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Xerostomia and associated factors among adults with HIV on HAART attending voluntary counseling and testing (VCT) clinics in Dar Es Salaam

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Abstract

Background Adequate saliva quantity and quality are necessary for proper oral function and protection. Xerostomia, or dry mouth, is a common complaint among people living with HIV (PLHIV) which increases their risk of acquiring oral diseases. This study aimed to assess the magnitude of xerostomia and the associated factors in this group of patients.

Methods A descriptive cross-sectional hospital-based study was conducted among 420 PLHIV on highly active antiretroviral therapy (HAART) aged 18 years and above. Informed consent was obtained from the participants during data collection. The xerostomia was assessed using a questionnaire. Pearson's χ^2 test was used to correlate independent (sociodemographic factors, oral health-related, and HIV-related factors) and dependent variables (xerostomia). Univariate and adjusted multinomial logistic regression were used to determine the odds ratio (OR) of xerostomia.

Results Xerostomia was observed in 36.3% of the respondents. The chi-square test showed a significantly higher proportion of xerostomia among the unemployed ($p=0.014$), those who were HIV diagnosed up to five years ($p=0.014$), and those having $CD4^+$ counts ≥ 500 cells/ mm^3 ($p=0.03$). In multivariate analysis, higher odds of having xerostomia were found among participants with higher viral load (OR = 2.6; CI = 1.07–6.3), whereas lower odds were found among self-employed participants (OR = 0.48; CI = 0.28–0.82) and employed participants (OR = 0.52; CI = 0.27–0.98).

Conclusion The prevalence of xerostomia is moderately high among PLHIV. Higher viral load and unemployment were the associated factors with xerostomia. Low $CD4^+$ counts, duration of HAART use, and HAART regime were not associated with xerostomia.

Keywords Xerostomia, People living with HIV (PLHIV), Highly active antiretroviral therapy, Antiretroviral therapy, Tanzania

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Introduction

The life expectancy of people living with HIV (PLHIV) who are on antiretroviral therapy (ART) has increased significantly over the past 25 years [1]. With the advent of ART, HIV-related deaths have declined, and HIV infection has evolved from a life-threatening illness to a manageable chronic condition [2]. The incidence of oral lesions, including candidiasis, oral hairy leukoplakia, and Kaposi's sarcoma in this group of patients significantly decreased after the introduction of HAART [3]. Despite these positive aspects, PLHIV still experiences various challenges, such as HIV-related complications, co-morbidities, and ART-related side effects [4, 5]. The current literature also suggests that oral conditions such as dental caries [6, 7] and periodontal disease [8, 9] have increased in PLHIV. PLHIV also are at risk of developing salivary hypofunction [10].

Saliva is a complex oral fluid that has a crucial role in maintaining the integrity of the oral environment. It lubricates the oral tissues and thus prevents oral mucosa erosions and ulceration during mastication. It also contains many proteins and peptides with antibacterial, antiviral, and antifungal properties, which help maintain a balanced oral microbiome and prevent systemic infections. Additionally, saliva buffers acids, aiding in the remineralization of the enamel [11]. Xerostomia is the subjective feeling of oral dryness experienced by an individual. It does not always coincide with salivary gland dysfunction, an objective disease characterized by reduced salivary flow [12]. Symptoms of xerostomia include a burning sensation, speech difficulties, taste disturbances, swallowing difficulties, and bad breath. On examination, xerostomia may show dry buccal mucosa, glossitis, cracked and peeled lips, oral candidiasis, and dental caries [12]. Xerostomia can arise from several factors, which include the side effects of certain medications, alcohol and drug abuse, and radiation therapy of the head and neck region [12].

