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Periodontal disease and associated risk factors among people living with HIV and HIV-negative adults in Rwanda: a comparative cross-sectional study

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Abstract

Introduction: *people living with HIV (PLHIV) are at high risk of developing periodontal disease. No study done regarding periodontal disease and associated risk factors among PLHIV in Rwanda. Rwanda Health services lack baseline data to plan for oral health and incorporate the plans into general health. This study aims to determine the prevalence of periodontal disease and associated risk factors among PLHIV and HIV-negative adults at an HIV clinic of Kigali teaching hospital.* ***Methods:*** *a comparative cross-sectional study was done among 400 adults (200 PLHIV and 200 HIV-negative), aged ≥18 years. Descriptive statistics, Chi2 test, and multiple logistic regression analysis were considered for data analysis using Stata version 15. Plaque index (PI), Clinical attachment loss (CAL), and the Community Periodontal Index of Treatment Need (CPITN) were used to assess periodontal disease.* ***Results:*** *dental calculus was the most prevalent item of CPITN recorded for PLHIV 168 (84%) and HIV-negative 182 (92%) adults. The mean (SD) score for CAL was significantly (p=0.003) higher in PLHIV 1.23 (0.95) than HIV-negative individuals 0.99 (0.75). PI categorized as fair to poor was significantly (p=0.019) higher among PLHIV 36 (18%) than HIV-negative persons 16 (8%). Being a male was a predictor of PI OR: 2.90 (95%CI=1.26-6.66) and CPITN OR: 3.33 (95%CI=1.14-9.70) among PLHIV and HIV-negative: PI OR: 3.28 (95%CI=1.48-7.28); CPITN: OR: 7.78 (95%CI=1.04-58.07) participants.* ***Conclusion:*** *people living with HIV had poorer periodontal health than HIV-negative individuals. There is a need for oral health program to prevent periodontal diseases among PLHIV in Rwanda.*

Introduction

Periodontal disease negatively affects the quality of life, especially among People Living with HIV (PLHIV) [1]. In addition to contributing as risk factors for opportunistic infections, dental and periodontal problems among PLHIV are known to be more severe and difficult to manage compared to oral conditions among HIV-negative persons [1]. Furthermore, PLHIV have been reported to have a higher grade of periodontal diseases than HIV-negative individuals [2]. Periodontal disease is a broad term that encompasses chronic inflammatory conditions of the gingiva, alveolar bone, and ligaments that support teeth [3]. It develops as an interaction between host immune and plaque bacteria, initially as gingivitis [4]. The untreated gingivitis may progress to the loss of gingiva, alveolar bone, and ligaments, and this creates periodontal pockets [3]. The process of periodontal disease results in the inflammation of the periodontium which leads to the elevation of inflammatory markers, mostly cytokines [5].

It has been reported that PLHIV who are affected by periodontal disease show a high level of interleukin-18 and interleukin-2 expression and high grade of inflammation than patients with healthy periodontal conditions [2]. Thus, PLHIV suffer a more aggressive type of periodontal disease than non-infected individuals [2]. Cytokine production can induce bone resorption around teeth, leading to clinical attachment loss [5] and the literature also highlights that the systemic spread of periodontal infection may contribute to the progression of HIV infection [6]. In sub-Saharan Africa, there is limited information on the prevalence of periodontal disease and associated factors among PLHI. The Rwandan National Oral Health Survey has highlighted the high prevalence of periodontal disease among the general population [7]. In Rwanda survey, 60% of participants had dental calculus and more than 34% had dental plaque [7]. To the best of our knowledge, Rwanda has no published information concerning the prevalence of periodontal disease and associated risk factors among PLHIV compared to HIV-negative persons. Given the effect of oral diseases on general health, the lack of this information in Rwanda is a barrier to developing comprehensive care protocols for PLHIV and HIV-negative individuals. This study was conducted to assess periodontal disease and associated risk facts among PLHIV and HIV-negative adults at an

HIV clinic of Kigali Teaching Hospital (CHUK) in Kigali, Rwanda.

