RISK FACTORS FOR CARIES AND PERIODONTAL DISEASES: A COMPARATIVE STUDY AMONG HIV-POSITIVE AND HIV-NEGATIVE ADULTS IN NYARUGENGE DISTRICT, RWANDA

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A Thesis submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of

Doctor of Philosophy

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DECLARATION

I, **Julienne Murererehe,** declare that this thesis is my own, unaided work. It is being submitted for the Degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University. I referenced or acknowledged any information used from previously published works.

Signature: 

Julienne Murererehe

23rd May 2024

DEDICATION

In memory of my mother Godiberthe Nyirandegeya,

who, with love and immeasurable effort, supported the foundation of my education.

INTERNATIONAL CONFERENCES, MEETINGS, AND OTHER ACCEPTED ORAL PRESENTATIONS ARISING FROM THIS THESIS

Oral presentation at 9th Annual Joint Advanced Seminars Conference on 29th July 2022

Oral presentation at the 5th annual meeting of the International Association for Dental Research-South Africa division on 21st September 2022

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3. Oral Health-related Quality of Life among People Living with HIV and HIV-negative adults in Rwanda: a comparative cross-sectional study" Published in BMC Oral Health January 25, 2024; 24(128).

4. Perceptions on causes and effects of oral diseases among HIV-positive and HIV-negative adults in Kigali, Rwanda: a qualitative study Manuscript to be pulished.

ABSTRACT

Background

Dental caries and periodontal diseases are among HIV-positive persons' most frequent oral conditions. These common oral diseases contribute to the impairment of general health and well-being. Dental and periodontal problems among HIV-positive individuals are more severe and difficult to manage than dental and periodontal problems among HIV-negative people. Thus, risk factors for caries and periodontal diseases must be controlled for comprehensive oral health and the general well-being of HIV-positive patients. The burden of oral diseases is reported to be high in Rwanda. Nearly 65% of the oral health survey participants had experienced dental caries and above 54% had untreated cavities. In addition, dental calculus was found among 60% of participants. More than 34% had oral debris. Surprisingly, more than 70% of this population has never visited dentists or dental facilities. This evidence gives impetus to undertake more focused investigations on oral diseases in Rwanda, particularly among HIV-positive people. Therefore, this study sought to assess the risk factors for caries and periodontal diseases among HIV-positive and negative adults in Nyarugenge District, Rwanda.

Methods

This research used a mixed-method approach (qualitative embedded design). For the quantitative part, a comparative cross-sectional study was conducted among 200 HIV-positive and 200 HIV-negative adults aged ≥18 years. Consecutive and purposive sampling method was used to select participants for quantitative and qualitative parts of the study respectively. Caries was assessed using the Decayed (D), Missing (M), and Filled Teeth (F) index (DMFT). Periodontal disease was assessed using the Plaque Index (PI), Community Periodontal Index of Treatment Need (CPITN), and Clinical Attachment Loss (CAL). Oral health Related Quality of Life (OHRQoL) was assessed using the oral health impact profile short version (OHIP-14). Descriptive statistics, Chi-square test, t-test, Cronbach alpha, and multiple logistic regression were applied to analyse quantitative data using Stata version 15. For the qualitative data collection, in-depth interviews (IDIs) were conducted among 10 HIV-positive and 11 HIV-negative adults with caries and periodontal diseases using a semi-structured interview guide.

Thematic content analysis using an inductive approach was applied for data analysis of IDIs. NVivo software version 11 was used to code and organize the data.

Results

A higher proportion (50.5%) of HIV-positive adults had experienced caries (DMFT>0) compared to HIV-negative counterparts (40.5%) and the difference was statisticaly significant (p=0.045). The prevalence of D was higher (23.5%) among HIV-positive compared to HIV-negative adults (13.6%) (p=0.011). The Mean (SD) DMFT score among HIV-positive and HIV-negative participants were 2.28 (3.68) and 1.29 (2.21) respectively (p=0.001). The predictors of caries in HIV-positive persons were being female (OR= 2.33; 95%CI= 1.14-4.75), frequent dental visits (OR= 4.50; 95% CI=1.46-13.86) and detectable RNA viral load (OR= 4.50; 95% CI=1.46-13.86). Among HIV-negative participants, the middle age range (36-45 years) [OR= 6.61; 95%CI=2.14-20.37], and frequent dental visits were significantly associated with caries (OR=3.42; 95%CI: 1.337-8.760). For periodontal status, having dental calculus was the most prevalent item of the CPITN found among HIV-positive 168 (84%) and 182 (92%) HIV-negativeIndividual. The mean (SD) score for CAL was higher in HIV-positive persons 1.23 (0.95) compared to HIV-negative counterparties 0.99 (0.75). The difference was statistically significant (p=0.003). Being a male was a predictor of having dental plaque and a need for periodontal treatment for both HIV-positive (PI OR: 2.90 (95%CI=1.26-6.66)); (CPITN OR: 3.33 (95%CI=1.14-9.70)) and HIV-negative respondents (PI OR:3.28 (95%CI=1.48-7.28)); (CPITN: OR: 7.78 (95%CI=1.04-58.07)). A higher percentage of HIV-positve individuals had poorer OHRoL than HIV-negative counterparties in all items of OHIP-14 except for OHIP3 (found it uncomfortable to eat any foods because of problems with teeth or mouth) and OHIP-14 items (being totally unable to function because of problems with teeth or mouth). The findings revealed significant results regarding OHIP1 “trouble pronouncing any word” with a prevalence of 11(2.5%) and 9(2.25%) in HIV-positive and HIV-negative participants, respectively. Also, HIV-positive persons had higher percentage 11(2.75%) for the OHIP 13 item “life not satisfying due to teeth and mouth problems” than HIV-negative counterparties 8(2%) and the difference was statistically significant $p \leq 0.05$.

Moreover, dental caries was significantly associated with poor OHRQoL among HIV-positive and HIV-negative participants for all 14 items of OHIP-14 tool. There was no association between periodontal disease and OHRQoL in both HIV-positive and HIV-negative adults. Two broad domains and five themes emerged fromthe interviews. The first broad domain was “perceptions on causes of oral diseases” with 2 themes (individuals and external themes).

The second broad domain was "perceptions on oral diseases effect" with 3 themes (physical or functional effect, psychological effect and social effect themes).

Conclusion and recommendations

This research showed a higher prevalence of caries and CAL among HIV-positive adults than HIV-negative counterparts. Also, the mean (SD) PI value was significantly higher in HIV-positive adults compared to the mean PI value in HIV-negative individuals. The reported higher prevalence of caries in HIV-positive persons was associated with being female, detectable viral load, and frequent dental visits.

Periodontal disease was associated with older age, being male in HIV-positive and HIV-negative participants. Moreover, HIV-positive adults reported poorer OHRQoL than HIV-negative counterparties. Furthermore, qualitative results revealed individual and external levels factors of oral disease and emphasized the physical/ functional, psychological and social effects of oral diseases on quality of life. Therefore, there is a need for effective oral health interventions specific to HIV-positive persons in Rwanda. The interventions should also raise awareness of the risk of common oral diseases (such as dental caries, and periodontal disease) and provide preventive oral health services among the Rwandan population, especially HIV-positive individuals. There is a need for a collaborative effort to establish programmes for regular and timely screening and management of periodontal disease and dental caries among the general population and specifically, HIV-positive individuals in Rwanda. To ensure timely oral health care among HIV-positive Rwandans, this study provides baseline data to aid policymakers and stakeholders to integrate oral health care services within HIV treatment programmes in Rwanda.

Key Words: Dental caries, periodontal diseases, Risk factors, Perceptions, Oral Health-Related Quality of Life, HIV, Adults, Rwanda.

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LIST OF ABBREVIATIONS AND ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
ART	Anti-Retroviral Treatment
CAL	Clinical Attachment Loss
CPITN	Community Periodontal Index of Treatment Need
CARTA	Consortium for Advanced Research Training in Africa
CMHS	College of Medicine and Health Sciences
CHUK	Centre Hospitalier Universitaire de Kigali
DC	Dental caries
DMFT	Decayed, Missing and Filled Teeth Index
HAART	Highly Active Antiretroviral Therapy
HIV	Human Immunodeficiency Virus
IADR	International Association for Dental Research
IRB	Institutional Review Board
MOH	Ministry of Health
PI:	Plaque Index

TN	Treatment Need
WHO	World Health Organization
OHRQoL	Oral Health-Related Quality of Life
OHIP	Oral Health Impact Profile
PD	Periodontal Disease
PHD	Doctor of Philosophy
STATA	Statistics and Data
QoL	Quality of Life

CHAPTER 1: INTRODUCTION

1.1 Background

Oral health is integral to overall health [1] and strongly associated with systemic conditions [2]. For example, the prevalence of oral diseases is higher among HIV-positive people than in the general population and among individuals who are known to be HIV-negative [3]. Scholars have reported high prevalence rates of more than 60% of periodontal diseases and/or caries among HIV-positive patients. A study in Brazil among 300 HIV-positive patients revealed that dental and periodontal diseases were among HIV-positive persons' most frequently diagnosed oral conditions [4]. Another study done on patients with HIV infection at University Hospital in Hradec Králové (East Bohemia-Czech) showed a high prevalence (more than 71%) of oral diseases, mainly dental caries and periodontal diseases [5]. Similarly, an African study in Côte d'Ivoire reported a high prevalence (above 62%) of oral diseases such as dental caries and periodontal diseases among HIV-positive female sex workers [6]. Most of the studies done did not compare HIV-positive with HIV-negative.

Rwanda has shown remarkable improvement in HIV services and outcomes. The prevalence of HIV is 3% [approximately 397000 of the whole Rwandan population] among adults in Rwanda [7] [8]. The number of health facilities that provide HIV services has considerably increased from 43% to 98% by 2013 [10], and ART services are available in 93% of those facilities [9]. Rwanda is also listed as one of the first countries to achieve the UNAIDS 90-90-90 targets [11]. Rwanda needs to sustain these improvements by controlling other chronic diseases that may impact the quality of life of HIV-positive people.

The recent and very first Rwandan National Oral Health Survey reported nearly 65% of the participants had experienced dental caries, with more than 54% having untreated caries [12]. In addition, researchers found dental calculus among 60% of oral health survey participants with more than 34% having oral debris. Surprisingly, over 70% of this population has never visited dentists or dental facilities [12]. Furthermore, authors reported a high impact of oral disease on the quality of life of affected individuals (pain, self-consciousness, difficulty chewing, inability to perform daily activity) among almost 64% of participants [12].

This evidence gives impetus to undertake more focused investigations on oral diseases among Rwandans with chronic diseases including HIV infection.

Caries and periodontal diseases contribute to the impairment of general health and well-being. Specifically, these common oral diseases negatively affect the quality of life of HIV-positive people [13] [14]. Dental and periodontal problems among HIV-positive individuals are more severe and difficult to manage than dental and periodontal problems among HIV-negative people [13]. Thus, there is a need to manage the risk factors for caries and periodontal diseases for comprehensive oral health and the general well-being of HIV-positive patients.

Periodontal disease develops from the inflammatory process of the periodontium and the process is also associated with the elevation of inflammatory markers, mostly cytokines [15]. According to the literature, HIV-positive individuals suffering from periodontal diseases show higher levels of interleukin-18 and interleukin-2 expression that contribute to a more destructive type of periodontal disease [15]. Moreover, the spread of periodontal infection contributes to the progression of HIV infection [16].

Many researchers have investigated the relationship between dental caries and HIV infection. They have reported higher caries prevalence rates among HIV-positive patients [17,18]. Even though there is no direct association between caries and HIV infection, researchers have linked the use of anti-retroviral treatment (ART) in HIV-positive patients to caries [17,18]. The literature highlights that ART leads to dry mouth, contributing to dental caries among HIV-positive patients [19].

Despite the adverse effects of caries and periodontal diseases on general health and well-being [2], the contributing risk factors are still controversial [20] [21]. It is unclear whether the higher prevalence of those common oral diseases is associated with HIV infection factors (CD4 cell counts, RNA viral load, AART, WHO staging) or is linked to other conventional risk factors like eating habits, poor oral hygiene, and lack of regular oral health check-ups. The ambiguities and contradictions in the existing published literature are a problem that requires more investigation because dental caries and periodontal diseases impact essential functions, including eating, sleeping, and socializing [5,22]. Moreover, being unable to eat due to oral health conditions, may further compound the already compromised immunity in HIV-positive patients, leading to opportunistic infections and death [23].

Even though the country has shown remarkable efforts to improve the well-being of HIV-positive people, no study has been conducted in Rwanda to identify the risk factors associated with caries and periodontal diseases and the effect of these common oral diseases on the quality of life of HIV-positive adults to inform the policy makers and oral health stake holders. Thus, the study intended to assess risk factors for caries and periodontal disease among HIV-positive adults compared to HIV-negative individuals in Kigali, Rwanda.

1.2 Problem statement

The first and very recent oral health survey in Rwanda revealed a high prevalence of common oral diseases (dental caries and periodontal diseases) among the majority of the general population (more than 60%) [23]. However, the prevalence among HIV-positive individuals and its contributing risk factors are yet to be determined in Rwanda, although the country aspires to eliminate HIV infection, HIV-related stigma, and HIV-related death [24].

Reresearch elsewhere underscores the high prevalence of caries and periodontal diseases among HIV-positive patients [25,26]. Generally, there is a lack of studies evaluating factors associated with common oral diseases (caries and periodontal diseases) among HIV-positive persons compared to HIV-negative individuals in Rwanda. For example, the few published studies on dental caries and periodontal diseases in Rwanda did not involve HIV-positive patients [27]. Additionally, the research on the impact of oral conditions on oral health-related quality of life (OHRQoL) among HIV-positive and HIV-negative individuals in Rwanda is necessary for integrated multidisciplinary care in the early diagnosis and treatment of oral diseases [28,29].

This study is the first to provide baseline data on risk factors for caries and periodontal contions for policymakers to make informed decisions on Rwanda's comprehensive oral health management of HIV-positive patients. The information enabled us to provide recommendations for Rwanda policymakers to ensure strategies to manage and improve oral health and, thus, the well-being of HIV-positive and HIV-negative persons.

1.3 Research gap

To the best of my knowledge, there are no published and documented literature sources regarding dental caries and periodontal diseases and their risk factors among HIV-positive people in comparison to HIV-negative persons in Rwanda on the common research databases. However, the studies done in developed and developing countries highlight the high prevalence of those common oral diseases among HIV-positive persons [4–6,21,30].

The limited oral disease studies conducted in Rwanda were retrospective or non-comparative and did not include HIV-positive people [27,31]. For the Rwandan health ministry to reduce HIV stigma and HIV-related deaths [24], the information from the current study may be necessary as evidence for practice and policy implementation.

There is controversy about risk factors associated with dental caries and periodontal diseases among HIV-positive people. One source of disagreement in the literature is whether HIV infection is associated with dental caries and periodontal disease [32]. Some scholars argue that CD4 counts and viral load are associated with dental caries and periodontal disease [33–35][25][36][37]. However, not all research supports thisfinding. For example, Yengopal and colleagues, Santo and colleagues, Kerdpon with colleagues, Rwenyonyi and colleagues, and Ferreira and colleagues found no association between dental caries and periodontal disease with CD4 counts [20,32,38–40]. Instead, the association was with socioeconomic, behavioural, and medical factors. The ambiguities and contradictions in the existing research pose a problem that warrants further investigation.

Dental caries and periodontal diseases influence the daily functions such as eating, swallowing, sleeping, speaking, and socializing [21] [41] [42] [5] [43]. HIV-positive person may have more compromised immunity due to difficulty in eating, thus, leading to increased opportunistic infections and death [44] [23].

The literature also shows oral disorders affect OHRQoL 14,45–47] and this effect is more pronounced in HIV-positive persons [48,49]. However, the associated risk factors are still in debate. There is a lack of research regarding oral diseases among HIV-positive persons and their impact on OHRQoL in Rwanda. But, studies done in other settings have reported a high prevalence

of dental caries and periodontal diseases among HIV-positive individuals [50–53]. In addition, the conflicting information about oral health status and associated risk factors in HIV-positive people compared to HIV-negative individuals is a problem that needs special attention, especially for a country like Rwanda that lacks baseline information on oral health matters. This lack of information means that there is no evidence for policymakers to use for supporting and advocate fo, there is no evidence to support and advocate for approaches to early diagnosis and treatment of oral diseases among HIV-positive people and improve their quality of life (QoL) [28,29].

1.4 Study Significance

Oral health is part of general health and should be optimized for all Rwandans. Given the high burden, oral diseases are a public health problem in Rwanda. Moreover, oral diseases such as dental caries and periodontal infections have substantial socioeconomic impact on those affected (opportunity costs off work and school, poor quality of life) and are expensive to treat at the individual and the country levels. Even more necessary is the evidence-based HIV oral health data to maximize the benefits of HIV services and outcomes. Chronic conditions such as dental caries and periodontal infections should be controlled, as well as other chronic diseases in people living with HIV, to improve their quality of life.

Thirdly, the study outputs will inform a multidisciplinary comprehensive oral care strategy generally and specifically for HIV-positive persons in Rwanda. The general medical physicians, dental practitioners, and allied healthcare workers will be better informed about the inter-linkages and inter-dependences of the effects of HIV on oral disorders and how oral diseases may worsen HIV comorbidities. The Rwandan health service lacks baseline data for planning oral health and incorporating the plans into general health.

1.5. Study aim

To assess the risk factors for caries and periodontal diseases among HIV-positive and negative adults in Nyarugenge District, Rwanda.

1.5.1 Specific objectives

1. 5.1.1. To determine caries and periodontal status among HIV-positive and HIV-negative adults at the HIV clinic of the University Teaching Hospital of Kigali (CHUK).

1.5.1. 2. To determine risk factors for caries and periodontal diseases among HIV-positive and HIV-negative adults at CHUK

1.5.1.3. To ascertain the association between HIV clinical markers with caries and periodontal diseases among adult HIV-positive patients at the HIV clinic of CHUK.

1.5.1.4. To assess and compare oral health-related quality of life among adult HIV-positive and HIV-negative patients at CHUK.

1.5.1.5. To explore and compare the perceptions on possible causes and effects of oral diseases on general health among HIV-positive and HIV-negative adults at CHUK.

1.7. Research questions

1. What is the status of dental caries and periodontal diseases among HIV-positive and HIV-negative adults at the HIV clinic of the University Teaching Hospital of Kigali (CHUK)?

2. What are the risk factors for caries and periodontal diseases among HIV-positive and HIV-negative adults at CHUK?

3. Is there the any association between HIV clinical markers with caries and periodontal diseases among adult HIV-positive patients at the HIV clinic of CHUK?

4. How is oral health-related quality of life among adult HIV-positive compared to HIV-negative patients at CHUK?

5. What are the perceptions about possible causes and effects of oral diseases on general health of HIV-positive adults compared to HIV-negative adults at CHUK?

1.8. Structure of the thesis

The presentation of this thesis refers to the divided block format according to guidelines sugeested by the the school of oral health sciences, University of the Witwatersrand. It comprises the following chapters:

Chapter 1

In Chapter 1, background information on common oral diseases, their associated risk factors, and the research gap and rationale is presented. In addition, this chapter included the study aim and objectives of the study.

Chapter 2

This chapter provides a comprehensive and critical review of this study's relevant literature.

Chapter 3

Chapter 3 details the study methods used in this study. It describes the study design, setting, sampling process, data collection techniques, and analysis.

Chapter 4

Presents the results from published paper one.

Chapter 5

Presents the results from published paper two.

Chapter 6

Presents the results from manuscript three submitted for publication

Chapter 7

Presents the results from manuscript four submitted for publication

Chapter 8

Chapter 8 gives a detailed integrated discussion of the results

Chapter 9

Chapter 9 consists of overall conclusions and recommendations.

1.8 References

1. Petersen PE. The World Oral Health Report 2003 : continuous improvement of oral health in the 21st century ± the approach of the WHO Global Oral Health Programme. 2003;31:3–23.

2. Rovaris NS, Galato D, Schuelter-Trevisol F, da Silva J, da Silva Linhar L, Nickel DA, et al. Oral health status and its impact on the quality of life of children and adolescents living with HIV-1. BMC Res Notes. 2014;7(1):478.

3. Brondani MA, Phillips JC, Kerston RP, Moniri NR. Stigma Around Hiv in Dental Care: Patients' Experiences. J Can Dent Assoc (Tor) [Internet]. 2016;82:g1–g1. Available from: http://search.ebscohost.com/login.aspx?direct=true&db=ccm&AN=113676385&site=ehost-live

4. Menezes TO de A, Rodrigues MC, Nogueira BML, de Menezes SAF, da Silva SHM, Vallinoto ACR. Oral and systemic manifestations in HIV-1 patients. Rev Soc Bras Med Trop. 2015;48(1):83–6.

5. Šembera Martin, Vladimíra R, Radovan S. Dental and Oral Lesions in HIV-Positive Individuals in East Bohemia – Czech Republic, Single Centre Experience. Acta Medica (Hradec Kral Czech Republic). 2016;58(4):298–309.

6. Nouaman MN, Meless DG, Coffie PA, Arrivé E, Tchounga BK, Ekouévi DK, et al. Oral health and HIV infection among female sex workers in Abidjan, Côte d'Ivoire. BMC Oral Health [Internet]. 2015;15(1):1–9. Available from: http://dx.doi.org/10.1186/s12903-015-0129-0

7. Nsanzimana S, Prabhu K, McDermott H, et al. Improving health outcomes through concurrent HIV program scale-up and health system development in Rwanda: 20years of experience. *BMC Med* 2015; 13: 1–7.

8. Nsanzimana S, Rwibasira GN, Malamba SS, Musengimana G, Kayirangwa E, Jonnalagadda S, et al. HIV incidence and prevalence among adults aged 15-64 years in Rwanda: Results from the Rwanda Population-based HIV Impact Assessment (RPHIA) and District-level Modeling, 2019. Int J Infect Dis [Internet]. 2022 Mar;116:245–54. Available

from: https://linkinghub.elsevier.com/retrieve/pii/S1201971222000315

9. Nsanzimana S, Kanters S, Remera E, Forrest JI, Binagwaho A, Condo J, et al. HIV care continuum in Rwanda: A cross-sectional analysis of the national programme. Lancet HIV [Internet]. 2015;2(5):e208–15. Available from: http://dx.doi.org/10.1016/S2352-3018(15)00024-7

10. Seymour B, Muhumuza I, Mumena C, Isyagi M, Barrow J, Meeks V. Including oral health training in a health system strengthening program in Rwanda. Glob Health Action. 2013;6(1):1–6.

11. Bridget H, Liliane N, Julien N, Gaspard H, Malick K. Visionary Leadership for the achievement of the UNAIDS 90-90-90 targets. Rwanda Public Heal Bull. 2019;1(3):13–4.

12. Morgan JP, Isyagi M, Ntaganira J, Gatarayiha A, E.Pagni S, Roomian TC, et al. Building oral health research infrastructure: the first national oral health survey of Rwanda. Glob Health Action [Internet]. 2018;11(1):298–309. Available from: https://doi.org/10.1080/16549716.2018.1477249

13. Brondani M, Phillips J, Kerston R, Moniri N. Stigma Around HIV in Dental Care: Patients' Experiences. J Can Dent Assoc [Internet]. 2016;(February):1–7. Available from: http://www.cda-adc.ca/_images/jcdatempimages/g1/g1.pdf

14. Yengopal V, Naidoo S. Do oral lesions associated with HIV affect quality of life? Oral Surgery, Oral Med Oral Pathol Oral Radiol Endodontology. 2008;106(1):298–309.

15. Fricke U, Geurtsen W, Staufenbiel I, Rahman A. Periodontal status of HIV-infected patients undergoing antiretroviral therapy compared to HIV-therapy naive patients : a case control study. 2012;2–7.

16. Ryder MI, Nittayananta W, Coogan M, Greenspan D, Greenspan JS. Periodontal disease in HIV/AIDS. Periodontol 2000 [Internet]. 2012 Oct 22;60(1):78–97. Available from: https://onlinelibrary.wiley.com/doi/10.1111/j.1600-0757.2012.00445.x

17. Palupi R, Sosiawan A, Gilang R, Ramadhani A. Factors Influencing Dental Caries in HIV

/ AIDS Patients. Acta Med Philipp. 2019;53(5):412–6.

18. Kalanzi D, Mayanja-Kizza H, Nakanjako D, et al. Prevalence and factors associated with dental caries in patients attending an HIV care clinic in Uganda: a cross sectional study. *BMC Oral Health* 2019; 19: 159.

19. Muraleedharan S, Panchmal GS, Shenoy RP, Jodalli P, Sonde L, Pasha I. Correlation of CD4 count with cariogenic oral flora indicators and dental caries in HIV-seropositive children undergoing antiretroviral therapy in Mangaluru, South India. J Investig Clin Dent [Internet]. 2017;(July 2017):298–309. Available from: http://doi.wiley.com/10.1111/jicd.12292

20. Santo A, Tagliaferro E, Ambrosano G, Meneghim M, Pereira A. Dental status of Portuguese HIV+ patients and related variables: A multivariate analysis. Oral Dis. 2010;16:176–84.

21. Souza AJ de, Gomes-Filho IS, Silva CAL da, Passos-Soares J de S, Cruz SS da, Trindade SC, et al. Factors associated with dental caries, periodontitis and intra-oral lesions in individuals with HIV / AIDS. AIDS Care [Internet]. 2018 May 4;30(5):578–85. Available from: https://www.tandfonline.com/doi/full/10.1080/09540121.2017.1400640

22. Lima SL de A, Santana CCP, Paschoal MAB, et al. Impact of untreated dental caries on the quality of life of Brazilian children: population-based study. *Int J Paediatr Dent* 2018; 28: 390–399.

23. Duggal S, Chugh T Das, Duggal AK. HIV and malnutrition: Effects on immune system. Clin Dev Immunol. 2012;2012.

24. Ministry of Health-Rwanda. *Rwanda HIV and AIDS National Strategic Plan July 2013 - June 2018*http://rbc.gov.rw/library/rwanda-hiv-and-aids-national-strategic-plan-july2013-june-2018 (2013).

25. Souza AJ de, Gomes-Filho IS, Silva CAL da, Passos-Soares J de S, Cruz SS da, Trindade SC, et al. Factors associated with dental caries, periodontitis and intra-oral lesions in individuals with HIV / AIDS*. AIDS Care - Psychol Socio-Medical Asp AIDS/HIV [Internet]. 2017;30(5):1–8. Available from: https://doi.org/10.1080/09540121.2017.1400640

26. Martin Š, Vladimíra R, Radovan S. Dental and Oral Lesions in HIV-Positive Individuals in East Bohemia – Czech Republic, Single Centre Experience. Acta Medica (Hradec Kral Czech Republic) [Internet]. 2016;58(4):298–309. Available from: http://actamedica.lfhk.cuni.cz/58/4/0123/

27. Rulisa S. Prevalence and Associated Risk Factors of Periodontal Disease among Adults Attending Dental Department in Rwanda Military Hospital (Rwanda): A Cross Sectional Study Prevalence and Associated Risk Factors of Periodontal Disease among Adults Attending Den. Open Dent J. 2015;2(4):105–11.

28. Khatibi M, Moshari AA, Jahromi ZM, Ramezankhani A. Prevalence of oral mucosal lesions and related factors in 200 HIV+/AIDS Iranian patients. J Oral Pathol Med [Internet]. 2011;40(8):659–64. Available from: http://doi.wiley.com/10.1111/j.1600-0714.2011.01013.x

29. Andrade NS, Pontes AS, de Sousa Paz HE, de Moura MS, Moura L de FA de D, Lima M de DM. Molar incisor hypomineralization in HIV-infected children and adolescents. Spec Care Dent. 2017;37(1):28–37.

30. Noguera-Julian M, Guillén Y, Peterson J, Reznik D, Harris E V., Joseph SJ, et al. Oral microbiome in HIV-associated periodontitis: Medicine (Baltimore). 2017 Mar;96(12):e5821.

31. Mukashyaka C, Uzabakiriho B, Amoroso CL, Mpunga T, Odhiambo J, Mukashema P, et al. Public Health Action. 2015;I(3):158–61.

32. Yengopal V, Ayodeji Esan T, Joosab Z. Is there an association between viral load, CD4 count, WHO staging, and dental caries in HIV-positive children? Int J Paediatr Dent [Internet]. 2021 Mar 4;31(2):231–7. Available from: https://onlinelibrary.wiley.com/doi/10.1111/ipd.12663

33. Nouaman MN, Meless DG, Coffie PA, Arrivé E, Tchounga BK, Ekouévi DK, et al. Oral health and HIV infection among female sex workers in Abidjan, Côte d'Ivoire. BMC Oral Health. 2015 Dec;15(1).

34. Askinyte D, Matulionyte R, Rimkevicius A. Oral manifestations of HIV disease: A review.

Stomatologija. 2015;17(1):21–8.

35. Lance V, Catherine D, Whalen C, et al. Characterizing Traditionally-defined Periodontal Disease in HIV+ Adults. *Community Dent Oral Epidemiol* 2009; 37: 427–437.

36. Souza AJ de, Gomes-Filho IS, Silva CAL da, Passos-Soares J de S, Cruz SS da, Trindade SC, et al. Factors associated with dental caries, periodontitis and intra-oral lesions in individuals with HIV / AIDS*. AIDS Care - Psychol Socio-Medical Asp AIDS/HIV. 2017;0121:1–8.

37. Irene T-M, James W, Sten V, Pauline J, Aban Inmaculada, Jeffrey H, et al. Contemporary profile of oral manifestations of HIV/AIDS and associated risk factors in a southeastern US clinic. J Public Health Dent. 2011;71(4):298–309.

38. Kerdpon D, Pongsiriwet S, Pangsomboon K, Iamaroon A, Kampoo K, Sretrirutchai S, et al. HIV Disease / Oral Medicine Oral manifestations of HIV infection in relation to clinical and CD4 immunological status in northern and southern Thai patients. 2004;(June 2003):138–44.

39. Rwenyonyi CM, Kutesa A, Muwazi L, Okullo I, Kasangakia A, Kekitinwab A. Oral Manifestations in HIV / AIDS- Infected Children. 2011;5(July):291–8.

40. Ferreira MS, Noce CW, Dongo M, Gonc LS, Dias EP, J AS. Gender differences in oral manifestations among HIV-infected Brazilian adults. 2013;(692):189–95.

41. OGAWA PEP &HIROSHI. The global burden of periodontal disease : towards integration with chronic disease prevention and control. Periodontol 2000. 2012;60:15–39.

42. Nasir EF, Marthinussen MC, Åstrøm AN. HIV/AIDS-related attitudes and oral impacts on daily performances: A cross-sectional study of Sudanese adult dental patients. BMC Health Serv Res. 2013;13(1).

43. Tirwomwe JF, Rwenyonyi CM, Muwazi LM, Besigye B, Mboli F. Oral manifestations of HIV/AIDS in clients attending TASO clinics in Uganda. Clin Oral Investig. 2007;11(3):289–92.

44. Patton; L, Phelan; J, Ramos-Gomez; F, et al. PPrevalence and classification of HIV-associated oral lesions. *Oral Dis* 2002; 8: 90–109.

45. Locker D, Quiñonez C. To what extent do oral disorders compromise the quality of life? Community Dent Oral Epidemiol. 2011;39(1):3–11.

46. Nurulasmak M, Norkhafizah S, Azizah Y, Anilawati Mat J. Association among oral symptoms, oral health-related quality of life, and health-related quality of life in a sample of adults living with HIV/AIDS in Malaysia. BMC Oral Health. 2017;17(1):298–309.

47. Parish C, Siegel K, Pereyra M, Liguori T, Metsch L. Barriers and facilitators to dental care among HIV-Infected adults. Spec Care Dent [Internet]. 2015 Nov;35(6):294–302. Available from: https://onlinelibrary.wiley.com/doi/10.1111/scd.12132

48. Mulligan R, Seirawan H, Alves ME, Navazesh M, Phelan JA, Greenspan D, et al. Oral health-related quality of life among HIV-infected and at-risk women. Community Dent Oral Epidemiol [Internet]. 2008 Dec;36(6):549–57. Available from: https://onlinelibrary.wiley.com/doi/10.1111/j.1600-0528.2008.00443.x

49. Khan SA, Moorthy J, Omar H, Hasan SS. People living with HIV /AIDS (PLWHA) and HIV/AIDS associated oral lesions; A study in Malaysia. BMC Public Health [Internet]. 2012;12(1):1. Available from: BMC Public Health

50. Agbelusi GA, Wright AA. Oral lesions as indicators of HIV infection among routine dental patients in Lagos, Nigeria. Oral Dis. 2005;11(6):370–3.

51. Oliveira T, Menezes DA, Rodrigues MC, Magdalena B, Nogueira L, Augusto S, et al. Short Communication Oral and systemic manifestations in HIV-1 patients. 2015;48(October 2014):83–6.

52. Da CAL, Da Silva CAL, Dourado I, Dahia SR, Harzheim E, Rutherford GW. Oral manifestations of HIV infection in patients receiving highly active antiretroviral therapy (HAART) in Bahia, Brazil. J Public Health Dent. 2008;68(3):178–81.

53. Prashanth L, Kattapagari KK, Chitturi RT, Ramana V, Baddam R, Prasad LK. A review on role of essential trace elements in health and disease. J Dr NTR. 2015;4(2):75–85.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Oral health is associated with systemic diseases, especially among HIV-positive individuals [26]. The prevalence of oral diseases is higher among HIV-positive people than in the general population [13]. Different reports in the literature highlight higher prevalence rates of periodontal diseases and/or dental caries occurring among HIV-positive patients [4,6,26]. The results of a research conducted in developing countries have also emphasized the high prevalence of common oral diseases among HIV-positive persons compared to HIV-negative individuals. For example, a study done in Uganda by Kalanzi and colleagues revealed high prevalence of dental caries (83.7%) among of HIV-positive participants [18]. Another study done in Côte d'Ivoire among HIV-positive sex workers also reported more than 62% of its participants with common oral diseases including dental caries and periodontal diseases [6]. More researches are important in developing countries to better inform the oral health policies and promote oral health among the high risk of HIV-positive persons. Therefore, this research intends to determine the prevalence of dental caries and periodontal diseases among HIV-positive and HIV-negative adults in Kigali-Rwanda. The study also investigated the risk factors associated with dental caries and periodontal diseases among HIV-positive adults in Kigali-Rwanda. Moreover, the study assessed and compared the Oral Health-Related Quality of Life (OHRQoL) of HIV-positive adults with dental caries and periodontal disease to their HIV-negative counterparties in Kigali, Rwanda. Lastly, it explored and compared perceptions about possible causes and effects of oral diseases on general health among HIV-positive and HIV-negative adults at CHUK.

