Public Health in Practice 7 (2024) 100492

Contents lists available at ScienceDirect

Public Health in Practice

journal homepage: www.sciencedirect.com/journal/public-health-in-practice

Herbal medicines use among HIV/AIDS patients on antiretroviral therapy and its influence on viral suppression and CD4 count: A survey at a tertiary hospital in Tanzania

Karol J Marwa [a,*], Josephine Kadodo [b], Shabani Iddi [c], Anthony Kapesa [d]

[a] Department of Pharmacology, Catholic University of Health and Allied Sciences, Mwanza, Tanzania
[b] School of Pharmacy, Catholic University of Health and Allied Sciences, Mwanza, Tanzania
[c] Department of Physiology, Catholic University of Health and Allied Sciences, Mwanza, Tanzania
[d] School of Public Health, Catholic University of Health and Allied Sciences, Mwanza, Tanzania

ARTICLE INFO

Keywords:
Herbal medicines
HIV
Treatment outcomes and Tanzania

ABSTRACT

Objectives: This study aimed to determine the magnitude of concurrent use of herbal medicines with ART, its associated factors and effect on viral load suppression and CD4 count among people living with HIV.
Study design: This was a cross-sectional study involving 375 HIV positive patients on ART attending at care and treatment clinic (CTC).
Methods: Data were obtained through face-to-face interviews using pre-structured questionnaires and patient's files through a checklist. Adherence was assessed though pill count method while CD4 count and viral load suppression were assessed using the Tanzania National guidelines for the management of HIV and AIDS. Data were analysed using STATA version 15. Independent predictors for herbal medicine use or viral suppression were assessed using univariate and multivariate logistic regression.
Results: Out of 375 PLHIV, 37 (35%) reported to use herbal medicines concurrently with ART. Predictors for herbal medicines use were existence of chronic disease (OR = 4.53; CI = 1.87–10.95) (p = 0.001), male gender (OR = 0.57; CI = 0.35–0.93) (p = 0.02) and HIV clinical stage (OR = 1.71; CI = 0.99–2.94) (p = 005). PLHIV who used herbal medicines along with ART did not have a significantly higher chance of achieving viral suppression than PLHIV who did not use herbal medicines (OR = 1.42; CI = 0.71–2.82). There was no statistically significant difference on CD4 count (p = 0.8943) and viral load (p = 0.8612) between herbal medicines users and non-users.
Conclusion: The utilization of herbal medicine among PLHIV on ART remains notably prevalent. Nonetheless, it is worth noting that despite the prevailing herbal medicine usage, there is no substantial effect on viral suppression. The primary determinants of the adoption of herbal medicines use were having chronic medical conditions and the stage of progression of the HIV infection.

1. Background

Herbal medicine is defined as herbs, herbal materials, herbal preparations and finished herbal products that contain active ingredients, part of plants, other plant materials or combination thereof [1]. More than 80% of population in developing countries particularly in Africa and Asia use herbal medicine for various conditions/diseases [2] whereby the pooled prevalence estimates of herbal medicines use among people living with HIV (PLWH) is high up to 90% [3,4]. Studies in developing countries suggest that belief in traditional medicine among PLWH is very strong to the extent that some individuals would quit antiretroviral therapy (ART) for herbal medicine [5–7].

The major issue regarding the use of herbal medicines in HIV patients on ART is the potential for herbal-drug interactions whereby herbal drugs may alter the pharmacokinetics of antiretroviral drugs (ARVs) thus influencing the efficacy and safety of these drugs [8]. The mechanisms of herbal-drug interactions involves the possibility of herbal drugs to induce or inhibit drug metabolizing enzymes (CYP450 isoforms) and transporters (P-glycoproteins). Clinically significant herbal drug interactions among HIV/AIDS patients on ART have been reported in some

* Corresponding author.
E-mail address: carol_maro@yahoo.com (K. J Marwa).

https://doi.org/10.1016/j.puhip.2024.100492
Received 13 September 2023; Received in revised form 13 March 2024; Accepted 22 March 2024
Available online 4 April 2024
2666-5352/© 2024 The Authors. Published by Elsevier Ltd on behalf of The Royal Society for Public Health. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

African countries [8,9]. Worse enough, studies have indicated that, majority of HIV/AIDS patients using herbal medicines and ARVs concomitantly do not disclose this information to their health care providres when they attend routine clinic visits [10–12] thus may act as a confounder during the assessment of clinical and immunological outcomes during clinic visits.