Methods

Study setting: the study was conducted in an HIV clinic at Kigali teaching hospital (CHUK) from August to December 2020. CHUK is one of tertiary national referral hospitals, and it has the capacity to accommodate more than 500 beds. The HIV clinic at CHUK receives more than 2700 cases of People living with HIV (PLHIV). The clinic also serves people who come for HIV voluntary testing.

Study design: this was a comparative cross-sectional study.

The study population: the study population consisted of PLHIV and HIV-negative adults. We included PLHIV (≥18 years old) diagnosed with HIV infection at least 3 months prior to recruitment. The study also included all HIV-negative attendees (≥18 years old) who came for HIV voluntary testing and whose HIV results became negative.

Sample size and sample size calculation: four hundred (400) participants, including 200 PLHIV and 200 HIV-negative adults, were considered for the study. The sample size was calculated using Stata software. It was calculated referring to literature information on how to calculate a sample size for a comparative cross-sectional study. Assuming a study power of 80%, and considering that the prevalence of periodontal disease was 60% in PLHIV and 45% in HIV-negative persons and considering a ratio of 1 [8]. The minimum study sample estimated was 346 participants. A target sample of 400 persons was recruited to account for non-responders.

Inclusion and exclusion criteria: all adults diagnosed with HIV infection at least 3 months prior to recruitment, and all adult attendees at HIV voluntary testing who were diagnosed as HIV-negative. People under 18 years old were excluded from the study.

Data collection tools and procedures: the researchers collaborated with physicians who did a follow-up of PLHIV and nurses who provided HIV results to the patients. PLHIV were recruited next to the physicians´ rooms. Physicians first informed them about the ongoing study, and those who agreed to participate were guided to the data collection room. To get HIV-negative persons, respondents were first given their HIV status by the nurses. Those who became HIV-negative were informed about the ongoing study by the nurses first. HIV-negative adults who accepted to participate in the study were then sent to the data collection room to provide informed consent. All consenting participants were examined for periodontal disease. Clinical examination was performed by an experienced calibrated dental examiner using the Plague Index (PI), Community Periodontal Index of Treatment Needs (CPITN), and Clinical Attachment Loss (CAL). The clinical examination was done in a research room at the HIV clinic. Participants were seated in a semi-supine position and then examined under natural light. For dental plaque assessment, the Plaque Index (PI) by Silness and Loe, which assesses the thickness of plaque at the gingival area, was used. A number of selected teeth (16,12,14,44,32,36) were considered to assess PI. Four gingival areas (lingual, facial, mesial, and distal) were systematically examined for each selected tooth. The teeth were dried before the examination. The assessment of plaque was done using a mouth mirror and explorer under natural rights.

To record the plaque index, scoring was recorded as follows: 0 was for no plaque, 1 for plaque adhering to the free gingival margin and adjacent area of the tooth which is only seen using a disclosing agent or running explorer around the tooth surface, 2 was recorded for moderate accumulation of soft deposits within the gingiva pocket that can be seen by the naked eye, and 3 was considered for an abundance of soft matter within the gingival pocket and/or on the tooth and gingiva margin. To calculate PI for each tooth, scores for each area were summed and divided by 4 (4 tooth surfaces examined). Plaque Index (PI)

for an individual was obtained by adding the scores for each tooth and dividing by the number of teeth examined. The range of scores for participant reference was 0 (excellent), (0.1-0.9 (good), 1.0-1.9 (fair) and 2.0-3.0 (poor). Community Periodontal Index of Treatment Needs (CPITN) was used to assess periodontal pockets, gingival bleeding and the presence of calculus. A periodontal probe (a calibrated probe (WHO 621) with a blunt tip end to avoid trauma to periodontium and mouth mirrors were used on supine patients using natural light for the full mouth examination. The examination was performed in sextants. At least 2 teeth had to be present in a sextant for it to be scored. If only 1 tooth was present in a sextant, it was included in the adjacent sextant. For each of 6 teeth (11, 16, 26, 36, 41, 46: in case of participants under 19 years old) or 10 teeth (11, 16, 17, 26, 27, 36, 37, 41, 46, 47: for respondents aged 20 years and above), we measured the probing pocket depth, presence of bleeding and calculus.