There is a lack of information regarding the prevalence of dental caries and periodontal disease and their associated risk factors among HIV-positive in comparison to HIV-negative persons in Rwanda. The Rwandan Health Ministry strategic plan of 2014-2019 on non-communicable diseases noted the lack of awareness of oral hygiene and poor dietary habits as a significant problem contributing to periodontal disease and dental caries [54].

The following literature review examined the existing research on oral diseases in HIV-positive and HIV-negative individuals, the gap, and the lessons learned from the literature. The critique of literature is aimed to evaluate what is known and what was unknown or missing on the topic. We used the following search words: 'dental caries'; and 'periodontal diseases'; and HIV; and 'risk factors'; 'determinants'; and 'oral-health-related quality of life'; 'patient-reported outcomes'; and /or Rwanda on Pubmed, Hinali and Google Scholar databases. Various sources of information were reviewed, including systematic reviews with meta-analyses. A a review matrix to summarizing the methods, findings, research concepts, and recommendations were used. The review ends with a discussion of the concepts and conceptual framework related to the study.

2.2. Definition of concepts

2.2.1. Risk factor

Contrary to many other discoveries in public health, the "*risk factor*" concept originates from two disciplines unrelated to the study of health and diseases [55]. Those are probability theory and statistics, and "the two disciplines were combined when probability theory was applied to the analysis of the population and mortality data being gathered by statisticians [55].” In the medical literature, the term risk factor was used since 1961[56].

To better define the "*Risk factor*" concept, it is essential to understand the term correlate. "A *correlate* is defined as a variable that is either negatively or positively associated with an outcome" [57]. A correlation can be measured simultaneously as an outcome or after the outcome. *A risk factor* is a type of correlation associated with an increased probability of a negative outcome [57]. The difference is that the risk factor always precedes the outcome [56,57] and indicates a higher-risk or low-risk subgroup [58].

Hertzel and Gerstein highlighted that several authors attempted to refine the definition of the term "risk factor" as variables that are causally related to the disease in question and that some researchers suggest that the terms, such as "risk indicator" and "risk marker," be used if the variable is not causally related to the event [59]. Hertzel and Gerstein argue that the problem with such distinctions lies in the inability of clinical research to establish causality with complete certainty. As such, they are unhelpful.

Therefore, Hertzel emphasizes that risk factors can be any imagined variable, ranging from a genetic mutation to a blood result, a previous disease, exposure to an infectious agent or toxin, a socioeconomic state, ethnicity, birth weight, or country of origin [59].

The literature also highlights different types of risk factors. The "*fixed marker*" is a risk factor that cannot be changed, like age or ethnicity [57]. Another type of risk factor is known as a "*variable risk factor*"; it can be changed spontaneously or by intervention. A risk factor that does not change the outcome risk upon manipulation is called "*a variable marker*." Finally, there is "*a causal risk factor*," defined as a risk factor that changes the probability of the outcome [57,58]. The main goal of our study is to assess risk factors of common oral diseases (dental caries and periodontal diseases). The study considered different risk factors, as indicated in the literature.

The term risk factor encompasses both causal and predictive factors [56]. Our study used "Prediction models" to determine the risk factors for dental caries and periodontal disease. The prediction model, also known as risk stratification, looks at people or groups at high risk of a particular health condition to intervene or provide other mitigatin processes [58] . Based on this theory, using this prediction model allowed us to identify risk factors that contribute to the development of common oral diseases (dental caries and periodontal diseases) and to figure out the extent to which they contribute to the outcome of interest (dental caries, periodontal disease, oral health-related quality of life (OHRQoL)).

2.2.2 Dental caries and Periodontal diseases

2.2.2.1 Dental caries

Dental caries is a biofilm-mediated, diet-modulated, multifactorial, non-communicable, dynamic disease resulting in net mineral loss of dental hard tissues [60–62]. Dental caries is determined by biological, behavioural, psychosocial, and environmental factors. As a consequence, a caries lesion develops [61]. Dental caries reflects ongoing and past disease symptoms, not the disease itself [63]. Therefore, clinical/ epidemiological studies require recording both continuing and past signs of dental caries [60].

Caries experience is the number of teeth/surfaces with caries lesions, restorations, and/or missing due to caries accumulated by an individual up to a designated point in time. Usually, it is measured using DMFT/S (Decayed, Missing, Filled Teeth/Surfaces) in permanent teeth and (dmft/s) for temporary dentition [61]. Caries prevalence is the number/ proportion of individuals with caries in a given population at a specified threshold at a designated point in time. In many studies, the prevalence of caries experience has been reported. Apart from DMFT, other measures include writing the total caries lesions in primary and permanent teeth or untreated caries which indicateslesions in primary and permanent teeth that have not received appropriate treatment [62].

Despite the accepted scientific evidence that dental caries create significant personal, societal, and economic burdens worldwide and that caries presents the most influential numerical impact across oral health, the disease has typically been invisible in health policies [64]. In this study, we determined caries experience and associated risk factors among HIV-positive in comparison to HIV-negative adults.

2.2.2.2 Periodontal disease

Periodontal disease is an inflammatory disease induced and maintained by the microbiota of the dental biofilm (dental plaque) [65]. This concept originated from "experimental gingivitis" done in human studies by Löe and coworkers in the mid-60s [66]. The literature highlights that the inflammatory response in the gingiva is the initial stage of the periodontal disease process, which, over time, transformed into a destructive phase known as periodontitis, characterized by periodontal attachment and bone loss [65]. The literature highlights that severe periodontitis affects about 10.8% of the global adult population, and the prevalence increases dramatically between 35 and 44 years of age [67].

2.2.2.2.1 Host response to periodontal disease

The host response to the microbial challenge in periodontal disease is complex, and various factors are involved in prolonged exposure of the gingiva to the dental biofilm, an immune-response phase involving lymphocytes and plasma cells is activated, and they produce and release mediators, including interleukins and cytokines characteristic for a more chronic type of inflammation [68,69].

In addition, the host is under constant or changing influence from external and internal factors such as systemic diseases, medications, and psychological factors such as stress, which makes the outcome of the inflammatory response at the individual level during many years of bacterial challenge highly unpredictable [59, 60] [70].

The literature recognizes the pathogenic biofilm as a necessary prerequisite for periodontitis [65]. But it is insufficient to cause the disease [65]. The disease results from complex interactions between the biofilm and the inflammatory immune response, and it is the latter that is estimated to account for almost 80% of the risk of periodontal tissue damage [65]. Periodontitis is a complex disease with multiple component causes, some with their basis in genetics, some caused by epigenetic influences, and others that are modifiable because they relate to patient behaviours, medications, or environmental factors, all of which combine to establish and propagate the periodontitis lesion [65,68].

In susceptible patients-, incipient dysbiosis can trigger an inappropriate and frequently excessive host response, in which excess cytokines, reactive oxygen species (oxidative stress), and matrix metalloproteinases are generated and overwhelm their respective antagonists (i.e., antioxidants and tissue inhibitors of matrix metalloproteinases), resulting in collateral periodontal tissue damage. Damage-associated molecular peptides are released, which further propagate the inflammatory response, and a subsequent failure of innate inflammation-resolving mechanisms results [65,68]. In this research, we also determined periodontal disease and associated risk factors among HIV-positive adults in comparison to HIV-negative counterparts in Kigali, Rwanda.

2.2.2.3 Overview of dental caries, periodontal disease, and underlying factors in HIV/AIDS.

Non-communicable diseases, dental caries, and periodontal diseases significantly burden humans [71]. The dental biofilm is a significant biological determinant common to the development of both disorders, and they share common risk factors and social determinants, important for their prevention and control [72]. Due to global population growth and increased tooth retention, the number of people affected by dental caries and periodontitis has grown substantially, increasing the total burden of these diseases globally up to 37% for untreated caries and 67% for severe periodontitis) [72].

The prevalence of dental caries and periodontitis is high, with untreated dental caries being the most common disease affecting humans worldwide [73]. The global estimates report 621 million children with untreated cavities in dentine in primary teeth and 2.4 billion people with untreated dentine in permanent teeth [71]. Caries and periodontal diseases are prevalent and more severe among people with other chronic conditions, including HIV-positive persons [74,75].

2.2.2.3.1 Periodontal diseases and its risk factors among HIV-positive patients

Periodontal diseases are chronic inflammatory diseases [76] of bacterial origin [77,78]. They are among the common oral diseases found in adults and are the second condition leading to tooth loss after dental caries in the developing world [78]. A high prevalence of periodontal diseases was reported in Rwanda (more than 50% of general Rwandans had oral debris, and 60% had calculus) [12]. However, the oral health status of HIV-positive people and its effect on their quality of life is unknown in Rwanda. Hence, it is essential to conduct this study to inform policymakers on strategies to improve oral health and quality of life of HIV patients in Rwanda.

Many bacteria are involved in periodontal disease. These bacteria can trigger innate, inflammatory, and adaptive immune responses [76]. They induce the production of cytokines and chemokines by the gingival epithelium that will lead to a common periodontal disease known as mild stage (gingivitis) and advanced stage (gingivitis) [76,79].

Researchers highlighted various risk factors for periodontal disease. For instance, the literature reports that stress is a risk factor for periodontal disease through changes in behaviours (smoking, drinking alcohol, and comfort eating) and lifestyle [80]. In addition, Pham and colleagues highlight that lack of oral health knowledge, nutritional status, and tobacco smoking are risk factors for periodontal disease [79]. Moreover, the change in the immune system, was also linked to periodontal disease [76,81]. Herrera and colleagues have categorized age, gender, genetic profile, and some systemic conditions as non-modifiable risk factors. At the same time, they classified lifestyle, metabolic factors (obesity), and dietary factors as modifiable risk factors [82]. In addition, these authors argue that local conditions such as plaque, calculus, dentures, over-hanged restorations, and teeth malposition are risk factors for periodontal disease.

The periodontal disease process results in the periodontium's inflammatory process, which elevates inflammatory markers, mostly cytokines. Evidence from the literature highlights that HIV-positive patients with periodontal disease have higher levels of interleukin-18 and interleukin-2 expression and higher grades of inflammation than patients with healthy periodontal conditions. Thus, HIV-positive patients suffer a more aggressive periodontal disease than non-infected individuals [15]. The literature also highlights that the systemic spread of periodontal infection may contribute to the progression of HIV infection [16].

HIV infection is also a condition that may affect behavior and lifestyle and contribute to a stressful life among affected individuals. All these conditions, together with other common risk factors such as diet habits, oral hygiene behaviours, tobacco smoking, alcohol consumption, frequency of dental visits, and immunity conditions, need to be studied together to understand better the risk factors of common oral diseases among HIV-positive people compared to HIV-negative persons. Furthermore, considering perceptions about possible causes and effects of oral diseases on general health among HIV-positive and HIV-negative adults is another essential component that may add more insight into the existing controversy about risk factors for caries and periodontal diseases and their effect among HIV-positive persons compared to HIV-negative individuals.

2.2.2.4 Dental caries and periodontal diseases in HIV/AIDS

HIV infection is one of the significant public health problems in both developed and developing countries including Sub-Saharan Africa [83]. HIV infection has a negative impact on the economy at the family and country level [83]. HIV impact aggravates the poverty, especially in developing countries. There is a need to combat the associated morbidities and mortality, especially in developing countries, through vibrant research works.

Common oral diseases are among the common morbidities that affect HIV-positive individuals [84]. Despite the use of ART, periodontal disease is still high, and associated risks are unclear [85]. The literature highlights the possible link between prolonged usage of ART and oral diseases [86,87].

However, some scholars link those common oral diseases with other conventional risk factors (i.e., oral hygiene, dietary, lifestyle) [21] and or immunity components like CD4 counts and Viral load [37,88]. It is thus paramount to study the risk factors associated with oral diseases among HIV patients to improve their oral health and general health.

2.2.3 Oral Health-Related Quality of Life (OHRQoL)

Oral health-related quality of life (OHRQoL) is defined as "a multidimensional construct that reflects (among other things) people's comfort when eating, sleeping and engaging in social interaction, their self-esteem, and their satisfaction concerning their oral health"[89][90]. OHRQoL's definition is mainly based on its constructs namely functional. psychological social, experience of pain or discomfort [90].

Dental caries and periodontal diseases are among the oral problems primarily associated with OHRQoL [91]. After an extensive literature search, no study has looked at OHRQoL among HIV-positive persons in Rwanda. Therefore, assessing the oral health-related quality of life in this research is essential.

Evaluation of the quality of life (QoL) has increased in the health area. However, its usage has affected its measurement to mean various things [92]. To respond to this problem, researchers introduce the concept of HRQoL to focus on the effect of health on QoL [92]. HRQoL is a multidimensional construct, and researchers conceptualize it differently [46]. Mohamed and colleagues defined HRQoL as "individuals 'self-perception of their wellbeing in a specified period which contributes to the satisfaction and happiness of life." Wilson and Cleary's model is the most known model on HRQoL. It highlights five categories of health outcomes in HRQoL (physical functioning, social functioning, mental health functioning, and perception of general health) [93].

The term health-related quality of life began in the 21st century, and now it is one of the main components of public health. Studying the effect of oral health on quality of life is paramount to contributing to the public health policy of a country [94]. Rwanda's oral health policy lacks information to take action [94]. The assessment of OHRQoL for this study will inform Rwanda's oral health policy to make informed decisions to improve the oral health of Rwandans.

2.2.3.1 Instruments to assess OHRQoL in adults.

According to the literature, the most widely used adult instruments to assess OHRQoL are Health Impact Profile (OHIP), oral impact on daily performances (OIDP), geriatric oral assessment index (GOHAI), subjective oral health status indicators (SOHSI) and nine specific ones (OHIP temporomandibular disorders, OHIP-masticatory efficiency, OHIP-edentulism, OHIP-aesthetic, OHIP-prosthodontics, Oral potentially malignant diseases (OPMDQoL [95].

2.2.3.2 Oral Health Impact Profile (OHIP)

We used the Oral Health Impact Profile (OHIP) for the current study and it is recommended in the literature to assess OHRQoL [91]. The OHIP-14 is a short version that was developed by Slade and Spancer in response to the lack of oral health consideration to assess HRQoL [46]. The OHIP-14 instrument is composed of 7 domains (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap) with two questions in each domain and thus composed of 14 items. OHIP-14 contains the same original conceptual dimensions as OHIP-49 [96].

2.2.3.3 Conceptual framework

Worldwide, communities are exposed to an unlimited range of risks to their health. The risks do not occur in isolation; they originate from a chain of risks. Petersen developed a model to indicate how different risk factors affect oral health status and quality of life. In his model, Petersen focused on the interconnection between the health system, social culture, environment, health services, and risk behaviour factors that lead to oral health outcomes [97].

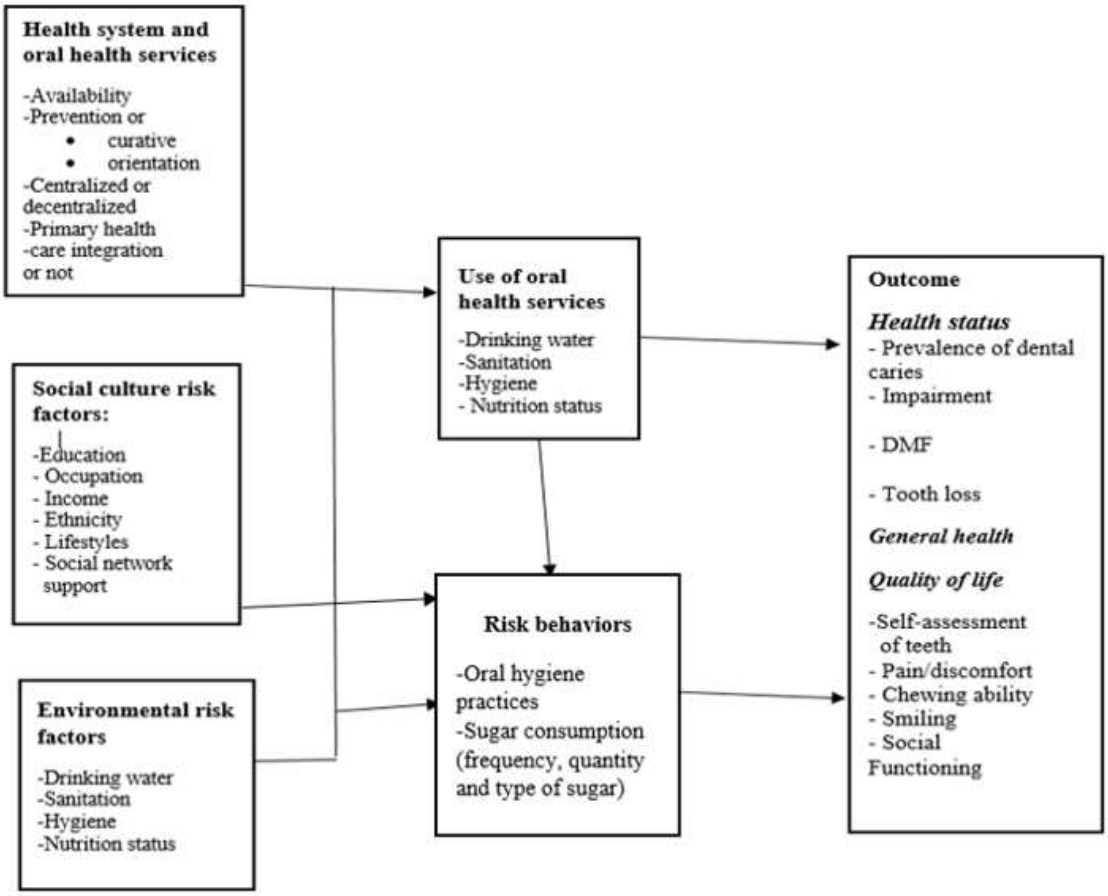

Figure 2. 1. WHO's Risk factor model with distal and proximal factors for analysis of dental caries [98].

Peterson's WHO model was chosen because it encompasses various risk factors highlighted in the literature and which are of interest according to the study objectives. In addition to give a light on different risk factors affecting oral health status, Petersen model further indicates the relation to quality of life outcome and this was one of our study outcome. This model simplifies and combined all the facets of the study with the clear linkage.

The study framework was modified from the WHO model. It depicts how social and cultural risk factors (education, occupation, lifestyle, traditional practices, beliefs, and customs) are distal risk factors for dental caries and periodontal disease, directly impacting oral health services and behavioural factors.

The literature emphasized that sociocultural factors affect individual decisions on the use of health services [89]. In addition, the literature links sociocultural risk factors to risk behaviours such as oral hygiene practices, dietary habits, smoking, and drinking alcohol) which directly affect oral health outcomes (caries, periodontal diseases, and OHRQoL).

On the other hand, empirical research emphasized the role of social and behavioural factors in dental caries development. The risk factor model for dental caries applied by the WHO describes various factors in the analysis of dental caries. The model classifies multiple categories of risk factors, as shown in Figure 1 [98]. In many studies, dental caries is measured through the Decayed, Missing, Filled Teeth (DMFT) index [84,99,100], and many risk factors for periodontal disease are also risk factors for dental caries [98,101,102]. It is essential to study these diseases together to explore their associated risk factors better.

The model was modified to include the HIV clinical markers (WHO HIV staging, types of ART, HIV infection duration, CD4 cell counts, and HIV RNA viral load) in the current framework as predictors of oral health status. We evaluated all these factors to assess how they affect oral health status (periodontal health, caries). A qualitative part was included in the framework to explore and compare the perceptions on possible causes and effects of oral diseases on general health among HIV-positive and HIV-negative adults. The purpose was to get insights into participants' perceptions on possible causes and effects of these common oral diseases. The results of both quantitative and qualitative parts together informed an integrated discussion of the results.

The literature gave insights on various risk factors associated with common oral diseases. It also showed that the Peterson’s model was used in various literatures and we considered this criterion to choose this framework to be able to compare our results with the existing ones.

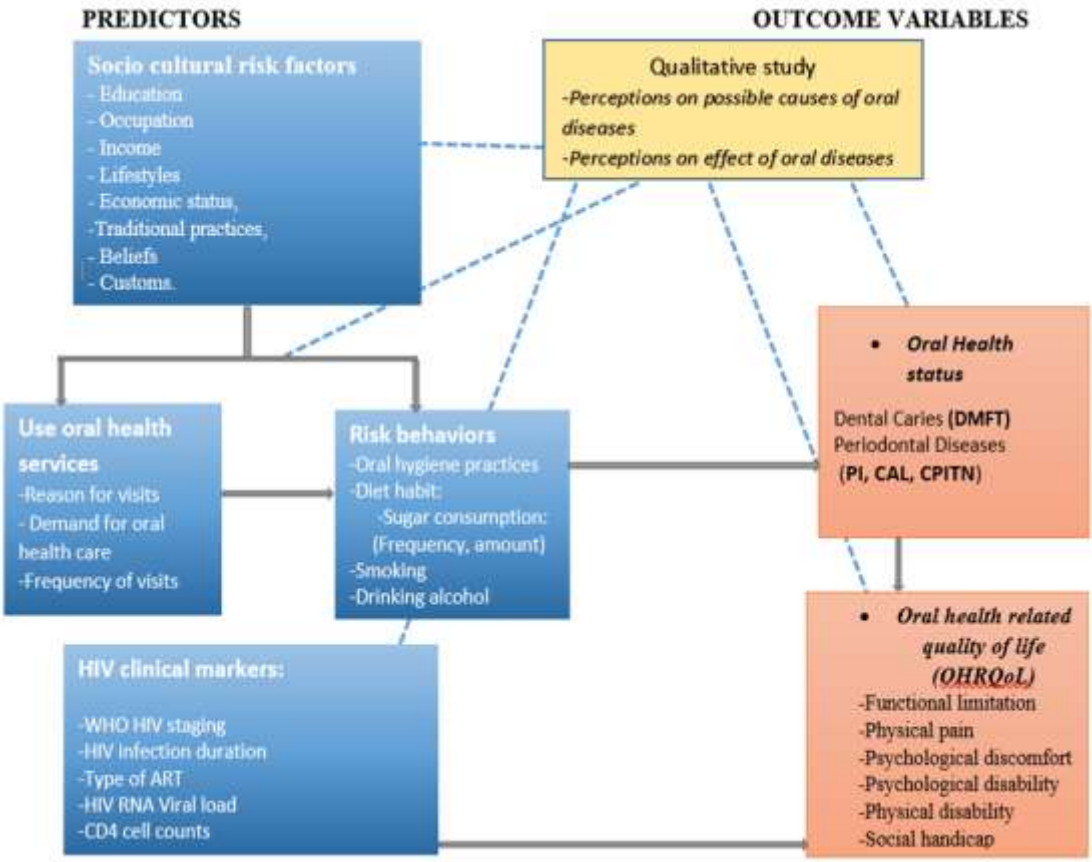

Figure 2. 2. Conceptual framework modified from WHO's Risk factor model with distal and proximal factors for analysis of dental caries [98] [86].

2.2.3.4 Review of the research approach used in the literature

Quantitative research approaches have been used in the literature to analyze the risk factors and OHRQoL among HIV-infected people with oral diseases. For example, a quantitative study with a cross-sectional design was done by Souza and colleagues among HIV-infected people in Brazil [25]. Researchers did another quantitative cross-sectional study among HIV-infected- people in Portugal to evaluate their dental status and its association with clinical, socioeconomic, and behavioural variables [20].

The literature shows many quantitative cross-section studies to identify the risk factors associated with dental caries and periodontal disease. However, there is a lack of studies that used a mixed-method approach. Including the qualitative component gave more insights into risk factors for caries and periodontal disease and their effects on OHRQoL.

As emphasized by scholars, using both quantitative and qualitative approaches allows for a deeper exploration of the research problem through analysis of quantitative and qualitative data [103]. In addition, different viewpoints are better explored and understood using mixed methods. Moreover, the mixed method approach provides contextual understanding based on experience or culture [104].

2.4. Conclusion

The scarcity of information regarding the status of common oral diseases , associated risk factors and their impact on OHRQoL in Rwanda is a problem that can negatively affect the general well-being of HIV-positive people. Also, there is a need to do a mixed-method study that includes different variables of interest, a bigger sample size, and appropriate sampling techniques. The study's results contribute to existing literature regarding dental caries and periodontal status, their associated risk factors, and the impact of common oral diseases on OHRQoL among HIV-positive persons compared to HIV-negative counterparts.

2.5 References

1. Petersen Pe. The World Oral Health Report 2003 : continuous improvement of oral health in the 21st century ± the approach of the WHO Global Oral Health Programme. 2003;31:3–23.
2. Rovaris Ns, Galato D, Schuelter-Trevisol F, da Silva J, da Silva Linhar L, Nickel DA, et al. Oral health status and its impact on the quality of life of children and adolescents living with HIV-1. BMC Res Notes. 2014;7(1):478.
3. Brondani Ma, Phillips JC, Kerston RP, Moniri NR. Stigma Around Hiv in Dental Care: Patients' Experiences. J Can Dent Assoc (Tor) [Internet]. 2016;82:g1–g1. Available from: http://search.ebscohost.com/login.aspx?direct=true&db=ccm&AN=113676385&site=ehost-live
4. Menezes To de A, Rodrigues MC, Nogueira BML, de Menezes SAF, da Silva SHM, Vallinoto Acr. Oral and systemic manifestations in HIV-1 patients. Rev Soc Bras Med Trop. 2015;48(1):83–6.
5. Šembera Martin, Vladimíra R, Radovan S. Dental and Oral Lesions in HIV-Positive

Individuals in East Bohemia – Czech Republic, Single Centre Experience. Acta Medica (Hradec Kral Czech Republic). 2016;58(4):298–309.

6. Nouaman MN, Meless DG, Coffie PA, Arrivé E, Tchounga BK, Ekouévi DK, et al. Oral health and HIV infection among female sex workers in Abidjan, Côte d'Ivoire. BMC Oral Health [Internet]. 2015;15(1):1–9. Available from: http://dx.doi.org/10.1186/s12903-015-0129-0

7. Nsanzimana S, Prabhu K, Mcdermott H, Karita E, Forrest JI, Drobac P, et al. Improving health outcomes through concurrent HIV program scale-up and health system development in Rwanda : 20 years of experience. 2015;1–7.

8. Nsanzimana S, Rwibasira GN, Malamba SS, Musengimana G, Kayirangwa E, Jonnalagadda S, et al. HIV incidence and prevalence among adults aged 15-64 years in Rwanda: Results from the Rwanda Population-based HIV Impact Assessment (RPHIA) and District-level Modeling, 2019. Int J Infect Dis [Internet]. 2022 Mar;116:245–54. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1201971222000315

9. Nsanzimana S, Kanters S, Remera E, Forrest JI, Binagwaho A, Condo J, et al. HIV care continuum in Rwanda: A cross-sectional analysis of the national programme. Lancet HIV [Internet]. 2015;2(5):e208–15. Available from: http://dx.doi.org/10.1016/S2352-3018(15)00024-7

10. Seymour B, Muhumuza I, Mumena C, Isyagi M, Barrow J, Meeks V. Including oral health training in a health system strengthening program in Rwanda. Glob Health Action. 2013;6(1):1–6.

11. Bridget H, Liliane N, Julien N, Gaspard H, Malick K. Visionary Leadership for the achievement of the UNAIDS 90-90-90 targets. Rwanda Public Heal Bull. 2019;1(3):13–4.

12. Morgan JP, Isyagi M, Ntaganira J, Gatarayiha A, E.Pagni S, Roomian TC, et al. Building oral health research infrastructure: the first national oral health survey of Rwanda. Glob Health Action [Internet]. 2018;11(1):298–309. Available from: https://doi.org/10.1080/16549716.2018.1477249

13. Brondani M, Phillips J, Kerston R, Moniri N. Stigma Around HIV in Dental Care: Patients' Experiences. J Can Dent Assoc [Internet]. 2016;(February):1–7. Available from: http://www.cda-adc.ca/_images/jcdatempimages/g1/g1.pdf

14. Yengopal V, Naidoo S. Do oral lesions associated with HIV affect quality of life? Oral

Surgery, Oral Med Oral Pathol Oral Radiol Endodontology. 2008;106(1):298–309.

15. Fricke U, Geurtsen W, Staufenbiel I, Rahman A. Periodontal status of HIV-infected patients undergoing antiretroviral therapy compared to HIV-therapy naive patients : a case control study. 2012;2–7.

16. Mark I R, Wipawee N, Maeve C, Deborah G, John S G. Periodontal disease in HIV/AIDS. 2012;60(1):78–97.

17. Palupi R, Sosiawan A, Gilang R, Ramadhani A. Factors Influencing Dental Caries in HIV / AIDS Patients. Acta Med Philipp. 2019;53(5):412–6.

18. Kalanzi D, Mayanja-kizza H, Nakanjako D, Mwesigwa CL, Ssenyonga R, Amaechi BT. Prevalence and factors associated with dental caries in patients attending an HIV care clinic in Uganda : a cross sectional study. 2019;1–8.

19. Muraleedharan S, Panchmal GS, Shenoy RP, Jodalli P, Sonde L, Pasha I. Correlation of CD4 count with cariogenic oral flora indicators and dental caries in HIV-seropositive children undergoing antiretroviral therapy in Mangaluru, South India. J Investig Clin Dent [Internet]. 2017;(July 2017):298–309. Available from: http://doi.wiley.com/10.1111/jicd.12292

20. Santo A, Tagliaferro E, Ambrosano G, Meneghim M, Pereira A. Dental status of Portuguese HIV+ patients and related variables: A multivariate analysis. Oral Dis. 2010;16:176–84.

21. Souza AJ de, Gomes-Filho IS, Silva CAL da, Passos-Soares J de S, Cruz SS da, Trindade SC, et al. Factors associated with dental caries, periodontitis and intra-oral lesions in individuals with HIV / AIDS. AIDS Care [Internet]. 2018 May 4;30(5):578–85. Available from: https://www.tandfonline.com/doi/full/10.1080/09540121.2017.1400640

22. Lima SL de A, Santana CCP, Paschoal MAB, et al. Impact of untreated dental caries on the quality of life of Brazilian children: population-based study. *Int J Paediatr Dent* 2018; 28: 390–399.

23. Duggal S, Chugh T Das, Duggal AK. HIV and malnutrition: Effects on immune system. Clin Dev Immunol. 2012;2012.

24. Rwanda Biomedical Center. Rwanda HIV and AIDS National strategic plan July2013-June 2018. 2014;

25. Souza AJ de, Gomes-Filho IS, Silva CAL da, Passos-Soares J de S, Cruz SS da, Trindade SC, et al. Factors associated with dental caries, periodontitis and intra-oral lesions in

individuals with HIV / AIDS*. AIDS Care - Psychol Socio-Medical Asp AIDS/HIV [Internet]. 2017;30(5):1–8. Available from: https://doi.org/10.1080/09540121.2017.1400640

26. Martin Š, Vladimíra R, Radovan S. Dental and Oral Lesions in HIV-Positive Individuals in East Bohemia – Czech Republic, Single Centre Experience. Acta Medica (Hradec Kral Czech Republic) [Internet]. 2016;58(4):298–309. Available from: http://actamedica.lfhk.cuni.cz/58/4/0123/

27. Rulisa S. Prevalence and Associated Risk Factors of Periodontal Disease among Adults Attending Dental Department in Rwanda Military Hospital (Rwanda): A Cross Sectional Study Prevalence and Associated Risk Factors of Periodontal Disease among Adults Attending Den. Open Dent J. 2015;2(4):105–11.

28. Khatibi M, Moshari AA, Jahromi ZM, Ramezankhani A. Prevalence of oral mucosal lesions and related factors in 200 HIV+/AIDS Iranian patients. J Oral Pathol Med [Internet]. 2011;40(8):659–64. Available from: http://doi.wiley.com/10.1111/j.1600-0714.2011.01013.x

29. Andrade NS, Pontes AS, de Sousa Paz HE, de Moura MS, Moura L de FA de D, Lima M de DM. Molar incisor hypomineralization in HIV-infected children and adolescents. Spec Care Dent. 2017;37(1):28–37.

30. Noguera-Julian M, Guillén Y, Peterson J, Reznik D, Harris E V., Joseph SJ, et al. Oral microbiome in HIV-associated periodontitis: Medicine (Baltimore). 2017 Mar;96(12):e5821.

31. Mukashyaka C, Uzabakiriho B, Amoroso CL, Mpunga T, Odhiambo J, Mukashema P, et al. Public Health Action. 2015;I(3):158–61.

32. Yengopal V, Ayodeji Esan T, Joosab Z. Is there an association between viral load, CD4 count, WHO staging, and dental caries in HIV-positive children? Int J Paediatr Dent [Internet]. 2021 Mar 4;31(2):231–7. Available from: https://onlinelibrary.wiley.com/doi/10.1111/ipd.12663

33. Nouaman MN, Meless DG, Coffie PA, Arrivé E, Tchounga BK, Ekouévi DK, et al. Oral health and HIV infection among female sex workers in Abidjan, Côte d'Ivoire. BMC Oral Health. 2015 Dec;15(1).

34. Askinyte D, Matulionyte R, Rimkevicius A. Oral manifestations of HIV disease: A review.

Stomatologija. 2015;17(1):21–8.

35. Esther M. Wilkins. Characterizing traditionally defined periodontal disease in HIV + adults. 2009;298–309.

36. Souza AJ de, Gomes-Filho IS, Silva CAL da, Passos-Soares J de S, Cruz SS da, Trindade SC, et al. Factors associated with dental caries, periodontitis and intra-oral lesions in individuals with HIV / AIDS*. AIDS Care - Psychol Socio-Medical Asp AIDS/HIV. 2017;0121:1–8.

37. Irene T-M, James W, Sten V, Pauline J, Aban Inmaculada, Jeffrey H, et al. Contemporary profile of oral manifestations of HIV/AIDS and associated risk factors in a southeastern US clinic. J Public Health Dent. 2011;71(4):298–309.

38. Kerdpon D, Pongsiriwet S, Pangsomboon K, Iamaroon A, Kampoo K, Sretrirutchai S, et al. HIV Disease / Oral Medicine Oral manifestations of HIV infection in relation to clinical and CD4 immunological status in northern and southern Thai patients. 2004;(June 2003):138–44.

39. Rwenyonyi CM, Kutesa A, Muwazi L, Okullo I, Kasangakia A, Kekitinwab A. Oral Manifestations in HIV / AIDS- Infected Children. 2011;5(July):291–8.