A part from HIV/AIDS patients who use herbal medicines concurrently with ART being at a risk of experiencing treatment failure or toxicity, herbal-drug interactions may also be a source for sub-therapeutic drugs levels exposure to the virus thus posing a risk for resistance considering high level of mutations conferring resistance to first-line ART that have been recently reported in Tanzania and other countries [13,14] thus jeorpodazing the United Nations HIV/AIDS 95-95-95 global target by 2035 which aims at ensuring 95% of individuals on ART achieve significant viral suppression (<1000 copies/ml) and complete eradication of HIV epidemic is attained [15].

In Tanzania, more than half of the population use traditional medicines particularly herbal medicines for management of various diseases/conditions including HIV symptoms [16]. The country is estimated to have over 12,000 plant species and approximately 10% of these are used for medicinal purposes [17]. The influence of herbal medicines use among HIV patients taking ART on clinical outcomes is uncharacterized phenomenon globally as well as Tanzania. Hence, the objective of this study was to determine the prevalence of herbal medicines utilization and to assess its associated factors and potential impact on markers of immunological response and early clinical failure in individuals living with HIV/AIDS who are undergoing ART.

2. Methods

2.1. Study area and design

This was a cross-sectional study conducted at the Bugando Medical Centre (BMC) Care and Treatment Clinic (CTC). BMC is a consultant and teaching referral hospital for the Lake and Western zones of the United Republic of Tanzania serving Mwanza, Mara, Geita, Kagera, Kigoma, Simiyu Tabora and Shinyanga regions. The CTC department was started in 2004 and serves about 14,000 clients [18].

2.2. Study participants and sampling procedure

This study included HIV positive patients on ART at the CTC unit of BMC. We enrolled participants who returned to the clinic for ARV refills and medical evaluation based on clinical symptoms and immunological progress. An assumed prevalence of herbal medicines use of 50% was used since prevalence of herbal medicines use among PLHIV is unknown in the study area to obtain 384 participants using the Kish Leslie (1965) formula. A systematic sampling method was employed where by numbers were assigned on the daily patient register from 1 to 10; then all 1st, 3rd and 5th numbers were picked randomly. Patients who were represented by these numbers were included in the study up to when the sample size was reached. The picked participants were interviewed on the same date of their visit to the clinic. Data for nine particpants was not included in the analysis due to incompleteness of the information.

2.3. Data collection

Data were collected using a pre-tested structured (Swahili translated) questionnaire which was administered through face to face interviews after obtaining written consent from respondents. The questionnaire captured the information on the socio-demographic characteristics, magnitude of herbal use and predictors for herbal use practice.

Data comprising clinical diagnoses, ART initiation, adherence to ART, CD4 count and viral load were obtained from patient's files using a pre-tested checklist which was adopted from similar studies in other areas. Then, files were extracted by the data clerks while data was extracted by the principal investigator after file reviews. The questionnaire and checklist instruments can be found in additional file 1.

2.4. Assessment of adherence to ART

Data on adherence to ART was obtained from CTC records whereby pill count method was employed. Patients were required to provide all ART pills that were dispensed during the last clinic visit and the remaining pills from the prior visit. The formulas below were used in calculating adherence.

% of pills missed = (No. of pills remaining / Total No. of pills prescribed) x 100 %

adherence = 100 - % of pills missed.

Adherence <95% to ART was considered as poor adherence while adherence >95% to ART was considered as optimal adherence according to the Tanzania National guidelines for the management of HIV and AIDS.