Xerostomia is a common complaint among PLHIV; with a prevalence rate ranging from 1.2 to 63%, depending on the specific characteristics of the population and geographical location studied [9, 10, 13–18]. HIV infiltration and CD8 + T lymphocyte proliferation in the salivary glands, along with the effects of HAART, are thought to contribute to reduced quality and quantity of salivary flow [19]. Furthermore, the frequent occurrence of co-morbidities like cardiac disease, diabetes, and mental health disorders along with the use of medications to treat these conditions, can also lead to xerostomia [4, 5]. Additionally, sociodemographic factors have been found to influence the prevalence and severity of xerostomia in PLHIV through interacting with the underlying pathophysiology of HIV infection and its treatments [10, 18]. Consequently, PLHIV are at an increased risk of oral diseases such as candidiasis, dental caries, and periodontal diseases [19–21]. Also, xerostomia can make it difficult for PLHIV to take necessary medications and affect proper nutrient intake, leading to malnutrition, ultimately negatively impacting the overall health and quality of life [22].

There is limited research on xerostomia, along with associated factors, among people living with HIV, especially in low and middle-income countries. In addition to individual characteristics and oral health-related behaviors, our interests were to asses HIV-related factors and xerostomia among people living with HIV. Understanding the variables linked to xerostomia is essential because saliva is critical in protecting oral tissues and influencing oral health-related quality of life. To our knowledge, there is no retrievable data in Tanzania on xerostomia among people living with HIV. Therefore, the objective of this study was to determine the prevalence of xerostomia among people living with HIV and to assess individual factors, oral health-related, and HIV-related factors associated with xerostomia.

Methodology

Study design

This cross-sectional study was conducted at two regional referral hospitals (Temeke and Mwananyamala), which receive patients from all over Dar es Salaam, Tanzania, and the Muhimbili National Referral Hospital, where patients from different parts of the country are attended. These medical facilities offer free public health HIV-AIDS care services, including HIV diagnostic tests. Once the HIV diagnosis is confirmed, the hospitals also offer the patients antiretroviral medications and laboratory tests for HIV monitoring.

Ethics approval and consent to participate

This study was conducted per the ethical standards outlined in the Declaration of Helsinki. The Muhimbili University of Health and Allied Sciences (MUHAS) Higher Degrees Research and Publications Committee granted the ethical approval via a letter Ref. No. DA.282/298/01.C/383 of 7th October 2020 before starting the study. Before signing the consent, each participant received a detailed oral explanation of the study's nature and purpose. Written informed consent was obtained from all participants before their involvement in the study.

Participants and personal data

The sample size was calculated to achieve a statistical power of 80%, a confidence level of 95%, an estimated prevalence of 50%, and a marginal error of 5%. The minimum number of required participants was 384; the study included a total of 427 HIV seropositive individuals. In

this study, a consecutive sampling method was employed to recruit participants. Every PLHIV who visited the hospitals mentioned above during the data collection period (December 2020 to March 2021) and met inclusion criteria was included in the study until the target sample size was reached. The inclusion criteria were patients who were HIV seropositive aged 18 years or older. The exclusion criteria included patients diagnosed with congenital salivary gland diseases, those who refused to complete the consent form, or those who could not respond adequately to the questions for any compelling reason.

All the participants were given a detailed oral explanation of the study's nature and purpose before signing a written consent form. A structured questionnaire prepared in English, translated into Swahili, and then pretested was used to collect information about sociodemographic (sex, age, education, occupation, and residence) and oral health-related behaviors (frequency of tooth brushing, use of fluoridated toothpaste, frequency of sugary- containing foods consumption, use of dental floss, and dental visits).

Clinical data

Data on HIV-related characteristics (latest $CD4^+$ counts, duration since HIV diagnosis and duration of HAART, latest viral load, and type of HAART class used) were obtained from the patient's hospital records. The $CD4^+$ count was categorized according to WHO guidelines into low (< 200 cells/ mm^3), medium (200–499 cells/ mm^3), and normal (≥ 500 cells/ mm^3). Viral load was classified as (< 40 cps/mL), (40–399 cps/mL), and (≥ 400 cps/mL). Duration after HIV diagnosis and duration on HAART were expressed in years. The antiretroviral drugs were categorized according to their type of mechanisms of action, which include non-nucleoside reverse transcriptase inhibitors (NNRTIs), nucleoside reverse transcriptase inhibitors (NRTIs), protease inhibitors (PIs), and integrase inhibitors (INSTIs).