40. Ferreira MS, Noce CW, Dongo M, Gonc LS, Dias EP, J AS. Gender differences in oral manifestations among HIV-infected Brazilian adults. 2013;(692):189–95.

41. Ogawa pep &hiroshI. The global burden of periodontal disease : towards integration with chronic disease prevention and control. Periodontol 2000. 2012;60:15–39.

42. Nasir EF, Marthinussen MC, Åstrøm AN. HIV/AIDS-related attitudes and oral impacts on daily performances: A cross-sectional study of Sudanese adult dental patients. BMC Health Serv Res. 2013;13(1).

43. Tirwomwe JF, Rwenyonyi CM, Muwazi LM, Besigye B, Mboli F. Oral manifestations of HIV/AIDS in clients attending TASO clinics in Uganda. Clin Oral Investig. 2007;11(3):289–92.

44. Patton LL, Phelan JA, Ramos-gomez FJ, Nittayananta W, Shiboski CH, Mbuguye TL. Prevalence and classification of HIV-associated. 2002;8.

45. Locker D, Quiñonez C. To what extent do oral disorders compromise the quality of life? Community Dent Oral Epidemiol. 2011;39(1):3–11.

46. Nurulasmak M, Norkhafizah S, Azizah Y, Anilawati Mat J. Association among oral

symptoms, oral health-related quality of life, and health-related quality of life in a sample of adults living with HIV/AIDS in Malaysia. BMC Oral Health. 2017;17(1):298–309.

47. Parish C, Siegel K, Pereyra M, Liguori T, Metsch L. Barriers and facilitators to dental care among HIV-Infected adults. Spec Care Dent [Internet]. 2015 Nov;35(6):294–302. Available from: https://onlinelibrary.wiley.com/doi/10.1111/scd.12132

48. Mulligan R, Seirawan H, Alves ME, Navazesh M, Phelan JA, Greenspan D, et al. Oral health-related quality of life among HIV-infected and at-risk women. Community Dent Oral Epidemiol [Internet]. 2008 Dec;36(6):549–57. Available from: https://onlinelibrary.wiley.com/doi/10.1111/j.1600-0528.2008.00443.x

49. Khan SA, Moorthy J, Omar H, Hasan SS. People living with HIV /AIDS (PLWHA) and HIV/AIDS associated oral lesions; A study in Malaysia. BMC Public Health [Internet]. 2012;12(1):1. Available from: BMC Public Health

50. Agbelusi GA, Wright AA. Oral lesions as indicators of HIV infection among routine dental patients in Lagos, Nigeria. Oral Dis. 2005;11(6):370–3.

51. Oliveira T, Menezes DA, Rodrigues MC, Magdalena B, Nogueira L, Augusto S, et al. Short Communication Oral and systemic manifestations in HIV-1 patients. 2015;48(October 2014):83–6.

52. Da CAL, Da Silva CAL, Dourado I, Dahia SR, Harzheim E, Rutherford GW. Oral manifestations of HIV infection in patients receiving highly active antiretroviral therapy (HAART) in Bahia, Brazil. J Public Health Dent. 2008;68(3):178–81.

53. Prashanth L, Kattapagari KK, Chitturi RT, Ramana V, Baddam R, Prasad LK. A review on role of essential trace elements in health and disease. J Dr NTR. 2015;4(2):75–85.

54. Health MOF. Rwanda Non- communicable Diseases National Strategic Plan. 2014;(July).

55. Dovjak M, Kukec A. Creating Healthy and Sustainable Buildings: An assessment of health risk factors [Internet]. NED-New. Tanja Rejc, National Institute of Public Health, Ljubljana S, editor. Boydell & Brewer, University of Rochester Press; 2003. 480 p. Available from: https://www.jstor.org/stable/10.7722/j.ctt14brtq7

56. Stampfer MJ, Ridker PM, Dzau VJ. Risk Factor Criteria. 2004;3–5.

57. Devid OR, Kraemer HC. Risk factors and prevention. 2000;3(August):70–1.

58. Schooling CM, Jones HE. Clarifying questions about " risk factors ": predictors versus explanation. Emerg Themes Epidemiol [Internet]. 2018;4–9. Available from:

https://doi.org/10.1186/s12982-018-0080-z

59. Gerstein HC. Epidemiologic analyses of risk factors, risk indicators, risk markers, and causal factors. Endocrinol Metab Clin North Am [Internet]. 2002 Sep;31(3):537–51. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0889852902000191

60. O. Fejerskov. Concepts of dental caries and their consequences for understanding the disease. Community Dent Oral Epidemiol. 1997;25:5–12.

61. Ana B, Acevedo M, Garcia-quintana A, Frattaroli-pericchi A. An Extended Concept of Dental Caries and Update of Cariology Terminology. 2022;22(2):0–5.

62. Pitts N, Mazevet M, Mayne C. Towards a cavity-free future. 2017;(June).

63. Kassebaum NJ, Bernabé E, Dahiya M, Bhandari B, Murray CJL, Marcenes W. Global burden of untreated caries: A systematic review and metaregression. J Dent Res. 2015;94(5):650–8.

64. Pitts N, Mayne C. a Global Consensus for achieving a dental cavity-free future. 2021;(March):1–32.

65. Dahlen G, Fejerskov O, Manji F. Current concepts and an alternative perspective on periodontal disease. BMC Oral Health. 2020;20(1):1–9.

66. Loe H, Theilade E, Jensen Sb. Experimental Gingivitis in Man. J Periodontol. 1965;36:177–87.

67. Kassebaum NJ, Bernabé E, Dahiya M, Bhandari B, Murray CJL, Marcenes W. Global burden of severe periodontitis in 1990-2010: A systematic review and meta-regression. J Dent Res. 2014;93(11):1045–53.

68. Meyle J, Chapple I. Molecular aspects of the pathogenesis of periodontitis. Periodontol 2000. 2015;69(1):7–17.

69. Ebersole JL, Dawson D, Emecen-Huja P, Nagarajan R, Howard K, Grady ME, et al. The periodontal war: microbes and immunity. Periodontol 2000. 2017;75(1):52–115.

70. Kornman KS. Patients Are Not Equally Susceptible to Periodontitis: Does This Change Dental Practice and the Dental Curriculum? J Dent Educ. 2001;65(8):777–84.

71. Jepsen S, Blanco J, Buchalla W, Carvalho JC, Dietrich T, Dörfer C, et al. Prevention and control of dental caries and periodontal diseases at individual and population level: consensus report of group 3 of joint EFP/ORCA workshop on the boundaries between caries and periodontal diseases. J Clin Periodontol. 2017;44:S85–93.

72. Jepsen S, Blanco J, Buchalla W, Carvalho JC, Dietrich T, Dörfer C, et al. Prevention and control of dental caries and periodontal diseases at individual and population level: consensus report of group 3 of joint EFP/ORCA workshop on the boundaries between caries and periodontal diseases. J Clin Periodontol. 2017;44:S85–93.
73. Vos T, Allen C, Arora M, Barber RM, Brown A, Carter A, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet. 2016;388(10053):1545–602.
74. Groenewegen H, Bierman WFW, Delli K, Dijkstra PU, Nesse W, Vissink A, et al. Severe periodontitis is more common in HIV- infected patients. J Infect [Internet]. 2019 Mar;78(3):171–7. Available from: https://doi.org/10.1016/j.jinf.2018.11.008
75. Akhigbe P, Chukwumah NM, Folayan MO, Divaris K, Obuekwe O, Omoigberale A, et al. Age-specific associations with dental caries in HIV-infected, exposed but uninfected and HIV-unexposed uninfected children in Nigeria. BMC Oral Health [Internet]. 2022 Sep 27;22(1):429. Available from: https://doi.org/10.1186/s12903-022-02421-w
76. Silva n, Abusleme l, Bravo d, Dutzan n, Garcia-sesnich j, Vernal r, et al. Host response mechanisms in periodontal diseases. J Appl Oral Sci [Internet]. 2015;23(3):329–55. Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1678-77572015000300329&lng=en&tlng=en
77. Fehrenbach MJ. Risk factors for periodontal disease. Richmond Inst. 2008;Vol 6(2):59–94.
78. Thomson WM, Sheiham A, Spencer AJ. Sociobehavioral aspects of periodontal disease. Periodontol 2000. 2012;60(1):54–63.
79. Pham TA V., Kieu TQ, Ngo LTQ. Risk factors of periodontal disease in Vietnamese patients. J Investig Clin Dent [Internet]. 2017;(December 2016):e12272. Available from: http://doi.wiley.com/10.1111/jicd.12272
80. Sabbah W, Gomaa N, Gireesh A. Stress, allostatic load, and periodontal diseases. Periodontol 2000 [Internet]. 2018;78(1):154–61. Available from: http://doi.wiley.com/10.1111/prd.12238
81. Bouchard P, Carra MC, Boillot A, Mora F, Rangï¿½ H. Risk factors in periodontology: a conceptual framework. J Clin Periodontol. 2017;44(2):125–31.
82. Herrera D, Meyle J, Renvert S, Jin and L. White Paper on Prevention and Management of

Periodontal Diseases for Oral Health and General Health FDI Global Periodontal Health Project Task Team. 2018;1–17. Available from: www.fdiworlddental.org

83. Petersen P. Policy for prevention of Oral Manifestations in HIV/AIDS: The approach of the WHO Global Oral Health Program. Adv Dent Res [Internet]. 2006;19(1):17–20. Available from: http://www.who.int/oral_health/publications/017-PETERSEN.pdf

84. Phelan JA, Mulligan R, Nelson E, Brunelle J, Alves MEAF, Navazesh M, et al. Dental caries in HIV-seropositive women. J Dent Res. 2004;83(11):298–309.

85. Liberali SA, Coates EA, Freeman AD, Logan RM, Jamieson L, Mejia G. Oral conditions and their social impact among HIV dental patients, 18 years on. Aust Dent J. 2013;58(1):18–25.

86. Nittayananta W, Talungchit S, Jaruratanasirikul S, Silpapojakul K, Chayakul P, Nilmanat A, et al. Effects of long-term use of HAART on oral health status of HIV-infected subjects. J Oral Pathol Med [Internet]. 2010;39:397–406. Available from: http://doi.wiley.com/10.1111/j.1600-0714.2009.00875.x

87. Filho JCC, Giovani EM. Xerostomy, dental caries and periodontal disease in HIV+ patients. Brazilian J Infect Dis [Internet]. 2009;13(1):13–7.

88. Halloran MO, Science D. HIV - A Dental Perspective HIV - A Dental Perspective. 2002;(2000):29–33.

89. US department of Health and Human Services, National Institute of Dental and Cranial facial Research, National Institute of Health. Oral health in America: a report of the Surgeon General. J Calif Dent Assoc [Internet]. 2000;1–308. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11324049

90. Darshana B, Reddy C.V.K. Health-Related Quality of Life. J internatioal Soc Prev Community Dent. 2013;3(1):735–47.

91. Alzoubi EE, Hariri R, Attard NJ. Oral health related quality of life impact in dentistry. 2017;6(6):183–8.

92. Ferrans CE, Zerwic JJ, Wilbur JE, Larson JL. Conceptual Model of Health-Related Quality of Life. J Nurs Scholarsh. 2005;34(4):336–42.

93. Wilson IB, Cleary PD. Linking clinical variables with health-related quality of life. A conceptual model of patient outcomes. JAMA J Am Med Assoc [Internet]. 1995;273(1):59–65. Available from: http://jama.ama-assn.org/cgi/doi/10.1001/jama.273.1.59

94. Mehta A, Kaur G. Oral health-related quality of life — the concept , its assessment and relevance in dental research and education. Indian J Dent [Internet]. 2011;2(2):26–9. Available from: http://dx.doi.org/10.1016/S0975-962X(11)60007-5
95. Riva F, Seoane M, Reichenheim ME, Tsakos G, Celeste RK. Adult oral health-related quality of life instruments: A systematic review. Community Dent Oral Epidemiol [Internet]. 2022 Oct 18;50(5):333–8. Available from: https://onlinelibrary.wiley.com/doi/10.1111/cdoe.12689
96. Grary S. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol. 1997;25(4):298–309.
97. Petersen PE. Priorities for research for oral health in the 21st century--the approach of the WHO Global Oral Health Programme. Community Dent Health. 2005;22:71–4.
98. WHO. The World Oral Health Report 2003 WHO Global Oral Health Programme. Community Dent Oral Epidemiol [Internet]. 2003;31 Suppl 1:3–23. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15015736
99. Bretz WA, Flaitz C, Moretti A, Corby P, Schneider LG, Nichols CM. Medication Usage and Dental Caries Outcome-Related Variables in HIV/AIDS Patients. AIDS Patient Care STDS [Internet]. 2000;14(10):549–54. Available from: http://www.liebertpub.com/doi/10.1089/108729100750018317
100. Rezaei-Souf L, Davoodi P, Abdolsamadi HR, Jazaeri M, Malekzadeh H. Dental Caries Prevalence in Human Immunodeficiency Virus Infected Patients Receiving Highly Active Anti-Retroviral Therapy in Kermanshah , Iran. 2014;16(1):73–8.
101. Selwitz RH, Ismail AI, Pitts NB. Dental caries Robert. Lancet [Internet]. 2007 Nov 7;369:51–9. Available from: http://www.sciencedirect.com/science/article/pii/S0140673607600312
102. Petersen PE. Sociobehavioural risk factors in dental caries - International perspectives. Community Dent Oral Epidemiol. 2005;33(4):274–9.
103. Ivankova N, Wingo N. Applying Mixed Methods in Action Research: Methodological Potentials and Advantages. Am Behav Sci [Internet]. 2018 Jun 27;1–20. Available from: http://journals.sagepub.com/doi/10.1177/0002764218772673
104. Ivankova N V., Creswell JW, Stick SL. Using Mixed-Methods Sequential Explanatory Design: From Theory to Practice. Field methods. 2006;18(1):3–20.

CHAPTER 3: METHODS

3.1 Study setting

Rwanda had 4 Provinces and the City of Kigali. The total number of Districts in Rwanda is 30. The Rwandan population was 13,246,394 million as of August 2022 [1]. Females represent 6,817,068 (51.5%) of the people, slightly higher than 6,429,326 males, representing 48.5% of the population [1]. The ratio of the Rwandan urban-rural population indicated that there are approximately three urban residents (i.e., 27.9%) for every seven rural residents (72.1%). The City of Kigali is the most urbanized (86.9%) [2] [1].

Our study was done in Kigali city at the HIV clinic of Kigali Teaching Hospital (CHUK) in Nyarugenge District. CHUK is the largest in the District of Nyarugenge. It is also the country's biggest referral hospital, with a capacity of 519 beds. CHUK was chosen because it is one of the largest referral hospitals and receives people from various corners of the country, including urban and rural populations. CHUK started to function in 1928 as a health center; in 1965, it became a hospital, and from 2000 to date, CHUK served as a university teaching hospital.

3.1.1. Map of Rwanda indicating Districts of Kigali city

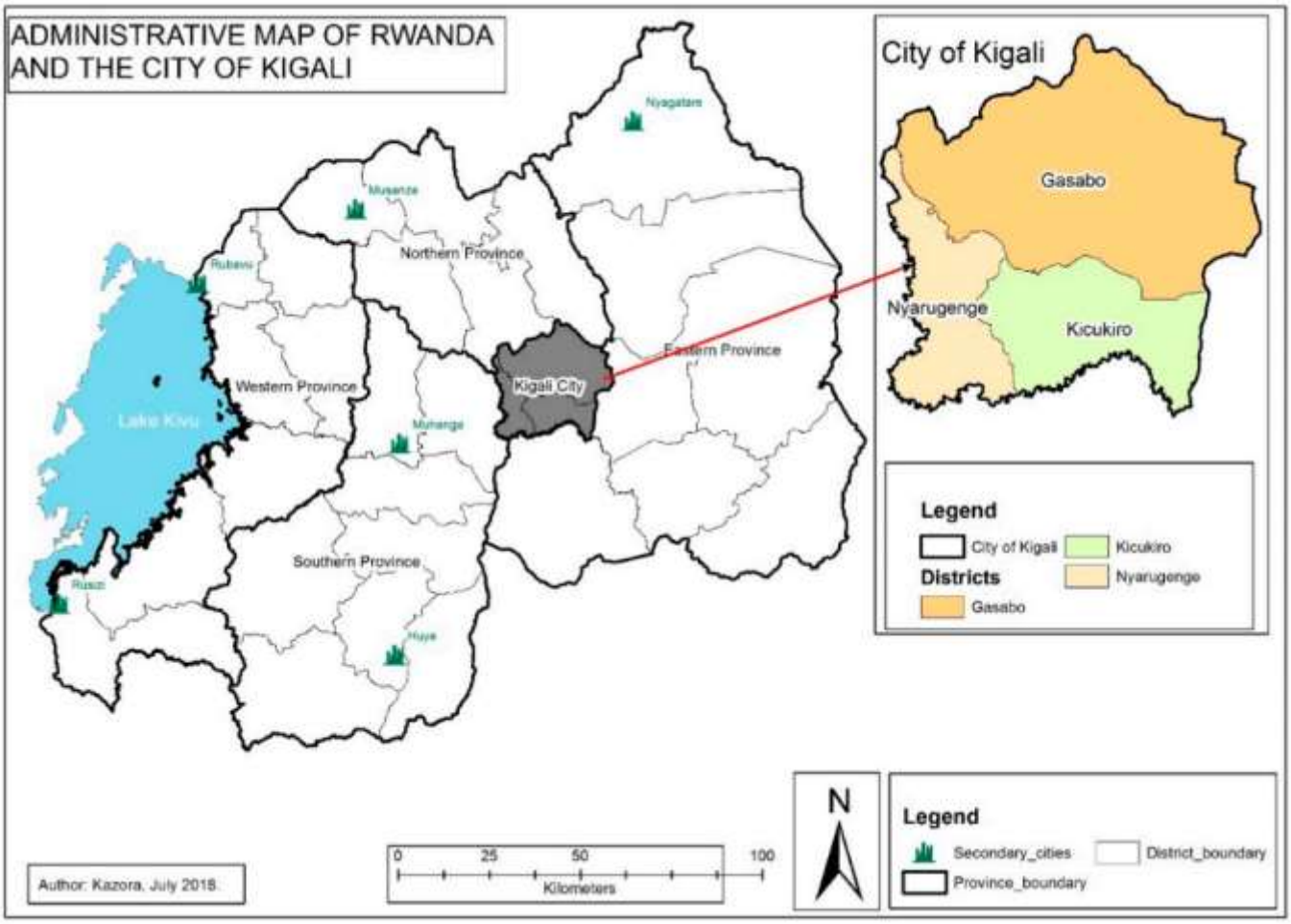

Figure 3.1. Map of Rwanda indicating the city of Kigali Districts [3].

In the City of Kigali, the majority of the population (74.8%) live in urban areas, while on a national level (countrywide), the majority of them live in rural areas (82.7%). The population density is the highest in the country but varies tremendously from one District to another. Nyarugenge District is the most populated, with 2,124 populations per square kilometer, followed by Kicukiro (1,911 populations per square kilometer) and Gasabo (1,234 population per square kilometer). Based on a new definition of the youth age category, which defines the youth as the population aged between 16-30, the youth constitutes 36% of the City population. According to the RPHC5 results, there were 8.2 million adults aged 15 years and above [1].

Among them, approximately 79% (6.5 million) could read and write with understanding in any language. Overall, results show that 2,954,770 of Rwanda residents (about 22.3%) have never attended school.

Urban areas had a lower proportion of individuals with no schooling (18%) as compared to rural areas (24%) [1]. The overall Net Attendance Rate (NAR) at primary was 89.3% and was higher among females than the male population [1]. Net Attendance Rate (NAR) at the secondary level of education was 22.3% [1].

Regarding the economy, Kigali has been Rwanda's economic and transport hub since it became the capital upon independence in 1962 [2]. According to the Census done in August 2022, Kigali city has a population of over 1.135 million [1] [2].

CHUK receives a daily frequency of 1,000 patients and around 400 hospitalized patients. This public hospital also received complicated cases of diseases referred from the district hospital; most of the population's health care is covered by community health insurance in the hospital. CHUK has about 800 staff including 87 Doctors, 397 permanent nurses, 200 paramedical health care providers, and 100 staff in administration service [4].

The HIV clinic is one of the clinics within the hospital. The clinic headcount is more than 2700 cases of HIV-positive people; the majority (>90%) are on ART. The HIV clinic also attends to people who come for HIV voluntary testing. According to the HIV clinic records, around 105 HIV-positive patients are seen daily for routine treatment and management of their condition. In addition, eight to fifteen people are seen daily (approximately 160 a month) for voluntary HIV testing. The HIV testing is done free of charge.

3.2 Study Population

The study population was adult patients (≥18 years old) attending the HIV clinic of CHUK. We sought to recruit HIV-positive and HIV-negative adults from the clinic to compare both cohorts' prevalence and experiences with dental caries and periodontal diseases.

3.3. Inclusion and exclusion criteria

HIV-positive adults diagnosed with HIV infection at least three months before starting data collection and adult HIV-negative attendees visiting HIV voluntary testing were included. Attendees under 18 years old were excluded from the study because oral diseases are better studied separately from adults, young adolescents, and children based on the literature. In addition, the study time length could not allow to have enough sample size for HIV-positive persons under 18 years old based on the smaller percentage of young persons infected by HIV infection at the clinic.

3.4 Study approach and design

A mixed-method approach was used for this study (embedded design).

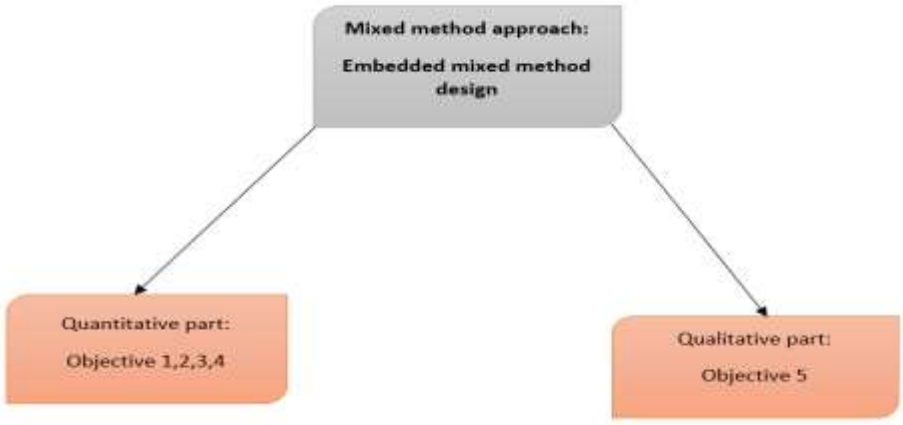

Figure 3. 2. Diagrammatic representation of the study approach

In an embedded design (Concurrent nested design), one collects and analyzes both data types simultaneously but within a main quantitative or qualitative study. One type of data is secondary to the other. According to the literature, this is an excellent approach if you have limited time or resources. An embedded design is used to strengthen or supplement your conclusions from the primary type of research design [5].

3.5 Data analysis plan

Table 3. 1. Summary of study design and method by objectives

PARTS	OBJECTIVES	Approach	Population	Sampling	Method/Tools	Variables	Analysis
Part1	1. To determine caries and periodontal status among adult HIV-positive and HIV-negative patients at an HIV clinic of the University Teaching Hospital of Kigali (CHUK).	Quantitative (comparative cross-sectional)	Adult patients (HIV-positive patients and HIV-negative) attending an HIV clinic at CHUK	Recruitment from the CHUK clinic sample size: We aimed to recruit 400 adults 200 HIV-positive patients 200 HIV-negative people	Clinical examination using DMFT PI CPITN CAL	-Independent: age, sex, education, economic status, comorbidities, medications, HIV status -Dependent: caries (DMFT), periodontal diseases (PD)	-Descriptive statistics (frequencies, Cross-tables, percentages, means score). -Bivariate (Chi-square, t-test) -Kappa score -Multiple logistic regression
	2. To determine risk factors for caries and periodontal diseases among adult HIV+ and HIV-negative people at CHUK.	Quantitative (comparative cross-sectional)	Adult HIV-positive and HIV-negative persons attending the HIV clinic at CHUK	Recruitment from the CHUK clinic sample size: 400 adults 200 HIV-positive patients 200 HIV-negative people	WHO-based survey questionnaire (Interview administered)	Independent variables: age, sex, level of education, economic status, lifestyle, behaviours, beliefs, and customs. Dependent: Caries & PD	-Descriptive statistics (frequencies, cross-tables, percentages, means). -Bivariate (Chi-square and t-test.) -Multiple logistic regression analysis (Odd ratios)
	3. To ascertain the association between HIV clinical markers with caries and/ or periodontal disease among adult HIV-infected patients at the HIV clinic of CHUK.	Quantitative (cross-sectional study design)	HIV-positive and HIV-negative adults attending the HIV clinic at CHUK	Recruitment from the CHUK clinic sample size: 400 adults 200 HIV-positive patients 200 HIV-negative people	Data extraction sheet Electronic Medical records (secondary data)	-Independent variables: HIV stage, HIV duration, types of ART, duration on ART, viral load, CD4 -Dependent variables: caries, PD	-Descriptive (frequencies, percentages, graphs cross-tables,), means -Bivariate (Chi-square, t-test) -Multiple logistic regression (Odd ratios)
	4. To assess and compare oral health-related quality of life (OHRQoL) among HIV-positive and HIV-negative adults at CHUK.	Quantitative (comparative cross-sectional study)	HIV-positive and HIV-negative adults attending the HIV clinic at CHUK	Recruitment from the CHUK clinic sample size: 400 adults 200 HIV-positive patients 200 HIV-negative people	Oral Health Impact Profile Short Version (OHIP-14) tool	Independent variables: Oral problems/ (DC and PD), Dependent variables: OHRQoL	-Cronbach alpha test. -Descriptive (frequencies, percentages, graphs cross-tables), means, -Bivariate (Chi-square, t-test) -Multi-variate logistic regression (analysis for -Odd ratios
Part 2	5. To explore and compare the perceptions on possible causes and effects of oral diseases on general health among HIV-positive and HIV-negative adults at CHUK	Qualitative Embedded design	HIV-positive and HIV-negative adults attending the HIV clinic at CHUK	A purposive sampling until saturation is reached. 21 respondents (10 HIV+ and 11 HIV-).	IDIs using Semi-structured interview guide	Themes and codes	Thematic content analysis

3.5.1 QUANTITATIVE STUDY

3.5.1.1 Study design

A comparative cross-sectional study design was used for four quantitative objectives.

3.5.1.2 Sample Size

Stata software version 15 was used for sample size calculation. Assuming a study power of 80%, considering that the prevalence of caries was 60% in HIV-positive people and 45% in HIV-negative persons and considering a ratio of 1[6], the minimum study sample was estimated at 346 participants. Given that the study included HIV-positive participants, there was anticipation of a challenge regarding responsiveness, especially in studies related to oral health which are not frequently done in Rwanda. Therefore, the calculated minimum sample was increased the by 20% to account for potential non-respondents [7]. Four hundred (400) participants were successfully collected within the timeline.

3.5.1.3 Data collection tools and procedures

HIV-positive and HIV-negative adults were informed about the study and recruited from rooms next to physicians and Voluntary HIV Counselling and Testing respectively. Participants at the HIV clinic of CHUK were all outpatients. We collaborated with physicians for HIV-positive patients and nurses who provided HIV results to the patients. To recruit HIV-negative persons, respondents were first given their HIV status results by the nurse. Then, the nurse informed people whose HIV results were negative about our research. HIV-negative adults who were interested to participate in the study, were sent to a data collection room for informed consent signature. Physicians for HIV-positive people also informed them about our ongoing research and HIV-positive persons who showed willingness to participate were guided to the researchers' room for information and consent signature. A consecutive sampling method was used to select study participants.

For data related to HIV infection (CD4 cell count, viral load, WHO staging, anti-retroviral treatment information), a data extraction sheet was used to record the required information from electronic medical records at the HIV clinic. All consenting HIV-positive participants were examined for dental caries. A calibrated, experienced dental professional performed the clinical oral examination using the WHO (DMFT) index, Plaque Index (PI), Community Periodontal Index of Treatment Need (CPITN) and Clinical attachment Loss (CAL). For intra-examiner reliability during examiner calibration, the Cohen Coefficient found was above 0.7. Participants were seated in a semi-supine position and examined under natural light. All consenting participants were assessed for caries and periodontal disease.

a. Data collection process for dental caries

Caries was assessed through the Decayed, Missing, and Filled Teeth (DMFT) index. DMFT is one of the most commonly used epidemiological indices to measure dental caries in a population [8]. It expresses the mean number of decayed, missing due to caries, and filled teeth due to caries. It measures the caries experience among people [9]. To score DMFT, zero (0) indicated sound teeth, (1) was for scoring untreated cavities, (2) was to score filled teeth with caries, (3) indicated filled teeth without caries, and 4 was for recording missing teeth due to caries.

b. Data collection process for Periodontal status

Plaque Index (PI), Clinical Attachment Loss (CAL), and community periodontal Index of Treatment Need (CPITN) were used to assess periodontal status. The Plaque Index (PI) by Silness and Loe, which assesses the thickness of plaque at the gingival area, was used. Teeth 16,12,14,44,32,36 were considered to determine PI. Lingual, facial, mesial, and distal tooth surfaces were examined for each tooth. For plaque index scoring, 0 was for no plaque, 1 for plaque adhering to the free gingival margin and adjacent tooth area, 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 the naked eye can see and 3 was considered for the abundant soft matter within the gingival pocket and/or on the tooth and gingiva margin.

For CPITN, there was assessment of periodontal pockets, gingival bleeding, and the presence of calculus using a calibrated probe (WHO 621) with a blunt periodontal probe based on sextants.

At least 2 teeth had to be present in a sextant for it to be scored. The CPITN score ranged from 0 to 4 where: 0 was scored for absence of condition (no bleeding, no calculus, no pathological pocket), 1 indicates bleeding upon gentle probing (no calculus, no pathological pocket) 2 stands for the presence of supra and /or subgingival calculus or other plaque retentive factors (with or without bleeding, no pathological pocket), 3 indicated 4 or 5 mm deep periodontal pockets (with or without bleeding and calculus), 4 stands for 6mm or deeper periodontal pockets (with or without bleeding and calculus).

Regarding CAL assessment, we considered pocket depth and gingival margin level measurements. CAL is the distance from the cementoenamel junction (CEJ) to the crevice. Firstly, the pocket depth was measured. Secondly, the distance from the gingiva margin level to the CEJ was also measured using a graduated periodontal probe. Then the two numbers were added to get CAL. The number 0 was considered for a gingiva margin at the same level as CEJ. A positive number was considered for a gingival margin below the CEJ level [10]. Rumford's teeth (16, 21, 24, 36, 41, and 44) were selected to assess CAL. Examiners from Rwanda were Calibration by experienced dentists and dental hygienist from University of Witwatersrand. Cohen's Kappas exceeded the criterion of 0.70. Calibration was done through online sessions using videos and images due to challenge of COVID-19 pandemic.

c. Data collection process for risk factors for caries and periodontal disease

The structured interviewer-administered questionnaire was used to determine social-cultural risk factors for oral diseases. The questionnaire included socio-cultural issues (level of education, economic status, lifestyle, traditional practices, behaviours, beliefs, and customs). The social-cultural questionnaire is based on items from a tool developed by the National Association of Community Health Centers (NACHC) [11]. The following variables were collected: education status, income levels, social connection, health insurance, employment status, lifestyle, beliefs, customs, and factors from the Protocol for Responding and Assessing Patients 'Assets, Risks, and Experiences (PREPARE) [12] [13] regarding social determinants of health [11]. The questionnaire was piloted to 10 adult (18 years old and above dental patients) prior to data collection to improve the clarity of the questionnaire. The questionnaire was interviewer administrated in a language participants could understand.

For HIV-positive patients, a data extraction sheet was used to collect data related to WHO HIV staging, HIV infection duration, types of ART medication, duration on ART, HIV RNA viral load, and CD4 counts were used to collect data from electronic medical record at HIV clinic of CHUK, other comorbidities related to oral disease (diabetes, hypertension, cancers) and pregnancy status were also recorded.

The Oral Health Impact Profile short version (OHIP-14) tool was used to evaluate the OHRQoL among our study participants. In addition, the tool was interviewer administered in a langaue participants could understand. Also, the Cronbach alpha test was performed to test the internal consistency of the OHIP-14 tool in Rwanda context, and the alpha coefficient scored 0.914.

.OHIP-14 tool comprises 7 domains (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap).
A 4-point Likert scale response was used to assess the frequency of oral health impacts during the previous 3 months for all domains. The expected answers were coded as: '0' for 'never,' '1' for 'hardly ever,' '2' for 'occasionally,' '3' for 'fairly often,' and '4 'very often. Great impact indicate poor OHRQoL and low impact indicate Good OHRQoL.

3.5.1.2 Data analysis

i. Caries and Periodontal diseases status

Descriptive statistics was used to calculate frequencies, percentages, and mean scores of oral diseases (DMFT, PI, CPTN, and CAL mean cores) among participants. A Chi-square was done to test the relationships between categorical variables (Age, gender, education, Sociaoeconomic status, residence eating habit, dental vists, oral hygiene beheviors), while a t-test was done to compare the mean scores of continuous variables. Binary logistic regression tests were done to determine the relationship between dental caries and periodontal disease (dichotomous outcome) with various factors. A separate analysis was done with HIV-related factors (CD4 counts, RNA viral load, type and duration of HIV treatment, and WHO staging) as independent variables and adjusted for the sociodemographic, nutritional, and behavioural variables.

Stata version 15 was used for the regression analysis. Kappa score statistical analysis was used to evaluate the intra-examiner reliability during examiner calibration, and the kappa score value found was 0.74. The level of significance was set at 5%.

ii. Analysis of risk factors

The chi-square test was used to evaluate the relationship between categorical variables. A T-test was done to compare means scores with independent continuous variables(age) for normally distributed data. In addition, a multiple binary logistic regression analysis was done to analyze the relationship of outcome dichotomous variables (caries, periodontal diseases) with various predictors.

iii. Oral Health-Related Quality of Life (OHRQoL)

To facilitate the interpretation of our results, participants' responses on the OHIP-14 questionnaire for "fairly often" (coded 3) and "very often" (coded 4) were combined to present high impact. "Occasionally" (coded 2) was counted on its own as neutral, while "hardly ever" (coded 1) and "never" (coded 0) were also added together to represent low impact.