2.5. Assessment of CD4 count and virological load suppression

In Tanzania, HIV viral load testing is usually done at six months after initiation of ART. Plasma HIV viral load ≥1000 copies/ml was regarded as virological failure while plasma HIV viral load < 1000 copies/ml was regarded as virological suppression. CD4 count ≤350 cells/mm^3 was defined as immunological failure as per the Tanzania National guidelines for the management of HIV and AIDS.

2.6. Statistical analysis

Data were analysed using STATA version 15 (Statistical Corporation, College Station, TX, US). Data were checked for errors, missing data and inconsistencies before the analysis. Chi-square and Fischer's exact tests were performed for determining association between categorical variables where appropriate. Demographic and socio-economic variables were assessed using logistic regression. The potential associations were assessed at univariate and multivariate level (using the multivariate model). Stepwise backward logistic regression was used to determine whether these variables were independent predictors for herbal medication use or viral suppression; odds ratios (OR) and 95% confidence intervals (95% CI) were reported as a measure of effect. Tests of significance were performed using the 0.05 level to infer significance.

3. Results

3.1. Characteristics of the study participants

A total of 375 PLHIV with a mean age of 39 years [Standard Deviation (SD): 0.7] were included in this study. Of the total, 132 (35%) used herbal medicines concomitantly with ART where by females were the most herbal medicines users 96 (72.7%). There were statistically significant difference in herbal medicine use between males and females (p = 0.047) (Table 1).

3.2. Factors associated with the use of herbal medicines

Having chronic medical conditions such as diabetes mellitus, peptic ulcer disease and hypertension, was significantly associated with herbal medicines use (p = 0.002). Other factors associated with the use of herbal medicines concurrently with ART therapy were gender (p = 0.047), area of residence (p = 0.036) and person caring stored drugs (p = 0.020) as shown in Table 1.

Having a with a chronic medical condition was a strong predictor for herbal medicines use (OR = 4.53; CI = 1.87–10.95; p = 0.001). Herbal medicines use concurrently with ART was less likely in males compared

Table 1
Sociodemographic characteristics of sudy participants.

Variable	Characteristic	Herbal medicine use		Chi 2	P-value
		Yes n (%)	No n(%)		
Sex	Female	96 (72.7)	152 (62.6)	2.0414	0.047
	Male	36 (27.3)	91 (37.4)		
Age (Years)	Mean	39.2			0.302
	Standard deviation	0.7			
Marital status	Married	71 (53.8)	138 (56.8)	0.3125	0.576
	Not married	61 (46.2)	105 (43.2)		
Family size	1–5	67 (50.8)	135 (55.6)	14.7758	0.097
	6–10	65 (49.2)	108 (44.4)		
Residence	Urban	107 (81.1)	218 (89.7)	6.6586	0.036
	Rural	25 (18.9)	25 (10.3)		
Care stored drugs	Me	122 (92.4)	240 (98.8)	11.6268	0.020
	Child	6 (4.5)	3 (1.2)		
	Relative	2 (1.5)	0 (0)		
	Mother	1 (0.8)	0 (0)		
	House girl	1 (0.8%)	0 (0)		
Occupation	Business	82 (62.2)	174 (71.6)	6.1601	0.406
	Student	14 (10.6)	19 (7.8)		
	Farming	12 (9.1)	14 (5.8%)		
	Unemployed	10 (7.6)	13 (5.3)		
	Fishing	6 (4.5)	15 (6.2)		
	Daily wage jobs	4 (3.0)	5 (2.1)		
	Employed	4 (3.0)	3 (1.2)		
Assets owned	House	37 (28.0)	67 (27.6)	7.0604	0.423
	Radio	78 (59.1)	153 (63.0)		
	Television	9 (6.8)	16 (6.6)		
	Car	0 (0)	1 (0.4)		
Sponsor	Myself	106 (80.3)	212 (87.2)	4.6333	0.201
	Father/mother	14 (10.6)	18 (7.4)		
	Insurance	3 (2.3)	6 (2.5)		
	Others	9 (6.8)	9 (3.7)		
Level of education	Primary	100 (75.7)	194 (79.9)	4.6713	0.323
	Secondary	22 (16.7)	37 (15.2)		
	Certificate/ diploma	7 (5.3)	9 (3.7)		
	University	0 (0)	2 (0.8)		
	Others	3 (2.3)	1 (0.4)		
Chronic medical condition	Yes	16 (12.2)	9(3.7)	9.7403	0.002
	No	116 (87.8)	238 (96.3)		