Table 1 Sociodemographic characteristics of the study population

Sociodemographic characteristics	Categories	*n* (%)
Age (mean ± SD) years	45.4 ± 11.0	
Age groups, years	≤ 46	226 (53.8)
	> 46	194 (46.2)
Sex	Male	121 (28.8)
	Female	299 (71.2)
Level of Education	Primary or less	286 (68.1)
	Secondary or higher	134 (31.9)
Employment status	Not employed	91 (21.7)
	Self-employed	237 (56.4)
	Employed	92 (21.9)
Residence	Temeke	129 (30.7)
	Kinondoni	116 (27.6)
	Ilala	82 (19.5)
	Ubungo	61 (14.5)
	Kigamboni	5 (1.2)
	Others	27 (6.4)

Assessment of Xerostomia

Xerostomia was assessed using subjective symptoms consisting of four yes-or-no questions as described by Sreebny and colleagues [23]. The questions are as follows: "1. Do you use chewing gum daily to alleviate the feeling of mouth dryness?", "2. Do you regularly do things to keep your mouth moist?", "3. Do you get out of bed at night to drink fluids?", "4. Does your mouth usually become dry when you speak?". A response of YES to any of the questions was regarded as a dry mouth experience (xerostomia).

Data analysis

We performed a descriptive and inferential analysis of the primary and secondary outcomes and factors associated with them. Categorical data were summarized using frequency counts and percentages, whereas continuous variables were summarized with mean and standard deviation. A chi-square test or Fisher's exact test was used to test the association between categorical values and the prevalence of xerostomia. Univariate and multivariate logistic regression were used to assess the factors influencing the prevalence of xerostomia. A variable with a p-value of less than 20% in univariate analysis was considered for inclusion in multivariate analysis. A backward elimination, with the help of a likelihood ratio test at a p-value of 5%, was used to keep the variable in the final model. The analysis was done using STATA (version 18; Stata Corp, College Station, TX, USA), and R Statistical Software (version 3.4.3, https://www.r-project.org/) was used for graphical analysis.

Results

Sociodemographic characteristics of the participants

A total of 427 HIV participants were screened. Seven participants were removed because they had not initiated ARV drugs. The statistical analysis included 420 participants, of whom 121 (28.8%) were males. The age range of the participants was 18–77 years, with a mean age of 45.4 years with a standard deviation of ± 11.0. More than half (53.8%) of the participants were 46 years old or less. Most (68.1%) of the study participants had a primary or lower education level, and those who reported being self-employed accounted for 56.4%. The majority (30.7%) of the participants came from Temeke district. The data on the demographic characteristics of the study participants is presented in Table 1.

Oral health behavior and HIV-related characteristics of the participants

Table 2 presents the characteristics of participants related to their oral health behavior and HIV status. Most (62.1%) participants reported brushing their teeth at least twice daily while 91.0% used fluoridated toothpaste. Four hundred and nine (97.4%) of participants reported that they had never used dental floss. Only 21 (5.0%) of the participants had never used sugar-containing foods and the majority (59.0%) reported using sugar-containing foods weekly. Only 42 (10.0%) of the participants visited a dentist in less than a year. The majority (62.9%) of the participants had their last visit to a dentist in more than a year, and 27.1% had never visited a dentist.

One hundred and seventy-one (40.7%) of participants were HIV infected for 6 to 10 years, while 106 (25.2%) were infected for more than 10 years. Ninety-seven (41.1%) participants had CD4 counts of a minimum of 500 cells/mm³. Twenty-three (5.9%) participants had a viral load of 400 cps/cells or more. Most (71.2%) of the participants used the NRTIs/INSTIs combination of HAART.