The number of Decayed, Missing, Filled Teeth, and CPITN were independent variables. Oral Health-related quality of life (OHRQoL) was considered the dependent variable. The descriptive statistics were used to see frequencies and percentages of OHRQoL. Chi-square test were used to see the association between oral health impact with demographic characteristics and clinical data (caries (DMFT) and periodontal disease (CPITN)) using Stata version 15. The Cronbach alpha test was performed to test the internal consistency of the OHIP-14 tool in the context of Rwanda, and the alpha coefficient scored 0.914.

3.5.2 QUALITATIVE STUDY

3.5.2.1. Design

Qualitative embedded design was used.

3.5.2.2. Population

HIV-positive and HIV-negative Adults with caries and periodontal diseases who attended HIV clinic at Kigali Teaching hospital (CHUK).

3.5.2.3. Sampling techniques:

Participants with caries and periodontal diseases were purposively recruited from the initial sample obtained through oral screening at the recruitment level at CHUK. To ensure diversity, the following inclusion representations from initial collected quantitative data were considered: HIV-positive vs. HIV-negative; young adults 18-30 years old vs. 31 years and above. We reached our data saturation after 10 interviews for HIV-positive people and 11 interviews for HIV-negative persons.

3.5.2.4. Data collection method and instrument

Before semi-structured interviews and digital recording, participants were informed in detail, and consent was requested. In-depth interviews were conducted in the privacy and convenience of the participants, while confidentiality was always respected. Semi-structured interviews were conducted based on interview-guide to ensure the consistency of interviewers and to increase the study's credibility. IDIs were chosen because they are effective in getting respondents talking about their personal experiences, feelings, and opinions [14]. In addition, respondents feel more relaxed and confident to express sincerely what they think about a given subject individually [14]. Interviewers underwent training about the appropriate use of probing, iterative questioning, and frequent debriefing to assure quality control measures. Interviews were done by 2 interviewers with a dental background, a master's in public health, and experience in qualitative data collection. Interviewers were required to recognize their potential preconceptions and biases "ability to sustain a reflexive stance" [15]. Bracketing method was assured.

3.5.2.5. Data analysis.

Thematic content analysis using inductive approach was used to analyze interview data. The goal of thematic analysis is to identify the themes of interest in the data and use them to interpret and make sense of research data [16]. The audio recordings were transcribed verbatim and translated into English by a professional university translator to ensure all the nuances were captured and translated into the transcripts. The English version was translated back again to the local language to ensure correcteness.

Thematic content analysis was done through various steps. The first step was to familiarize with the data. Familiarization with data was achieved by reading and re-reading textual data, listening to audio-recording, writing notes on the data as we read, and generally looking through each transcript to get familiar with the data. In addition, we coded data by identifying relevant and interesting phrases and sentences regarding our study aim. We then organized all the highlighted data into groups determined by code to gain a summarized general idea of common meanings within our qualitative data. Moreover, we generated themes by identifying patterns within created codes. Also, we reviewed the themes for their accuracy and made improvements where needed. Furthermore, we defined and gave meaning to each theme. Finally, we did the write-up of the report in line with the identified themes. The trustworthiness was ensured through the following criteria:

i. Credibility

Credibility refers to the degree to which your research can be deemed responsible and accurate. It safeguards against subjective experiences, emotions, and perspectives that may otherwise obscure the true nature of your research subject [12]. Credibility establishes whether the research findings represent reasonable information drawn from the participants' original data and is a correct interpretation of the participants' original views [12]. For our study, credibility was observed by considering 2 different researchers who independently coded, analyzed, and interpreted data on perceptions of possible causes and effect of oral diseases.

ii. Transferability

Refers to the degree to which the results of qualitative research can be transferred to other contexts or settings with another group of people [12]. For our study, a comprehensive and detailed description of the research setting and participants was done to be able to understand the context of our research. Also, the description of the data collection process was clearly detailed.

iii. Dependability

The stability of findings over time. It involves in-depth methodological description to allow study to be repeated [12]. As recommended in the literature, we also provided in-depth methodological description to allow our study to be repeated.

3.6. Ethical consideration

The ethical clearances to conduct the study were received from the Human Research Ethics Committee (No M200351) from the University of Witwatersrand, the Institutional Review Board (No 573/CMHSIRB/2019) from the University of Rwanda, and the Research Ethics Committee of Kigali Teaching Hospital (No EC/CHUK/026/2020). Informed written consent was given to all participants before data collection. To obtain informed consent, we first provided adequate information to participants through an information sheet that explained in detail the nature and processes involved in the study, the reason for the study, and the intended outcomes. We allowed participants to ask questions and respond to each question. We ensured participants comprehended the provided information. Then, participants who agreed to participate in our study voluntarily signed the consent form. The confidentiality of patients was observed by using an anonymous questionnaire.

3.7 References

1. Ashagrie M. Which formula to use to calculate the sample size for a cross sectional comparative study? 2020.

2. Ntampaka P, Nyaga PN, Niragire F, Gathumbi JK, Tukei M. Knowledge, attitudes and practices regarding rabies and its control among dog owners in Kigali city, Rwanda. Arez AP, editor. PLoS One [Internet]. 2019 Aug 20;14(8):e0210044. Available from: https://dx.plos.org/10.1371/journal.pone.0210044

3. AHamide M, Ali J, Rezaee Reza, Daraei Hiua, Siros S, Rezaei Shima, et al. Assessment of DMFT and its influencing factors in guidance school students in Piranshahr city , Iran. 2017;298–309.

4. Cypriano S, Maria de S, Ronaldo Seichi W. Evaluation of simplified DMFT indices in epidemiological surveys of dental caries. 2005;39(2):298–309.

5. Karmakar S, Prakash S. Clinical Attachment Level: an Unsung Hero in Periodontal Diagnosis. Int J Adv Res. 2019;7(4):106–11.

6. Kusnoor S V., Koonce TY, Hurley ST, McClellan KM, Blasingame MN, Frakes ET, et al.

Collection of social determinants of health in the community clinic setting: a cross-sectional study. BMC Public Health [Internet]. 2018 Dec 24;18(550):1–9. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-018-5453-2

7. Masovic A. Socio-Cultural Factors and Their Impact on the Performance of Multinational Companies. Ecoforum. 2018;7(1).

8. US department of Healthand Human Services, National Institute of Dental and Cranialfacial Research, National Institute of Health. Oral health in America: a report of the Surgeon General. J Calif Dent Assoc [Internet]. 2000;1–308. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11324049

9. Milena ZR, Stancu A. Qualitative research methods: A comparison between focus-group and in-depth interviews. Romania: University of Oradea, Economic Science Series. 2008;(May):17(4): 1279-1283.

10. Lea T, Peter N. Bracketing in qualitative research. Qual Soc Work. 2010;11(1):298–309.

11. Moire M, Brid D. Doing a Thematic Analysis: A Practical, Step-by-Step. All Irel J Teach Learn High Educ [Internet]. 2017;8(3):298–309. Available from: http://ojs.aishe.org/index.php/aishe-j/article/view/335

CHAPTER 4: PREVALENCE OF DENTAL CARIES AND ASSOCIATED RISK FACTORS AMONG HIV-POSITIVE AND HIV-NEGATIVE ADULTS AT AN HIV CLINIC IN KIGALI, RWANDA.

Results from a paper published in Plos One journal :

Murererehe, J., Malele-Kolisa, Y., Niragire, F., & Yengopal, V. (2023). Prevalence of dental caries and associated risk factors among People Living with HIV/AIDS and HIV uninfected adults at an HIV clinic in Kigali, Rwanda. *PLOS ONE*, *18*(4), e0276245. https://doi.org/10.1371/journal.pone.0276245

4.1 Abstract

Background

Dental caries is among the most frequent oral conditions in HIV-positive. There is a lack of baseline information on the prevalence of dental caries and associated risk factors among HIV-positive in comparison to HIV-negative people in Rwanda.

Objective

This study was conducted to determine the prevalence of dental caries and associated risk factors among HIV-positive and HIV-negative adults at an HIV clinic of Kigali Teaching Hospital (CHUK) in Kigali, Rwanda.

Methods

A comparative cross-sectional study was conducted among 200 HIV-positive and 200 HIV-negative adults aged 18 years and above attending an HIV clinic in CHUK. An oral examination was performed by a calibrated examiner. Dental caries was assessed using the WHO Decayed (D), Missing (M), and Filled Teeth (F) index (DMFT). Descriptive statistics, Chi-square, t-tests, and multiple binary logistic regression analyses were used for data analysis.

Results

Overall, a higher prevalence (50.5%) of HIV-positive people had experienced dental caries (DMFT>0) compared to HIV-negative counterparts (40.5%) and the difference was statistically significant (p=0.045).

The prevalence of Decayed teeth (D) was also higher (23.5%) among HIV-positive people compared to HIV-negative persons (13.6%) (p=0.011). The Mean(SD) DMFT scores among HIV-positive people and HIV-negative participants were 2.28 (3.68) and 1.29 (2.21) respectively (p=0.001). After performing multiple binary logistic regression analysis, the predictors of dental caries in HIV-positive people were being female (OR= 2.33; 95%CI= 1.14-4.75), frequent dental visits (OR= 4.50; 95% CI=1.46-13.86) and detectable RNA viral load (OR= 4.50; 95% CI=1.46-13.86). In HIV-negative participants, the middle age range (36-45 years), and frequent dental visits were significantly associated with dental caries (OR= 6.61; 95%CI=2.14-20.37) and (OR=3.42; 95%CI: 1.337-8.760) respectively.

Conclusion

The prevalence of dental caries was higher in HIV-positive people than in HIV-negative counterparts. The reported higher prevalence of caries in HIV-positive participants was associated with being female, detectable viral load, and frequent dental visits. Therefore, there is a need for effective oral health interventions specific to HIV-positive people in Rwanda to raise awareness of the risk of dental caries and provide preventive oral health services among this population. To ensure timely oral health care among HIV-positive persons, there is a need for an effort from policymakers and other stakeholders to integrate oral health care services within the HIV treatment programme in Rwanda.

4.2 Introduction.

Oral health is an integral part of overall health and it is strongly associated with systemic conditions [1] including Human Immunodeficiency Virus (HIV) [2], Alzheimer's disease [3], cardiovascular diseases, diabetes and obesity [4]. The prevalence of caries is higher among HIV-positive people than among the general population [2,5–7]. Therefore, effective treatment of HIV-positive people should include oral diseases management.

Acquired Immune Deficiency Syndrome is considered an important public health problem in developed and developing countries [8]. More than 1.5 million people globally became newly infected with HIV in 2020 [9]. The WHO African region is the most affected region, accounting for more than two-thirds of HIV-positive people worldwide [8]. In Rwanda, HIV prevalence is higher in urban areas (7.1%) compared to rural settings (2.3%) [10].

Since the introduction of highly active antiretroviral treatment (HAART) in 1996, the life expectance of HIV-positive people has considerably increased [11,12]. HAART has also significantly reduced the occurrence of HIV related oral lesions [13]. As HIV-positive persons live longer, it is imperative to promote their good oral health and access to quality dental care.

Dental care is reported as the least frequently met healthcare need among HIV-positive people [14]. Poor dental function resulting from oral diseases such as dental caries affect the general health of HIV-positive individuals [15,16]. Moreover, dental decay negatively affects the physical, mental, and social life of affected people [17]. In addition, oral diseases can affect adherence to antiretroviral therapy (ART) among HIV-positive people [17]. Also, dental problems among HIV-positive individuals are known to be more severe and difficult to manage compared to oral problems among HIV-negarive people [15]. Thus, oral health care should not be ignored and should form an important component of comprehensive treatment available for HIV-positive people.

There is a high burden of oral diseases in Rwanda according to the latest Rwandan National Oral Health Survey. Nearly 65% of participants in the survey had dental caries with more than 54% untreated caries [18]. Data on caries prevalence and associated risk factors among HIV-positive people is lacking in Rwanda. This study was conducted to provide baseline information on the prevalence of dental caries and associated risk factors among HIV-positive people in comparison to HIV-negative individuals at an HIV clinic of Kigali Teaching hospital (CHUK). The information from this study will enable us to inform policymakers and other stakeholders on the best strategies to prevent oral diseases, specifically dental caries among HIV-positive people thereby contributing to the improvement of their oral health-related quality of life.

4.3 Materials and Methods

4.3.1 Study design and participants

This was a comparative cross-sectional study. The study population consisted of HIV-positive people and HIV-negative adults attending the HIV clinic of Kigali Teaching Hospital (CHUK). HIV-positive people, aged 18 years and older, and diagnosed as HIV-positive 3 months before recruitment were included in the study. HIV-negative attendees aged 18 years and above who came for HIV voluntary testing and who were diagnosed as HIV-negative were also included. To control for confounders, information on dietary habits, Oral hygiene behaviours, socio-economic status education, gender, age were collected.

4.3.2 Sample size and sample size calculation

The sample size for comparative cross-sectional study objectives was calculated using Stata software version 15. Assuming a study power of 80%, considering that the prevalence of caries is 60% in HIV-positive people and 45% in HIV-negative persons and considering a ratio of 1 [19]. The minimum study sample estimated was 346 participants. The study included HIV-positive people with the challenge regarding responsiveness especially in studies related to oral health that are not frequently done in Rwanda. For that reason, the decision was to increase the calculated minimum sample by 20% to account for potential none respondents [20]. The study target became 415 participants of whom, 400 participants were successful collected.

3.3.3 Data collection tools and procedures

Participants were informed about the study and recruited at the two sites of the clinic as they attended for care on the recruitment day. HIV-positive and HIV-negative participants at the HIV clinic of CHUK were outpatients. The first site of recruitment was at the Voluntary HIV Counselling and Testing (VCT) and it was for the recruitment of HIV-negative adults. The second site was next to the physicians' rooms, and it was for recruiting eligible HIV-positive persons at HIV clinic of CHUK. We worked hand in hand with physicians and practitioners who provided HIV results to the patients. To get HIV-negative people, respondents were first given their HIV status results by the nurse. After providing the results, the nurse informed people whose HIV results were negative about the ongoing research. HIV-negative adults who showed interest to participate in the study, were sent to a data collection room to get informed consent.

To recruit HIV-positive people, physicians/ nurses also first informed them about the ongoing study. Those who agreed to participate in the study were sent to the researchers 'room for consent signature before starting data collection.

Consecutive sampling method was used to select study participants. For data related to HIV infection (CD4 cell count, viral load, WHO staging, anti-retroviral treatment information), we used data extraction sheet to record the information needed from electronic medical record at HIV clinic. All consenting participants were examined for caries. The Clinical oral examination was performed by a calibrated experienced dental professional working at the University of Rwanda using the WHO (DMFT) index. Participants were seated in a semi-supine position and examined under natural light.

3.3.4. Statistical analysis

Descriptive statistics including frequencies, percentages and means scores of oral diseases (DMFT mean cores) were computed. The Chi-square test was used to test the relationships between the presence of caries and categorical variables. A t-test was used for data associations between continuous variables. Binary logistic regression tests were done to determine the relationship of dental caries (dichotomous outcome) with various factors (age, sex,education,socio-economic, status, eating habit, dental visits). A separate analysis was done with HIV- related factors (CD4 counts, RNA viral load, type and duration on HIV treatment, WHO staging) as independent variables and adjusted for the sociodemographic, nutritional, and behavioural variables. Stata version 15 was used for the regression analysis. Kappa score statistical analysis was used to evaluate the intra-examiner reliability during examiner calibration and the kappa score value found was 0.74. The level of significance was set at 5%.

3.3.5 Ethical consideration

The ethical clearances to conduct the study were received from Human Research Ethics Committee (No M200351) from the University of Witwatersrand, Institutional Review Board (No 573/CMHSIRB/2019) from University of Rwanda and Research ethics committee of Kigali Teaching Hospital (No EC/CHUK/026/2020). The informed written consents were given to all participants before data correction.

To obtain informed consent, we first provided adequate information to participants through information sheet that explained in detail the nature and processes involved in the study, the reason for the study, and the intended outcomes. Participants were given opportunity to ask questions and and each raised question was answered. The was assurance that participants comprehended the provided information before requesting them to sign the consent. Then, participants who agreed to participate in our study voluntarily signed the consent form. The confidentiality of patients was observed by using an anonymous questionnaire.

4.4 Results

4.4.1 Demographic characteristics

The demographic characteristics of HIV-positive people and HIV-negative adults are presented in table 1. The results revealed a statistically significant difference in age group among HIV-positive adults compared to HIV-negative individuals (p=<0.001). The mean age was significantly higher in HIV-positive people (43.51, 95%CI:41.51-45.51) than the mean age in HIV-negative persons (36.53, (95% CI: 34.72-38.33) (p<0.001). Also, the majority of HIV-positive people was living in urban areas (81.5%) (n=163) compared to HIV-negative adults (63%) (p<0.001). More HIV-positive persons completed primary (40%) and secondary school (34 %) compared to HIV-negative individuals who completed primary (37%) and secondary school level (25%) (p=0.020). In addition, significantly (p=0.024) more HIV-positive people were unemployed (32 %) compared to employed HIV-negative persons (22 %). The prevalence of HIV-positive people in ubudehe (socio-economic status) category 3 and 4 was significantly higher (67.5%) compared to the prevalence of HIV-negative respondents in ubudehe category 3 and 4 (51,5%) (p=0.005).

Table 4. 1. Comparison of Socio demographic characteristics of participants

Social demographic characteristics	**HIV-positive n(%) ; n=200**	**HIV-negative n(%) ; n=200**	**p value**
Age			**<0.001***
18-24	30(15)	39(19.5)	
25-35	31(15.5)	77(38.5)	
36-45	34(17.0)	39(19.5)	
46-55	57(28.5)	23(11.5)	
56+	54(24.0)	21(12.0)	

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)[+]			
Category1	18(9.0)	24(12.0)	**0.005**
Category2	47(23.5)	73(36.5)	
Category3 and 4	135(67.5)	103(51.5)	

[+]Category 1: (Families who do not own a house and can hardly afford basic needs); Category 2: (Those who have a dwelling of their own or can rent one but rarely get one; Category 3: Those who have a job and farmers and go beyond subsistence farming to produce a surplus which can be sold. Also include those with small and medium enterprises who can employ dozens of people; Category 4: Those who own large-scale business, individuals working with international organizations and industries as well as public servants.

4.4.2 Comparison of dental caries among participants according to HIV infection status.

The results in Table 2 show that HIV-positive people experienced significantly more caries than HIV-negative individuals [(Decay (D) 47 (23.5%) vs. 27 (13.6%)]; p< 0.01]. The mean (SD)

DMFT scores for HIV-positive participants and HIV-negative persons were 2.28 (3.68) and 1.29 (2.21) respectively, (p=0.001).

Table 4. 2. Distribution of dental caries according to HIV infection status.

Variable	HIV-positive (n=200)		HIV-negative (n=200)		P-value
	n(%)Yes	**n(%) No**	**Yes N(%)**	**n(%) No**	
D	47(23.5)	153(76.5)	**27(13.6)**	172(86.4)	**0.011***
M	80(40)	120(60)	69(34.5)	131(65.5)	0.255
F	23(11.6)	176(88.4)	14(7)	186(93)	0.117
DMFT	101(50.5)	99(49.5)	81(40.5)	119(59.5)	**0.045***
	Mean	**SD**	**Mean**	**SD**	**P value**
D	0.57	1.42	0.17	0.47	**<0.001***
M	1.36	2.78	**0.96**	1.84	0.091
F	0.37	1.31	**0.17**	0.78	0.069
DMFT	2.28	3.68	1.29	2.21	**0.001***

4.4.3 Comparison of factors associated with dental caries among HIV-positive people and HIV-negative adults.

The results in Table 4.3+ showed that HIV-positive females were 2.33 times more likely than HIV-positive males to have dental caries (95% CI=1.142-4.252). Although not significant, HIV-negative females were also 1.37 times more likely than HIV-negative males to have dental caries 1.37 (95%CI= 0.680-2.774).

Amongst HIV-negative adults, participants aged 36-45 years were 6.61 times more likely than the younger age group (18-14) to develop dental caries (95% CI=2.146-20.370), the result was statistically significant (p=0.001). The remaining age categories were not statistically significant. HIV-negative respondents who have visited a dentist within less than 6 months to 1-year period were 3.24 times more likely to have dental caries (95%CI= 1.34-8.76) compared to HIV-negative adults who never visited dentists. The difference was statistically significant. Participants who visited dentists within 5 years were approximately twice more likely to have dental caries (95%CI=0.75-5.76) than the research participants who never received dental care. Those who

visited dentist after 5 years were 1.30 times less likely to have dental caries (95% CI=0.329-1.805) than those who never visited a dentist. In the following table, caries corresponds to DMF greater than 0 and 1 in regression analysis is a reference or baseline or usual value that is observed for the given variable.

Table 4. 3 +. Comparison of factors associated with dental caries among participants according to HIV status

Variables	**Subgroups**	**HIV-positive OR (95% CI)**	**P value**	**HIV-negative OR (95% CI)**	**P value**
Gender	male	1		1	
	Female	2.33(1.142-4.752)	**0.020**	1.37(0.680-2.774)	0.375
Age (years)	18-24	1		1	
	25-35	0.62(0.184-2.051)	0.429	1.52(0.575-3.995)	0.400
	36-45	0.50(0.160-1.577)	0.239	6.61(2.146-20.370)	**0.001***
	46-55	0.74(0.261-2.068)	0.561	3.48(0.953-12.689)	0.059
	56+	2.04(0.650-6.412)	0.221	2.66 (0.698-10.120)	0.152
Residence	Rural	1		1	
	Urban	0.95(0.239-3.787)	0.944	1.39(0.577-3.341)	0.463
	Peri-urban	1.18(0.230-6.060)	0.840	1.03(0.324-3.287)	0.955
Education					
	Tertiary	1		1	
	No or less than primary school	0.93(0.244-3.557)	0.919	1.92(0.575-6.415)	0.288
	Primary school completed	0.92(0.329-2.581)	0.877	0.93(0.294-2.951)	0.905
	Secondary school	1.41(0.500-4.005)	0.513	1.30(0.388-4.376)	0.667
Occupation	Not employed	1		1	
	Employed	0.98(0.478-2.007)	0.957	2.12(0.860-5.220)	0.102
Ubudehe	Category1	1		1	
	Category 2	0.69(0.300-1.596)	0.389	1.12(0.367-3.419)	0.841
	Category 3 and 4	0.92(0.285-2.994	0.896	1.07(0.357-3.189)	0.907
Dental visit	Never received dental care	1		1	
	less than 6 months to 1 year	4.50(1.460-13.865)	**0.009***	3.42(1.337-8.760)	**0.010***

	more than 1 year but less than 5 years	4.58(1.901-11.010)	**0.001***	2.08(0.754-5.761)	0.157
	5 years and more	1.53(0.694-3.358)	0.292	0.77(0.329-1.805)	0.550
Frequency of eating fruits	several times a day or every day	1		1	
	several times a week or once a week	0.59(0.239-1.466)	0.258	1.24(0.455-3.398)	0.669
	several times a month or seldom/never	0.73(0.265-2.015)	0.546	1.59(0.518-4.880)	0.417
Frequency of drinking tea with sugar	several times a month or seldom/never	1		1	
	several times a day or every day	2.02(0.891-4.590)	0.092	1.85(0.770-4.344)	0.169
	several times a week or once a week	2.37(0.889-6.290)	0.084	1.01(0.360-2.834)	0.984
Alcohol consumption	No	1		1	
	Yes	1.59(0.748-3.393)	0.227	1.63(0.785-3.373)	0.190
Fitting test result		X		XX	

+The indicator of dental caries (DMFT) that we used in comparison with factors associated with dental caries was prevalence

X Pseudo R2= 0.131

XX pseudo R2= 0.141

4.4.4 Multiple binary logistic regression analysis of HIV related factors associated with dental caries among HIV-positive people.

After adjusting for all factors not related to HIV infection (gender, age, residence, education, occupation, ubudehe (income status), dental visit, frequency of eating fruits, frequency of drinking tea with sugar and alcohol consumption), the results in table 4 revealed that HIV-positive people with detectable RNA-Viral Load (≥20) were 2.69 times more likely (95% CI= 1.004-7.208) to have dental caries than participants with undetectable RNA-Viral Load and the results were statically significant (p =0.049).

Table 4. 4. √ Logistic regression analysis of HIV-related factors associated with dental caries among HIV-positive people.

Variable	Subgroups	OR (95% CI)	P value
CD4	Group I (≥ 500)	1	
	Group II (200-499)	0.904(0.440-1.856)	0.784
	Group III (<200)	2.150(0.572-8.075)	0.257
RNA-Viral Load	Undetectable	1	
	Detectable	2.691(1.004-7.208)	**0.049***
WHO staging	Stage I	1	
	Stage II To IV	2.130(0.658-6.895)	0.207
Types of ART	Class II and III	1	
	Class I	1.707(0.703-4.143)	0.237
Duration on ARVs	11-15 years	1	
	1-5 years	1.089(0.313-3.788)	0.893
	6-10 years	0.988(0.436-2.237)	0.978
Duration of HIV-infection	1-8 years	1	
	9-16 years	0.566(0.1552.059)	0.388
	17+ years	1.176(0.281-4.909)	0.824
Fitting test result		●	

√Adjusted for gender, age, residence, education, occupation, ubudehe (SES), dental visit, frequency of eating fruits, frequency of drinking tea with sugar and alcohol consumption.

● pseudo R2= 0.174

4.5 Discussion

The findings of this study revealed a significantly higher prevalence of dental caries in HIV-positive people compared to HIV-negative individuals. Amongst HIV-positive people, cohort females, frequent dental visits, and detectable RNA-viral load were significantly associated with dental caries. In HIV-negative participants, caries prevalence was associated with frequent dental visits and the age range of 36-45.

The findings of this study are in line with growing evidence of a higher prevalence and risk of dental caries among HIV-positive persons compared to the general population [5,21,22].

The higher prevalence of caries in HIV-positive adults than in HIV-negative individuals is similar to results by other scholars in developed and developing countries [2,5-7]. Untreated dental caries or decay (D) was also more prevalent in HIV-positive people 47(23.5%) than in HIV-negative individuals 27(13.6%). This may be explained by the unavailability of oral health education and inaccessibility to dental care at HIV clinics. In addition, the lack of knowledge on oral health or the low priority given to the effect of oral conditions on the general health in Rwanda's HIV clinics can explain the higher prevalence of untreated dental caries among HIV-positive people. This is because, without knowledge, practitioners at HIV clinics cannot motivate or timely refer HIV-positive individuals to look for oral health services. Moreover, the shortage of oral health personnel, the lack of adequate dental infrastructure the and unavailability of caries preventive programmes throughout HIV clinics in the country can be associated with a higher prevalence of untreated dental caries among HIV-positive people.

Although Rwanda has shown remarkable improvement in HIV services and HIV-positive persons can easily access ARVs, counselling services, and regular checkups for non-communicable and other infectious diseases [23], no oral health services are available at these specialized services.

In addition, there are no regular prevention services, no program to raise awareness about dental caries and to inform HIV-positive people about dental caries risks and effects in existing HIV services or at the community level. This may contribute to a higher prevalence of dental caries among HIV-positive individuals than HIV-negative individuals.

In their research, Feng and colleagues emphasized that oral health programme that target HIV-positive people should consider affordable dental care, a stigma-free setting, care delivered safely, and accessible locations [24]. Thus, there is a need for an oral health programmes that can benefit HIV-positive people in Rwanda.

In contrast to the present study, in a study by Malele-Kolisa and colleagues, in South Africa, younger adolescents living with HIV had reported lower caries prevalence (D) than those of undiagnosed school children [25]. This may be explained by contextual factors where there were oral health strategies and programme that targeted HIV-infected adolescents and allowed them to have timely access to regular oral health education and preventive services in South Africa.

The Rwandan first national oral health strategic plan has highlighted barriers that may be associated with the burden of oral diseases in the country. The major part of oral health services is provided in District and referral hospitals. Very few primary health posts and centers can provide dental services. Many private dental clinics are mostly located in the City of Kigali and some other secondary cities. Primary oral health service is only provided in the form of analgesics for pain release in health posts and health centers and all patients are referred to hospitals for oral health care [26].

Since oral healthcare is provided in hospitals, it is not easy for the majority of Rwandans (who normally access primary health care at health posts and health centers level) to access oral health care due to the long distance to the hospitals. These issues result in the abandonment of oral health care for many patients. In addition, there is an overload of patients in hospitals with a shortage of oral health providers [26].

Moreover, in Rwanda District hospitals, there is a shortage of infrastructure including the lack of adequate space and functional dental equipment such as dental chairs to provide oral health services [26].

Apart from the recent and very first National strategic plan, there is no specific policy or plan that is specifically dedicated to oral health in Rwanda. Oral health is integrated into different policy and regulatory documents related to None Communicable Diseases (NCDs) and there is no focal person in charge of oral health at the Ministry of Health level to ensure the coordination and address issues related to oral health care in the country [26].

All those problems related to oral health services in Rwanda are not exceptional to HIV-positive people and since this group is more exposed to oral health problems including dental caries, it is very important to develop oral health interventions specific to HIV-positive people in Rwanda.

The results of our study also revealed a significant association between detectable HIV RNA-viral load and caries among HIV-positive participants after adjusting for the other factors not related to HIV infection. Similar to the results of our study, different researchers have also found an association between HIV RNA-viral load with dental caries [11,25,27,28]. These findings may suggest that dental caries can affect the immunity of HIV-positive people.

However, based on the design of our study, it is not possible to determine the causal relationship between dental caries and higher RNA viral load among HIV-positive people. Thus, further studies are needed to give more clarifications on the mechanism of this relationship. On the other hand, HIV-positive people with immune suppression are reported to experience a reduction of saliva flow (xerostomia) [5]. The decreased saliva flaw contributes to the easy development of dental caries due to the lack of saliva buffering capacity that controls the Ph of the mouth environment [29]. Based on the relationship between RNA viral load and dental caries, there is a need for oral health strategies to provide oral health education and early preventive dental services among HIV-positive people in Rwanda.

In our study, dental caries was significantly associated with being a female among HIV-positive adults. These findings are similar to recent results of a study done in Uganda by Kalanzi and colleagues where HIV-negative females had a higher prevalence of dental caries than HIV-positive people [30]. Although not significant, HIV-negative females were also more affected by dental caries than HIV-negative males. The literature highlights different factors that expose women to dental caries than males in the general population. Women's family role has been shown as one of the factors for the higher prevalence of dental caries compared to males. Commonly, women have been family members with the responsibility for food preparation. This allows them to have access to foods and snacks between meals more frequently than males, which increases their chance of caries development compared to men [31,32]. For that reason, there is a need to develop vivacious oral health strategies that will target women in particular, especially in high-risk groups such as HIV-positive people.

Based on their exposure, women, especially those living with HIV/AIDS have to be given greater attention when planning preventive and oral health education interventions to decrease the risk of dental caries among this group.

To increase the number of women who access dental services, previous interventions have considered home visits and oral health programmes to provide oral education, and preventive oral health services [33]. Therefore, to increase accessibility to preventive oral health care among HIV-positive people women, there is a need for contextual oral health models among this population in Rwanda.

The results of our study revealed that a higher prevalence of HIV-positive and HIV-negative adults who frequently visited dentists experienced more caries compared to participants who less frequently visited dentists. Consistent results were reported in the literature [34,35]. As highlighted by other researchers, the DMFT index takes into account the past treatment history. Therefore, the DMFT index is affected by extracted teeth (M) and the fillings done due to dental caries (F). In our study, the M (Missing teeth due to caries) was the most prevalent component of DMFT in the group of HIV-positive and HIV-negative people. Having a higher prevalence of people with M component (extracted teeth) along with higher untreated caries among participants who frequently visited dentists suggests that participants in our study mostly received treatment for advanced dental caries leaving out caries that could be saved.

A higher prevalence of people with the M component may suggest sub-optimal dental treatment in areas where our study participants visited dentists. The sub-optimal dental care may be associated with a lack of conservative dental services in those areas or an overload of practitioners due to a shortage of dental personnel and lack of adequate infrastructure as highlighted in the recent first National oral health strategic plan in Rwanda [26]. Thus, there is a need to do further study to better understand factors associated with caries among participants who frequently visited dentists in Rwanda.

To minimize the risk of progression of caries, there is a need to raise awareness and enforce caries risk assessment strategies for every dental patient in Rwanda especially among HIV-positive people.

Amongst HIV-negative adults, middle age (36-45 years) was significantly associated with dental caries experience. A study from four countries (England and Wales, the United States, Japan, and Sweden) revealed a larger increase in DMFT in adulthood compared to the young group [36].

A recent study done in Ethiopia has also highlighted that age increase is significantly associated with caries experience [37]. However, some researchers have reported contrasting results where young age was associated with increased dental caries compared to adulthood [38]. These findings may be explained by various factors across different communities. For example, in many developing countries, factors such as an increase in sugary diets in young people, unavailability of preventive services, lack of awareness on how to do good oral hygiene and high cost of dental treatments expose young adults to caries than adults [37].

4.6 Strength of the Study

In Rwanda, this is the first study to look at the prevalence of dental caries and associated risk factors among HIV-positive persons in comparison to HIV-negative individuals. It is also among the few studies that compared HIV-positive and HIV-negative adults regarding caries and its associated risk factors in Sub-Saharan Africa.

4.7 Limitations

The results of the study may not be generalizable to the general population of Rwanda because the study was done in an urban HIV clinic in Kigali city which could not represent the whole country. In addition, a cross-sectional study design makes it difficult to establish causality. Large longitudinal studies are needed to better understand the nature of the associations between caries and various risk factors. Our study was a comparative cross-sectional study that did not consider matching factors among two groups of HIV-positive people and HIV-negative participants.

4.8 Conclusion

After adjusting for key factors that were differentiating HIV-positive people and HIV-negative participants, the prevalence of dental caries remained higher in HIV-positive people than in HIV-negative participants. The reported higher prevalence of caries in HIV-positive people was associated with being female, detectable viral load, and frequent dental visits. Therefore, there is a need for effective oral health interventions specific to HIV-positive people in Rwanda to raise awareness of the risk of dental caries and provide preventive oral health services among the Rwandan population, especially HIV-positive people. To ensure timely oral health care among HIV-positive people, there is a need for effort from policymakers and stakeholders to integrate oral health care services within HIV treatment programmes in Rwanda.