to females (OR = 0.57; CI = 0.35–0.93; p = 0.02). Patients on clinical stage 2 & 3 (OR = 1.71; CI = 0.99–2.94; p = 005) had higher odds of using herbal medicines compared to those on clinical stage 1 (OR = 1.71; CI = 0.95–3.09; p = 0.07). Patients on second line ART and who have used ART for more than 5 years had higher odds of using herbal medicines (OR = 1.71; CI = 0.42–6.81 & OR = 1.31; CI = 0.79–2.18 respectively) but this observed trend was not statistically significant (Table 2).

3.3. Types, sources and reasons for use of herbal medicines among PLHIV

For the purpose of this study, herbal medicine was considerd as plant parts used for medicinal purposes. The use of plant parts for food purposes was excluded in this definition. The major herbal medicines used by PLHIV concurrently with ART were *Allium sativum* (24.2%), *Zingiber officinale* (22.7%), *Moringa oleifera* (17.4%) and *Aloe vera* (14.4%). The most reported source of these herbal medicines was herbal shops accounting for 56.7%. The main reason for using herbal medicines concurrently with ART was to achieve combined effect of the two (56%) (Table 3).

3.4. Change in viral load and $CD4^+$ count among people using ART and herbal medicine

The findings of this study suggest lack of significant difference in the change of viral load and $CD4^+$ count among PLHV on concurrent use of ART with herbal medicine compared those using ART alone (Table 4).

3.5. Factors associated with viral suppression among PLHIV on ART

Patients on ART only had increased odds of archieveing viral suppression (OR = 1.42; CI = 0.71–2.82) compared to those who took ART and herbal medicines concurrently. Education level above primary education was a strong predictor of viral non-suppression in both models (OR = 0.47; CI = 0.23–0.92). Patients on advanced WHO HIV clinical stage (stage 4) had lower odds of archieving viral suppression than those on early stage of the disease (OR = 0.38; CI = 0.13–1.09) (Table 5).

4. Discussion

In this study, we identified the level of herbal medicines use and associted factors among PLHIV. The influence of herbal medicines use on CD4 improvement and viral load supression among these patients was also evaluated. Viral load measurement among PLHIV on ART every six months is essential in confirming viral replication and treatment failure (immunological and clinical) [19].

Herbal medicines use was high (35.2%) among PLHIV receiving ART at the CTC clinic in Tanzania. The documented prevalence of concurent herbal medicines and ART use among PLHIV receiving ART is similar to findings from urban areas in Ethiopia [11]. This similarity may be due to similarities in culture, lifestyle, beliefs and economic levels within these African populations. However, these findings are relatively low as compared studies done in Nigeria, Uganda and Kenya [20–22]. This discrespancy can be attributed to diferences in study populations where by most of participants in the present study were from urban area of Mwanza, City while in those previous studies, particpants were mainly from rural area. Studies have documented the use of herbal medicines to be higher in rural than urban populations [23,24].

The most commonly herbal medicines used concurrently with ART in our study population were *Allium sativum, Zingiber officinales, Moringa oleifera* and *Aloe vera.* These herbal medicines have been suggested to have various effects when taken concurrently with ARVs. *Allium sativum* has been suggested to lower plasma concentration of protease inhibitors such as saquinavir through its CYP450 enzymes inducing potential [25,26] while the suggested mechanism of *suMoringa oleifera* was inhibition of HIV replication [27] and inhibition of CYP450 enzymes mainly CYP3A4 [28] thus could influence plasma levels of ARV used in clinical practice.