Table 2 Oral health behaviors and HIV-related characteristics of the participants

Parameter	Categories	*n* (%)
Oral health-related behaviors		
Tooth brushing frequency, *n* = 420	Once a day or less	159 (37.9)
	Twice more per day	261 (62.1)
Use of fluoridated toothpaste, *n* = 420	Yes	382 (91.0)
	No	38 (9.0)
Use toothpicks, *n* = 420	Yes	306 (72.9)
	No	114 (27.1)
Use dental floss, *n* = 420	Yes	11 (2.6)
	No	409 (97.4)
Frequency of sugar-containing foods, *n* = 420	Never	21 (5.0)
	Once per day	151 (36.0)
	Weekly	248 (59.0)
Last dental visit (years), *n* = 420	Never	114 (27.1)
	Less than a year	42 (10.0)
	More than a year	264 (62.9)
HIV related characteristics		
Duration of infection (years), *n* = 420	≤ 5	143 (34.1)
	6–10	171 (40.7)
	> 10	106 (25.2)
Duration of HAART (years), *n* = 420	≤ 3	89 (21.2)
	> 3	331 (78.8)
CD4 counts (cells/ mm³), *n* = 236	< 200	37 (15.7)
	200–499	102 (43.2)
	≥ 500	97 (41.1)
Viral load (cps/mL), *n* = 388	< 40	298 (76.8)
	40–399	67 (17.3)
	≥ 400	23 (5.9)
Type of HAART class used, *n* = 420	NRTIs/INSTIs	299 (71.2)
	NRTIs/NNRTs	104 (24.8)
	NRTIs/PIs	17 (4.0)

Values are reported as n (%); % can be more or less than 100 due to rounding error

Prevalence of Xerostomia

The proportion of participants with xerostomia was 36.7% and was significantly higher among participants with no employment, (p-value = 0.014), Table 3. Moreover, a significantly higher proportion of xerostomia was observed among the participants who were infected for up to 5 years (p-value = 0.014), and those with CD4 counts ≥ 500 cells/ mm³ (p-value = 0.03), compared to their counterparts, Table 3.

Factors associated with Xerostomia

The results from logistic regression on the factors associated with xerostomia are presented in Table 4. After controlling for employment status and viral load, participants residing in Ilala had significantly higher odds of xerostomia (odds ratio = 2.09, p-value = 0.021) than participants from Temeke. After controlling for residence and viral load, self-employed participants had 52% less odds of xerostomia (odds ratio = 0.48, p-value = 0.007) than participants without formal employment. Furthermore, employed participants had 48% less odds of xerostomia (odds ratio = 0.52, p-value = 0.042) compared to participants who had no formal employment. After controlling for residence and employment status, participants who presented with a viral load of at least 400 (cps/mL) had higher odds (odds ratio = 2.6, p-value = 0.034) of having xerostomia compared to participants who had a viral load of less than 40 cps/mL. In univariate analysis, participants who were infected for 6–10 years had 49% decreased odds of xerostomia (odds ratio = 0.51, p-value = 0.005) compared to those who were infected up to 5 years. However, in multivariate analysis, this association was not significant. Similarly, participants with CD4 counts of 200–499 cells/ mm³ had a 52% decrease in odds of xerostomia (odds ratio = 0.48, p-value = 0.014) compared to participants with CD4 counts of ≥ 500 cells/ mm³. This association was also not significant in multivariate analysis.

Discussion

In the present study which evaluated xerostomia among adults with HIV on HAART, the prevalence of xerostomia was found to be 36.8%. These findings are close to previous reports which reported a prevalence of xerostomia of 30% and 39.0% respectively among HIV-positive individuals on care [18, 24]. Research has shown that HIV infection and the use HAART regime affects salivary gland function resulting in reduced salivary flow

Table 3 Xerostomia according to sociodemographic characteristics, oral health behaviors, and HIV-related factors