The community periodontal index of treatment needs score ranged from 0 to 4 where clinically community periodontal index was described as follows: community periodontal index 0= Absence of condition (no bleeding, no calculus, no pathological pocket), CPI 1= Bleeding upon gentle probing (no calculus, no pathological pocket, CPI 2 = presence of supra and/or subgingival calculus or other plaque retentive factors (with or without bleeding, no pathological pocket), CPI 3 = 4 or 5 mm deep periodontal pockets (with or without bleeding and calculus), CPI 4 = 6 mm or deeper periodontal pockets (with or without bleeding and calculus). Periodontal management according to the “Treatment Need” (TN) code are as follows: CPI-0: TN-0 home care; CPI-1: TN-1 instructions on proper oral hygiene; CPI-2, CPI-3: TN-2 instructions on proper oral hygiene and professional scaling; CPI-4: TN-3 complex periodontal treatment. To assess clinical attachment loss (CAL), pocket depth and gingival margin level measurements were done using manual probing at four sites (mesial, distal, mid-buccal, and mid-lingual). Clinical Attachment Loss (CAL) is the distance from the cemento-enamel junction (CEJ) to the probeable crevice. Clinical Attachment Loss (CAL) takes into account two measurements, which are pocket probing depth and gingival margin level. The first step was to measure the pocket depth. The second step was to measure the distance from the gingiva margin level to the CEJ and add the two numbers to get CAL. In case the gingival margin level was above CEJ, we gave it a negative number. If the gingiva margin was at the same level as CEJ, then the number was 0. Once the gingival margin was below the CEJ level, the measurement value given was positive [9]. We also considered the addition of pocket depth and gingival margin level measurement where slight CAL was considered for 1-2 mm, moderate CAL= 3-4 mm and severe CAL was 5 mm and above. Rumford's teeth (16, 21, 24, 36, 41, and 44) were considered for CAL assessment. Kappa score statistical analysis was done for inter-examiner reliability during examiner calibration, and a score above 0.7 was recorded for all indices.

Data analysis: data were analyzed using the STATA software version 15. Periodontal disease was considered a dependent variable. Descriptive statistics were used to calculate frequencies, percentages, and means scores of periodontal disease among the study participants. Bivariate analysis was done through Chi-square and t-test. The Chi-square test was used to test the relationships between categorical variables, and the t-test was done to compare the mean scores of continuous variables for normally distributed data. Multiple logistic regression tests were done to determine the relationship between caries and periodontal diseases (dichotomous outcome) with multiple socio-demographic variables. Logistic regression analysis also supported to control confounders.

Research ethics: ethical clearance was obtained from Human Research Ethics Committees (HREC) and Institutional Review Board (IRB) of the University of Witwatersrand and the University of Rwanda respectively. The permission to conduct the study was obtained from the research ethical

committee of Kigali Teaching Hospital (CHUK). Informed written consent was given to all participants before data correction. The confidentiality of participants was observed by using an anonymous questionnaire.

Results

Participants characteristics: the mean age in people living with HIV (PLHIV) was 43.5 (95% CI: 41.5-45.5) and 36.5, (95% CI: 34.7-38.3) in HIV-negative (p<0.001) adults. Also, the majority of PLHIV were living in urban areas (81.5%) (n=163) compared to HIV-negative participants (63%) (p<0.001). A big number of PLHIV completed primary (40%) and secondary school (34 %) compared to HIV-negative individuals who completed primary (37%) and secondary education (Table 1).

Comparison of periodontal disease among PLHIV and HIV-negative adults: regarding plaque index, the results in Table 1 revealed a significantly higher prevalence of PLHIV with fair to poor oral hygiene 36 (18%) compared to HIV-negative counterparts 16 (8%) (p=0.019). The mean (SD) PI value was significantly higher in PLHIV 0.554 (0.543) compared to the mean (SD) PI value in HIV-negative individuals 0.427 (0.426) (p=0.010). The presence of dental calculus (which is TN-2 corresponding to the need for instructions on proper oral hygiene and professional scaling) was the most item of CPITN recorded for PLHIV and HIV-negative adults. The mean (SD) CPITN score value was significantly higher among HIV-negative adults 1.90 (0.46) than the mean (SD) CPITN score value in PLHIV 1.73 (0.70) (p=0.013). Overall, the results revealed that PLHIV had a significantly higher prevalence of CAL 91 (45.50%) compared to HIV-negative persons 68 (34.00%) (p=0.019). The mean (SD) CAL value was significantly higher among HIV-positive persons 1.23 (0.95) compared to mean (SD) CAL value in HIV-negative individuals 0.99 (0.75) (p=0.003) (Table 2).