The findings fromthis study suggest that having chronic medical conditions such as diabetes mellitus, peptic ulcer disease and hypertension, is significantly associated with herbal medicines use among

Table 2
Factors associated with herbal medicines use among PLHIV on ART.

Variable	Category	Univariate analysis			Multivariate analysis		
		cOR	95% CI	P Value	aOR	95% CI	P Value
Clinical stage	1	Ref	.	.	Ref	.	.
	2	1.65	0.97–2.80	0.06	1.71	0.99–2.94	0.05
	3	1.77	1.01–3.10	0.04	1.71	0.95–3.09	0.07
	4	1.19	0.56–2.53	0.64	1.04	0.46–2.29	0.93
Regimen	First line	Ref	.	.	Ref	.	.
	Second line	1.48	0.39–5.63	0.56	1.71	0.42–6.81	0.45
Chronic disease	No	Ref	.	.	Ref	.	.
	Yes	3.58	1.53–8.36	0.003	4.53	1.87–10.95	0.001
Education	Primary	1	.	.	1	.	.
	Above primary	0.86	0.53–1.41	0.57	0.83	0.49–1.37	0.46
Sex	Female	Ref	.	.	Ref	.	.
	Male	0.63	0.40–1.01	0.057	0.57	0.35–0.93	0.02
Duration on ART	0–5 years	Ref	.	.	Ref	.	.
	>5 years	1.44	0.89–2.32	0.13	1.31	0.79–2.18	0.28
Viral suppression	Yes	Ref			Ref		
	No	1.23	0.64–2.36	0.52	1.41	0.71–2.78	0.328

Table 3
Herbal medicines used, sources, types of preparation used and reasons among PLHIV.

Herbal medicines used	Frequency (n)	Percentage (%)
Allium sativum (Alliaceae)	32	24.2
Zingiber officinales (Zingiberaceae)	30	22.7
Moringa oleifera	23	17.5
Aloe vera (Aloaceae)	19	14.4
Others	28	21.2
Total	132	100
Source of herbal medicines		
Herbal medicine shops	75	57.3
Others	44	33.6
Traditional healer	12	9.1
Total	131	100
Type of preparation		
Mixed preparation	49	37.1
Leaves	42	31.8
Roots	33	25
Others	8	6.1
Total	132	100
Reason for using herbal medicines		
Combining effects	76	57.6
ARV side effects	19	14.3
Conviced by fellow patient or HCWs	31	23.5
Others	6	4.6
Total	132	100

Table 4
Viral load and CD4 count among PLHIV using herbal medicines compared to those not using herbal medicines.

SN	Variable	Herbal medicine use		95% Conf. Interval	P-value
		Yes	No		
		Mean	Mean		
1	CD4 starting (cells/mm^3)	365.75	368.96	−49.00 to 55.42	0.54
2	CD4 during treatment (cells/mm^3)	423.07	505.35	−47.91 to 212.49	0.89
3	Viral load starting (copies/ml)	8961.25	2734.47	−11013.48 to −1440.07	0.99
4	Viral during in midline time (copies/ml)	4165.89	1189.69	−5899.24 to −53.15	0.97
5	Current Viral load (copies/ml)	1533.42	651.90	−2475.5 to 712.45	0.86

PLHIV on ART. This corresponds to a study in Thailand which reported high use of herbal medicines among patients with chronic diseases [23]. The present study has also reported higher odds of herbal medicines use concurrently with ART therapy in females. This could be explained by difference in health seeking behaviour between the genders in the population whereby more females tend to attend to health facility for consultation than males.

Moreover, our current study implies that patients with the advanced stage of the diseases have higher odds of using herbal medicines which may possibly be due to side effects of ART or an increase in opportunistic infections and lower odds of viral suppression compared to those in the early clinical stage. Patients on second line ART had higher odds of using herbal medicines than those on the first line although this observed trend was not statistically significant. Patients are normally switched to second line whenever there is failure in treatment or severe adverse effects, therefore patients may be tempted to look for an alternative treatment due to the treatment outcomes. Duration of ART use was a strong predictor for herbal medicine use although this observed trend was not statistically significant.