Variable		Xerostomia	No Xerostomia	
		n **= 154 (36.7%)**	***n*** **= 266 (63.3%)**	***p*****-value**
Patient demographics				
Age groups	≤ 46 years	83 (36.7%)	143 (63.3)	0.978
	> 46 years	71 (36.6)	123 (63.4)	
Sex	Male	45 (37.2)	76 (62.8)	0.887
	Female	109 (36.5)	190 (63.5)	
Residence	Temeke	40 (31.0)	89 (67.0)	0.03
	Kinondoni	37 (31.9)	79 (68.1)	
	Ilala	37 (45.1)	45 (58.9)	
	Ubungo	22 (36.1)	39 (63.9)	
	Others*	18 (56.2)	14 (43.8)	
Level of Education	Primary or less	99 (34.6)	187 (65.4)	0.202
	Secondary or higher	55 (40.0)	79 (59.0)	
Employment status	Not employed	45 (49.4)	46 (50.6)	0.014
	Self-employed	76 (32.1	161 (67.9)	
	Employed	33 (35.9)	59 (64.1)	
Oral health-related behaviors				
Tooth brushing frequency	Once a day or less	67 (42.1)	92 (57.9)	0.069
	Twice or more per day	87 (33.3)	174 (66.7)	
Use of fluoridated toothpaste	Yes	135 (35.3)	247 (64.7)	0.074
	No	19 (50.0%)	19 (50.0%)	
Use toothpicks	Yes	111 (36.3)	195 (63.7)	0.785
	No	43 (37.7)	71 (62.3)	
Use dental floss	Yes	3 (27.3)	8 (72.7)	0.512
	No	151 (36.9)	258 (63.1)	
Frequency of sugar-containing foods.	Never	9 (42.9)	12 (57.1)	0.666
	Once per day	58 (38.4)	93 (61.6)	
	Weekly	87 (35.1)	161 (64.9)	
Last dental visit	Never	40 (35.1)	74 (64.9)	0.255
	Less than a year	11 (26.2)	31 (73.8)	
	More than a year	103 (39.0)	161 (61.0)	
HIV related characteristics				
Duration of infection (years)	≤ 5	63 (44.1)	80 (55.9)	0.014
	6–10	49 (28.6)	122 (71.4)	
	> 10	42 (39.6)	64 (60.4)	
Duration of HAART (years)	≤ 3	39 (43.8)	50 (56.2)	0.115
	> 3	115 (34.7)	216 (65.3)	
CD4 counts (cells/ mm^3)	< 200	11 (29.7)	26 (70.3)	0.03
	200–499	30 (29.4)	72 (70.6)	
	≥ 500	45 (46.4)	52 (53.6)	
Viral load (cps/mL)	< 40	106 (35.6)	192 (64.4)	0.106
	40–399	22 (32.8)	45 (67.2)	
	≥ 400	13 (56.5)	10 (43.5)	
Type of HAART class used	NRTIs/INSTIs	113 (37.8)	186 (62.2)	0.16
	NRTIs/NNRTIs	32 (30.8)	72 (69.2)	
	NRTIs/PIs	9 (52.9)	8 (47.1)	

p-values were derived from the Chi-square or Fisher's exact test when more than 20% of cells have expected frequency < 5

and xerostomia [19]. Higher prevalence rates of xerostomia, reported at 60.4% and 59% among people living with HIV, have been documented in other studies [9, 10]. The variability observed in different studies may be influenced by factors such as the characteristics of the population under investigation and the geographic location of the study. Xerostomia has consequences in the life of the affected individuals, including disturbances in swallowing food, which often lead to diminished quality of life.

Although the risk of experiencing xerostomia has been demonstrated to increase with age [25], no significant association was demonstrated in this study. This observation could be because this study involved individuals aged between 18 and 77 years, the majority being relatively young or middle-aged, i.e., below 46 years of age. The inclusion of older individuals without an upper age limit was intended to evaluate the cumulative impact of HAART and HIV. Nevertheless, with only 2.6% of participants aged 65 years and above, this group did not have much impact on the result of this study. These results are consistent with findings from other researchers [15], who also did not identify a relationship between age and xerostomia among PLHIV.

Furthermore, this study found no significant association between sex and xerostomia among PLHIV. This finding contradicts a previous study by Busato and colleagues in which a higher proportion of females experiencing xerostomia than males was reported [15]. On the other hand, this study revealed a statistically significant higher proportion of xerostomia among PLHIV who reported being unemployed compared to those who were eitherself-employed or employed. Research has shown that financial insecurity leads to increased stress and anxiety [26], which are known contributors to the occurrence of dry mouth. In Tanzania which is a developing country, unemployed individuals are more likely to be of lower socio-economic status and therefore more subjected to stress. As a result, unemployed participants might have experienced increased stress levels, potentially exacerbating their oral status issues, including oral dryness experience.