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4.10. References

1. Sabbah W, Folayan MO, El Tantawi M. The Link between Oral and General Health. Int J Dent [Internet]. 2019 May 29;2019:1–2. Available from: https://www.hindawi.com/journals/ijd/2019/7862923/
2. Birungi N, Fadnes LT, Marie I, Stadskleiv E, Tumwine JK, Lie SA, et al. Caries experience by socio-behavioural characteristics in HIV-1-infected and uninfected Ugandan mothers – a multilevel analysis. Acta Odontol Scand [Internet]. 2022;80(2):91–8. Available from: https://doi.org/10.1080/00016357.2021.1942544
3. Tsuneishi M, Yamamoto T, Yamaguchi T, Kodama T, Sato T. Association between the number of teeth and Alzheimer's disease using the National Database of Health Insurance Claims and Specific Health Checkups of Japan. Mogi M, editor. PLoS One [Internet]. 2021 Apr 30;16(4):e0251056. Available from: http://dx.doi.org/10.1371/journal.pone.0251056
4. Sabharwal A, Stellrecht E, Scannapieco FA. Associations between dental caries and systemic diseases: a scoping review. BMC Oral Health [Internet]. 2021 Dec 25;21(1):472. Available from: https://doi.org/10.1186/s12903-021-01803-w
5. Palupi R, Sosiawan A, Gilang R, Ramadhani A. Factors Influencing Dental Caries in HIV / AIDS Patients. Acta Med Philipp. 2019;53(5):412–6.
6. Kumar S, Mishra P, Warhekar S, Airen B, Jain D, Godha S. Oral Health Status and Oromucosal Lesions in Patients Living with HIV/AIDS in India: A Comparative Study. AIDS Res Treat [Internet]. 2014;2014:480247. Available from: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=25215229
7. Cavasin Filho JC, Giovani EM. Xerostomy, dental caries and periodontal disease in HIV+ patients. Braz J Infect Dis [Internet]. 2009;13:13–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19578624
8. Who. The global health observatory. 2021.

9. Who. Global HIV Epidemic. 2020.
10. Ministry of Health. NATIONAL HIV/AIDS TARGETS 2018-2020-2030. 2015;1–29.
11. Kikuchi K, Yasuoka J, Tuot S, Okawa S, Yem S, Chhoun P, et al. Dental caries in association with viral load in children living with HIV in Phnom Penh, Cambodia : a cross-sectional study. BMC Oral Health. 2021;159(21):1–8.
12. Weiss RA. Special Anniversary Review : Twenty-five years of human immunodeficiency virus research : successes and challenges. Br Soc Immunol Clin Exp Immunol. 2008;152:201–10.
13. Nicolatou-Galitis O, Velegraki A, Paikos S, Economopoulou P, Stefaniotis T, Papanikolaou IS. HIV Disease / Oral Medicine Effect of PI-HAART on the prevalence of oral lesions in HIV-1 infected patients. A Greek study. Oral Dis. 2004;10(July 2003):145–50.
14. Adedigba MA, Adekanmbi T, Asa S. Pattern of Utilisation of Dental Health Care Among HIV-positive Adult Nigerians. *Oral Heal Prev Dent* 2016; 14: 215–225.
15. Brondani MA, Phillips JC, Kerston RP, Moniri NR. Stigma Around Hiv in Dental Care: Patients' Experiences. J Can Dent Assoc (Tor) [Internet]. 2016;(December):g1–g1. Available from: http://search.ebscohost.com/login.aspx?direct=true&db=ccm&AN=113676385&site=ehost-live
16. Yengopal V, Naidoo S. Do oral lesions associated with HIV affect quality of life? Oral Surgery, Oral Med Oral Pathol Oral Radiol Endodontology. 2008;106(1):298–309.
17. Dios PD, Scully C. Antiretroviral therapy : effects on orofacial health and health care. Oral Dis. 2014;20(January 2013):136–45.
18. Morgan JP, Isyagi M, Ntaganira J, Gatarayiha A, E.Pagni S, Roomian TC, et al. Building oral health research infrastructure: the first national oral health survey of Rwanda. Glob Health Action [Internet]. 2018;11(1):298–309. Available from: https://doi.org/10.1080/16549716.2018.1477249
19. Ashagrie M. Which formula to use to calculate the sample size for a cross-sectional comparative study? [Internet]. ResearchGate. 2020. p.1–7. Available from: https:// www. resea rchga te. net/ post/ which_ formula_ to_ use_ to_ calcu late_ the_ sample_ size_ for_a_ cross_ secti onal_compa rative_ study.

20. Ntampaka P, Nyaga PN, Niragire F, Gathumbi JK, Tukei M. Knowledge, attitudes and practices regarding rabies and its control among dog owners in Kigali city, Rwanda. Arez AP, editor. PLoS One [Internet]. 2019 Aug 20;14(8):e0210044. Available from: https://dx.plos.org/10.1371/journal.pone.0210044
21. Nugraha AP, Mensana MP, Soebadi B, Husada D, Astha E, Prasetyo RA, et al. Correlation of Low CD4 + Counts with High Dental Caries Prevalence in Children Living with Perinatal HIV / AIDS Undergoing Antiretroviral Therapy. 2019;1–7.
22. Rajonson N, Meless D, Ba B, Faye M, Diby JS, N'zore S, et al. High prevalence of dental caries among HIV-infected children in West Africa compared to uninfected siblings. J Public Health Dent. 2017;77(3):234–43.
23. Nsanzimana S, Kanters S, Remera E, Forrest JI, Binagwaho A, Condo J, et al. HIV care continuum in Rwanda: A cross-sectional analysis of the national programme. Lancet HIV [Internet]. 2015;2(5):e208–15. Available from: http://dx.doi.org/10.1016/S2352-3018(15)00024-7
24. Feng I, Brondani M, Bedos C, Donnelly L. Access to oral health care for people living with HIV / AIDS attending a community-based program. Can J Dent Hyg. 2020;54(1):7–15.
25. Kolisa YM, Yengopal V, Shumba K, Igumbor J. The burden of oral conditions among adolescents living with HIV at a clinic in Johannesburg, South Africa. PLoS One. 2019;14(10):1–14.
26. Ministry of Health. National Oral Health Strategic Plan 2019-2024. 2019.
27. Souza AJ de, Gomes-Filho IS, Silva CAL da, Passos-Soares J de S, Cruz SS da, Trindade SC, et al. Factors associated with dental caries, periodontitis and intra-oral lesions in individuals with HIV / AIDS*. AIDS Care - Psychol Socio-Medical Asp AIDS/HIV. 2017;0121:1–8.
28. Chen F, Cheng Y, Xie T. Oral Health Status of Young People Infected with HIV in High Epidemic Area of China. J Multidiscip Healthc ©. 2021;14:831–7.
29. Malekipour MR, Messripour M, Shirani F. Buffering capacity of saliva in patients with active dental caries. Asian J Biochem. 2008;3(5):280–3.
30. Kalanzi D, Mayanja-Kizza H, Nakanjako D, et al. Prevalence and factors associated with dental caries in patients attending an HIV care clinic in Uganda: a cross sectional study. *BMC Oral Health* 2019; 19: 159.

31. Ferraro M, Vieira AR. Explaining Gender Differences in Caries : A Multifactorial Approach to a Multifactorial Disease. 2 Int J Dent. 2010;1–5.
32. Kessler JL. A Literature Review on Women's Oral Health Across the Life Span. Nurs Women Health. 2017;21(2):108–21.
33. Lam SC, Traylor DO, Anderson EE. Primary Care Recommendations for Oral Health Care in HIV + Patients [Internet]. 2014. Available from: https://www.centerfororalhealth.org/wp-content/uploads/2018/11/Oral-Health-Policy-HIV-2014-6-27-14.pdf
34. Costa SM, Vasconcelos M, Haddad JPA, Henrique M, Abreu NG. The severity of dental caries in adults aged 35 to 44 years residing in the metropolitan area of a large city in Brazil : a cross-sectional study. BMC Oral Health. 2012;12(25).
35. Varenne B, Paris F, Petersen PE, Geneva S, Ouattara S. Oral health behaviour of children and adults in urban and rural areas of Burkina Faso, Africa. Int Dent J. 2006;56(2):61–70.
36. Bernabé E, Sheiham A. Age, Period and Cohort Trends in Caries of Permanent Teeth in Four Developed Countries. Am J Public Health [Internet]. 2014 Jul;104(7):e115–21. Available from: https://ajph.aphapublications.org/doi/full/10.2105/AJPH.2014.301869
37. Bogale B, Engida F, Hanlon C, Prince MJ, Gallagher JE. Dental caries experience and associated factors in adults: a cross-sectional community survey within Ethiopia. BMC Public Health [Internet]. 2021 Dec 21;21(1):180. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-021-10199-9
38. Oscarson N, Espelid I, Jönsson B. Is caries equally distributed in adults? A population-based cross-sectional study in Norway – the TOHNN-study. Acta Odontol Scand [Internet]. 2017 Nov 17;75(8):557–63. Available from: https://doi.org/10.1080/00016357.2017.1357080

CHAPTER 5. PERIODONTAL DISEASE AND ASSOCIATED RISK FACTORS AMONG HIV-POSITIVE AND HIV-NEGATIVE ADULTS IN RWANDA: A COMPARATIVE CROSS-SECTIONAL STUDY.

Results from a paper published in Pan African Medical Journal

Murererehe, J., Malele-Kolisa, Y., Niragire, F., & Yengopal, V. (2023). Periodontal disease and associated risk factors among people living with HIV and HIV-negative adults in Rwanda: a comparative cross-sectional study. *PAMJ Clinical Medicine, 11(43).* https://doi.org/10.11604/pamj-cm.2023.11.43.38073.

5.1 Abstract

Background

HIV-positive people are at high risk of developing periodontal disease. No study done regarding periodontal disease and associated risk factors among HIV-positive people in Rwanda. Rwanda Health Services lacks baseline data to plan for oral health and incorporate the plans into general health.

Aim

This study aims to determine the prevalence of periodontal diseases and associated risk factors among HIV-positive and HIV-negative adults at an HIV clinic at Kigali Teaching Hospital.

Methods.

A comparative cross-sectional study was done among 400 adults (200 HIV-positive and 200 HIV-negative persons), aged 18≥ years. Descriptive statistics, Chi-square 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 HIV-positive people 168 (84%) and HIV-negative 182 (92%) adults.

The mean (SD) score for CAL was significantly (p=0.003) higher in HIV-positive people 1.23 (0.95) than in HIV-negative individuals 0.99 (0.75). PI categorized as fair to poor was significantly (p=0.019) higher among HIV-positive- people 36 (18%) than HIV-negative persons 16 (8%). Being a male was a predictor of having dental plaque and a need for periodontal treatment for both HIV-positive (PI OR: 2.90 (95%CI=1.26-6.66)); (CPITN OR: 3.33 (95%CI=1.14-9.70)) and HIV-negative respondents (PI OR:3.28 (95%CI=1.48-7.28)); (CPITN: OR: 7.78 (95%CI=1.04-58.07)).

Conclusion

HIV-positive people had poorer periodontal health than HIV-negative individuals as witness CAL and PI results. There is a need for oral health programme to prevent periodontal diseases among HIV-positive people in Rwanda.

Keywords

Periodontal disease, risk factors, HIV, adults, Rwanda.

5.2 Introduction

Periodontal disease negatively affects the quality of life, especially among HIV-positive people [1]. In addition to contributing as risk factors for opportunistic infections, dental and periodontal problems among HIV-positive people are known to be more severe and difficult to manage compared to oral conditions among HIV-negative persons [1]. Furthermore, HIV-positive people 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 HIV-positive people who are affected by periodontal disease show a higher level of interleukin-18 and interleukin-2 expression and a higher grade of inflammation than patients with healthy periodontal conditions. Thus, HIV-positive people 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 HIV-positive people. The Rwandan National Oral Health Survey has highlighted the high prevalence of periodontal disease among the general population [7]. In this 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 HIV-positive people 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 HIV-positive people and HIV-negative individuals. This study was conducted to assess periodontal disease and associated risk facts among HIV-positive people and HIV-negative adults at an HIV clinic of Kigali Teaching Hospital (CHUK) in Kigali, Rwanda.

5.3 Methods

5.3.1 Study setting

This was a comparative cross-sectional study and it was conducted in an HIV clinic at Kigali Teaching Hospital (CHUK). CHUK is one of the tertiary national referral hospitals and it can accommodate more than 500 beds. The HIV clinic at CHUK receives more than 2700 cases of HIV-positive people. The clinic also serves people who come for HIV voluntary testing.

5.3.2 The study population

The study population consisted of HIV-positive people and HIV-negative adults. HIV-positive people (≥18 years old) diagnosed with HIV infection at least 3 months before recruitment were included. The study also included all HIV-negative attendees (≥18 years old) who came for HIV voluntary testing and whose HIV results became negative.

5.3.3 Sample size and sample size calculation

Four hundred (400) participants, including 200 HIV-positive people and 200 HIV-negative adults were considered for the study. The sample size was calculated using Stata software.

Assuming a study power of 80%, and considering that the prevalence of periodontal disease was 60% in HIV-positive people 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.

5.3.4. Data collection tools and procedures

The authors collaborated with physicians who did a follow-up of HIV-positive people and nurses who provided HIV results to the patients. HIV-positive people 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. HIV-negative respondents were first given their HIV status results by the nurses. Those who became HIV-negative were first informed about the ongoing study by the nurses.

HIV-negative adults who agreed 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 Plaque 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. Some 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).

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).

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 was used on supine patients using natural light for the full mouth examination.

The examination was performed based on sextants. 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 CPITN score ranged from 0 to 4 where clinically CPI is described as follows:
CPI 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 sub-gingival 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= 6mm 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, 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). CAL is the distance from the cementoenamel junction (CEJ) to the probeable crevice.

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].

The addition of pocket depth and gingival margin level measurement were considered where slight CAL was considered for 1-2 mm, moderate CAL= 3-4mm 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.

5.3.5 Data analysis

Data were analyzed using the Stata software version 15. Periodontal disease was considered a dependent variable. Descriptive statistics was used to calculate frequencies, percentages, and mean 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 of caries and periodontal diseases (dichotomous outcome) with multiple socio-demographic variables

5.3.6 Research ethics

Ethical clearance was obtained from the 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.

5.4 Results

5.4.1 Comparison of demographic characteristics of participants

The mean age for HIV-positive and HIV-negative respondents was 43.5 (95% CI:41.5-45.5) and 36.5, (95% CI: 34.7-38.3) respectively (p<0.001). In addition, the majority of HIV-positive people were from urban areas 81.5% (n=163) compared to HIV-negative participants 63% (n=126) (p<0.001). A large number of HIV-positive people completed primary 40% (n=80) and secondary school 68 (34%) compared to HIV-negative individuals who completed primary 74(37%) and secondary education 50 (25%).

Table 5.1. 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)$^{+}$			

Category1	18(9.0)	24(12.0)	**0.005***
Category2	47(23.5)	73(36.5)	
Category3 and 4	135(67.5)	103(51.5)	

5.4.2. Comparison of periodontal disease among HIV-positive and HIV-negative adults

Regarding plaque index, the results in Table 5.2 revealed a significantly higher prevalence of HIV-positive adults 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 HIV-positive adults 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 common item of CPITN recorded for HIV-positive adults and HIV-negative persons. HIV-negative respondents had a higher prevalence of calculus 182 (91.92%) compared to HIV-positive adults 168 (84%) and the difference between the two groups was statistically significant (p=0.022). The mean (SD) CPITN score value was significantly higher among HIV-negative individuals 1.90 (0.46) than the mean (SD) CPITN score value in HIV-positive persons 1.73 (0.70) (p=0.013). Overall, the results revealed that HIV-positive participants 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 score value was significantly higher among HIV-positive persons 1.23 (0.95) compared to the mean (SD) CAL value in HIV-negative individuals 0.99 (0.75) (p=0.003).

Table 5. 2. Comparison of periodontal disease status among HIV-positive 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
	0.554 ± 0.543	0.427 ± 0.426	0.010*
Community Periodontal Index of Treatment Need (CPITN)			
Prevalence of CPITN categories	**HIV-positive 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 subgingival 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	1.73±0.70	1.90±0.46	0.013*
Clinical Attachment Loss (CAL)			
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*

5.4.3. Comparison of risk factors associated with periodontal disease among HIV-positive and HIV-negative persons.

Among HIV-positive adults, 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 4.3.2. None of the remaining factors were associated with the presence of dental plaque among HIV-positive persons. 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). Amongst HIV-positive persons, males were 3.33 times more likely than females to have a need for periodontal treatment (Community Periodontal Index of treatment Need (CPITN) (95% CI=1.14-9.70)). In addition, HIV-positive aged 36 and above were 7.15 times more likely than those aged 18-35 to show a need for periodontal treatment (CPITN (95% CI=2.38-21.40)). HIV-negative males were 7.78 times more likely than females to have a need for periodontal treatment CPITN (95% CI=1.04-58.07). Regarding CAL, HIV-positive participants aged 36+ years old were 7.83 times more likely than those between 18-35 years old to have CAL (95%CI=3.119-19.66). Amongst 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 5.3. Comparison of risk factors associated with periodontal disease among HIV-positive and HIV-negative adults.

PI					
Factors not related to HIV infection	**Subgroups**	**Odds ratio (95% CI) for HIV-positive adults**	**P value**	**Odds ratio (95% CI) for HIV-negative 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-.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					
	Subgroups	**The odds ratio (95% CI) for HIV+ people**	**P value**	**The 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 (3.119-19.66)	0.000*	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

5.4.4. Distribution of HIV-related factors associated with periodontal disease among HIV-positive adults.

After adjusting for gender, age, residence, education, occupation, ubudehe, dental visit, frequency of eating fruits, frequency of drinking tea with sugar, and alcohol consumption, HIV-positive participants on lines 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) according to table 4.3.3 below. In addition, respondents with <200 CD4 cell counts were 4.59 times more likely than those with CD4 cell counts of ≥ 500. The latter was not statistically significant. The only factor that was associated with CPITN among HIV-positive adults was short duration (1-5 years) and none of the HIV-related factors was associated with CAL after adjusting for all those factors.

Table 5. 4.+ HIV-related factors associated with periodontal disease among HIV-positive adults

PI			
HIV-related factors associated 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
	17+ years	1.23(0.240-3.6.335)	0.801
CPITN			
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
	9-16 years	1.44(0.341-6.069)	0.619
CAL			
HIV-related factors associated 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	Lines 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

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5.5 Discussion

The results of this study revealed a higher prevalence of HIV-positive participants with Clinical attachment loss (CAL) and Plaque index (PI) categorized as fair to poor compared to HIV-negative individuals. Dental calculus was high for both HIV-positive people (84%) and HIV-negative (almost 92%) participants. Similarly, A study done in an African country (Nigeria) showed a higher prevalence of HIV-positive people with poor oral hygiene (16.4%) compared to HIV-negative individuals (9.1%) [10]. In addition, a study done in Indonesia reported a higher prevalence of HIV-positive people with CAL than HIV-negative counterparties. [11]. According to the literature, the prevalence of periodontal disease varies from 27% up to 76% [12]. Our results support these findings, especially for severe periodontal disease (CAL).

The dental plaque shows poor oral hygiene, and the biofilm of dental plaque harbours microbes in charge of inflammation of the gingiva, which subsequently progresses into severe periodontal conditions, including CAL, and can progress to tooth mobility and loss [13]. Periodontal disease and many other oral conditions are easily preventable, yet they have substantial socio-economic cost effects. Therefore, it is essential to ensure oral health strategies that can engage HIV-positive persons to practice oral hygiene and to timely have accessibility to periodontal health care services within the existing HIV treatment programme in Rwanda.

The results of this study are in alignment with previous research, which reported a higher prevalence of periodontal diseases among HIV-positive people compared to the general population [2, 11]. Evidence highlights higher levels of interleukin-18 and interleukin-2 expression and high grade of inflammation among HIV-positive people who are affected by periodontal disease than patients with healthy periodontal conditions [11]. Thus, HIV-positive persons suffer a more aggressive type of periodontal disease than non-infected individuals [2]. In addition, HIV infection alters antibody responses against periodontopathic bacteria, which exposes HIV-positive individuals to periodontal disease more than HIV-negative individuals [13].

Recently, the literature also highlights that a more severe periodontal disease reported among HIV-positive people results from multi-resistant pathogens, including *Pseudomonas aeruginosa*,

Acinetobacter baumannii, Enterobacter faecalis, Escherichia coli, Clostridium clostridiiforme, Klebsiella pneumoniae, Candida spp [12].

Regarding CPITN, the majority of our study participants required professional dental scaling and instructions on oral hygiene (TN2). So far, no information in Rwanda regarding this matter among HIV-positive persons. However, previous studies on periodontal status highlighted a higher prevalence of periodontal diseases (about 60%) in the general population of Rwanda [7, 14] [15].

Numerous risk factors, including shortage of dental personnel, unavailability of oral health services, poor working conditions, low priority given to oral health care, and late visits to dentists with emergency oral case presentations, are reported in Africa [16–18]. In addition, various African countries have few effective oral health promotion programmes, low priority to oral health, lack of reliable data related to oral health, and inequality of oral health [17]. All those issues contribute to a higher burden and severity of oral problems, including periodontal disease in Africa [17]. The oral health system in Rwanda also faces a shortage of appropriate dental infrastructure, scarcity of dental personnel, and unavailability of sound and regular preventive and oral health education programmes at the community level [19].

Our study showed an association between being male and older (36+ years old) with periodontal disease. Scholars previously reported consistent results [20–22]. For instance, the literature highlighted that men develop higher periodontal disease (more than 56%) compared to women (about 38 %) [22]. The higher rate of periodontal conditions in men is explained by the fact that men ignore their oral health compared to females [23]. In addition, men have poorer oral hygiene behaviours and rarely visit dentists for prevention services compared to females [22]. Likewise, 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 it, and these differences also affect the oral microbiome [22].

Previous studies reported consistent results regarding the association of periodontal diseases with age increases.

For example, a study done in Saudi Arabia reported older age as a predictor of severe periodontal disease [24]. Also, the survey results in Indonesia reported that older age contributes to the high prevalence and severity of periodontal disease [25]. Age contributes to periodontal diseases through pathological age-related changes to key cellular regulators of the immune cells (Neutrophils, macrophages, and T cells) [26]. These cells contribute to inflammation initiation, propagation, and resolution [26]. Hence, there is a need to ensure oral health preventive interventions specific to older people.

Less education (elementary schooling or less) was associated with poor oral hygiene (fair to poor plaque). Similar findings were reported in the literature [27–29]. Therefore, education should also be considered while planning preventive programmes for periodontal diseases. Also, early life interventions are recommended to eliminate educational inequalities in periodontal diseases [30].

In addition, not working was associated with periodontal disease. Similar results were reported in the literature [31,32]. For example, a study by Quinn and colleagues reported that lack of employment decreases the utilization of preventive dental care services [32].

The main strength of this study is that it compared HIV-positive people and HIV-negative individuals, which is the first study conducted in Rwanda among very few studies in Sub-Saharan Africa. However, the study was a comparative cross-sectional study and could not establish a causal relationship between the independent variables and outcomes. Thus, we recommend further cohort studies to better assess this relationship. Also, this study cannot be generalized to the country because it was done in an HIV clinic in Kigali.

4.6 Conclusion

This study revealed poorer periodontal health among HIV-positive people than in HIV-negative persons, evidenced by PI and CAL. There is a need for a collaborative effort to establish programmes for regular and timely screening and management of periodontal disease among HIV-positive people in Rwanda. It is essential to ensure community-based oral health education programmes to engage and encourage good oral hygiene behaviours and regular dental visits for periodontal screening among the Rwandan population.

4.7 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.

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4.9 References

1. Brondani MA, Phillips JC, Kerston RP, Moniri NR. Stigma Around Hiv in Dental Care: Patients' Experiences. J Can Dent Assoc (Tor) [Internet]. 2016;82:g1–g1. Available from: http://search.ebscohost.com/login.aspx?direct=true&db=ccm&AN=113676385&site=ehost-live

2. Fricke U, Geurtsen W, Staufenbiel I, Rahman A. Periodontal status of HIV-infected patients undergoing antiretroviral therapy compared to HIV-therapy naive patients : a case-control study. 2012;2–7.

3. Kinane DF, Stathopoulou PG, Papapanou PN. Periodontal diseases. Nat Publ Gr [Internet]. 2017;3(June):1–14. Available from: http://dx.doi.org/10.1038/nrdp.2017.38

4. Robinson PG, Marshman Z. Dental Epidemiology. In Boston: Lippincott Williams & Wilkins; 2008. p. 119–26.

5. Fokam J, Geh BKN, Sosso SM, Takou D, Ngufack ES, Nka AD, et al. Determinants of periodontitis according to the immunological and virological profiles of HIV-infected patients in Yaoundé, Cameroon. BMC Oral Health [Internet]. 2020 Dec 11;20(1):359. Available from: https://bmcoralhealth.biomedcentral.com/articles/10.1186/s12903-020-01353-7

6. Mark I R, Wipawee N, Maeve C, Deborah G, John S G. Periodontal disease in HIV/AIDS. 2012;60(1):78–97.

7. Morgan JP, Isyagi M, Ntaganira J, Gatarayiha A, Pagni SE. Building oral health research infrastructure : the first national oral health survey of Rwanda. Glob Health Action [Internet]. 2018;11(1):1–10. Available from: https://doi.org/10.1080/16549716.2018.1477249

8. Ashagrie M. Which formula to use to calculate the sample size for a cross-sectional comparative study? 2020.

9. Karmakar S, Prakash S. Clinical Attachment Level: an Unsung Hero in Periodontal Diagnosis. Int J Adv Res. 2019;7(4):106–11.

10. Umeizudike KA, Ayanbadejo PO, Savage KO, Nwhator SO, Akanmu AS, Ogunleye O. Comparative periodontal status of human immunodeficiency virus-positive patients and controls in a dedicated human immunodeficiency virus clinic in Nigeria. 2016;19(1):35–40.

11. Berniyanti T, Setijanto RD, Hariani N, Romadhoni SF. Relationship Between HIV / AIDS and Periodontal Health Status among Population at High Risk of HIV / AIDS. OCTA medica Philipp. 2019;53(5):402–6.

12. Monserrat S, Alicia L, Jes A De, Arturo M, Yolanda S, Esther A, et al. Oral Manifestations Associated with HIV / AIDS Patients. Medecina. 2022;58(1214):1–14.

13. Sahbandar I, Terakubo J, Pattison RJ, Park E, Oishi MK, Oishi MM, et al. Anti-Periodontopathic Antibody Response in Chronic HIV Infection. J HIV AIDS I. 2020;6(2):1–5.

14. Rulisa S. Prevalence and Associated Risk Factors of Periodontal Disease among Adults Attending Dental Department in Rwanda Military Hospital (Rwanda): A Cross-Sectional Study Prevalence and Associated Risk Factors of Periodontal Disease among Adults Attending Den. Open Dent J. 2015;2(4):105–11.

15. Mutamuliza J, Rulisa S, Ntaganira J. Prevalence and Associated Risk Factors of Periodontal Disease among Adults Attending Dental Department in Rwanda Military Hospital (Rwanda): A Cross Sectional Study. Open Dent J. 2015;2(4):105–11.

16. Kaguru G, Ayah R, Mutave R, Mugambi C. Integrating Oral Health into Primary Health Care: A Systematic Review of Oral Health Training in Sub-Saharan Africa. J Multidiscip Healthc [Internet]. 2022 Jun;Volume 15(June):1361–7. Available from: https://www.dovepress.com/integrating-oral-health-into-primary-health-care-a-systematic-review-o-peer-reviewed-fulltext-article-JMDH

17. Abid A, Maatouk F, Berrezouga L, Azodo C, Uti O, El-Shamy H, et al. Prevalence and Severity of Oral Diseases in the Africa and Middle East Region. Adv Dent Res [Internet]. 2015 Jul 22;27(1):10–7. Available from: http://journals.sagepub.com/doi/10.1177/0022034515582062

18. Thorpe S. Oral health issues in the African region: current situation and future perspectives. J Dent Educ. 2006;70(11 suppl):8–15.

19. MOH. National Oral Health Strategic Plan 2019-2024. 2019.

20. Karuveettil V, Krishna K, Ramanarayanan V. Is gender a risk factor for oral diseases in India? A metadata exploration. Public Heal Toxicol [Internet]. 2022 Mar 31;2(1):1–14. Available from: http://www.publichealthtoxicology.com/Is-gender-a-risk-factor-for-oral-diseases-in-India-A-metadata-exploration,145517,0,2.html

21. Ioannidou E. The sex and gender intersection in chronic periodontitis. Front Public Heal. 2017;5(AUG):1–8.

22. Lipsky MS, Su S, Crespo CJ, Hung M. Men and Oral Health: A Review of Sex and Gender Differences. Am J Mens Health [Internet]. 2021 May 15;15(3):155798832110163. Available from: http://journals.sagepub.com/doi/10.1177/15579883211016361

23. Rajeh MT. Gender Differences in Oral Health Knowledge and Practices Among Adults in Jeddah, Saudi Arabia. Clin Cosmet Investig Dent [Internet]. 2022 Aug;Volume 14(August):235–44. Available from: https://www.dovepress.com/gender-differences-in-oral-health-knowledge-and-practices-among-adults-peer-reviewed-fulltext-article-CCIDE

24. Al-Abdaly MMAA, AlQahtani HSH, Al-Qahtani SSH. The Impact of Age and Gender on Severity and Types of Periodontal Diseases among Patients from Two Regions in Saudi Arabia. Open J Stomatol [Internet]. 2019;09(03):39–53. Available from:

http://www.scirp.org/journal/doi.aspx?DOI=10.4236/ojst.2019.93005

25. Tadjoedin FM, Fitri AH, Kuswandani SO, Sulijaya B, Soeroso Y. The correlation between age and periodontal diseases. J Int Dent Med Res. 2017;10(2):327–32.

26. Clark D, Radaic A, Kapila Y. Cellular Mechanisms of Inflammaging and Periodontal Disease. 2022;3(May):1–10.

27. Yamamoto T, Tanaka M, Kuribayashi N, Okuguchi F, Isotani H, Iwamoto M, et al. Low education is associated with poor periodontal status in patients with type 2 diabetes mellitus: A cross-sectional study. Clin Exp Dent Res [Internet]. 2021 Aug 30;7(4):419–28. Available from: https://onlinelibrary.wiley.com/doi/10.1002/cre2.363

28. Srinarupat J, Oshiro A, Zaitsu T, Prasertsom P, Niyomsilp K, Kawaguchi Y, et al. Inequalities in periodontal disease according to insurance schemes in Thailand. Int J Environ Res Public Health. 2021;18(11).

29. Carlos J, Ramírez M, Lopera NS, López AP, Agudelo-suárez AA, Botero JE. Periodontal disease and its relationship with clinical and sociodemographic variables in adult patients treated in a service/teaching institution. 2017;21(3):160–7.

30. Boillot A, Halabi B El, Batty GD, Bouchard P. Education as a Predictor of Chronic Periodontitis : A Systematic Review with Meta-Analysis Population-Based Studies. 2011;6(7).

31. Fyh A, Mm V, Al S. The association between current unemployment and clinically determined poor oral health. 2015;1–13.

32. Quinn BC, Catalano RA, Felber E. The Effect of Community-Level Unemployment on Preventive Oral Health Care Utilization. 2008;162–81.

CHAPTER 6: ORAL HEALTH-RELATED QUALITY OF LIFE AMONG HIV-POSITIVE AND HIV-NEGATIVE PEOPLE IN RWANDA: A COMPARATIVE CROSS-SECTIONAL STUDY

Results from a paper published in BMC Oral Health journal

Julienne Murererehe, Yolanda Malele-Kolisa, François Niragire and Veerasamy Yengopal (2024). Oral health-related quality of life among people living with HIV and HIV-negative adults in Kigali, Rwanda: a comparative cross-sectional study. *BMC Oral Health, 24(128)*. https://doi.org/10.1186/s12903-023-03828-9.

6.1 Abstract

Introduction

Oral Health-Related Quality of Life (OHRQoL) assessment, has become integral to HIV-positive patients' follow-up. Little is known about the impact of oral health on the quality of life among HIV-positive people compared to HIV-negative individuals in Rwanda.

Aim

The study assessed OHRQoL among HIV-positive people compared to HIV-negative individuals in Kigali, Rwanda.

Methods

This was a comparative-cross-sectional study, conducted at Kigali Teaching Hospital among (≥18 years old) 200 HIV-positive and 200 HIV-negative persons using the Oral Health Impact Profile short version (OHIP-14) tool. A 4-point Likert scale was used to assess the frequency of oral impacts for 14 items of the OHIP-14 tool. The descriptive statistics and Chi-square tests were used to analyze data using Stata software version 15.

Results

The results showed poorer OHRQoL in HIV-positive people compared to HIV-negative individuals. The findings revealed a higher prevalence of HIV-positive adults with poor OHRQoL than HIV-negative people in all items of OHIP-14 except for OHIP 3 OHIP-14. Significant results were found for the OHIP1 item "trouble pronouncing any word," with a prevalence of 11(2.5%) and 9(2.25%) in HIV-positive and HIV-negative, respectively ($p \leq 0.05$). Also, a higher prevalence of impact was found among HIV-positive persons 11(2.75%) compared to HIV-negative individuals 8(2%) for the OHIP 13 item "life not satisfying due to teeth and mouth problems ($p \leq 0.05$). Dental caries was significantly associated with poor OHRQoL among HIV-positive and HIV-negative adults and for all 14 items of OHIP.

Conclusion

This study revealed poor OHRQoL among HIV-positive compared to HIV-negative adults. There is a need for further longitudinal studies to investigate the OHRQoL in Rwanda, especially among HIV-positive adults. Also, It is essential to include oral health care as one of the components of the medical health care programmes for HIV-positive persons in Rwanda

Keywords: HIV, Oral Health-Related Quality of Life, Oral Health Impact Profile, adult, Rwanda

6.2 Introduction

Human Immune Deficiency Virus (HIV) infections remain a global health crisis [1]. About 680,000 people died from AIDS-related causes in 2020 [2]. Although overshadowed by the more recent COVID-19 pandemic, almost 4,000 new HIV infections are reported worldwide [3]. Among those, 60% of daily new HIV infections occur in Sub-Saharan Africa [3]. Recently, the 90-90-90 targets (by 2020, (1) 90% of all people living with HIV will know their HIV status; (2) 90% of all people diagnosed with HIV infection will receive sustained antiretroviral therapy; (3) 90% of all people receiving antiretroviral therapy will have viral suppression) have contributed to an increased number of HIV-infected persons with suppressed viral load [3] and having an increased life expectancy [2]. As HIV-positive people live longer, controlling other chronic diseases, such as oral diseases, that hinder their quality of life is paramount.