To rule out the influence of ART adherence on immunological and clinical outcomes, the ART adherence was evalauted. The present study reports a good adherence among patients who used ART and herbal medicines concurently and those who use ART alone regardedless of the disease stage. The lack of difference in adherence between the two groups indicates lack of influence of adherence in the reported results between herbal medicines users and non users.

Despite the high use of herbal medicines among PLHIV on ART, viral suppression remained significantly high among patients who used herbal medicines concurrently with ART and those who used ART only (Table 5) suggesting insignificant influence of herbal medicines use on viral load supression in the study area. This finding is encouraging taking into account herbal medicines use has been reported to result into poor viral supression among patient on ART in other areas in Africa.

The observation on similar viral suppression in herbal users and non users is supported by the mean CD4 count and mean viral load between the two groups. Whereby there was no statistically significant difference between PLHIV using on herbal medicines cocurrently with ART and those on ART only. However, it is worth to note that, although there was no statistically significant difference, an interesting trend was observed for the viral load. Patients using ART concurrently with herbal medicines had higher initial viral load and viral load after six months than their counterpart (Table 4) implying that herbal medicines could still have an effect on viral load suppression.

The lack of differences in the viral load supression and CD4 cell

Table 5
Factors associated with viral suppression among PLHIV on ART.

Variable	Category	Univariate analysis			Multivariate analysis		
		cOR	95% CI	P Value	aOR	95% CI	P Value
Clinical stage	1	Ref	.	.	Ref		.
	2	0.69	0.31–1.56	0.37	0.71	0.31–1.62	0.41
	3	0.72	0.30–1.72	0.46	0.71	0.28–1.76	0.46
	4	0.46	0.17–1.24	0.12	0.38	0.13–1.09	0.07
Herbal medicines	Yes	Ref	.	.	Ref		.
	No	1.23	0.64–2.36		1.42	0.71–2.82	0.31
Chronic disease	Yes	Ref			Ref	.	.
	No	0.31	0.04–2.31	0.25	0.24	0.03–1.93	0.18
Education	Primary	Ref			Ref		
	Above primary	0.45	0.23–0.88	0.02	0.47	0.23–0.92	0.03
Sex	Female	Ref			Ref		
	Male	0.66	0.35–1.28	0.22	0.65	0.33–1.28	0.21
Duration on ART	0–5 years	Ref			Ref		
	>5 years	1.45	0.75–2.82	0.26	1.40	0.68–2.81	0.35

improvement between herbal medicines users and non users may also suggest lack of significant herbal medicines-ART interaction(s) in the study area. The use of herbal medicines is a function of belief, it could be that, these medicines have little or do not have any effect on immunological or clinical outcomes among PLHIV.

This study was limited by the fact that the proportion of virally suppresed PLHIV was obtained among those who had viral load records since not all participant files had viral load records thus the viral suprresion proportion may have been over estaimated or underestimated. Furthermore, there was a potential for recall bias since the herbal medicine details were obtained from face-to-face interviews. In Tanzania, HIV viral load testing is usually done at six months after initiation of ART therefore changes in VL and CD4 with time could not be established in the present study. Lastly, The dose of herbal medicines taken and the influence of individual genetics which could substantially modify ART effect on viral suppression were not etablished in this retrospective study.

5. Conclusion

The concurrent use of herbal medicines alongside ART is high among PLHIV attending CTC in the study area. However, immunological and clinical outcomes were not compromised by herbal medicines use among PLHIV on ART suggesting a lack of pharmacological effect or herbal medicines-ART interactions for the herbal medicines used in this setting.

Authors' contributions

JK participated in proposal development, data collection and manuscript drafting. KJM played a key role in concept development, supervision of the data collection, data analysis and manuscript drafting. AK and SI contributed in concept development, data analysis and revising the manuscript for submission.

Funding

This work was technically supported by the Catholic University of Health and Allied Sciences and Bugando Medical Centre. No grant was received.