This study further revealed that individuals with higher viral loads (at least 400 cps/mL) had higher odds of xerostomia than those with lower viral loads (less than 40 cps/

Table 4 Univariate and multivariate logistic regression analysis of the factors associated with Xerostomia

Parameter	Univariate analysis			Multivariate analysis		
	Odds ratio (SE.)	95% CI	*p*-value	Odds ratio (SE.)	95% CI	*p*-value
Patient demographics						
Residence of patient						
Temeke	Reference					
Kinondoni	1.04 (0.29)	0.61, 1.79	0.881	1.31 (0.38)	0.74, 2.32	0.359
Ilala	1.83 (0.53)	1.03, 3.24	0.039	2.09 (0.67)	1.12, 3.91	0.021
Ubungo	1.26 (0.41)	0.66, 2.39	0.488	1.48 (0.51)	0.75, 2.92	0.254
Others*	2.86 (1.16)	1.3, 6.31	0.009	3.43 (1.47)	1.48, 7.95	0.004
Education level of patient						
Primary or less	Reference					
Secondary and above	1.32 (0.28)	0.86, 2	0.203			
Employment status of the patient						
Not employed	Reference					
Self-employed	0.48 (0.12)	0.29, 0.79	0.004	0.48 (0.13)	0.28, 0.82	0.007
Employed	0.57 (0.17)	0.32, 1.03	0.064	0.52 (0.17)	0.27, 0.98	0.042
Oral health-related behaviors						
Tooth brushing frequency						
Less than two a day	Reference					
Twice a day or more	0.69 (0.14)	0.46, 1.03	0.07			
Not using fluoridated toothpaste.	Reference					
Use of fluoridated toothpaste	0.55 (0.19)	0.28, 1.07	0.077			
HIV related characteristics						
Duration of HIV infection (years)						
≤ 5	Reference					
6–10	0.51 (0.12)	0.32, 0.81	0.005			
> 10	0.83 (0.22)	0.5, 1.39	0.484			
CD4 counts (cells/mL)						
≥ 500	Reference					
200–499	0.48 (0.14)	0.27, 0.86	0.014			
<200	0.49 (0.2)	0.22, 1.1	0.083			
Viral load (cps/mL)						
< 40	Reference					
40–399	0.89 (0.25)	0.5, 1.55	0.672	0.93 (0.27)	0.52, 1.66	0.808
≥ 400	2.35 (1.03)	1, 5.55	0.05	2.6 (1.17)	1.07, 6.3	0.034
Duration of HAART (years)						
≤ 3 years	Reference					
> 3 years	0.68 (0.17)	0.42, 1.1	0.116			
Type of HAART						
NRTIs/NNRTIs	Reference					
NRTIs/INSTIs	1.37 (0.33)	0.85, 2.2	0.2			
NRTIs/PIs	2.53 (1.34)	0.9, 7.16	0.08			

SE = Standard error; CI = Confidence interval

mL). Since all of the patients were on HAART, it is perhaps not surprising to find that only 5.6% had a viral load of 400 cps/mL or more. In multivariate analysis, the prevalence of xerostomia was significantly higher among this particular group. This observation possibly suggests that a greater viral load adversely impacts salivary flow which may result in xerostomia. It lends support to the previous studies, that linked higher viral load to an increased prevalence of xerostomia [10].

Studies have proposed that $CD4^+$ cell count (< 200 cell/ mm^3) is a risk factor for developing salivary gland hypofunction and xerostomia [6, 27]. In this study, xerostomia was compared across different $CD4^+$ counts to determine whether the level of immune suppression affects xerostomia levels. At univariate analysis, a moderate $CD4^+$ count (200–499 cells/ mm^3) was significantly associated with less odds of xerostomia compared to participants with normal $CD4^+$ counts (≥ 500 cells/ mm^3); however, in multivariate analysis, this association was not statistically

significant. The lack of association between xerostomia and $CD4^+$ counts in this study is similar to the results of a previous report from Mexico [28]. Also, Schiødt postulated that the degree of inflammatory infiltration in the gland which results in a change in salivary quality and output is not necessarily associated with the degree of immune deficiency [19]. On the other hand, other researchers found that lower $CD4^+$ cell counts were significantly associated with decreased salivary flow rates and xerostomia in HIV-infected individuals on HAART [6, 29].

