not getting nutritional counseling (β = 0.63; p = 0.32) and diarrheal disease (β = -0.04; p = 0.129) were negatively associated with improvement in BMI indices.

It is known that eating problems and gastrointestinal opportunistic diseases are common among HIV positives. Among these, oral ulcers, oral candidiasis, esophageal candidiasis, some lymphomas and diarrheal diseases are common co-morbidities. It is evident that, these co-morbidities significantly reduce the food intake of an individual, which is one of the immediate causes of malnutrition. Furthermore, diarrheal diseases are major contributors for an increased nutrient loss from the patient's body. These factors may result in lower BMI score of clients and worse nutritional status, which in turn reduce immunity, increase infection rate, decrease resistance and ultimately increasing the risk of malnutrition and subsequent death of clients.

Another study showed the mean BMI score of 26.67 kg/m^2 and 30.16 kg/m^2 among males and females respectively (P < 0.001) [24]. Those adults above the age of 60 had lower BMI trend (estimate = − 0.04 kg/m2) and (estimate = − 0.11 kg/m2) for males and females respectively. Those with higher alcohol intake is associated with lower BMI trend (estimates = − 0.06 kg/m2) and (estimates = − 0.20 kg/m2) for males and females respectively, as compared to those who did not drink alcohol at all (P > 0.05) [24]. Patients current smoking, higher viral load, and lower CD4 cell count were found to be significant predictors of low BMI among HIV positives [23].

Similarly, ART clients having longer follow up interval was important predictor of higher BMI score (β = 0.04; p = 0.129). It is prudent that ART clients on early follow up periods and with advanced WHO stage or immunological damage, they are more likely to be under strict ART follow up schedule. While those with good functional status and WHO stage, they will be under loose schedules. Thus, this clients who are in good health had good appetite, smaller energy and nutrient requirement in which they will have good nutritional status.

The previous studies done on predictors of malnutrition among adult ART clients involves the usual logistic regression. However, the present study involves repeated measures of BMI at important milestone times after initiation of ART. Thus it better address the important predictors as it considers fixed and random effects through linear mixed models than the usual linear regression.

Conclusions

There is significant improvement in nutritional status after initiation of ART treatment, even if they have marginal BMI. Presence of eating disorder, anemia, do not get nutritional counseling, short follow interval were significant predictors of nutritional status.

Recommendations

As nutritional status of ART clients was marginal, health professionals working in ART clinics should emphasize on the early detection, and treatment of causes of eating disorders, diarrheal disease and others. In each follow up periods, there should be effective nutritional counseling for the ART clients. Additionally, adherence support should be given due attention and strengthen on HAART intake and nutritional cares.

Declarations

Availability of data and material: All data generated or analyzed during this study are included in this published article.

Competing interests

Authors declare that they have no competing of interests.

Funding: Not applicable

Authors' contributions

AO, and BA participated in from initial inception, proposal writing, preparing data collection tool, pretesting, data collection, data analysis, result write up, preparation of manuscript to submission.

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Ethics approval and consent to participate

The research was reviewed and ethically adopted by Wolkite University ethical Review committee. Then a written informed consent considering their free will to collect data was obtained from Hospital manager. All possible ethical cares were respected throughout the conduct of research project.