Ethical approval and consent to participate

Ethical and study approval was granted by the joint Catholic University of Health and Allied Sciences (CUHAS)/Bugando Medical Centre (BMC) Institutional Review Board. All patients or parent/guardian signed a written informed consent.

Consent for publication

Written consent was obtained from all study participants after clarification on the objectives of the study and their right to quit the study without compromising the clinical care provided to them.

Declaration of competing interest

All authors declare to have no competing interests.

Acknowledgements

We sincerely thank study participants,nurses,pharmacists and medical doctors at the CTC for their valuable cooperation and inputs during the study period.

Abbreviations

ACT	Artemisinin-based combination therapy
ART	antiretroviral therapy
ARVs	antiretroviral drugs
BMC	Bugando Medical Centre
CTC	care and treatment clinic
PLHIV	people living with HIV
WHO	World Health Organization

References

[1] Organization WH, WHO Global Report on Traditional and Complementary Medicine 2019, World Health Organization, 2019.
[2] G. Tesfahuneygn, G. Gebreegziabher, Medicinal plants used in traditional medicine by Ethiopians: a review article, J Respir Med Lung Dis 4 (1) (2019) 1–3.
[3] J.P. Liu, E. Manheimer, M. Yang, Herbal medicines for treating HIV infection and AIDS, Cochrane Database Syst. Rev. (3) (2005).
[4] A. Lorenc, N. Robinson, A review of the use of complementary and alternative medicine and HIV: issues for patient care, AIDS patient care and STDs 27 (9) (2013) 503–510.
[5] M. Roura, J. Busza, A. Wringe, D. Mbata, M. Urassa, B. Zaba, Barriers to sustaining antiretroviral treatment in Kisesa, Tanzania: a follow-up study to understand attrition from the antiretroviral program, AIDS patient care and STDs 23 (3) (2009) 203–210.
[6] M. Musheke, V. Bond, S. Merten, Individual and contextual factors influencing patient attrition from antiretroviral therapy care in an urban community of Lusaka, Zambia, J. Int. AIDS Soc. 15 (2012) 17366.
[7] I.N. Azia, F.C. Mukumbang, B. Van Wyk, Barriers to adherence to antiretroviral treatment in a regional hospital in Vredenburg, Western Cape, South Africa, South. Afr. J. HIV Med. 17 (1) (2016) 1–8.
[8] P.S. Fasinu, B.J. Gurley, L.A. Walker, Clinically relevant pharmacokinetic herb-drug interactions in antiretroviral therapy, Curr. Drug Metabol. 17 (1) (2015) 52–64.
[9] E. Mills, B.C. Foster, R. van Heeswijk, E. Phillips, K. Wilson, B. Leonard, K. Kosuge, I. Kanfer, Impact of African herbal medicines on antiretroviral metabolism, Aids 19 (1) (2005) 95–97.