Good oral health is crucial to a better quality of life. The World Health Organization (WHO) distinguishes the Oral Health-Related Quality of Life (OHRQoL) concept as essential to general and oral health. Also, WHO recognizes oral health as a significant part of the Global Oral Health Programme [4]. For years, the impact of oral diseases on quality of life was ignored, and more effort was put into evaluating oral diseases clinically [5]. However, oral conditions, mostly caries and periodontal disease are reported as a highly prevalent group of pathologies globally [6] and have been shown to affect the ability to eat, speak, smile, and psychological status.

The literature defines OHRQoL as "a multidimensional construct that reflects people's comfort when eating, sleeping, and engaging in social interaction, their self-esteem, and their satisfaction concerning their oral health" [7,8]. The definition of OHRQoL is mostly based on its constructs: functional factors (mastication, speaking); psychological factors (appearance, self-esteem); social factors (intimacy, communication) and experience of pain (acute or chronic) or discomfort [8].

Oral conditions affect OHRQoL through interference with daily activities such as chewing, swallowing, speaking, sleeping, choosing what to eat, schooling social interaction, and more [4]. Poor oral health negatively affects the quality of life generally [5], especially among people with other chronic diseases such as HIV infection [9]. For example, pain and discomfort caused by dental caries and periodontal diseases interfere with nutritional intake among HIV-positive people and, therefore, can affect their immunity and general well-being [10].

Assessing the health-related quality of life became integral to HIV/AIDS patients' follow-up [11]. There is still a lack of studies on OHRQoL among the general population in Rwanda. However, elsewhere, studies have reported poorer OHRQoL, especially among high-risk groups such as HIV-positive people [12].

To the best of our knowledge, no study has assessed the OHRQoL among HIV-positive people compared to HIV-negative individuals in Rwanda. Thus, this study aimed to assess Oral Health-Related Quality of Life among HIV-positive people and HIV-negative adults in Kigali, Rwanda.

The results from this study will provide much-needed data for stakeholders to contribute to improving oral health generally and for HIV-positive people in Rwanda. It may also guide other researchers in Rwanda to include an OHRQoL component in their future oral health research.

6.3 Method

6.3.1 Study design and participants

This study used a comparative cross-sectional design comprising HIV-positive and HIV-negative adults aged ≥18 years.

6.3.2 Study setting

The study was conducted at the HIV Clinic of Kigali Teaching Hospital (CHUK) from August 2020 to December 2021. CHUK is the largest tertiary national referral hospital located in Kigali City, Rwanda. It is also one of the biggest referral hospitals in the country. HIV clinic within CHUK sees more than 2700 cases of HIV-positive people, and the majority (>90%) of them are on ART. HIV clinic also receives people who come for HIV voluntary testing.

6.3.3 Recruitments process

HIV-positive adults were recruited next to the physicians' rooms after being informed about the ongoing study by the nurse or physician. HIV-negative persons were recruited in the room next to the Counselling and Testing site (VCT). HIV-negative participants were first given results by their nurses, and they were informed about the ongoing study. Only HIV-negative participants who agreed to participate were guided to data collectors to sign the consent before starting data collection.

6.3.4 Sample Size

The sample for this study was delivered from a broader PhD study that sought to assess risk factors for caries and periodontal diseases among HIV-positive and HIV-negative adults in Rwanda. The sample size calculation for the comparative cross-sectional study was done using Stata software version 15. Assuming a study power of 80%, considering that the prevalence of caries and periodontal disease is 60% in HIV-positive adults and 45% in HIV-negative individuals, and considering a ratio of 1 [14], the minimum study sample was estimated to be 346. Four hundred participants were recruited to account for non-responders.

6.3.5 Data collection tools and procedure

The Oral Health Impact Profile short version (OHIP-14) tool was used to evaluate the OHRQoL among our study participants. Socio-demographic characteristics, including age, sex, occupation, and socioeconomic status (SES) of participants, were also collected. Two clinical indices: DMFT (Decayed, Missing, and filled) and CPITN (Community Periodontal Index of Treatment Need) were considered for association with OHRQoL. 4-point Likert scale responses was used to assess the frequency of oral impacts during the previous 3 months for all domains. The coding for 4-point Likert was '0' for 'never,' '1' for 'hardly ever,' '2' for 'occasionally', '3' for 'fairly often,' and '4' for 'very often.

6.3.6 Variables

The explanatory variables were age, sex, occupation, socio-economic status (SES), caries experience, and periodontal disease (CPITN). The outcome variable was OHRQoL.

6.3.7 Statistical analysis

A 4-point Likert scale was used to assess the frequency of oral impacts during the previous 3 months for all domains. To facilitate the interpretation of our results, participants' responses on the OHIP-14 questionnaire for "fairly often" (coded 3) and "very often" (coded 4) were combined to present high impact. "Occasionally" (coded 2) was counted on its own as neutral, while "hardly ever" (coded 1) and "never" (coded 0) were also added together to represent low impact.

The descriptive statistics and Chi-square test were used to see frequencies/ percentages of OHRQoL among study participants and to determine and compare the association between OHRQoL and common oral diseases (caries and periodontal diseases) among HIV-positive and HIV-negative adults, respectively. Stata version 15 was used to analyze data. The Cronbach alpha test was performed to test the internal consistency of (the OHIP-14) tool in Rwanda, and the alpha coefficient scored 0.914.

6.3.8 Ethical consideration

The study was approved by the Human Research Ethics Committee from the University of Witwatersrand (reference no M200351), the Institutional Review Board from the University of Rwanda (reference no 573/CMHSIRB/2019), and the Research Ethics Committee of

Kigali Teaching Hospital (reference no EC/CHUK/026/2020). Our study participants were informed and signed the written consent before data collection. The confidentiality of patients was observed by using an anonymous questionnaire.

6.4 Results

Demographic characteristics of participants

The mean age of HIV-positive and HIV-negative participants were 43.5 (95% CI: 41.5-45.5) and 36.5 (95% CI: 34.7-38.3) respectively ($p<0.001$). In addition, a higher prevalence (32%) of HIV-positive people were employed compared to HIV-positive individuals without employment (22%) ($p=0.024$). Also, the high prevalence of HIV-positive participants in socioeconomic status categories 3 and 4 (considered as having enough income) was significantly higher (67.5%) compared to the prevalence of HIV-negative respondents in the same socioeconomic status (51.5%) ($p = 0.005$). Comparison of Mean OHIP score among HIV-positive and HIV-negative adults.

6.4.1. Comparison of OHIP scores in HIV-positive and HIV-negative adults using frequency counts.

Based on the "high impact" category for all 14 items of OHIP, the results in Table 6.1 revealed a higher percentage of high impact among HIV-positive adults than HIV-negative people in all items of OHIP-14 except for OHIP 3(found it uncomfortable to eat any foods because of problems with teeth or mouth.) and OHIP-14 (being unable to function because of problems with teeth or mouth). The findings revealed statistically significant results ($p\leq0.05$) for the OHIP1 item "trouble pronouncing any word," with a prevalence of 2(0.5%) and 9(2.25%) in HIV-positive and HIV-negative, respectively. Also, the results showed a higher prevalence of impact among HIV-positive persons 11(2.75%) compared to HIV-negative individuals 8(2%) for the OHIP 13 item "life not satisfying due to teeth and mouth problems." The difference was statistically significant $p \leq 0.05$.

Table 6.1. Comparison of OHIP-14 scores in HIV-positive and HIV-negative adults using frequency counts.

OHIP-14 dimensions	OHIP-14 items	Categorized impact Within each item of OHIP-14	HIV-negative n(%)	HIV-positive n(%)	Total N(%)	p-value
1. Functional limitation	OHIP1: Had trouble pronouncing any words because of problems with teeth or mouth.	low impact	195(48.75)	180(45)	375(93.75)	
		neutral impact	3(0.75)	11(2.75)	14(3.5)	
		high impact	2(0.5)	9(2.25)	11(2.75)	**0.008**
	OHIP2: Felt that the sense of taste has worsened because of problems with teeth or mouth.	low impact	173(43.25)	158(39.5)	331(82.75)	
		neutral impact	16(4)	20(5)	36(9)	
		high impact	11(2.75)	22(5.5)	33(8.25)	0.091
2. Physical pain	OHIP3: Found it uncomfortable to eat any foods because of problems with teeth or mouth.	low impact	99(24.75)	91(22.75)	190(47.5)	
		neutral impact	45(11.25)	54(13.5)	99(24.75)	0.559
		high impact	56(14)	55(13.75)	111(27.75)	
	OHIP4: Found it uncomfortable to eat any foods because of problems with teeth or mouth.	low impact	124(31)	105(26.25)	229(57.25)	
		neutral impact	41(10.25)	41(10.25)	82(20.5)	
		high impact	35(8.75)	54(13.5)	89(22.25)	0.06
3. Psychological discomfort	OHIP5: Been self-conscious because of teeth or mouth.	low impact	143(35.75)	122(30.5)	265(66.25)	
		neutral impact	25(6.25)	36(9)	61(15.25)	
		high impact	32(8)	42(10.5)	74(18.5)	0.082
	OHIP6: Felt tense because of problems with teeth or mouth.	low impact	140(35)	123(30.75)	263(65.75)	
		neutral impact	27(6.75)	31(7.75)	58(14.5)	
		high impact	33(8.25)	46(11.5)	79(19.75)	0.173
4. **Physical disability**	OHIP7: Diet has been unsatisfactory because of problems with teeth or mouth.	low impact	138(34.5)	131(32.75)	269(67.25)	
		neutral impact	34(8.5)	34(8.5)	68(17)	
		high impact	28(7)	35(8.75)	63(15.75)	0.619
	OHIP8: Had to interrupt meals because of problems with my teeth or mouth.	low impact	151(37.75	136(34)	287(71.75)	
		neutral impact	27(6.75)	30(7.5)	57(14.25)	0.173
		high impact	22(5.5)	34(8.5)	56(14)	

5. Psychological disability	OHIP9: Found it difficult to relax because of problems with teeth or mouth.	low impact	137(34.25)	133(33.25)	270(67.5)	0.669
		neutral impact	36(9)	34(8.5)	70(17.5)	
		high impact	27(6.75)	33 (8.25)	60(15)	
	OHIP10: Been a bit embarrassed because of problems with teeth or mouth.	low impact	161(40.25)	154(38.5)	315(78.75)	0.469
		neutral impact	19(4.75)	18(4.5)	37(9.25)	
		high impact	20(5)	28(7)	48(12)	
6. Social handicap	OHIP11: Been a bit irritable with other people because of problems with teeth or mouth.	low impact	168(42)	164(41)	332(83)	0.139
		neutral impact	19(4.75)	13(3.25)	32(8)	
		high impact	13(3.25)	23(5.75)	36(9)	
	OHIP12: Had difficulty doing your usual jobs because of problems with teeth or mouth.	low impact	163(40.75)	155(38.75)	318(79.5)	0.216
		neutral impact	24(6)	22(5.5)	46(11.5)	
		high impact	13(3.25)	23(5.75)	36(9)	
7. Handicap	OHIP13: Felt that life, in general, was less satisfying because of problems with teeth or mouth.	low impact	183(45.75)	162(40.5)	345(86.25)	**0.005**
		neutral impact	9(2.25)	27(6.75)	36(9)	
		high impact	8(2)	11(2.75)	19(4.75)	
	OHIP14: Been totally unable to function because of problems with your teeth or mouth.	low impact	181(45.25)	179(44.75)	360(90)	921
		neutral impact	12(3)	14(3.5)	26(6.5)	
		high impact	7(1.75)	7(1.75)	14(3.5)	

6.4.2. Association of Oral Health-Related Quality of Life (OHRQoL) with demographic characteristics among HIV-positive adults in comparison to HIV-negative persons.

Table 6.2 shows HIV-positive females reported a higher prevalence of 28(25.00%) and significantly higher OHIP-14 impact compared to males 8(9.09%). Although not statistically significant, a large number of HIV-negative females, 12(10.81%), also reported a higher OHIP impact than HIV-negative males 8(8.99%). In addition, a higher prevalence of HIV-positive 25(17.99%) and HIV- negative 11(13.10%) participants in older age (36+), reported higher OHIP impact compared to young aged (18-35) HIV-positive 11(18.03%) and HIV-negative 9(7,76%) adults with high OHIP impact.

Moreover, a higher prevalence of employed HIV-positive persons 22 (16.18%) and HIV-negative counterparties 16(10.26%) reported high OHIP impact compared to unemployed HIV-positive 14(21.88%) and HIV-negative persons 4(9.09%).

Table 6. 2. Association of OHRQoL with demographic characteristics of HIV-positive participants in comparison to HIV-negative individuals.

Variables	**HIV+**			**P value**	**HIV-**			**P value**
	High impact n(%)	Neutral impact n(%)	Low impact n(%)		High impact n(%)	Neutral impact n(%)	Low impact n(%)	
AGE								
18-35	11(18.03)	25(40.98)	25(40.98)	0.645	9(7.76)	41(35.34)	66(56.90)	**0.001**
36+	25(17.99)	66(47.48)	48(34.53)		11(13.10)	48(57.14)	25(29.76)	
SEX								
Male	8(9.09)	42(47.73)	**38(43.18)**		8(8.99)	35(39.33)	46(51.69)	**0.0290**
Female	28(25.00)	49(43.75)	35(31.25)	**0.011**	12(10.81)	54(48.65)	45(40.54)	
UBUDEHE (SES)								
Cat 1&2 (poor)	12(18.46)	29(44.62)	24(36.92)	0.984	9(9.28)	43(44.33)	45(46.39)	0.936
Cat 3& 4 (Rich)	24(17.78)	62(45.93)	49(36.30)		11(10.68))	46(44.66)	46(44.66)	
OCCUPATION								
employed	14(21.88)	35(54.69)	15(23.44)	**0.031**	499.09)	20(45.45)	20(45.45)	0.971
unemployed	22(16.18)	56(41.18)	58(42.65)		16(10.26)	69(44.23)	71(45.51)	

6.4.3. Association between dental caries (DMFT) and OHRQoL according to participants' HIV status.

6.4.3.1. Comparisons of OHIP-14 among HIV-positive and HIV-negative adults according to DMFT index.

According to results in Table 6.3 and Table 6.4, dental caries (DMFT>0) were associated with poorer OHRQoL for all OHIP-14 items and among both groups of HIV-positive and HIV-negative.

3013 **Table 6. 3. Association between dental caries (DMFT) and OHRQoL among HIV-positive persons**

OHIP items	HIV-positive						
	DMFT						
	Yes (DMFT>0)			No (DMFT=0)			
	High impact	Neutral impact	Low impact	High impact	Neutral impact	Low impact	P value
OHIP1	8(7.92)	11(10.89)	82(81.19)	1(1.01)	0(0.00)	98(98.99)	**0.000**
OHIP2	17(16.83)	15(14.85)	69(68.32)	89(89.90)	5(5.05)	5(5.05)	**0.001**
OHIP3	43(42.57)	40(39.60)	18(17.82)	12(12.12)	14(14.14)	73 (73.74)	**0.000**
OHIP4	42(41.58)	30(29.70)	29(28.71)	12(12.12)	11(11.11)	76(76.77)	**0.000**
OHI 5	32(31.68)	26(25.74)	43(42.57)	10(10.10)	10(10.10)	79(79.80)	**0.000**
OHIP 6	35(34.65)	25(24.75)	41(40.59)	11(11.11)	6(6.06)	82(82.83)	**0.000**
OHIP 7	29(28.71)	26(25.74)	46(45.54)	6(6.06)	8(8.08)	85(85.86)	**0.000**
OHIP 8	27(26.73)	26(25.74)	48(47.52)	7(7.07)	4(4.04)	88(88.89)	**0.000**
OHIP 9	29(28.71)	28(27.72)	44(43.56)	4(4.04)	6(6.06)	89(89.90)	**0.000**
OHIP 10	20(19.80)	12(11.88)	69(68.32)	8(8.08)	6(6.06)	85(85.86)	**0.012**
OHIP 11	19(18.81)	10(9.90)	72(71.29)	4(4.04)	3(3.03)	92(92.93)	**0.000**
OHIP 12	21(20.79)	18(17.82)	62(61.39)	2(2.020	4(4.04)	93(93.94)	**0.000**
OHIP 13	8(7.92)	18917.82)	75(74.26)	3(3.03)	9(9.09)	87(87.88)	**0.046**
OHIP 14	6(5.94)	10(9.90)	85(84.16)	1(1.01)	4(4.04)	94(94.95)	**0.037**

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Table 6. 4. Association between dental caries (DMFT) and OHRQoL among HIV-negative participants.

OHIP items	HIV-negative						
	DMFT						
	Yes			No			
	High impact	Neutral impact	Low impact	High impact	Neutral impact	Low impact	P value
OHIP1	2(2.47)	3(3.70)	76(93.83)	0(0.00)	0(0.00)	119(100.00)	**0.023**
OHIP2	7(8.64)	11(13.58)	63(77.78)	4(3.36)	5(4.20)	110(92.44)	**0.011**
OHIP3	34(41.98)	31(38.27)	16(19.75)	22(18.49)	14(11.76)	83(69.75)	**0.000**
OHIP4	25(30.86)	28(34.57)	28(34.57)	10(8.40)	13(10.92)	96(80.67)	**0.000**
OHI 5	21(25.93)	15(18.52)	45(55.56)	11(9.24)	10(8.40)	98(82.35)	**0.000**
OHIP 6	23(28.40)	16(19.75)	42(51.85)	10(8.40)	11(9.24)	98(82.35)	**0.000**
OHIP 7	19(23.46)	25(30.86)	37(45.68)	9(7.56)	9(7.56)	101(84.87)	**0.000**
OHIP 8	15(18.52)	22(27.16)	44(54.32)	7(5.88)	5(4.20)	107(89.92)	**0.000**
OHIP 9	19(23.46)	26(32.10)	36(44.44)	8(6.72)	10(8.40)	101(84.87)	**0.000**
OHIP 10	14(17.28)	16(19.75)	51(62.96)	6(5.04)	3(2.52)	110(92.44)	**0.000**
OHIP 11	8(9.88)	17(20.99)	56(69.14)	5(4.20)	2(1.68)	112(94.12)	**0.000**
OHIP 12	8(9.88)	19(23.46)	54(66.67)	5(4.20)	5(4.20)	109(91.60)	**0.000**
OHIP 13	6(7.41)	6(7.41)	69(85.19)	291.68)	3(2.52)	114(95.80)	**0.029**
OHIP 14	5(6.17)	12(14.81)	64(79.01)	2(1.68)	0(0.00)	117(98.32)	**0.000**

6.4.4. Comparisons of OHIP-14 among and HIV-positive and HIV-negative adults according to Community Periodontal index of treatment need (CPITN).

There was no significant association between OHRQoL and periodontal (CPITN) in all items of OHIP-14 tool and for both HIV-positive (Table 6.5) and HIV-negative (Table 6.6) respondents.

Table 6. 5. Association between periodontal disease (CPITN) and OHRQoL among HIV-positive persons

	HIV-positive						
	CPITN						
	Yes (Need periodontal treatment)			No (Do not need periodontal treatment)			
	High impact	Neutral impact	Low impact	OHIP items	Neutral impact	Low impact	P value
OHIP1	9(5.20)	10(5.78)	154(89,02)	0(0.00)	1(3.70)	26(96.30)	0.422
OHIP2	20(11.56)	16(9.25)	137(79.19)	2(7.41)	4(14.81)	21(77.78)	0.578
OHIP3	48(27.75)	46(26.59)	79(45.66)	7(25.93)	8(29.63)	12(44.44)	0.944
OHIP4	47(27.17)	34(19.65)	92(53.18)	7(25.73)	7(25.73)	13(48.15)	0.750
OHIP5	36(20.81)	31(17.92)	106(61.27)	6(22.22)	5(18.52)	16(59.26)	0.979
OHIP6	39(22.54)	27(15.61)	16(59.26)	7(25.93)	4(14.81)	16(59.26)	0.927
OHIP7	29(16.76)	29(16.76)	115(66.47)	6(22.22)	5(18.52)	16(59.26)	0.731
OHIP8	30(17.34)	23(13.29)	120(69.36)	4(14.81)	7(25.93)	16(59.26)	0.232
OHIP9	28(16.18)	30(17.34)	115(66.47)	5(18.52)	4(14.81)	18(66.67)	0.921
OHIP10	25(14.45)	15(8.67)	133(76.88)	3(11.11)	3(11.11)	21(77.78)	0.842
OHIP11	19(10.98)	11(6.36)	143(82.66)	4(14.81)	2(7.41)	21(77.78)	0.816
OHIP12	19(10.98)	17(9.83)	137(79.19)	4(14.81)	5(18.52)	18(66.67)	0.305
OHIP13	11(6.36)	25(14.45)	137(79.19)	0(0.00)	2(7.42)	25(92.59)	0.213
OHIP14	7(4.05)	13(7.51)	153(88.44)	0(0.00)	1(3.70)	26(96.30)	0.419

Table 6. 6. Association between periodontal disease (CPITN) and OHRQoL among HIV-negative persons

	HIV-negative						
	CPITN						
	Yes (Need periodontal treatment)			No (Do not need periodontal treatment)			
	High impact	Neutral impact	Low impact	High impact	Neutral impact	Low impact	P value
OHIP1	2(1.06)	3(1.59)	184(97.35)	0(0.00)	0(0.00)	9(100.00)	0.885
OHIP2	9(4.76)	16(8.47)	164(86.77)	1(11.11)	0(0.00)	8(88.89)	0.484
OHIP3	50(26.46)	44(23.28)	95(50.26)	4(44.44)	1(11.11)	4(44.44)	0.441
OHIP4	32(16.93)	40(21.16)	117(61.90)	3(33.33)	1(11.11)	5(55.56)	0.410
OHIP5	30(15.87)	23(12.17)	136(71.96)	2(212.22)	2(22.22)	5(55.56)	0.542
OHIP6	30(15.87)	25(13.23)	134(70.90)	3(33.33)	2(22.22)	4(44.44)	0.229
OHIP7	25(13.23)	32(16.93)	132(69.84)	3(33.33)	2(22.22)	4(44.44)	0.182
OHIP8	20(10.58)	25(13.23)	114(76.19)	2(22.22)	2(22.22)	5(55.56)	0.360
OHIP9	24(12.70)	35(18.52)	130(68.78)	1(11.11)	3(33.33)	5(55.56)	0.206
OHIP10	20(10.58)	17(8.99)	152(80.42)	0(0.00)	2(22.22)	7(77.78)	0.283
OHIP11	12(6.35)	18(9.52)	159(84.13)	1(11.11)	1(11.11)	7(77.78)	0.835
OHIP12	12(6.35)	21(11.11)	156(82.54)	1(11.11)	3(33.33)	5(55.56)	0.102
OHIP13	8(4.23)	8(4.23)	173(91.53)	0(0.00)	1(11.11)	8(88.89)	0.527
OHIP14	7(3.70)	11(5.82)	171(90.48)	0(0.00)	1(11.11)	8(88.89)	0.693

6.4 Discussion

This study is the first to assess the Oral Health-Related Quality of Life (OHRQoL) of HIV-positive people compared to HIV-negative individuals using the Oral Health Impact Profile (OHIP-14) tool short version in Rwanda. The results revealed poorer OHRQoL among HIV-positive than HIV-negative people in almost all items of OHIP-14 except OHIP-3 and OHIP-14. Similar results were reported in the literature [15,16]. HIV infection is known to have a detrimental effect on OHRQoL and this effect may be explained by the HIV infection role in the development of higher prevalence and severe common oral diseases (mostly caries and periodontal disease) reported by various researchers [18–20].

The study done in Uganda showed contradicting results by reporting no significant difference in OHRQoL among mothers living with HIV compared to HIV-negative counterparts [21]. This difference may be related to the fact that pregnant women, regardless of their HIV status, are exposed to various oral problems because of pregnancy changes [22]. Pregnant women also rarely look for oral health services mainly because they fear the impact of dental care on future babies [15,23].

Also, in HIV-positive and HIV-negative adults, dental caries were significantly associated with poorer OHRQoL in all items of OHIP-14. Previous researchers revealed the association of dental caries with poorer OHRQoL regardless of HIV status [6,16,21,24–26]. Having dental caries is linked to experiencing various physical, psychological, and social problems, mostly based on the severity of dental caries. For example, dental caries impair the ability to eat, do daily activities, and socialize with others, leading to unbearable pain [27,28].

Moreover, dental caries affect communication, speaking, and aesthetic [29]. Missing teeth may lead to psychological disturbances such as low self-esteem and undermined self-image [29]. In summary, if one can't eat properly, sleep, perform daily activities, or socialize due to severe dental caries, then general well-being is affected. Therefore, since dental caries affect OHRQoL, there is a need for oral health policies to ensure the improvement of OHRQoL in the Rwandan population, especially among HIV-positive people.

Previous studies have also reported the effect of oral diseases on various OHIP domains among HIV-positive people compared to the general population [9,24] [17].

For example, a study in Nigeria reported the domain of physical pain to have the highest impact among HIV-positive people [9]. Another study done in Saudi Arabia reported physical pain as the most affected dimension of OHRQoL [24]. The higher prevalence of oral health impact in various domains of OHIP may be explained by the effect of DMF experience, which was found to affect HIV-positive and HIV-negative persons in our study significantly. Issues such as painful aching, lack of comfort to eat, feeling nervous, and self-consciousness due to oral problems were reported by participants and are linked to dental caries experience among HIV-positive and HIV-negative individuals. These results call for a combined effort from policymakers, oral health, and general health teams to ensure oral health programmes and strategies to promote oral health and raise awareness on prevention measures to improve oral health-related quality of life in general and specifically for HIV-positive people.

Females in HIV-positive and HIV-negative adults reported poorer oral health-related quality of life than males. The literature highlights that males ignore their oral health and rarely visit dentists for prevention services compared to women [30,31]. These findings in males may suggest that males do not worry much or see dental problems as an important issue for their quality of life.

Surprisingly, none of the 14 oral health impact profile items was significantly associated with periodontal disease assessed through the Community Periodontal Index of Treatment Need (CPITN). Similarly, some researchers reported no association between periodontal diseases and poor OHRQoL [16,17,32].

Pain in periodontal conditions rarely occurs compared to dental caries. The lack of pain can be linked to the absence of an association of oral health impact with periodontal diseases reported by study participants. OHRQoL results are the outcome of the self-reported impact of oral disorders on quality of life. Participants with painless periodontal disease might be feeling not concerned about oral issues and do not report the impact on their oral health. As said for most other non-communicable conditions, it is rare to look for medical help if there is no pain [27]. There should be strategies to engage the Rwandan people to do periodontal check-ups on time regardless of pain.

The literature reports scarce research regarding OHRQoL of HIV-positive people and recommends more studies in this area [16,33]. To the best of our knowledge, there is no single study done in Rwanda on OHRQoL among HIV-positive people. In addition, there is still a lack of oral health prevention and promotion strategies unique to this high-risk group of HIV-positive people.

This lack of oral health strategies is a barrier to better management of HIV-positive people in Rwanda because caries and periodontal negatively affect social interaction, leading to chronic distress, depression, heart disease, and stroke [29]. Moreover, these common oral diseases affect vital functions such as breathing, speaking, selection of what to eat, swallowing, daily work, schooling, and family interaction [27,28]. The results of this study are essential to inform practice change regarding HIV services by incorporating oral health components to treat HIV-positive people in Rwanda comprehensively.

6.5 Strength of the Study

To the best of our knowledge, this is the first study to assess OHRQoL among HIV-positive persons compared to HIV-negative counterparties in Rwanda. In addition, this study considered a comparison group of HIV-negative adults, which is essential to understanding the oral health status of HIV-positive compared to their HIV-negative counterparts. The comparison component is scarce in previous literature.

6.6 Limitation

Lastly, the study did not look at the association of OHRQoL with ulcerations or infections other than caries and periodontal diseases which may affect OHRQoL. We recommend future studies to look at the effect of other ulcerations and infections on OHRQoL.

6.7 Conclusion

Our study revealed poorer OHRQoL among HIV-positive than HIV-negative adults. Dental caries was significantly associated with poorer OHRQoL among HIV-positive and HIV-negative individuals. Oral health programmes are needed to improve the OHRQoL in Rwanda, especially among people at high risk of developing oral disease, such as HIV-positive people. More attention should be given to caries and periodontal diseases. Further similar longitudinal studies and those that consider people with other chronic diseases are needed in Rwanda. It is essential to include oral health care as one of the components of the medical health care programmes for HIV-positive people.

6.8 Authors contributions

Julienne Murererehe, Yolanda Malele-Kolisa and Veerasamy Yengopal contributed to the study's conception and design. Julienne collected the data and drafted the manuscript. Julienne Murererehe, Yolanda Malele-Kolisa, Francois Niragire and Veerasamy reviewed the manuscript and supported data analysis, data interpretation and discussions. All authors revised and approved the final version of the manuscript.

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6.10. References

1. UNAIDS. UNAIDS data 2021. Joint United Nations Programme on HIV/AIDS. 2021.
2. Kikuchi K, Yasuoka J, Tuot S, Okawa S, Yem S, Chhoun P, et al. Dental caries in association with viral load in children living with HIV in Phnom Penh, Cambodia : a cross-sectional study. BMC Oral Health. 2021;159(21):1–8.
3. Shaghaghian S, Saranjam E, Homayooni M. Oral health-related quality of life in patients infected with HIV, Iran : a cross-sectional study. BMC Oral Health [Internet]. 2021;1–8. Available from: https://doi.org/10.1186/s12903-021-01660-7
4. Spanemberg JC, Cardoso JA, Slob EMGB, López-López J. Quality of life-related to oral health and its impact in adults. J Stomatol Oral Maxillofac Surg [Internet]. 2019 Jun;120(3):234–9. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2468785519300473
5. Kassebaum NJ, Smith AGC, Bernabé E, Fleming TD, Reynolds AE, Vos T, et al. Global, Regional, and National Prevalence, Incidence, and Disability- Adjusted Life Years for Oral Conditions for 195 Countries, 1990 – 2015 : A Systematic Analysis for the Global Burden of Diseases, Injuries, and Risk Factors. J Dent Res. 2017;96(4):380–7.
6. Vieira C, Lins L, Sarmento VA, Netto EM, Brites C. Oral health and health-related quality of life in HIV patients. BMC Oral Health. 2018;1–7.
7. Anna Thereza Thome Leao AKB. Evaluation of Quality of Life in HIV-Infected Children and Children with Cancer. Dentistry. 2015;05(01):1–7.

8. Singh S, Talmale P. Impact of dental caries and nutritional status on oral health-related quality of life in young Indian adolescents. J Oral Biol Craniofacial Res [Internet]. 2023;13(4):506–10. Available from: https://doi.org/10.1016/j.jobcr.2023.05.002

9. Adesola Umeizudike K, Bamidele Osagbemiro B, Oluwayemisi Daramola O, Adenike Adeyemo T. Oral health-related quality of life among HIV positive patients attending two HIV outpatient clinics in Nigeria - a cross-sectional study. Afr Health Sci [Internet]. 2021 Aug 2;21(2):566–75. Available from: https://www.ajol.info/index.php/ahs/article/view/211706

10. US Department of Health and Human Services, National Institute of Dental and Cranial Facial Research, National Institute of Health. Oral health in America: a report of the Surgeon General. J Calif Dent Assoc [Internet]. 2000;1–308. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11324049

11. Darshana B, Reddy C.V.K. Health-Related Quality of Life. J international Soc Prev Community Dent. 2013;3(1):735–47.

12. Alzoubi EE, Hariri R, Attard NJ. Oral health-related quality of life impact in dentistry. 2017;6(6):183–8.

13. Nurulasmak M, Norkhafizah S, Azizah Y, Anilawati Mat J. Association among oral symptoms, oral health-related quality of life, and health-related quality of life in a sample of adults living with HIV/AIDS in Malaysia. BMC Oral Health. 2017;17(1):298–309.

14. Ashagrie M. Which formula to use to calculate the sample size for a cross-sectional comparative study? 2020.

15. Mulligan R, Seirawan H, Alves ME, Navazesh M, Phelan JA, Greenspan D, et al. Oral health-related quality of life among HIV-infected and at-risk women. Community Dent Oral Epidemiol [Internet]. 2008 Dec;36(6):549–57. Available from: https://onlinelibrary.wiley.com/doi/10.1111/j.1600-0528.2008.00443.x

16. Rocha Trindade RTVM, Marques JROF, Veiga MAG da, Marques DN da S, Mata ADSP da. HIV-1 impact on oral health-related quality of life: a cross-sectional study. AIDS Care [Internet]. 2021 Oct 3;33(10):1321–8. Available from: https://doi.org/10.1080/09540121.2020.1798866

17. Muralidharan S, Mahendrakar S, Nara A, Talekar A, Kanitkar AA, Kanitkar A. Oral Health-

related Quality of Life in HIV: A Systematic Review. J Contemp Dent Pract [Internet]. 2020 May 30;21(5):585–92. Available from: https://www.thejcdp.com/doi/10.5005/jp-journals-10024-2833

18. Palupi R, Sosiawan A, Gilang R, Ramadhani A. Factors Influencing Dental Caries in HIV / AIDS Patients. Acta Med Philipp. 2019;53(5):412–6.

19. Rajonson N, Meless D, Ba B, Faye M, N'Diaye C, Aka EA, et al. High prevalence of dental caries among HIV-infected children in West Africa compared to uninfected siblings. J Public Health Dent. 2017;3(77):234–43.

20. Nugraha AP, Mensana MP, Soebadi B, Husada D, Astha E, Prasetyo RA, et al. Correlation of Low CD4 + Counts with High Dental Caries Prevalence in Children Living with Perinatal HIV / AIDS Undergoing Antiretroviral Therapy. 2019;1–7.

21. Birungi N, Fadnes LT, Engebretsen IMS, Tumwine JK, Åstrøm AN. The prevalence and socio-behavioural and clinical covariates of oral health-related quality of life in Ugandan mothers with and without HIV-1. Health Qual Life Outcomes [Internet]. 2021 Dec 23;19(1):201. Available from: https://doi.org/10.1186/s12955-021-01844-3

22. Ueno M, Ohara S, Inoue M, Tsugane S, Kawaguchi Y. Association between parity and dentition status among Japanese women: Japan public health centre-based oral health study. BMC Public Health [Internet]. 2013 Dec 22;13(1):993. Available from: BMC Public Health

23. Cozier YC, Heaton B, Bethea TN, Freudenheim JL, Garcia RI, Rosenberg L. Predictors of self-reported oral health in the Black Women's Health Study. J Public Health Dent [Internet]. 2020 Jan 16;80(1):70–8. Available from: https://onlinelibrary.wiley.com/doi/10.1111/jphd.12351

24. Bukhari OM. Dental Caries Experience and Oral Health-Related Quality of Life in Working Adults. Saudi Dent J [Internet]. 2020 Dec;32(8):382–9. Available from: https://doi.org/10.1016/j.sdentj.2019.11.003

25. de Sousa PCB, Mendes FM, Pettorossi Imparato JC, Ardenghi TM. Differences in responses to the Oral health impact profile (OHIP14) used as a questionnaire or in an interview. Braz Oral Res. 2009;23(4):358–64.