Comparison of risk factors associated with periodontal disease among PLHIV and HIV-negative persons: among PLHIV, males were 2.90 times more likely than females to have dental plaque (95% CI=1.26-6.66), and having more dental plaque indicates poor oral hygiene as shown in Table 2. None of the remaining factors were associated with the presence of dental plaque among PLHIV. HIV-negative males were 3.28 times more likely than HIV-negative females to have dental plaque (95% CI=1.48-7.28). In addition, HIV-negative participants with secondary education were 2.63 less likely than those with no or less than the primary school to have dental plaque (95% CI= 0.16-0.91). Moreover, HIV-negative participants who were not employed were 3.58 times more likely than those employed to have dental plaque (95% CI=1.28-10.01). Among PLHIV, males were 3.33 times more likely than females to have community periodontal index of treatment need (CPITN) (95%CI=1.14-9.70). In addition, PLHIV aged 36 and above were 7.15 times more likely than those aged 18-35 to have CPITN (95% CI=2.38-21.40). HIV-negative males were 7.78 times more likely than females to have CPITN (95% CI=1.04-58.07). Regarding CAL, PLHIV aged 36+ years old were 7.83 times more likely than those within 18-35 years old to have CAL (95%CI=3.119-19.66). Among HIV-negative persons, males were 2.39 times more likely than HIV-negative females to have CAL (95%CI=1.15-4.99). In addition, HIV-negative participants aged 36+ years were 5.55 times more likely than those ages 18-35 years to have CAL (95%CI = 2.52-12.19) (Table 3).

Distribution of HIV-related factors associated with periodontal disease among PLHIV: after adjusting for gender, age, residence, education, occupation, ubudehe (SES), dental visits, frequency of eating fruits, frequency of drinking tea with sugar, alcohol consumption, PLHIV on line II and III HIV-regimen were 4.41 times more likely than those on line I to have dental plaque (95% CI= 1.084-20.003). In addition, respondents with <200 CD4 cell counts were 4.59 times more likely than those with CD4 cell counts of ≥ 500 to have PI. The

latter was not statistically significant. Moreover, the only factor that was associated with CPITN among PLHIV was short duration on ART (1-5 years). None of HIV-related factor was associated with CAL after adjusting for all those factors (Table 4).

Discussion

This comparative cross-sectional study assessed and compared the prevalence of periodontal disease and associated risk factors among PLHIV and HIV-negative respondents. Plaque index (PI), Community Periodontal Index of Treatment Need (CPITN), and clinical attachment loss (CAL) were the tools used to assess periodontal disease. The results revealed a higher prevalence of PLHIV with PI categorized as fair to poor and CAL compared to HIV-negative persons. Dental calculus was the most item of CPITN recorded, and it was high for both PLHIV (84%) and HIV-negative (almost 92%) participants. Being male and older age were common factors associated with periodontal disease in both PLHIV and HIV-negative adults. PLHIV had a higher prevalence regarding fair to poor plaque, 18% compared to HIV-negative individuals (8%). The same results were reported in a study done in Nigeria, where a higher prevalence of PLHIV had poor oral hygiene (16.4%) compared to HIV-negative counterparts (9.1%) [10]. In addition, our study revealed that overall, a higher prevalence of PLHIV (45.5%) was affected by CAL compared to HIV-negative participants (34.00%). Consistent results were previously reported in a study done in Indonesia [11]. The literature reported that the prevalence of periodontal disease varies from 27% up to 76% [12]. Our results support these findings, especially for severe periodontal disease (CAL).