Consent to Publish: Not Applicable

References

1. Federal Ministry of Health (FMOH), *National guidelines for comprehensive HIV prevention, care and treatment*, 2018, FMOH: Addis Ababa. p. 43-56.
2. World Health Organization (WHO). *Nutrition Requirements for People Living with HIV/AIDS*. Nutrition in the Context of HIV/AIDS 2018 [cited 2018 12/27]; Available from:http://motherchildnutrition.org/nutrition-hiv-aids/nutrition-living-with-hiv-aids/nutrition-requirements-for-people-living-with-hiv-aids.html.
3. Federal Ministry of Health (FMOH), *National guidelines for comprehensive HIV prevention, care and treatment*, 2018, FMOH: Addis Ababa. p. 60-64.
4. World Health organization (WHO). *BMI classification*. Global Data Base on Body mass index: http://www.assessmentpsychology.com/icbmi.htm 2018 [cited 2018 12/25].
5. Ahoua, L., et al., *Nutrition outcomes of HIV-infected malnourished adults treated with ready-to-use therapeutic food in sub-Saharan Africa: a longitudinal study.* J Int AIDS Soc. , 2011. **14**(2).
6. UNAIDS, *UNAIDS Report on Global AIDS Epidemic*, in *Global Report on global AIDS epidemic*2012, UNAIDS. p. 8-12.
7. Audain KA, et al., *Food supplementation among HIV-infected adults in Sub-Saharan Africa: impact on treatment adherence and weight gain.* roc Nutr Soc. , 2015. **74**(4): p. 517-25.
8. Assefa Y, et al., *Performance of the Antiretroviral Treatment Program in Ethiopia, 2005-2015: strengths and weaknesses toward ending AIDS.* Int J Infect Dis. , 2017. **60**: p. 70-76.
9. Weldegebreal F, et al., *Dietary diversity and associated factors among HIV positive adults attending antiretroviral therapy clinics at Hiwot Fana and Dilchora Hospitals, eastern Ethiopia.* HIV AIDS, 2018. **10:**: p. 63-72.
10. World Health organization (WHO), *Global health sector strategy on HIV, 2016-2021*, Nutrition, Editor 2016, WHO: Geneva, Swizerland. p. 5-17.
11. Amara E., et al., *Age, sex, and nutritional status modify the CD4+ T-cell recovery rate in HIV–tuberculosis co-infected patients on combination antiretroviral therapy.* International Journal of Infectious Diseases, 2015. **35**: p. 73-79.

12. Gabriel Somarriba, et al., *The effect of aging, nutrition, and exercise during HIV infection* HIV AIDS (Auckl), 2010. **2**: p. 191-201.
13. Harrington M, Gibson S, and Cottrell RC., *A review and meta-analysis of the effect of weight loss on all-cause mortality risk.* Nutr Res Rev, 2009. **22**: p. 93-108.
14. Sharma A, et al., *Relationship between Body Mass Index and Mortality in HIV-Infected HAART Users in the Women's Interagency HIV Study. .* PLoS ONE, 2015. **10**(12): p. e0143740.
15. Koethe, J.R., et al., *An Optimal Body Mass Index Range Associated With Improved Immune Reconstitution Among HIV-Infected Adults Initiating Antiretroviral Therapy* Clinical Infectious Diseases,, 2011. **53**(9): p. 952-960.
16. *Guraghe zone health office report*, 2018.
17. Pinto GS, et al., *Nutritional status and food intake of HCV/HIV coinfected patients.* Nutr Hosp., 2016. **33**(5): p. 576.
18. Wondmagegn, G.S., et al., *Under Nutrition Status and Its Determinants among Adult HIV and AIDS Clients Enrolled on Antiretroviral Therapy at Nigest Elleni Mohammed Memorial Hospital, Southern Ethiopia.* Journal of AIDS & Clinical Research, 2017. **8**(9): p. 1-5.
19. Yi Guo, et al., *Selecting a sample size for studies with repeated measures.* BMC Med Res Methodol., 2013. **13**: p. 100.
20. Solomon, H., T.B. Girma, and T.A. Henok, *Malnutrition: Prevalence and its associated factors in People living with HIV/AIDS, in Dilla University Referral Hospital.* Arch Public Health. , 2013. **71**(1): p. 13.
21. Yuh B, T., ate J, and Butt AA, *Weight change after antiretroviral therapy and mortality. .* Clin Infect Dis 2015. **60**: p. 1852-9.
22. Zambian Ministry of Health, *Nutrition Guidelines for Care and Support of People with HIV*, F.a. Nutrition, Editor 2017, National Food and Nutrition Commission and Food and Nutrition Technical Assistance III Project (FANTA). : Lusaka. p. 4-20.
23. Justman JE, Hoover DR, and Shi Q, *Longitudinal anthropometric patterns among HIV-infected and HIV-uninfected women. ;.* J Acquir Immune Defic Syndr 2008. **47**: p. 312-9.
24. Erlandson, K.M., et al., *Changes in weight and weight distribution across the lifespan among HIV-infected and -uninfected men and women.* Medicine (Baltimore), 2016. **95**(46): p. e5399.
25. Sharma A, Bynum SA, and Schneider MF, *Changes in body mass index following HAART initiation among HIV-infected women in the Women's Interagency HIV Study. ;.* J AIDS Clin Res, 2014. **5**.
26. Nnyepi MS, *The risk of developing malnutrition in people living with HIV/AIDS: Observations from six support groups in Botswana* S Afr J Clin Nutr, 2009. **22**(2): p. 89-93.
27. Dereje Gedle, et al., *Prevalence of malnutrition and its associated factors among adult people living with HIV/AIDS receiving anti-retroviral therapy at Butajira Hospital, southern Ethiopia.* BMC Nutrition, 2015. **1**(5): p. 1-5.