26. Pesaressi E, Villena RS, Frencken JE. Dental caries and oral health-related quality of life of 3-year-olds living in Lima, Peru. Int J Paediatr Dent [Internet]. 2020 Jan 31;30(1):57–65.

Available from: https://onlinelibrary.wiley.com/doi/10.1111/ipd.12582

27. Pitts N, Mayne C. A Global Consensus for achieving a dental cavity-free future. 2021;(March):1–32.

28. Santos PS, Martins-Júnior PA, Paiva SM, Klein D, Torres FM, Giacomin A, et al. Prevalence of self-reported dental pain and associated factors among eight- to ten-year-old Brazilian schoolchildren. Braga MM, editor. PLoS One [Internet]. 2019 Apr 8;14(4):e0214990. Available from: https://dx.plos.org/10.1371/journal.pone.0214990

29. Silva MF, Batista MJ, da Luz Rosário de Sousa M. Risk factors for tooth loss in adults: A population-based prospective cohort study. PLoS One. 2019;14(7):1–14.

30. Thompson AE, Anisimowicz Y, Miedema B, Hogg W, Wodchis WP, Aubrey-Bassler K. The influence of gender and other patient characteristics on health care-seeking behaviour: a QUALICOPC study. BMC Fam Pract [Internet]. 2016 Dec 31;17(1):38. Available from: http://dx.doi.org/10.1186/s12875-016-0440-0

31. Lipsky MS, Su S, Crespo CJ, Hung M. Men and Oral Health: A Review of Sex and Gender Differences. Am J Mens Health [Internet]. 2021 May 15;15(3):155798832110163. Available from: http://www.ncbi.nlm.nih.gov/pubmed/33993787

32. R. D. Z. Meusel D, C. Ramacciato J, H. L. Motta R, B. Brito Júnior R, M. Flório F. Impact of the severity of chronic periodontal disease on quality of life. J Oral Sci [Internet]. 2015;57(2):87–94. Available from: https://www.jstage.jst.go.jp/article/josnusd/57/2/57_87/_article

33. Anup N, Sikka M, Biswas G, Shravani G, Jain P, Sontakke P. Oral health-related quality of life among HIV patients at antiretroviral therapy centre government hospital, Jaipur. J Indian Assoc Public Heal Dent [Internet]. 2015;13(2):148. Available from: http://www.jiaphd.org/text.asp?2015/13/2/148/159051

CHAPTER 7: PERCEPTIONS ON CAUSES AND EFFECTS OF ORAL DISEASES AMONG HIV-POSITIVE AND HIV-NEGATIVE ADULTS IN KIGALI, RWANDA: A QUALITATIVE STUDY.

Manuscript to be published

7.1. Abstract

Introduction

Assessing perceptions of oral health can influence the design of interventions to contribute to quality dental care and improved quality of life of patients. There is a lack of qualitative studies that explored patients' perceptions regarding possible causes and effects of oral diseases in Rwanda.

Aim

The study aimed to explore the perceptions of the participants on the causes and effects of oral disease among HIV-positive and HIV-negative adults in Kigali, Rwanda.

Method

A qualitative study design using in-depth interviews (IDIs) was conducted among 10 HIV-positive and 11 HIV-negative adults from the HIV clinic of Kigali Teaching Hospital (CHUK). The interview was conducted in Kinyarwanda using an interview guide. The audio recording was done for subsequent data analyses. Thematic content analysis was used to analyze the data using an inductive approach. NVivo software version 11 was used to code and organize the data

Results

Two broad domains and five themes emerged from the results. The first broad domain was "perceptions on causes of oral diseases" with individuals and external themes. The second broad domain was "perceptions on oral diseases effect" with physical or functional effects, psychological effects and social effects themes.

Interviewees perceived individual' factors (diet, lack of oral hygiene, older age, delayed dental visit, negligence, lack of knowledge, poverty, heredity) as possible causes for their oral diseases. In addition, HIV-positive participants perceived antiretroviral treatment and HIV infection as the possible causes of their caries and periodontal disease. The reported perceptions of oral disease effect were physical or functional effects (affected appearance, eating difficulty, pain, difficulty smiling or laughing,); psychological effects (heartbreak, being annoyed, feeling inferior, anxiety, being unhappy, being worried, hopelessness) and social effects (avoidance or self-isolation, shame or embarrassment and exposure to mockeries). The summary patterns on perceptions of oral diseases showed more HIV-positive interviewees reporting physical or functional effects and psychological effects compared to HIV-negative counterparts.

Conclusion

Interventions are needed to prevent caries and periodontal diseases and their effects by tackling various individual, and external factors thereby limiting physical, psychological and social effects associated with oral diseases. More attention should be given to high-risk groups of HIV-positive people.

Keywords: Perceptions, possible causes, common oral diseases, HIV, adults, Rwanda

7.1 Introduction

Oral diseases, mostly caries and periodontal diseases, are associated with various problems, including tooth loss, incapability to masticate or eat properly, adverse effects on systemic health, affected aesthetics, limited suffers' ability to attend work or perform well in school, compromised psychological well-being and economy of affected people [1–3]. There is a paucity of literature exploring patients' perceptions of possible causes and effects of oral diseases generally and in Rwanda [1]. Assessing these perceptions can influence the design of interventions to contribute to quality dental care and improve the quality of life of affected individuals.

Caries and periodontal diseases are prevalent, severe, and challenging to manage among people generally and those living with other chronic diseases, including HIV-positive people [4].

On the other hand, controversies exist in the published research on possible causes contributing to the higher prevalence of common oral diseases among HIV-positive persons compared to HIV-negative counterparts [5].

In Rwanda, especially, studies on oral disease are generally scarce. However, few published studies on dental and periodontal diseases in Rwanda revealed a high prevalence of dental caries and periodontal diseases. A study by Janvière and colleagues in Rwanda military hospital revealed a high prevalence of periodontal disease among participants [6]. In their research, HIV infection was one of the systemic diseases associated with periodontal diseases [6]. In addition, recent comparative studies revealed a higher prevalence of periodontal diseases [7] and dental caries [8] among HIV-positive people than HIV-negative counterparts in Rwanda.

Nevertheless, most studies done on this matter used quantitative approaches. Understanding patients' perceptions of possible causes and effects of caries and periodontal diseases will help plan interventions to improve oral health and general health among the Rwandan population, especially those living with HIV infection. This qualitative study can also reveal new or contextual possible causes and perceptions regarding oral diseases that could not easily be discovered through the quantitative approach. Hence, this study aimed to explore perceptions of the causes and effects of common oral diseases among HIV-positive and HIV-negative adults at an HIV clinic in CHUK Rwanda.

7.3 Methods

7.3.1 Study setting

The study was conducted in an HIV clinic at Kigali Teaching Hospital (CHUK) located in Kigali city. CHUK is located in the capital city of Rwanda but since CHUK is a referral hospital it also receives both urban and rural populations with diverse beliefs, perceptions and lifestyles.

7.3.2 Population

The study population was HIV-positive and HIV-negative adults (aged 18 years and above) diagnosed with dental caries and/or periodontal diseases. Participants who did not want their interviews to be audio-recorded and those without caries and/or periodontal diseases were excluded from the study.

7.3.3 Sampling techniques

Participants with caries and periodontal diseases were purposively recruited from the initial sample obtained through oral screening at the recruitment level in the HIV clinic of CHUK. This study is part of a bigger study on risk factors for caries and periodontal diseases. The following inclusion criteria were considered to ensure diversity: HIV-positive vs. HIV-negative; young adults 18-30 years old vs. 31 and above. Purposive sampling for recruitment was carried out until data saturation was achieved and no new information appeared. The data saturation was reached after 10 in-depth interviews with HIV-positive individuals and 11 HIV-negative persons.

7.3.4 Data collection method and instrument

In-depth interviews (IDIs) were used to collect information related to the study objective. IDIs were chosen because they are effective in getting respondents to talk about their personal experiences, feelings, and opinions [9]. In addition, respondents feel more relaxed and confident to express sincerely what they think about a given subject individually [9]. Interviewees were asked about their experiences of living with common oral diseases and the possible causes of their oral conditions. Participants were probed further on provided responses to understand deeper their perceptions about oral diseases.

Interviewers underwent training about the appropriate use of probing, iterative questioning, and frequent debriefing to assure quality control measures. Interviews were done by 2 trained interviewers with a dental background, a master's in public health, and previous experience in qualitative data collection. Interviews were guided by a semi-structured interview guide to ensure the consistency and trustworthiness of the study results. The semi-structured interview guide explored the respondents' perceptions of possible causes and effects of common oral diseases they suffered from in the language they understood. Interviewers were required to recognize their potential preconceptions and biases "ability to sustain a reflexive stance" [10].

The bracketing method was assured by discussing with fellow researchers earlier during the conceptualization of the research protocol by making notes on existing personal viewpoints. During data collection, daily discussions occurred to recognize and put aside the preconceptions and biases among researchers.

7.3.5 Data management and analysis

Data from the participants were transcribed verbatim by the research team and then translated into English for analysis. The thematic analysis aimed to inductively identify the themes and sub-themes of interest in the data and use them to interpret and make sense of research data [11]. The researchers [JM, YM-K] first read the transcripts independently without any coding. NVivo software version 11 was used to code and organize the data. The codebook was created by each investigator; initial 'codes' were identified and assigned to a group of text'. An agreed codebook with finalized codes was used to code the rest of the transcripts. The second level of analysis included consensus by coders [JM; YM-K] on the higher-level codes, sub-themes and themes arising from the codes. Five themes emerged that were categorized into two broad domains (Figure 1). Trustworthiness was ensured through the following criteria:

i. Credibility

Credibility refers to the degree to which your research can be deemed responsible and accurate. It safeguards against subjective experiences, emotions, and perspectives that may otherwise obscure the true nature of your research subject [12]. Credibility establishes whether the research findings represent reasonable information drawn from the participants' original data and is a correct interpretation of the participants' original views [12]. For our study, credibility was observed by considering 2 different researchers who independently coded, analyzed, and interpreted data on perceptions of possible causes and effects of oral diseases.

ii. Transferability

Refers to the degree to which the results of qualitative research can be transferred to other contexts or settings with another group of people [12]. For our study, a comprehensive and detailed description of the research setting and participants was done to be able to understand the context of our research. Also, the description of the data collection process was detailed.

iii. Dependability

The stability of findings over time. It involves an in-depth methodological description to allow the study to be repeated [12]. As recommended in the literature, we also provided an in-depth methodological description to allow our study to be repeated.

7.3.6 Ethical approvals

The ethical approvals to conduct the study were received from the Human Research Ethics Committee (No M200351) of the University of Witwatersrand, Institutional Review Board (No 573/CMHSIRB/2019) from the University of Rwanda, and the Research Ethics Committee of Kigali Teaching Hospital (No EC/CHUK/026/2020). The written informed consent was obtained from participants before conducting the interviews and audio-recording.

7.4 Results

7.4.1 Participants' Characteristics

Twenty-one adults, age group 18-30 years and age 31 years and above (Table 1) participated in the IDIs until no new information was retrieved.

Table 7. 1. Distribution of participants in the studyTable

Interviewees groups	**18-30 years old**	**31 and above**	**Total =21**
HIV-positive	4	6	10
HIV-negative	5	6	11

Regarding the domain of possible causes of oral diseases of common oral diseases (caries and/or periodontal diseases), two major themes emerged (individual causes and external causes).

For the second domain on perceptions about oral diseases, three themes identified were physical effect, psychological effect and social effect as represented in Figure1.

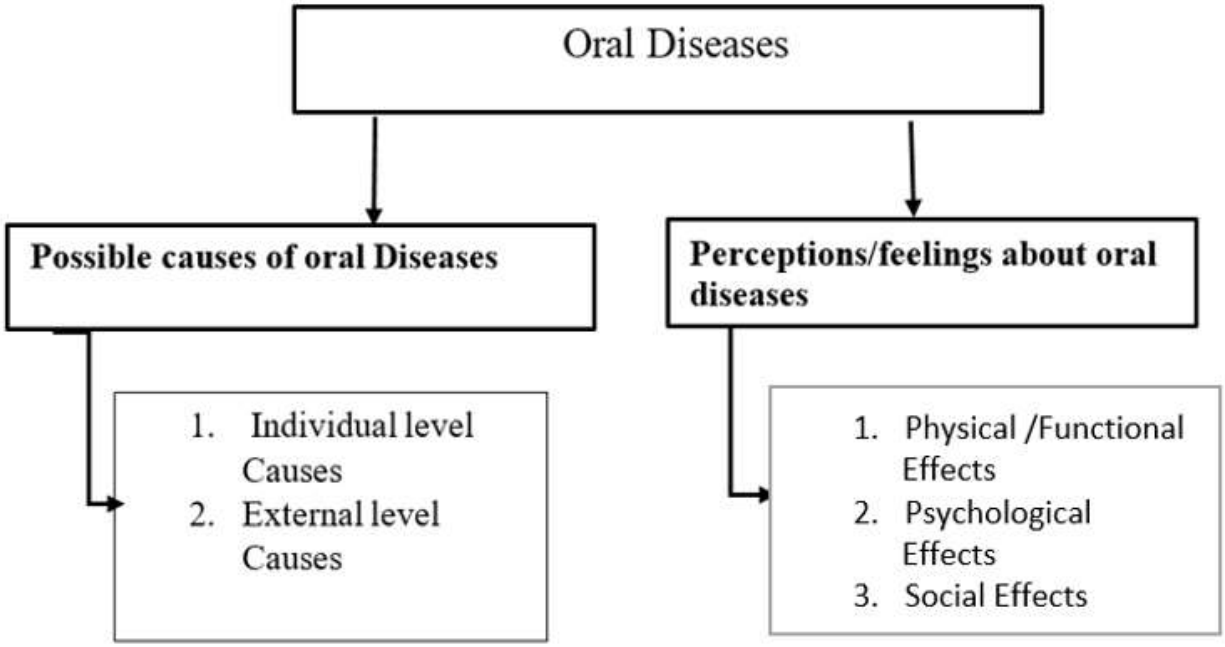


Figure 7.1. Illustration of domains and themes that emerged from data

7.4.1 First domain: Possible causes of oral diseases

In the domain of possible causes of oral diseases, the individual/ and external causes emerged as felt and experienced by the participants.

Theme 1: Individual level causes of oral diseases

Under this theme, respondents described various individual-related factors that they perceived as possible causes for developing their common oral diseases (caries and/or periodontal diseases). For individual causes, interviewees described the behavioural lifestyles that they thought contributed to the development of dental caries and periodontal diseases. They highlighted dietary habits, oral hygiene, delay of dental visit or check-ups and negligence among possible causes of their oral diseases. In addition, participants highlighted older age, lack of knowledge and poverty among individual causes of their oral conditions.

For diet habit, HIV-positive and HIV-negative participants highlighted consuming sugary foods such as biscuits, candy, sugary drinks, and syrup medication as the main risk factors for their teeth destruction.

"It (i.e. dental caries) was caused by eating too much of biscuits and licking too much of candies" (A19-year-old HIV-positive female).

"I used to be that person who was taking much sugar, very fond of sweet stuff and like chocolate" (A 50-year-old HIV-negative female).

In addition, respondents highlighted sweets from fruits, stones within food and food that was not well cooked among the causes of their oral disease development.

"*The fruits that we like to take, such as pineapples, figs, mangos, they are very sweet and sugary and I guess that they can also have a negative effect, so presumably they can act as the catalysts for the teeth disease" (A 42 years old HIV-negative man).*

"According to what I think, the food that we used to take at school, can be blameworthy because I used not to have teeth diseases but as we all know, sometimes at high school the food that we eat isn't ready enough to be eaten and it has fractured all my teeth". *(A 20-year-old HIV-positive female).*

Regarding oral hygiene, interviewees mentioned not cleaning their teeth and the use of inappropriate tooth-cleaning material as causes of their common oral diseases.

"The teeth disease that I am living with, has been perhaps caused by the fact that I used to live my life without cleaning my teeth. I was acting very childishly, I didn't know the importance of brushing my teeth regularly, especially after eating, and for some reason, the toothache was caused by that". (A 47 year old HIV-positive female)

"At my time, many people didn't have tooth brushes and toothpaste. We used teeth sticks. We used to select soft sticks which were everywhere along the path. There were also some herbs they used to tell us that they can brighten the teeth but as we grew up, we realized that those herbs also were harmful". (A 49 year old HIV-negative female)

Participants also mentioned delay in dental health seeking as a possible cause of their oral diseases. They highlighted that they only remembered dentists when their oral needs became severe.

"You know that here in Rwanda we don't go immediately for treatment. A tooth can start to cause pain and you delay, thinking that it is not serious and sometimes the pain gets relieved; but when you finally go for treatment, they tell you that the cavity has already been very deep". (A 39 year old HIV-negative male).

Respondents further reflected on their neglecting behaviours as another possible cause for their oral disease.

"I used to be very neglectful, all I could do was to gargle water and then spit, but I couldn't afford toothbrush and brush my teeth. (A 19 year old HIV-positive female).

Interviewees mentioned older age among possible causes for their oral diseases.

"Things are extremely different from how they used to be during childhood, as we keep growing up, teeth also tend to become mediocre, the gums also start to get ruined, it is very disappointing to face that misadventure, I wish we could age differently". (A 42 year old HIV-negative male).

"Are you kidding! We didn't know about them (meaning about toothbrushes and tooth paste), we were using some thin pieces of wood, we didn't know about toothbrushes or toothpaste, only thin pieces of wood and gargle with water, that's all. But astonishingly, when I started to brush my teeth they were still intact. I started to have the teeth disease in adulthood." (A 47 year old HIV-positive female)

Respondents also cited their poverty or financial problems as a possible cause for their oral diseases.

"Poverty sometimes kills, you can think: will I keep getting Colgate for teeth cleaning all the time? Where will I get that money?" (A 49-year-old HIV-negative female).

"*It was tough for me to get the money; I was broke to buy even a toothpaste; I was telling my children, who were supposed to go to school, to use only the toothbrush". (A 61 year old HIV-positive female*)

Lastly, lack of knowledge was among individual possible causes of oral disease development as shown by answers from the interviewees.

"Exactly, it did happen to me, I am not exaggerating, but another thing that I can say is that, the lack of enough knowledge related to how people are supposed to take care of their teeth. May have played a major role" (A 32 years old HIV-negative male)

Theme 2: External causes of oral diseases

Under the second domain, the participants highlighted issues such as staying in a rural area, effect of genocide and HIV-related factors as possible causes of their oral diseases.

Respondents highlighted that living in rural area is destructive to oral health mainly due to carelessness regarding oral health and the use of traditional medicine in rural area.

"living in a rural area also sometimes is not easy. At first I suffered from the gum and in that rural area they never used to care about that, unless may be now they might have started to be aware, the gum became swollen and slowly by slowly it removed from the teeth. They told me that it is "ifumbi" and told me that they will bring some herbs which treat that. They applied 'medicine' on the gum and they gave me others to drink, I think I might have drunk like ten liters like that. When they applied them, the following morning there was like a very big blood clot. When it didn't work, someone came and advised my parents to look for amoxicillin tablets which might be effective. They gave them to me but without taking me to the health facility. Rural area might be destructive". (A 49 years old HIV-negative female)

When asked about the possible causes of her oral conditions, one interviewee perceived the head injury from the Rwanda genocide perpetrated against Tutsi in 1994 as a possible cause of her oral diseases.

"It is a big problem; my teeth disease is a consequence of the genocide against Tutsis where I was wounded on the head. That is where it started from". (A 38 years old HIV-negative female).

Different views were highlighted by HIV-positive participants regarding HIV-associated factors. Few interviewees perceived ARVs as a possible cause for their oral diseases (dental caries and periodontal diseases).

"I started to feel that there was something wrong with my teeth, when I was taking the ARVs. I was not supporting them, my teeth would hurt right after taking them and it was an unbearable pain and the teeth felt loose." (A 50 years old HIV-positive female)

One HIV-positive participant was unsure whether HIV-related factors were associated with their caries and / or periodontal disease development.

"What makes me think so, is that before I got that information that there was something wrong with my blood (meaning HIV-infection), I hadn't had any problem in my mouth. During my 4th pregnancy that is when I found out. I went for the antenatal care, and I had not started to considerably suffer from the teeth. I was told that I had been infected by the virus, my teeth were still fine, but what I do remember is that, during that pregnancy, my teeth were extracted but I am still not able to link one disease to another, it was vague, because I also remember that I used to feel slight tooth pain, even before the infection was discovered." (A 47 years old HIV-positive female).

Table 7. 2. Summary of interviewees' responses in regards to possible causes of their oral diseases

HIV status	Themes about possible causes of oral diseases	
	Indiviual causes	**External causes**
HIV- positive	xxxxxxxxxx xxxxxxxxx	xx
HIV- negative	xxxxxxxxxx xxxxxxxxxx xxx	xxxxxx

x stands for the number of frequency interviewees indicated possible causes of oral diseases under each theme category

7.4.3 Second domain: Perceptions about effect of oral diseases

HIV-positive and HIV-negative adults expressed their perceptions on having oral diseases (dental caries and periodontal diseases) through the following main themes: Physical/ functional effect, psychological effect, and social effect.

Theme1: Physical/ Functional effect

Within the physical or functional effect, interviewees expressed any physical or functional issue experienced as a result of their oral diseases. They mentioned inability to eat, inability to smile or laugh and pain.

"They (caries) make me look as if I am toothless, I am like the famous "Manyobwa (a Rwandan lady famous in local movies known of speaking and looking funny because she lacks all her teeth) who was edentulous" (59 years old HIV-negative male).

"The consequence is that my cheeks keep on falling more and more, because as the teeth go out, the appearance becomes bad" (A 34 years old HIV-positive male).

In addition, all participants reported difficulty in eating various kinds of food due to caries and/or periodontal diseases.

"I am talking about meat, cassava, all those kind of things, you know, my teeth can't handle them, stuff like the sugarcane I can't really try to take" (A 28 years old HIV-negative female).

"I cannot chew the sugar cane, and I used to, no more eating sweetcorn, I can't take meat on a bone and so on"(A 34 years old HIV-positive male).

Participants also expressed that they could not smile or laugh as they wanted due to caries and periodontal diseases that made their teeth unattractive.

"You don't feel free. When you want to smile, you try to hide your teeth when you should be laughing like others do" (A 49 years old HIV-negative female).

"Now I hardly laugh, I don't do it like I used to when my teeth were still looking attractive" (A 34 years' old HIV-positive male).

Furthermore, respondents experienced pain due to common oral diseases. They experienced double pain, including pain during tooth extraction and the pain (described as emotional pain) of losing their teeth.

"It was very painful I couldn't help it, it really drove me crazy, I was unable to take anything. When something metallic touched that tooth, I felt like an electric current crossing my body" (A 19 years old HIV-negative male).

"So you understand how it feels, one will have to deal with double pain, the first one is that you have lost your tooth, and another one is the pain that you will get when the dentist will be taking out the rest of the tooth" (A 50 years old HIV-positive female).

Theme 2: Psychological effect

For this theme, IDIs interviewees reflected on psychology-related matters they faced as a result of living with oral diseases (caries and periodontal diseases).

Affected appearance, annoyance with the presence of oral diseases, broken heart due to oral diseases, feeling inferior, anxious, unhappy, worry and hopeless. Regarding appearance**,** all participants reported that their look or appearance was affected due to teeth or gum; they felt unattractive and had fallen cheeks resulting from tooth loss.

HIV-positive living with caries and/or periodontal diseases reported that they were annoyed by these common oral diseases.

"It has been very annoying to see my gum getting thicker, and to suffer from the dental caries, there were always some food rests that were remaining in those cavities, leading to that severe pain." *(A 34 years old HIV-positive male).*

"I am very annoyed because my teeth are broken and leave some space between them". (A 59 years old HIV-Positive male).

In addition, interviewees highlighted that they had a broken heart as a result of caries and/or periodontal diseases.

"Look, I might be with people and when you laugh like the others, they might see blood all over your teeth and ask you what happened. At that time, you feel touched" (A 49 years old HIV-negative female).

"Teeth problems broke my heart". (A 50 years old HIV-positive female)

Moreover, interviewees reported that they experienced feelings of inferiority and lack of pride due to caries and/or periodontal diseases.

"To be honest, I was not proud of myself" (due to holes in the teeth). (A 24years old HIV-negative female).

"Since my early childhood, I couldn't stand the fact that my teeth were not as attractive as I wanted them to be, it was making me feel very inferior". (A 50 years old HIV-positive female).

Participants also showed the feeling of anxiety related to the potential of having their teeth extracted due to oral diseases (dental caries and/or periodontal disease).

"Well! There is always an anxiety about how it will be when the teeth will be taken out". (A 42 years old HIV-negative male)

Furthermore, interviewees highlighted that they were unhappy due to caries and/or periodontal diseases.

I see them (teeth) badly; I am not happy with them". (A 20 years old HIV-negative male).

"I can't be happy with missing teeth, and the remaining ones being carious and broken". (A 34 years old HIV-positive male)

Some respondents were worried about losing their teeth due to caries and periodontal diseases and that common oral disease might result in oral cancers. Some HIV-positive interviewees were worried about interactions with other due to toothless.

"There are a lot of questions that I always have on my mind, wondering how it can be if I turn toothless in case all the teeth would be taken out" (A 42 years old HIV-negative male).

"Nowadays the fear of oral cancer is hunting me because recently I saw a swelling in regards to this upper tooth when usually it is this lower anterior. I kept thinking that this might be oral cancer up to the time it busted. But even now I am still thinking like that" (A 49 Years old HIV-negative female).

"I was having that kind of feeling wondering how I will get back to mingle with others while looking toothless" (A 50 years old HIV-positive female).

Lastly, one interviewee experienced hopelessness and wished to die due to common oral diseases (dental caries and periodontal disease).

Sometimes I am full of sorrow because I know where my teeth problem is coming from (genocide head wound). I keep thinking about it and feel desperate, saying to myself that it would have been much better if I died instead of living with such a handicap. (A 38 years old HIV-negative female)

Theme 3: Social effect

For social effect, participants expressed isolation/ avoidance of social interactions, feeling ashamed and exposure to mockery as effects resulting from their oral diseases.

Respondents of IDIs reflected on self-isolation due to caries and periodontal disease effects.

"It is not easy. Like now that I lost teeth, I cannot join peers without wearing a prosthesis. It is a problem. Another thing, you cannot tell everyone about your problem, that is also a consequence". (A 28 years old HIV-negative female.)

"I used to be a member of the choir but right now, I don't think that I can take a microphone and sing anymore, it's not easy". (A 50 years old HIV-positive female)

In addition, HIV-positive and HIV-negative respondents reflected on experience of feeling shame, hiding teeth and embarrassment as a result their oral diseases (caries and periodontal disease).

"See, you cannot even kiss your lover, in the way that you want to I can't judge people but on my side I feel very ashamed." (A 50 years old HIV-positive female)"

"These days I am glad that I wear my face mask to hide this, but I don't know what will happen after this (meaning after COVID-19 pandemic). It (face mask) has been a solution, sometimes I tell myself that God did this to help me stepping out, otherwise I wouldn't be seen in public". (A 50 years old HIV-positive female).

Interviewees also highlighted the experience of being mocked by others due to the problem of caries and/or periodontal diseases.

"Another area in which my teeth are hindering me is in social life where many people show a bad reaction towards me. In their conversations they can mock me and point at me, saying: look that young man, he is edentulous, he lost his teeth. All that are hindrances". (A 20 years old HIV-negative male)

Table 7. 3. Patterns comparing HIV-positive and HIV-negative interviewees' responses in regard to perceptions of oral diseases effect.

HIV status	Themes from perception of oral diseases		
	Physical/functional effect	**Psychological effect**	**Social effect**
HIV-positive	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx xxxxxxx	xxxxxxxxxx xxxxxxxxxx xxxxxxxxxx x	xxxxxxxxxx x
HIV-negative	xxxxxxxxxx xxxxxxxxxx	xxxxxxxxxx xxxxxxx	xxxxxxxxxx xxx

X stands for the number of frequency interviewees indicated perceptions on oral diseases under each theme category

7.4 Data visualization

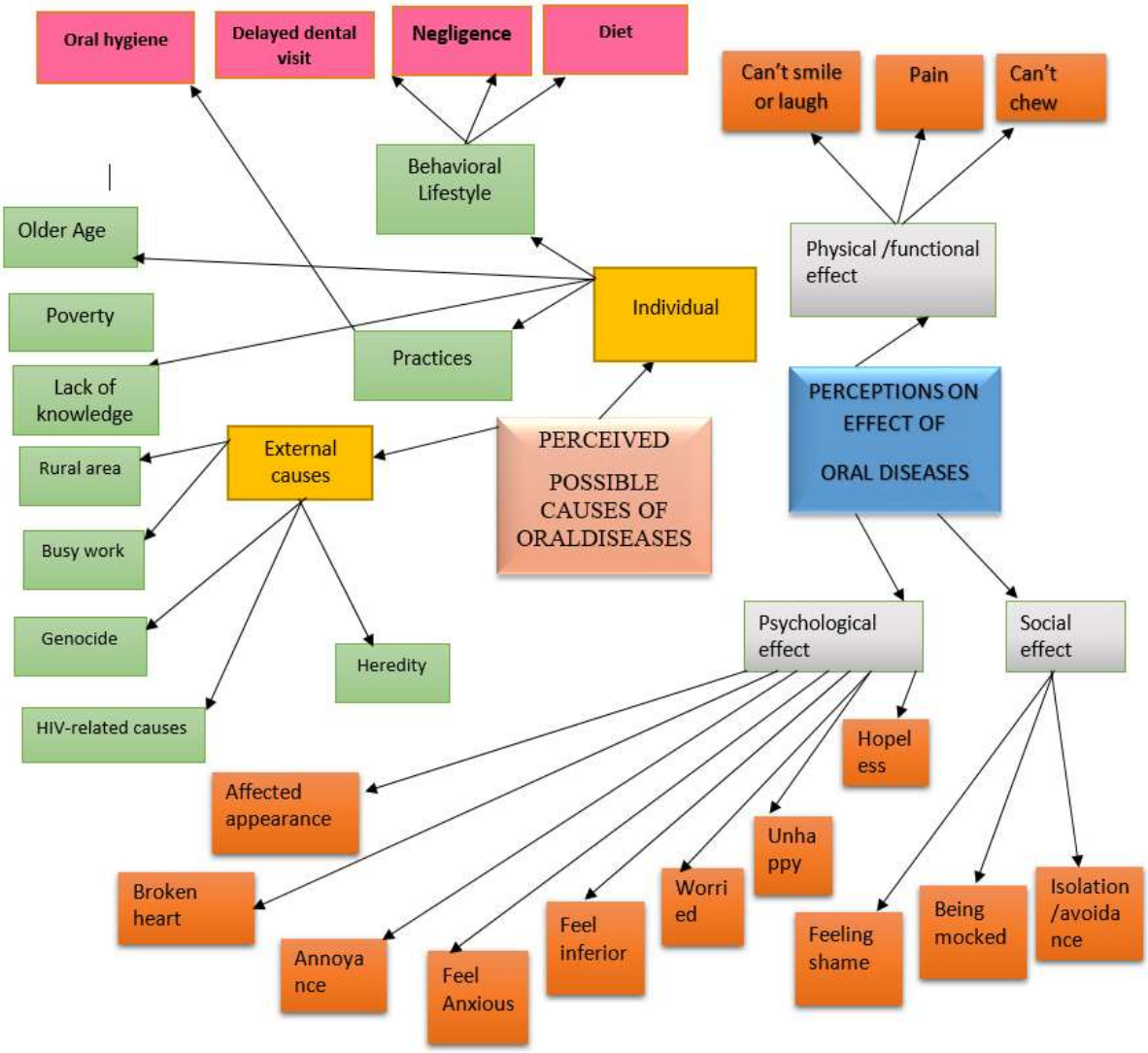


Figure 7. 2. Data visualization diagram about perceptions on possible causes and effects of oral disease

7.5 Discussion

7.5.1 Possible causes of oral diseases

This study explored perceptions about possible causes and effects of caries and/or periodontal diseases on HIV-positive and HIV-negative adults.

The study is the first to consider qualitatively, the perceptions on possible causes and effect of oral diseases among HIV-positive and HIV-negative adults in Rwanda. According to the results from this qualitative study, interviewees perceived individual factors (diet habit, lack of oral hygiene, delayed dental visits, negligence, older age, heredity) and external factors (living in rural area, HIV-infection, genocide and poverty, busy work) as possible causes for their oral diseases (dental caries and/ or periodontal diseases). In addition to the common factors, some HIV-positive participants perceived HIV-related factors (using ARVs and HIV infection) as possible causes for their oral conditions.

7.5.1.1 Individual level possible causes for oral diseases

As per the literature, individual factors such as behaviours and lifestyle factors play a significant role in caries and periodontal development. As reported by Štefanová and colleagues, sugary diet and poor tooth brushing habits are among the main risk factors for caries developments [13]. Similarly, the behavioural factors were perceived to be associated with caries and periodontal diseases. Hall-Collin and colleagues also reported sugary diet and lack of oral hygiene among risk factors for dental caries [14]. In addition, our study findings were similar to a study by Versa and colleagues in Ethiopia, which showed a relation between dental caries with a lack of toothbrushes, consumption of sugary food, and low income [15]. Same as dental caries, poor oral hygiene, poor work flexibility (busy work), and dietary factors (sugary, inadequate diet), were reported among risk factors for periodontal disease development [16].

In addition, older age and HIV-related factors (ARVs), arose as one of the perceived risk factors contributing to the participants' common oral diseases. Similar results were reported by Gayatri and colleagues who found older age to be significantly associated with oral diseases.

Fokam and colleagues also emphasized the role of systemic diseases (mostly those that decrease the Immunity system capability) regarding common oral disease development. For example, HIV infection is reported to be a risk factor for periodontal diseases [17]. This issue is linked to immunological changes in HIV infection that may alter the patient's ability to respond appropriately to infection, including those due to sub-gingival bacteria [18].

Heredity was also highlighted among possible causes of common oral diseases for our study.