The presence of plaque indicates individual poor oral hygiene and the biofilm of dental plaque harbor microorganisms colonizing responsible for inflammation of the gingiva and which subsequently progress into severe periodontal diseases such as CAL and which can lead to tooth loss [13]. Periodontal disease, as well as many other oral conditions, are easily preventable yet, they have huge socio-economic costs to both the individuals (opportunity costs-time off work and school, poor quality of life) and they are costly to treat at both an individual level and the country level. Therefore, since good oral hygiene practices and accessibility to proper periodontal care services are key to preventing dental plaque accumulation and CAL, it is necessary to ensure oral health strategies that can engage PLHIV to practice oral hygiene and to timely have accessibility to periodontal health care services within the existing HIV treatment program in Rwanda. Our study results agree with previous studies that have highlighted that PLHIV are prone to periodontal disease than the general population [2,11]. Periodontal disease process results in the inflammatory process of the periodontium which results in the elevation of inflammatory markers, mostly cytokines. It has been reported that PLHIV who are affected by periodontal disease show a high level of interleukin-18 and interleukin-2 expression and high grade of inflammation than patients with healthy periodontal conditions [11]. Thus, PLHIV suffer a more aggressive type of periodontal disease than non-infected individuals [2]. In addition, recent literature has revealed the effect of HIV infection to alter antibody responses against periodontopathic bacteria, which exposes PLHIV to periodontal disease more than HIV-negative individuals [13]. Recently, the literature also highlights that a more severe periodontal disease reported among PLHIV result from multiresistant pathogens including *Pseudomonas aeruginosa, Acinetobacter baumannii, Enterobacter faecalis, Escherichia coli, Clostridium clostridioforme, Klebsiella pneumoniae, Candida spp* [12].

Regarding CPITN, the majority of PLHIV and HIV-negative participants needed professional dental scaling together with instructions on oral hygiene (TN2). No study done in Rwanda regarding this matter among PLHIV so far. However, similarly to our findings, previous studies done in general

population of Rwanda reported consistent results [7,14]. For example, the results of Rwanda's national oral health survey reported that up to 60% of participants had dental calculus [7]. Another study done in Rwanda military hospital revealed that almost half (50%) of study participants had dental calculus [14]. In Africa, several risk factors are known to contribute to the higher prevalence of periodontal disease. Those include but are not limited to shortage of dental personnel, unavailability of oral health services, poor working conditions, low priority given to oral health care compare to general health care, and late visits to dentists with emergency oral cases presentation [15-17]. Poor oral hygiene is also highlighted as a measure issue in sub-Saharan Africa [16]. In addition, Many African countries are reported to have few effective oral health promotion programs, low priority to oral health, lack of reliable data related to oral health, and inequality of oral health. All those contribute to higher prevalence and severity of oral problems, including periodontal disease, in many countries of Africa [16]. In Rwanda, the Ministry of Health reported different problems faced by the oral health System. Those include but are not limited to the shortage and inappropriate dental infrastructure, shortage of dental personnel, unavailability of sound and regular preventive and oral health education programs at the community level [18]. Being male and having 36+ years old were associated with periodontal disease in our study. Various researchers have reported consistent results previously [19-21].

For example, according to National Health and Nutrition Examination Survey report, men develop higher periodontal disease (more than 56%) compared to women (about 38%) [21]. This is because men ignore their oral health compared to women [22]. In addition, men are reported to have poorer oral hygiene behaviors and rarely visit dentists for prevention services compared to women [21]. Furthermore, differences in immunity between men and women contribute to a difference in periodontal disease. Sex hormones and X-linked genes influence and modulate the immune response, respectively. For example, testosterone suppresses the immune response while estrogen enhances the immune response [21]. These differences also affect the oral microbiome [21]. It is therefore important to advocate for oral health promotion programs that engage male to positively change their oral health practices. Our findings match previous studies that reported that periodontal diseases tend to increase as age increases. For example, a study done in Saudi Arabia reported older age as a predictor of severe periodontal disease [23]. Another study conducted in Indonesia revealed that periodontal severity and prevalence increase with age [24]. The mechanism through which age contributes to periodontal diseases is explained by the fact that there are pathological age-related changes to key cellular regulators of the immune cells (Neutrophils, macrophages, and T cells) [25]. These cells are involved in the pathogenesis of periodontal disease. They contribute to the initiation, propagation, and resolution of inflammation [25]. This indicates how oral health preventive interventions specific to older people are imperative.