[10] B.M. Shelley, A.L. Sussman, R.L. Williams, A.R. Segal, B.F. Crabtree, 'They don't ask me so I don't tell them': patient-clinician communication about traditional, complementary, and alternative medicine, Ann. Fam. Med. 7 (2) (2009) 139–147.
[11] A. Shiferaw, A.M. Baye, W. Amogne, M. Feyissa, Herbal medicine use and determinant factors among HIV/AIDS patients on antiretroviral therapy in tikur anbessa specialized hospital, Addis Ababa, Ethiopia, HIV/AIDS-Research and Palliative Care (2020) 941–949.
[12] K.T. Haile, A.A. Ayele, A.B. Mekuria, C.A. Demeke, B.M. Gebresillassie, D.A. Erku, Traditional herbal medicine use among people living with HIV/AIDS in Gondar, Ethiopia: do their health care providers know? Compl. Ther. Med. 35 (2017) 14–19.
[13] R.Z. Sangeda, P. Gómes, S.-Y. Rhee, F. Mosha, R.J. Camacho, E. Van Wijngaerden, E.F. Lyamuya, A.-M. Vandamme, Development of HIV drug resistance in a cohort of adults on first-line antiretroviral therapy in Tanzania during the stavudine era, Microbiol. Res. 12 (4) (2021) 847–861.
[14] N. Mbhele, B. Chimukangara, M. Gordon, HIV-1 integrase strand transfer inhibitors: a review of current drugs, recent advances and drug resistance, Int. J. Antimicrob. Agents 57 (5) (2021) 106343.
[15] HIV/AIDS JUNPo: Understanding Fast-Track: Accelerating Action to End the AIDS Epidemic by 2030, June 2015. Geneva, Switzerland).
[16] J.W. Stanifer, U.D. Patel, F. Karia, N. Thielman, V. Maro, D. Shimbi, H. Kilaweh, M. Lazaro, O. Matemu, J. Omolo, The determinants of traditional medicine use in northern Tanzania: a mixed-methods study, PLoS One 10 (4) (2015) e0122638.
[17] R. Mahunnah, F. Uiso, E. Kayombo, Documentation of Traditioanal Medicine in Tanzania: A Traditioanal Medicine Resource Book, vol. 8, Dar es Salaam University Press, Dar es Salaam–Tanzania, 2012.
[18] D.W. Gunda, S.B. Kilonzo, T. Mtaki, D.M. Bernard, S.E. Kalluvya, E.R. Shao, Magnitude and correlates of virological failure among adult HIV patients receiving PI based second line ART regimens in north western Tanzania; a case control study, BMC Infect. Dis. 19 (1) (2019) 1–7.
[19] Organization WH: WHO, in: Consolidated Guidelines on the Use of Antiretroviral Drugs for Treating and Preventing HIV Infection, vol. 2021, WHO Geneve, Suisse, 2016.
[20] A.U. Idung, F. Abasiubong, Complementary and alternative medicine use among HIV-infected patient's on anti-retroviral therapy in the Niger Delta Region, Nigeria, Clin. Med. Res. 3 (5) (2014) 153–158.
[21] S. Lubinga, A. Kintu, J. Atuhaire, S. Asiimwe, Concomitant herbal medicine and Antiretroviral Therapy (ART) use among HIV patients in Western Uganda: a cross-sectional analysis of magnitude and patterns of use, associated factors and impact on ART adherence, AIDS Care 24 (11) (2012) 1375–1383.
[22] J.M. Nagata, A.R. Jew, J.M. Kimeu, C.R. Salmen, E.A. Bukusi, C.R. Cohen, Medical pluralism on Mfangano Island: use of medicinal plants among persons living with HIV/AIDS in Suba District, Kenya, J. Ethnopharmacol. 135 (2) (2011) 501–509.
[23] K. Peltzer, S. Pengpid, The use of herbal medicines among chronic disease patients in Thailand: a cross-sectional survey, J. Multidiscip. Healthc. (2019) 573–582.
[24] O. Henke, W. Bruchhausen, A. Massawe, Use of herbal medicine is associated with late-stage presentation in Tanzanian patients with cancer: a survey to assess the utilization of and reasons for the use of herbal medicine, JCO Global Oncology 8 (2022) e2200069.
[25] F. Borrelli, R. Capasso, A.A. Izzo, Garlic (Allium sativum L.): adverse effects and drug interactions in humans, Mol. Nutr. Food Res. 51 (11) (2007) 1386–1397.
[26] S.C. Piscitelli, A.H. Burstein, N. Welden, K.D. Gallicano, J. Falloon, The effect of garlic supplements on the pharmacokinetics of saquinavir, Clin. Infect. Dis. 34 (2) (2002) 234–238.
[27] V. Sangar, L. Samant, S. Pawar, S. Vaidya, A. Chowdhary, In silico approach to combat HIV using phytoconstituents of Moringa oleifera Lam, J. Chem. Pharmaceut. Res. 7 (2015) 997–1021.
[28] T.G. Monera, A.R. Wolfe, C.C. Maponga, L.Z. Benet, J. Guglielmo, Moringa oleifera leaf extracts inhibit 6β-hydroxylation of testosterone by CYP3A4, Journal of infection in developing countries 2 (5) (2008) 379.