Figures

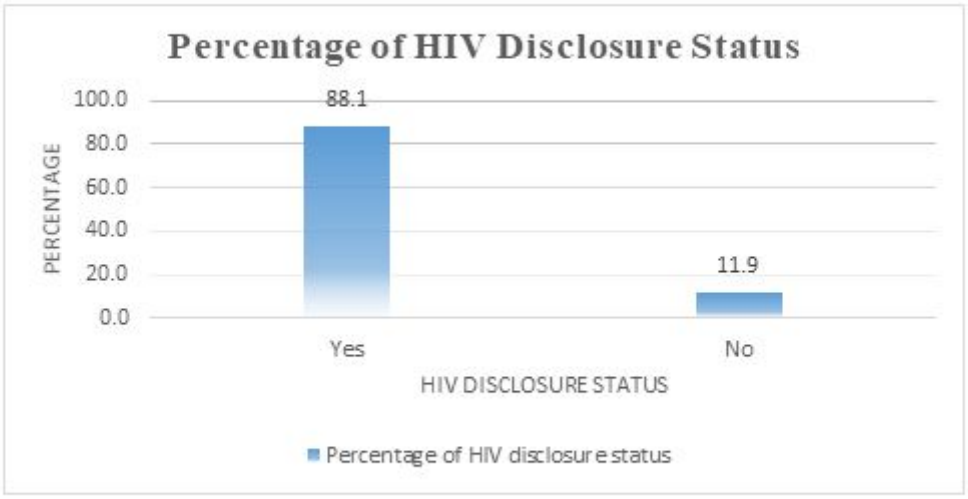

Figure 1

HIV Disclosure status of Adult ART clients, in Southwest Ethiopia, 2019.