Not having or completing elementary school were predictors of fair to poor plaque among HIV-negative people. Similar findings were reported in the literature [26-28]. As recommended previously, education may be the main target for preventive programs for periodontal diseases. Also, early life interventions were recommended in the literature to eliminate educational inequalities in periodontal diseases [29]. In addition, unemployment was also a predictor of periodontal disease in our study. Our results are consistent with previous findings by other researchers [30,31]. For example, a study by Quinn and colleagues revealed that unemployment decreases the utilization of preventive dental care services [31]. Therefore, when planning for preventive and oral health care interventions, unemployment should be considered as a risk factor for poor periodontal health. The main strength of this study is that it compared PLHIV and HIV-negative individuals, which is the first

study conducted in Rwanda among very few studies in sub-Saharan Africa.

Conclusion

This study revealed poorer periodontal health among PLHIV than in HIV-negative persons evidenced by PI and CAL. There is a need for a collaborative effort to establish programs for regular and timely screening and management of periodontal disease among PLHIV in Rwanda. There is also a need to establish community-based oral health education programs to encourage oral hygiene practice and regular dental visits for periodontal screening among the Rwandan population in general. Further studies are recommended for the rural population in Rwanda.

What is known about this topic

- *Periodontal disease affects the wellbeing of PLHIV;*
- *Existing controversial about risk factors associated with periodontal disease among PLHIV.*

What this study adds

- *Higher prevalence of periodontal disease among PLHIV than HIV-negative adults;*
- *This study identified key factors influencing PI, CPITN and CAL in Rwanda.*

Competing interests

The authors declare no competing interests.

Authors' contributions

Julienne Murererehe, contributed to the conception, design, data acquisition, analysis, interpretation, writing, original draft, review, and editing of the manuscript. Yolanda Malele Kolisa contributed to the conception, design, data acquisition, analysis, interpretation, writing, original draft, review and editing the manuscript. Francois Niragire contributed to the conception, design, data acquisition, analysis, interpretation, writing, original draft, review and editing the manuscript. Veerasamy Yengopal, contributed to the conception, design, data acquisition, analysis, interpretation, writing original draft, review and editing the manuscript. All the authors have read and agreed to the final manuscript.

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Tables

Table 1: comparison of demographic characteristics of participants

Table 2: comparison of periodontal disease status among PLHIV and HIV-negative adults

Table 3: comparison of risk factors associated with periodontal disease among PLHIV and HIV-negative adults

Table 4: HIV-related factors associated with periodontal disease among PLHIV

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Table 1: comparison of demographic characteristics of participants			
Social demographic characteristics	**HIV+ n(%); n=200**	**HIV-n(%); n=200**	**P-value**
Mean age (mean, 95%CI)	43.51(41.51-45.51)	36.53(34.72-38.33)	<0.001*
Sex			
Male	88(44.0)	89(44.5)	0.920
Female	112(56.0	111(55.5)	
Residence			
Urban	163(81.5)	126(63.0)	<0.001*
Peri-urban	25(12.5)	32(16.0)	
Rural	12(6.0)	42(21.0)	
Education			
No formal schooling or less than primary school	27(13.5)	50(25.0)	0.020*
Primary school completed	80(40.0)	74 (37.0)	
Secondary school	68(34.0)	50(25.0)	
Tertiary	25(12.5)	26(13.0)	
Occupation			
Unemployed	64(32.0)	44(22.0)	0.024*
Employed	136(68.0)	156(78.0)	
Use medical insurance			
Yes	199(99.5)	195(97.5.0)	0.10
No	5(2.5)	22(11.0)	
Ubudehe (SES)+			
Category 1	18(9.0)	24(12.0)	0.005*
Category 2	47(23.5)	73(36.5)	
Category3 and 4	135(67.5)	103(51.5)	
*Statistically significant results P <0.05			