In multivariate analysis, neither the duration of HIV infection nor the long-term use of HAART medication was correlated with the occurrence of xerostomia. This result is similar to the study by Umniyati et al. which found that neither HAART nor duration of HIV infection was associated with xerostomia [17]. However other research has demonstrated that patients developed xerostomia with a longer duration of HAART [30]. It is suggested that HIV infiltration and CD8 + T lymphocyte proliferation in the salivary glands, as well as the side effects of HAART, might contribute to reduced quality and quantity of salivary flow [19]. Additionally, PLHIV also suffers from other co-morbidities such as cardiac disease, diabetes, and mental health disorders [4, 5], which, together with the medications used to treat them, can also contribute to xerostomia [31]. The fact that there was no significant association between the occurrence of xerostomia may suggest the role of other factors apart from the duration of HAART use. There are some other studies, however, that have reported that long-term use of HAART had adverse effects on the subjective oral dryness of the subjects [30].

Combination therapy, usually consisting of three or more drugs, such as two NRTIs along with either a PIs or an NNRTIs, effectively reduces HIV viral load to undetectable levels [32]. PIs and NRTIs are thought to contribute to reduced salivary flow rates, which may result in xerostomia [19]. However, no significant association was observed in this study between xerostomia and the type of HAART regime used, a finding that might be partly explained by the fact that most subjects did not have PIs in their regime.

In summary, this study assessed the prevalence of xerostomia and associated factors among adults with HIV infection receiving HAART in Dar es Salaam, Tanzania. The fact that moderately high proportion of the participants had xerostomia underscores the necessity of assessing this condition in PLHIV and to develop effective management strategies that will improve their quality of life.

Strengths and limits of the study

To the best of our knowledge, this is the first study investigating the occurrence of xerostomia and associated factors in adult PLHIV on HAART in Tanzania. However, among the limitation of this study include the fact that it was a cross-sectional study design, and therefore cannot establish causal relationships between the variables. Furthermore, the assessment was subjective as it depended on the client's perception but this was mitigated by conducting the interview under conducive environment without conflicting attractions which made the participants recall the trend of events related to general and oral health. Also, the results of this study should be interpreted with the consideration that other systemic conditions that may influence the occurrence of xerostomia were not included. Finally, comparative studies including HIV patients before and after starting HAART and a healthy control group are recommended to determine whether xerostomia is linked to the viral infection, HAART treatment, or both.

Conclusion and recommendation

This study demonstrated a moderately high (36.8%) proportion of PLHIV on HAART with xerostomia. Among the factors associated with this condition included unemployment and higher viral loads. Low CD^4 + T-cell count, duration of HAART use, and class of HAART regime did not show any significant association with the occurrence of xerostomia. Routine oral health assessment, including evaluation of xerostomia for PLHIV, should be included as a crucial part of the medical care program to improve their quality of life.

Abbreviations

PLHIV	People living with HIV
ART	Antiretroviral therapy
MUHAS	Muhimbili University of Health and Allied Sciences
HAART	Highly active antiretroviral therapy
NRTIs	Nucleoside reverse transcriptase inhibitors
NNRTIs	Non-nucleoside reverse transcriptase inhibitors
PIs	Protease inhibitors
INSTIs	Integrase inhibitors
WHO	World Health Organization
CD4	Cluster of differentiation 4

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Author contributions

LEM and LAM conceived and designed the study. LAM collected, entered, and organized the data into the computer. LEM and LAM performed some statistical data analyses and interpretations. LEM drafted the manuscript. Both authors read and approved the final manuscript.

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Data availability
All the generated and analyzed data are available from the authors (corresponding author) upon reasonable request and with the permission of the MUHAS and the Ministry of Health Tanzania.

Declarations

Ethical approval
The MUHAS Higher Degrees Research and Publications Committee granted the ethical approval via a letter Ref. No. DA.282/298/01.C/383 of 7th October 2020 before starting the study. Before signing the consent, each participant received a detailed oral explanation of the study's nature and purpose. Written informed consent was obtained from all participants before their involvement in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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