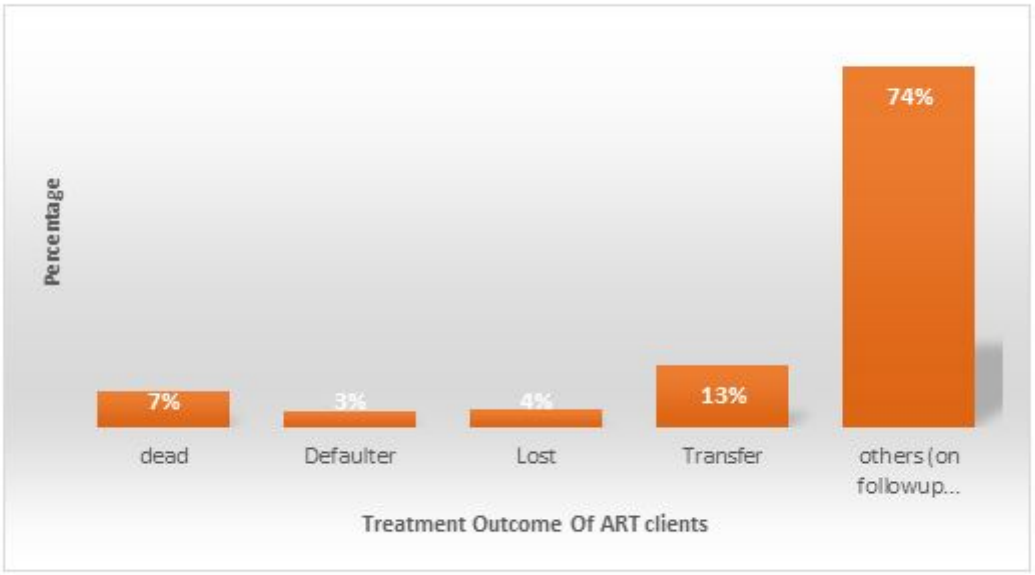

Figure 2

Treatment outcomes of Adult ART clients, Southwest Ethiopia, 2019

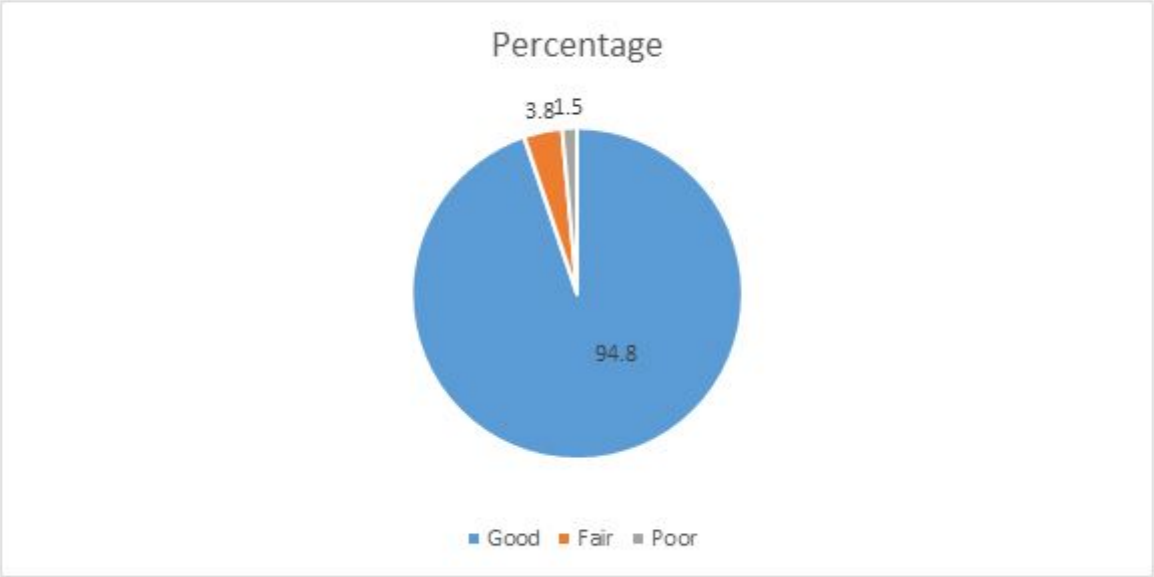

Figure 3

Level of current ART adherence of clients to chronic HIV care and treatment