Table 2: comparison of periodontal disease status among PLHIV and HIV-negative adults			
Plaque index (PI)			
Prevalence for PI categories	**HIV+ N (%)**	**HIV- N (%)**	**P-value**
Excellent	43 (21.5%)	56(28%)	0.008*
Good	121(60.5%)	128(64%)	
Fair to poor	36(18%)	16(8%)	
Mean (SD) PI	Mean ±SD	Mean ±SD	P value
			0.010*
Community Periodontal Index of Treatment need (CPITN)	0.554 ± 0.543	0.427 ± 0.426	
Prevalence of CPITN categories	PLHIV n =200N= 200	HIV-negative n =200	P-value
	n(%)	n(%)	0.022*
CPITN=0 (Healthy periodontium)	27(13.50%)	9 (4.55%)	
CPITN=1 (Bleeding upon gentle probing)	2(1.00%)	4(2.02%)	
CPITN=2 (Presence of supra and/or sub gingival calculus)	168(84.00%)	182(91.92%)	
CPITN=4 and 5 (Periodontal pocket of 4 or deeper)	3(1.50%)	3(1.52%)	
Mean +SD CPITN		1.90±0.46	0.013*
Clinical Attachment Loss (CAL)	1.73±0.70		
Prevalence of CAL categories	HIV+ (n=200)	HIV- (n=200)	P-value
	N(%)	N(%)	N(%)
Absence of pathological CAL	109(54.5%)	132(66%)	0.063
Slight CAL	80(40%)	60(30%)	
Moderate to severe CAL	11 (5.50%)	8(4%)	
overall CAL presence	91(45.50%)	68(34.00%)	0.019*
Mean (SD) CAL	1.23 (0.95)	0.99 (0.75)	0.0032*
* Statistically significant results P <0.05			

Table 3: comparison of risk factors associated with periodontal disease among PLHIV and HIV-negative adults					
PI					
Factors not related to HIV infection	**Subgroups**	**Odds ratio (95% CI) for HIV+ adults**	**P-value**	**Odds ratio (95% CI) for HIV- adults**	**P-value**
Gender	Female	1		1	
	male	2.90(1.268-6.664)	0.012*	3.28(1.480-7.284)	0.003*
Age	18-35	1		1	
	36+	1.48 (0.620-3.532)	0.377	1.77 (0.797-0.936)	0.160
Education					
	No or less than primary school	1		1	
	Secondary school	1.19(0.506-2.815)	0.685	0.38(0.161-0.913)	0.031*
	Tertiary	1.33(0.421-4.239)	0.623	0.45(0.155-1.316)	0.145
Occupation	Employed	`1		1	
	Not employed	1.39(0.612-3.162)	0.430	3.58(1.282-10.014)	0.015*
Frequency of eating biscuits	several times a month or seldom/never	1			
	several times a day or every day	1.72(0.176-16.846)	0.640	0.74(0.171-3.249)	0.697
	several times a week or once a week	0.83(0.303-2.290)	0.724	2.71(1.081-6.823)	0.033*
Alcohol consumption	Yes	1		1	
	No	1.74(0.741-4.110)	0.202	2.03(0.935-4.442)	0.073
CPITN					
Variables	Subgroups	Odds ratio(95% CI) for HIV+ people	P-value	Odds ratio(95% CI) for HIV-	P-value
Gender	Female	1		1	
	male	3.33(1.143-9.701)	0.027*	7.78(1.047-558.072)	0.045*
Age	18-35	1		1	
	36+	7.15 (2.386-21.400)	0.000*	1.87(0.253-13.880)	0.539
Education					
	Tertiary	1		1	
	No or less than primary school.	0.91(0.219-3.796)	0.900	0.69(0.041-11.607)	0.795
	Secondary school	1.14(0.265-4.886)	0.860	0.39(0.021-7.267)	0.531
Occupation	Employed	1		1	
	Not employed	1.79(0.596-5.372)	0.299	0.72(0.072-7.227)	0.782
Frequency of drinking tea with sugar	Several times a day or every day	1		1	
	Several times a week or once a week	0.60(0.195-1.841)	0.372	1.60(0.110-23.310)	0.728
	Several times a month or seldom/never	1.26(0.345-4.631)	0.722	0.07(0.007-0.588)	0.015*
Alcohol consumption	No	1		1	
	Yes	1.03(0.327-3.273)	0.953	0.07(0.084-0.683)	0.022*
CAL					
Variables	Subgroups	Odds ratio (95% CI) for HIV+ people	P-value	Odds ratio (95% CI) for HIV-	P-value
Gender	Female	1		1	
	male	1.27 (0.624-2.586)	0.509	2.39(1.150-4.998)	0.020*
Age	18-35			1	
	36+	7.83 (3.119-19.660)	o.000*	5.55 (2.528-12.199)	0.000*
Dental visit	Never received dental care	1		1	
	less than 6 months to 1 year	2.57(0.801-8.243)	0.112	1.63(0.666-4.021)	0.282
	more than 1 year but less than 5 years	1.30(0.368-2.454)	0.559	0.36(0.108-1.198)	0.096
	5 years and more	1.68(0.536-3.168)	0.287	0.31(0.119-0.823)	0.019*
Frequency of eating fruits	Several times a day or every day	1		1	
	Several times a week or once a week	1.21(0.484-3.019)	0.683	0.35(0.133-0.958)	0.041*
	Several times a month or seldom/never	1.74(0.625-4.847)	288	0.74(0.256-2.164)	0.588
Alcohol consumption	No	1		1	
	Yes	2. 12(0.941-4.778)	0.070	0.76(0.350-1.649)	0.489
*Statistically significant results P <0.05					