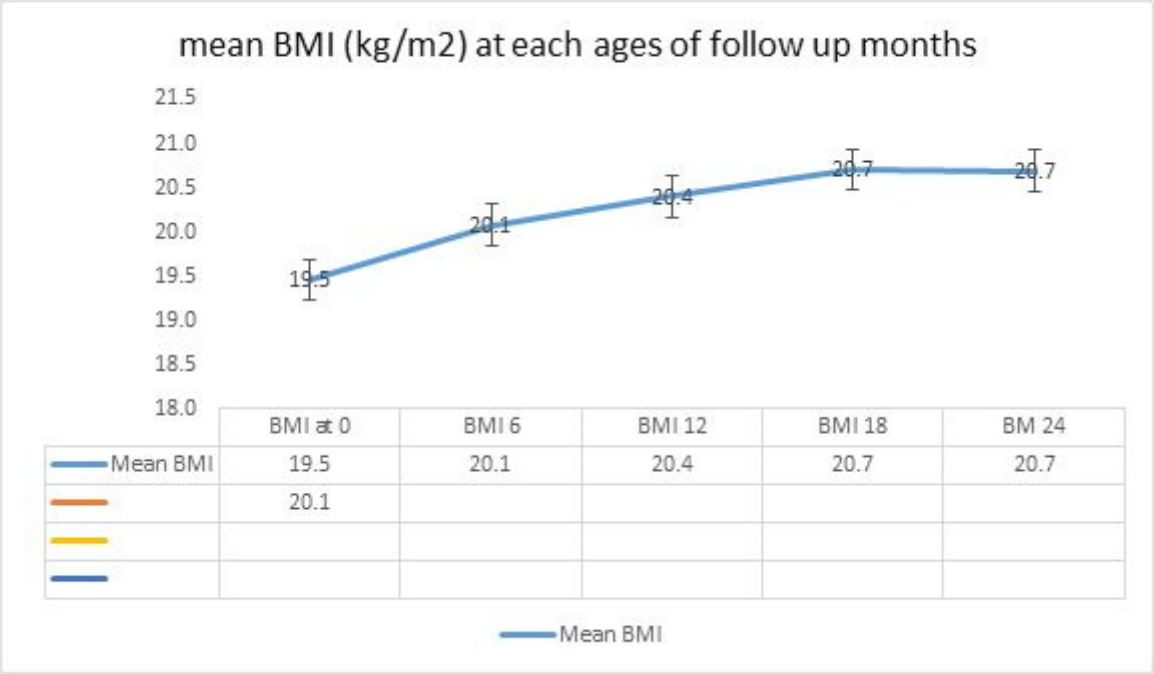

Figure 4

Mean BMI of Adult clients at different intervals of ART follow ups, Southwest Ethiopia, 2019

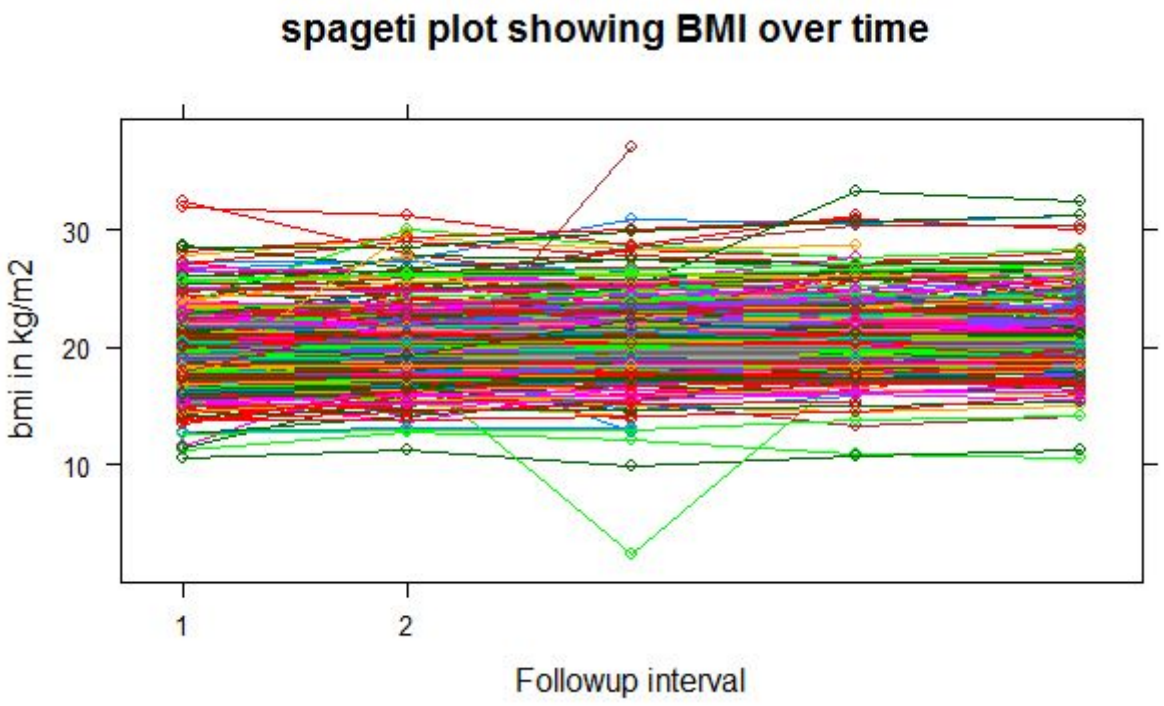

Figure 5

Spaghetti plot for BMI in kg/m2 along with follow up periods of Adult ART clients