Table 4: HIV-related factors associated with periodontal disease among PLHIV			
Plaque index			
HIV-related factors associate with PI	**Subgroups**	**Odds ratio (95% confidence interval)**	**P-value**
CD4	Group III (≥ 500)	1	
	Group II (200-499)	2.36 (0.547-10.178)	0.056
	Group I (<200)	4.59 (0.963-21.897)	0.249
RNA-viral load	Detectable	1	
	Undetectable	1.03 (0.344-3.094)	0.954
WHO staging	Stage I	1	
	Stage II to IV	1.30 (0.343-4.927)	0.699
Types of ART	Line I	1	
	Line II and III	4.41 (1.065-18.282)	0.041*
Duration on ARVs	1-5 years	1	
	6-10 years	2.01 (0.542-7.490)	0.296
	11-15 years1	2.03 (0.538-7.728)	0.294
Duration of HIV-infection	1-8 years	1	
	9-16 years	1.05 (0.248-4.483)	0.941
		1.23 (0.240-3.6.335)	0.801
CPITN	17+ years		
HIV-related factors associate with CPITN	Subgroups	Odds ratio (95% confidence interval)	P-value
CD4	(≥ 500) Group III	1	
	Group I (<200)	2.33 (0.381-14.309)	0.359
	Group II (200-499)	2.28 (0.369-14.182)	0.374
RNA-viral load	Detectable	1	
	Undetectable	3.52 (0.880-14.099)	0.075
WHO staging	Stage II To IV	1	
	Stage I	1.00 (0.199-5.015)	0.99
Types of ART	Line I	1	
	Line II and III	2.03 (0.500-8.240)	0.322
Duration on ARVs	11-15 years	1	
	1-5 years	6.96 (1.050-46.200)	0.044*
	6-10 years	0.95 (0.271-3.374)	0.947
Duration of HIV-infection	17+ years	1	
	1-8 years	0.89 (0.117-6.805)	0.913
CAL	9-16 years	1.44 (0.341-6.069)	0.619
HIV-related factors associate with CAL	Subgroups	Odds ratio (95% confidence interval)	P-value
CD4	(≥ 500) Group III	1	
	Group I (<200)	2.473 (0.571-10.715)	0.226
	Group II (200-499)	3.85 (0.963-15.423)	0.057
RNA-viral load	Detectable	1	
	Undetectable	1.71 (0.624-4.708)	0.295
WHO staging	Stage I	1	
	Stage II to IV	1.23 (0.417-3.655)	0.702
Types of ART	Line II and III	1	
	Line I	1.01 (0.405-2.521)	0.980
Duration on ARVs	1-5 years	1	
	6-10 years	1.21 (0.317-4.630)	0.779
	11-15 years	1.18 (0.305-4.587)	0.808
Duration of HIV-infection	17+ years	1	
	1-8 years	1.26 (0.255-6.286)	0.771
	9-16 years	0.91 (0.399-2.094)	0.833
+Adjusted for age, gender, education, occupation, Ubudehe (SES), eating biscuits, drinking sugary tea, dental visits, alcohol * Statistically significant results P <0.05			