The literature highlights genetics as one of the determinants of highly prevalent oral diseases, mostly dental caries, periodontal disease, and some oral cancers [19]. Various suggested genetic differences exist in caries susceptibility, especially between Africans and Caucasians [19,20]. The literature highlighted different genes and gene-protein networks associated with protection or risk of dental caries [19,21]. Those genes are related to enamel formation, development and mineralization, host immune response, and the composition of saliva [21]. Considering genetic factors, there is a need for contextual strategies to promote oral health, especially in African countries, including Rwanda.

7.5.1.2 External level causes for oral diseases

One interviewee perceived genocide as a possible cause for caries and periodontal diseases she experienced. The respondent expressed that the head wounds she experienced during the genocide against Tutsi were the main possible cause for oral conditions (Dental caries and periodontal diseases) she suffer from. These surprising results are plausible and should not be ignored because previous studies have linked traumatic head injury to dental caries and periodontal diseases [22]. This relationship can be explained by the inability to do proper oral hygiene, the post-traumatic anxiety, depression, and distress that can affect individuals' behaviours towards oral care.

Despite this arising from a single participant, this provides information on possible effects of these external factors on oral health. Rwanda had a unique experience in Africa of passing through genocide and the consequences of genocide on general health are numerous. Korman highlighted that the genocide has left scars that are not only mental but physical as well [23]. Therefore, oral health interventions should consider the uniqueness of Rwanda's context for effectiveness.

In addition, HIV-positive and HIV-negative respondents of IDIS, perceived living in rural areas as a possible cause for their oral diseases (caries and periodontal diseases). Researchers have documented similar results about disparities in distributions of caries and periodontal. People from rural areas are more affected by dental caries and/or periodontal diseases mostly due to inaccessibility to oral health services, low socio-economic status, and low education level [24] [25]. Therefore, interventions specific to rural populations are essential to ensure good oral health in rural areas.

7.5.2 Perceptions of participants on effects of oral diseases.

The reported perceptions of oral diseases among HIV-positive and HIV-negative interviewees was through physical and/or functional effects. Participants reported that their appearance, eating, smiling or laughing, were negatively affected and that they experienced pain from oral diseases.

Interviewees also highlighted psychological effects of oral diseases including heartbreak, annoyance, feeling inferior, anxiety, unhappiness, worry, hopelessness, and unhappiness. Lastly, participants of IDIs interviews experienced social effects, including avoidance or self-isolation, embarrassment or shame and being mocked.

In line with our study, scholars have also reported the effect of having caries and periodontal diseases on physical, functional, psychological, and social lives [29]. Similar to the findings from our qualitative study, the literature highlights that dental caries and/or periodontal diseases lead to pain, suffering, psychological embarrassment, social deprivation, difficulties in eating various foods, affected well-being, and this causes individual and collective damages [30]. For example, a study by Shahzad and colleagues reported sadness, sleeplessness due to pain , shame, and difficulty living and working as consequences experienced by people affected with caries and or periodontal diseases [31]. This effect indicates the importance of considering oral health interventions' physical, psychological, and social components.

7.6 Conclusion

According to study results, HIV-positive and HIV-negative adults reported various individual level, and external level factors as possible causes for caries and periodontal diseases they were suffering from. Also, HIV-positive and HIV-negative participants experienced physical or functional, psychological, and social effects due to having oral diseases with more patterns in HIV-positive interviewees. Therefore, oral health interventions are needed to prevent caries and periodontal diseases and promote oral health among Rwandese especially those at high-risk such as HIV-positive persons.

7.7 Significance and implications of the qualitative findings

The findings of qualitative study provided insights to better understand perceptions of interviewees with regards to reasons of common oral diseases (caries and periodontal diseases). The qualitative approach helped explore different viewpoints relating to perceptions on reasons of caries and periodontal diseases among HIV-positive and HIV-negative persons. The results of qualitative

study have also complimented and enforced the findings of quantitative data. Moreover, the approach assisted to uncover new unexpected findings regarding the perceptions on reasons of common oral diseases among study participants. Further, qualitative study findings gave insights about the gap of research to be conducted.

7.8 References

1. Yin J, Li Y, Feng M, Li L. Understanding the feelings and experiences of patients with periodontal disease: a qualitative meta-synthesis. Health Qual Life Outcomes. 2022;20(1):1–11.

2. Kastenbom L, Falsen A, Larsson P, Sunnegårdh-Grönberg K, Davidson T. Costs and health-related quality of life in relation to caries. BMC Oral Health [Internet]. 2019 Aug 16;19(1):187. Available from: http://www.ncbi.nlm.nih.gov/pubmed/31419988

3. Paiva SM, Abreu-Placeres N, Camacho MEI, Frias AC, Tello G, Perazzo MF, et al. Dental caries experience and its impact on quality of life in Latin American and Caribbean countries. Braz Oral Res [Internet]. 2021;35(suppl 01):e052. Available from: http://www.ncbi.nlm.nih.gov/pubmed/34076076

4. Shaghaghian S, Homayooni M, Amin M, Rezazadeh F. Oral health status of patients infected with human immunodeficiency virus and related factors, Iran: a cross-sectional study. BMC Oral Health [Internet]. 2021 Dec 18;21(1):657. Available from: https://doi.org/10.1186/s12903-021-02002-3

5. Kolisa YM, Yengopal V, Shumba K, Igumbor J. The burden of oral conditions among adolescents living with HIV at a clinic in Johannesburg , South Africa. PLoS One. 2019;14(10):1–14.

6. Mutamuliza J, Rulisa S, Ntaganira J. Prevalence and Associated Risk Factors of Periodontal Disease among Adults Attending Dental Department in Rwanda Military Hospital (Rwanda): A Cross Sectional Study. Open Dent J. 2015;2(4):105–11.

7. Murererehe J, Malele-Kolisa Y, Niragire F, Yengopal V. Periodontal disease and associated risk factors among people living with HIV and HIV-negative adults in Rwanda: a comparative cross-sectional study. PAMJ Clin Med [Internet]. 2023;11. Available from:

https://www.clinical-medicine.panafrican-med-journal.com/content/article/11/43/full

8. Murererehe J, Malele-Kolisa Y, Niragire F, Yengopal V. Prevalence of dental caries and associated risk factors among People Living with HIV/AIDS and HIV uninfected adults at an HIV clinic in Kigali, Rwanda. Isola G, editor. PLoS One [Internet]. 2023 Apr 6;18(4):e0276245. Available from: http://medrxiv.org/content/early/2022/10/06/2022.10.04.22280701.abstract

9. Milena ZR, Stancu A. Qualitative research methods: A comparison between focus-group and in-depth interviews. Romania: University of Oradea, Economic Science Series. 2008;(May):17(4): 1279-1283.

10. Lea T, Peter N. Bracketing in qualitative research. Qual Soc Work. 2010;11(1):298–309.

11. Moire M, Brid D. Doing a Thematic Analysis: A Practical, Step-by-Step. All Irel J Teach Learn High Educ [Internet]. 2017;8(3):298–309. Available from: http://ojs.aishe.org/index.php/aishe-j/article/view/335

12. Korstjens I, Moser A. Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing. Eur J Gen Pract [Internet]. 2018 Jan 1;24(1):120–4. Available from: https://doi.org/10.1080/13814788.2017.1375092

13. Štefanová E, Baška T, Holubčíková J, Timková S, Tatarková M, Sovičová M, et al. Selected Behavioural Factors Affecting Oral Health in Schoolchildren: Results from the Health Behaviour in School-Aged Children (HBSC) Slovak Study. Int J Environ Res Public Health [Internet]. 2020 Oct 15;17(20):7516. Available from: https://www.mdpi.com/1660-4601/17/20/7516

14. Hall-Scullin E, Goldthorpe J, Milsom K, Tickle M. A qualitative study of the views of adolescents on their caries risk and prevention behaviours. BMC Oral Health. 2015;15(1):1–11.

15. Geleto A, Sinba E, Ali MM. Dental caries and associated factors among patients visiting Shashamane Comprehensive Specialized Hospital. Denis F, editor. PLoS One [Internet]. 2022 Mar 3;17(3):e0265000. Available from: http://dx.doi.org/10.1371/journal.pone.0265000

16. Sharma S, Trivedi H, Gupta ND. Behavioral factors and periodontal diseases. Eur J Pharm Med Res. 2016;1(9):207–13.

17. Fokam J, Geh BKN, Sosso SM, Takou D, Ngufack ES, Nka AD, et al. Determinants of periodontitis according to the immunological and virological profiles of HIV-infected patients in Yaoundé, Cameroon. BMC Oral Health [Internet]. 2020 Dec 11;20(1):359. Available from: https://bmcoralhealth.biomedcentral.com/articles/10.1186/s12903-020-01353-7

18. Noguera-Julian M, Guillén Y, Peterson J, Reznik D, Harris E V., Joseph SJ, et al. Oral microbiome in HIV-associated periodontitis. Medicine (Baltimore) [Internet]. 2017 Mar;96(12):e5821. Available from: https://journals.lww.com/00005792-201703240-00002

19. Sudi SM, Kabbashi S, Roomaney IA, Aborass M, Chetty M. The genetic determinants of oral diseases in Africa: The gaps should be filled. Front Oral Heal [Internet]. 2022 Oct 11;3(October):1–9. Available from: https://www.frontiersin.org/articles/10.3389/froh.2022.1017276/full

20. Orlova E, Carlson JC, Lee MK, Feingold E, McNeil DW, Crout RJ, et al. Pilot GWAS of caries in African-Americans shows genetic heterogeneity. BMC Oral Health [Internet]. 2019 Dec 18;19(1):215. Available from: https://bmcoralhealth.biomedcentral.com/articles/10.1186/s12903-019-0904-4

21. Cavallari T, Arima LY, Ferrasa A, Moysés SJ, Tetu Moysés S, Hirochi Herai R, et al. Dental caries: Genetic and protein interactions. Arch Oral Biol [Internet]. 2019 Dec;108(August):104522. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0003996918307672

22. Omar S. Health Professional Students' Understanding of Oral Health in Traumatic Brain Injury [Internet]. Western Ontario; 2018. Available from: https://ir.lib.uwo.ca/etd/5583

23. Korman R. When the body is forgotten: The physical consequences of genocide for the survivors. Témoigner Entre Hist mémoire [Internet]. 2016 May 2;(122):150–3. Available from: http://journals.openedition.org/temoigner/4678

24. Ana SS, Mph LS, Conner JM, Dmd EP. Rural–urban disparities in the distribution of dental

caries among children in south-eastern Louisiana: a cross-sectional study. Rural Remote Health. 2020;20(3):1–7.

25. Zander A, Sivaneswaran S, Skinner J, Byun R, Jalaludin B. Risk factors for dental caries in small rural and regional australian communities. Rural Remote Health. 2013;13(3):1–9.

26. Irie K, Tsuneishi M, Saijo M, Suzuki C, Yamamoto T. Occupational Difference in Oral Health Status and Behaviors in Japanese Workers: A Literature Review. Int J Environ Res Public Health. 2022;19(13).

27. Alraqiq H, Eddali A, Boufis R. Prevalence of dental caries and associated factors among school-aged children in Tripoli, Libya: a cross-sectional study. BMC Oral Health [Internet]. 2021 Dec 30;21(1):224. Available from: https://doi.org/10.1186/s12903-021-01545-9

28. ZAITSU T, KANAZAWA T, SHIZUMA Y, OSHIRO A, TAKEHARA S, UENO M, et al. Relationships between occupational and behavioral parameters and oral health status. Ind Health [Internet]. 2017;55(4):381–90. Available from: https://www.jstage.jst.go.jp/article/indhealth/55/4/55_2017-0011/_article

29. Hijryana M, MacDougall M, Ariani N, Kusdhany LS, Walls AWG. Impact of Periodontal Disease on the Quality of Life of Older People in Indonesia: A Qualitative Study. JDR Clin Transl Res [Internet]. 2022 Oct 22;7(4):360–70. Available from: http://journals.sagepub.com/doi/10.1177/23800844211041911

30. Veras S, Kozmhinsky V, Goes P, Heimer M. Behavioral and Psychosocial Factors as Mediators of the Oral Health Impact on Adolescents Quality of Life. In: Quality of Life - Biopsychosocial Perspectives [Internet]. IntechOpen; 2020. p. 1–12. Available from: https://www.intechopen.com/books/quality-of-life-biopsychosocial-perspectives/behavioral-and-psychosocial-factors-as-mediators-of-the-oral-health-impact-on-adolescents-quality-of

31. Shahzad H Bin, Majeed HA. The impact of dental caries on oral health related quality of life amongst adult population in Lahore, Pakistan. Makara J Heal Res [Internet]. 2020;24(1):1–7. Available from: https://scholarhub.ui.ac.id/mjhr/vol24/iss1/1/

CHAPTER 8: INTEGRATED DISCUSSION OF RESULTS

8.1 introduction

The results showed a higher prevalence of dental caries and periodontal diseases in HIV-positive persons compared to HIV-negative participants and the difference was statistically significance. The risk factors that were significantly associated with dental caries in HIV-positive and HIV-negative persons were being female, frequent dental visits, detectable RNA-viral load and frequent dental visits and the age range of 36-45 respectively. Also, being male and older age (36+ years old), not having or completing elementary school and unemployment were associated with periodontal disease in our study.

Although quantitative results did not show significant results about sugary diet, lack of oral hygiene, and delayed dental visits, qualitative interviewees' responses confirmed the relationship mentioned above. HIV-positive and HIV-negative interviewees perceived individual-level factors (sugary diet, lack of oral hygiene, delayed dental visits, negligence, age, HIV-related factors and heredity,) and external factors (genocide effect, poverty, living in a rural area, busy work) as risk factors to their dental and/ or periodontal health.

Quantitative and qualitative study results showed the impact of oral diseases on the affected individuals. Quantitative results revealed poorer oral health-related quality of life through functional limitation, psychological discomfort, and physical disability, and HIV-positive individuals were more affected than HIV-negative individuals. Qualitative findings supported quantitative results since the reported lived experience was through physical or functional effects (eating difficulty, pain, difficulty smiling or laughing, and pain); psychological impact (heartbreak, being annoyed, affected appearance, feeling inferior, anxiety, being unhappy, being worried, hopeless and unhappiness) and social effect (avoidance or self-isolation, shame and exposure to mockeries)

8.2 Dental caries and associated risk factors

Similar to the findings of our study, a higher prevalence and risk of dental caries among HIV-positive people compared to the general population was reported by other researchers [1–3] in developed and developing countries [2,4–6].

Rwanda generally lacks robust oral health preventive services, specifically for HIV-infected people. Despite its apparent effort to improve HIV services in Rwanda [7], there is a gap regarding the programme to raise awareness to inform the community (especially those at high risk) about dental caries risks and effects. The problem of lack of understanding about the risk of dental caries and good oral health practices was also supported by the results from IDIS interviews.

During in-depth interviews, HIV-positive participants' responses conformed to the lack of knowledge about the risk of oral diseases and the good practice of preserving good oral health.

"But um, I can't be 100% sure of what caused the teeth diseases, my tooth used to break and I didn't know what was behind it" (A 34-year-old HIV-positive male).

Some of the study respondents showed a lack of awareness of the diet harmful to their dental health. They thought that sweet fruits such as pineapples, mangos and figs could damage their teeth. Others argue that oral diseases are caused by another condition known as "Ifumbi" (ifumbi is a Kinyarwanda term that is commonly interpreted as any disease attacking teeth or surrounding features) and further said that teeth were destroyed by stones in the food such as corn that they eat.

"The fruits that we like to take, such as pineapples, figs, mangos, they are very sweet and sugary and I guess that they can also have a negative effect, so presumably they can act as the catalysts for the teeth disease. (A 20 years old HIV- positive female).

"No I don't, I still can't understand what mainly caused my teeth disease. People use to talk about "ifumbi" [Kinyarwanda term that was used to mean any dental and gum disease], but till now I am still confused I don't know what it is all about". (a 47 years old HIV-positive female)

The literature recommends oral health programmes appropriate for HIV-positive individuals [8]. Currently, these oral programs are lacking in Rwanda. Hence, there is a need for oral health programmes that can promote the oral health of Rwandese, especially among HIV-positive persons.

The literature revealed lower caries prevalence in HIV-positive people compared to HIV-negative individuals in areas where oral health strategies and programmes are available to target HIV-positive people and give them timely access to regular oral health education and preventive services. For example, in a study done in South Africa, HIV-positive younger adolescents reported lower caries prevalence than those of undiagnosed school children [9]. Rwanda should learn from such successful oral health programmes to mitigate barriers to appropriate and timely oral health services.

In our in-depth interview, HIV-positive and HIV-negative participants supported the argument regarding barriers to oral health care services in Rwanda. They reported that they had experienced various transfers before receiving the dental treatment needed due to a lack of dental equipment in the various hospitals they visited.

"I used to have a problem with my teeth, I was a student in Ruhengeri and I started at this hospital (one of the District hospitals in Rwanda), and they told me that my teeth had little cavities, and they weren't capable of treating them. I got transferred to CHUK (a referral and teaching hospital in the capital city of Rwanda), and the answer was still the same, I went to Kanombe (a military hospital in Kigali City), and they also told me that they couldn't help, finally, I went to King Faysal hospital (a referral and teaching hospital in Kigali city), and it is there that I got the treatment of my two lower teeth, I will show them to you. At that time, they used what they call amalgam, and the problem was solved until now" (a 39-year-old, HIV-negative male).

In addition, responses from in-depth interviews supported the argument about the lack of accessibility to oral health services for people living in rural areas.

"They extracted that one (tooth) and then a second one and a third one, I think they have already extracted four teeth but the initial cause was that [Living in the rural area and not having access to quality dental care]. Maybe if I had been treated at first, especially since I was still young, maybe I would not be in such current condition. The gum never returned where it was removed, leading to other consequences" (a 49-year-old HIV-positive female).

The quantitative results showed a high prevalence of HIV-positive and HIV-negative respondents who frequently visited dentists. The literature reported similar results [10,11].

In our study, missing teeth due to caries (M) was the most prevalent component of DMFT for HIV-positive and HIV-negative participants.

A higher prevalence of missing teeth due to caries implies that participants seek access to oral health services at an advanced stage where it is difficult to save their teeth or that the dental service is unable to place restorations. This issue also suggests the lack of awareness that was previously highlighted. The results from the qualitative part of the study provide more insights into why we had more Missing teeth due to caries (M) compared with the remaining DMFT components. Some of the explanations reported included the lack of awareness about existing dental treatment options.

"But I always go to the dentist and tell them how I feel, sometimes they advise me not to insist on tooth removal and suggest that they can be filled, but I always insisted and said:" The best cure for a tooth is to pull it out because it is painful" (a 61 years old HIV-positive female).

Also, the responses from IDIs revealed a lack of dental check-ups and delayed dental treatment among participants. Some respondents reported that they never go for dental check-ups and only visit dentists in case of problems.

"No. Never [expressing that she never went for a dental check-up). We only remember dental professionals when we have a problem. We remember health professionals when we have a problem" (a 49 years old HIV-negative female)

On the other hand, the higher prevalence of caries experience among participants who frequently visited dentists may suggest their poor oral healthcare-seeking behaviour. The issue of poor oral health-seeking behaviour was previously discussed in the literature, especially among people in Sub-saharan Africa, where oral diseases are overlooked by the general population and people only visit dentists in emergencies and for symptomatic reasons [12].

In our in-depth interviews, participants supported the above argument by reporting that they consult dentists when oral diseases become severe.

"If it (pain from dental caries) gets worse because I see some of them getting progressively carious on the upper side, I can plan to go there (to dentist)" (a 52 years old HIV-negative male)

"You know that here in Rwanda we don't go immediately for treatment. A tooth can start to cause pain and you delay, thinking that it is not serious and sometimes the pain gets relieved; but when you finally go for treatment, they tell you that the cavity has already been very deep" (a 39 years old HIV-negative male).

Older age was significantly associated with dental caries. Previous research from developed and developing countries supported our results. [13,14]. Older age was highlighted as a risk factor for oral diseases by participants who had in-depth interviews.

"Things they are extremely different from how they used to be during the childhood, as we keep growing up teeth also tend to become mediocre, the gums also start to get ruined, it is very disappointing to face that misadventure, I wish we could age differently" (a 42 years old HIV+ male).

However, some researchers found contrasting results where younger ages (20 to 34 years old) were associated with a high prevalence of dental caries compared to prevalence rates in adulthood (≥35 year old) [15]. Various factors across communities, behaviours, and lifestyles may explain this difference. For instance, in some countries, factors such as an increase in sugary diets in young people, unavailability of preventive services, lack of awareness on how to do good oral hygiene, and high cost of dental treatments expose young adults to more caries than that found in adults [14].

Detectable HIV RNA-viral load was significantly associated with dental caries among HIV-positive respondents. Comparable results were reported in the literature [9,16–18]. These findings may suggest that dental caries can affect the immunity of HIV-positive persons. However, our cross-sectional study design could not establish a causal relationship. Thus, further studies are needed to give more clarifications on the mechanism of this relationship.

In the in-depth interviews, some HIV-positive persons supported our findings by reporting that HIV-related factors, such as Anti-retroviral treatments (ART), contributed to developing their oral conditions.

"I started to feel that there was something wrong with my teeth, when I was taking the ARVS. I was not supporting them, my teeth would hurt right after taking them and it was an unbearable

pain and the teeth felt loose. Afterwards, my molars started to have holes, even when it was not painful, I could chew something hard and when I checked it was a piece of tooth" (A 50 years old HIV+ female).

In addition, previous studies linked a reduction in saliva flow known as xerostomia to an increased risk of caries among HIV-positive persons with immune suppression [2,19]. Therefore, Rwanda's health policymakers should ensure contextually appropriate strategies to prevent oral diseases, mostly caries and periodontal diseases, among HIV-positive persons.

8.3. Discussion of results on periodontal status and associated risk factors among HIV-positive and HIV-negative adults.

Regarding periodontal diseases, the quantitative part of the study showed dental plaque (PI) categorized as fair to poor, dental calculus (which was the most item of community periodontal index of treatment need (CPITN) recorded), and clinical attachment loss (CAL) as main periodontal problems among HIV-positive and HIV-negative persons. HIV-positive were more affected by periodontal diseases compared to HIV-negative individuals.

Similarly to the results of our study, various studies have highlighted increased periodontal diseases among HIV-infected people compared to HIV-negative ones [20–22]. Again, the main periodontal problems reported by participants in our in-depth interviews were gun swelling, gum bleeding on brushing, and attachment loss.

"When I am cleaning my teeth I can really notice the blood from the gum. Sometimes you can think that it is coming from the throat when it is only coming from the gum. Reason why a good oral hygiene is paramount" (A 42 years old HIV- negative males).

"Sometimes I suffered from gum disease where it was swollen, and it bleed whenever I was brushing, because there was something wrong with it" (A 34 years old HIV-positive males).

Our quantitative study revealed poor oral hygiene, evidenced by dental plaque. Dental plaque is the source of microorganisms responsible for gingiva inflammation, which subsequently

progresses into severe CAL that can even lead to tooth loss [23]. Practicing good oral hygiene can easily prevent severe periodontal conditions that have an urge effect on the quality of life of affected individuals. However, the findings in this study emphasized the lack of awareness about risk of common oral disease and misunderstanding about the use of existing oral health services.

In addition, respondents highlighted the delay in accessing dental services due to a lack of dental infrastructure, which led to transfers in distant areas. Thus, it is necessary to ensure oral health strategies that can engage people in Rwanda to practice oral hygiene. There is also a need do advocate for decentralization of dental services and to have oral health care services within the existing HIV treatment programmes.

Regarding CPITN, most HIV-positive and HIV-negative participants needed professional dental scaling and oral hygiene instructions (TN2). No study has been done in Rwanda regarding this matter among HIV-positive people. However, similarly to our findings, previous studies done in the general population of Rwanda reported consistent results [24] [25]. For example, Rwanda's national oral health survey results reported that up to 60% of participants had dental calculus [24]. Another study in Rwanda military hospital revealed that almost half (50%) of participants had dental calculus [26].

In developing countries, many economic-related factors, including shortage of dental personnel, unavailability of oral health services, poor working conditions, late visits to dentists with emergency oral cases presentation, the lack of adequate oral health promotion programmes, low priority to oral health, lack of reliable data related to oral health, and inequality of oral health predispose people to common oral diseases [27–29] [28]. Rwanda also faces similar oral health problems, as reported by the Ministry of Health [30].

The results from in-depth interviews revealed that less attention is given to oral diseases, as evidenced by participant's responses. In addition, participants expressed the lack of oral care due to inaccessibility and lack of oral health information.

"On my side, when I think about since when I am suffering from teeth disease, I am suffering from teeth disease from my tender age like when I was in primary six, living in a rural area also sometimes is not easy. At first I suffered from the gum and in that rural area they never used to care about that" (A 49 years old HIV- negative female).

"There was some fuel at home, I was taking a sip of it and didn't swallow it right away, and then spit it. Some people had advised me to do such a thing, telling me that it helps" (a 28 years old HIV-positive female).

Being older (36+ years) and being of male sex was significantly associated with periodontal diseases. Evidence showed similar results that male sex hormones (testosterone) suppress immunity more than do female sex hormones (estrogen) and predispose males to periodontal diseases than females [31]. In addition, females are more attentive to oral hygiene than males [32]. Moreover, various published research highlights that as a risk factor for periodontal diseases [33] [34].

In the responses from in-depth interviews, adulthood was perceived as a risk factor associated with dental problems:

"Are you kidding! We didn't know about them, we were using some thin pieces of wood, we didn't know about toothbrush or toothpaste, only thin pieces of wood and gargle with water, that's all. But astonishingly, when I started to brush my teeth they were still intact. I started to have the teeth disease in the adulthood" (A 47 years old HIV-positive female).

8.4 Discussing impact of common oral diseases on oral health related quality of life

The quantitative results revealed that HIV-positive people had poorer oral health-related quality of life than HIV-negative individuals. Matching results were reported in the literature. For example, various researchers supported our results [35],[36]. Nevertheless, a study done in Uganda found no significant difference in OHRQoL among mothers living with HIV compared to HIV-negative counterparts [37]. This difference may be due to pregnancy changes and behaviours predisposing pregnant women to periodontal diseases regardless of their HIV status [35,38,39].

As shown by other researchers [36,37,40–43], the results of our study revealed a significant association of dental caries with poorer OHRQoL in all items of OHIP-14. HIV-positive showed poorer OHRQoL regarding Physical pain, psychological discomfort, and physical disability.

Unexpectedly, none of the 14 oral health impact profile items was associated with periodontal disease assessed through the Community Periodontal Index of Treatment Need (CPITN). These findings may be explained by how periodontal disease develops silently in terms of its symptoms compared to dental caries.

Periodontal diseases often progress slowly, without clear, apparent signs and symptoms, especially in their early stages [44].

Also, our study's most prevalent component of CPITN was dental calculus. Dental calculus is painless compared to dental caries. Moreover, our participants were more concerned about dental pain and affected appearance. Hence, the respondent could not have seen dental calculus as a problem to their OHRQoL. Therefore, interventions that ensure oral hygiene practice and timely dental visits are essential in Rwanda, especially among high-risk populations such as HIV-positive people.

According to results of IDIs, participants experienced physical /functional-related, Psychological, and social effects. The following are examples where participants reported their experiences on oral diseases:

IDIs interviewees experienced an impact on their school performance due to caries and/or periodontal diseases.

"It was very annoying, I remember that sometimes I could be sitting for exam checking the questionnaire, I was finding some of the questions very difficult because, contrary to my classmates, I had not been there when those things were taught and I could fail, or get less marks required to advance, so you understand how it was" (a 19 years old HIV-negative male)

"Personally there are different huge opportunities that I lost, even at school, I was afraid to ask a question in class, I had to remain silent and passive all the time" (a 24 years old HIV-positive female).

During IDIs, participants highlighted that they could not eat properly due to dental and periodontal diseases.

"What I can tell you is that when a person is suffering from such a disease, what they only fell is pain, so that they can't even eat or drink a thing" (a 19 years old HIV-positive male").

"The side which was treated is the one I use. I think you understand that it's not easy because you cannot chew well the food and grind them properly and it makes the digestion awkward. Either hot or cold foods or drinks are painful" (a 32 years old HIV-negative male).

Also, interviewees reported that oral diseases affect their social interaction.

"Another area in which my teeth are hindering me is in social life where many people show a bad reaction towards me. In their conversations they can mock me and point at me, saying: look that young man, he is edentulous, he lost his teeth. All that are hindrances" (a 20 years old HIV-negative male).

Participants also discussed their experience with the economic impact that oral disease has, especially for people with low resources and those who hardly access oral health services.

"The very first consequence I can talk about was on my family members. My father used to work in order to pay for his daughter's dental treatment. The money which would have intervened in other stuff were spent just for the treatment, and the latter was something which was persistent, you had to go for it over and over again. Personally there are different huge opportunities that I lost, even at school, I was afraid to ask a question in class, I had to remain silent and passive all the time" (a 24 years old HIV-negative female).

According to responses from IDIs, dental and periodontal conditions contribute to an unhappy life and self-consciousness about future life.

"There are a lot of questions that I always have on my mind, wondering how it can be if I turn toothless in case all the teeth would be taken out, it's not easy to live with edentulous spaces while you weren't born like that, it makes someone feel ashamed and very uncomfortable" (a 42 years old HIV-negative male).

Participants expressed how they experienced anxiety and worry about losing teeth without being able to afford the artificial ones. They wondered how their appearance changed (look old) due to losing teeth.

"Well! There is always an anxiety about how it will be when the teeth will be taken out and you don't have the means that would help you to buy artificial ones, you become edentulous like a very

old person while you are not. You understand, it is very uncomfortable" (a 42 years old HIV-negative male).

The literature highlights a need to do OHRQoL research among HIV-positive persons and emphasizes the importance of doing so [45]; [36]. To the best of my knowledge, this is the first study to look at OHRQoL among HIV-positive persons compared to HIV-negative in Rwanda.

In addition, there is no programme to promote oral health among high-risk groups of HIV-positive persons. This lack of OHRQoL information is a serious issue because poor oral health interferes with the general well-being of HIV-positive people.

Caries and periodontal diseases negatively affect physical, psychological, and social well-being. Therefore, ignoring their effect on HIV-positive persons means the lack of comprehensive management. Hence, Rwanda's health policymakers and other stakeholders should be well-informed and engaged in promoting oral health services, especially among high-risk people such as HIV-positive persons.

8.5 References

1. Nugraha AP, Mensana MP, Soebadi B, et al. Correlation of Low CD4+ Counts with High Dental Caries Prevalence in Children Living with Perinatal HIV/AIDS Undergoing Antiretroviral Therapy. *Pesqui Bras Odontopediatria Clin Integr* 2019; 19: 1–7.
2. Palupi R, Sosiawan A, Gilang R, Ramadhani A. Factors Influencing Dental Caries in HIV / AIDS Patients. Acta Med Philipp. 2019;53(5):412–6.
3. Rajonson N, Meless D, Ba B, Faye M, Diby JS, N'zore S, et al. High prevalence of dental caries among HIV-infected children in West Africa compared to uninfected siblings. J Public Health Dent. 2017;77(3):234–43.
4. Kumar S, Mishra P, Warhekar S, Airen B, Jain D, Godha S. Oral Health Status and Oromucosal Lesions in Patients Living with HIV/AIDS in India: A Comparative Study. AIDS Res Treat [Internet]. 2014;2014:480247. Available from: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=25215229
5. Cavasin Filho JC, Giovani EM. Xerostomy, dental caries and periodontal disease in HIV+ patients. Braz J Infect Dis [Internet]. 2009;13:13–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19578624

6. Birungi N, Fadnes LT, Marie I, Stadskleiv E, Tumwine JK, Lie SA, et al. Caries experience by socio-behavioural characteristics in HIV-1-infected and uninfected Ugandan mothers – a multilevel analysis. Acta Odontol Scand [Internet]. 2022;80(2):91–8. Available from: https://doi.org/10.1080/00016357.2021.1942544
7. Nsanzimana S, Kanters S, Remera E, Forrest JI, Binagwaho A, Condo J, et al. HIV care continuum in Rwanda: A cross-sectional analysis of the national programme. Lancet HIV [Internet]. 2015;2(5):e208–15. Available from: http://dx.doi.org/10.1016/S2352-3018(15)00024-7
8. Feng I, Brondani M, Bedos C, Donnelly L. Access to oral health care for people living with HIV / AIDS attending a community-based program. Can J Dent Hyg. 2020;54(1):7–15.
9. Kolisa YM, Yengopal V, Shumba K, Igumbor J. The burden of oral conditions among adolescents living with HIV at a clinic in Johannesburg , South Africa. PLoS One. 2019;14(10):1–14.
10. Costa SM, Vasconcelos M, Haddad JPA, Henrique M, Abreu NG. The severity of dental caries in adults aged 35 to 44 years residing in the metropolitan area of a large city in Brazil : a cross-sectional study. BMC Oral Health. 2012;12(25).
11. Varenne B, Paris F, Petersen PE, Geneva S, Ouattara S. Oral health behaviour of children and adults in urban and rural areas of Burkina Faso , Africa. Int Dent J. 2006;56(2):61–70.
12. Varenne B, Petersen PE, Fournet F, Msellati P, Gary J, Ouattara S, et al. Illness-related behaviour and utilization of oral health services among adult city-dwellers in Burkina Faso: Evidence from a household survey. BMC Health Serv Res. 2006;6:1–11.
13. Bernabé E, Sheiham A. Age, Period and Cohort Trends in Caries of Permanent Teeth in Four Developed Countries. Am J Public Health [Internet]. 2014 Jul;104(7):e115–21. Available from: https://ajph.aphapublications.org/doi/full/10.2105/AJPH.2014.301869
14. Bogale B, Engida F, Hanlon C, Prince MJ, Gallagher JE. Dental caries experience and associated factors in adults: a cross-sectional community survey within Ethiopia. BMC Public Health [Internet]. 2021 Dec 21;21(1):180. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-021-10199-9
15. Oscarson N, Espelid I, Jönsson B. Is caries equally distributed in adults? A population-based cross-sectional study in Norway – the TOHNN-study. Acta Odontol Scand [Internet]. 2017 Nov 17;75(8):557–63. Available from: https://doi.org/10.1080/00016357.2017.1357080
16. Souza AJ de, Gomes-Filho IS, Silva CAL da, Passos-Soares J de S, Cruz SS da, Trindade SC, et al. Factors associated with dental caries, periodontitis and intra-oral lesions in individuals

with HIV / AIDS*. AIDS Care - Psychol Socio-Medical Asp AIDS/HIV. 2017;0121:1–8.
17. Kikuchi K, Yasuoka J, Tuot S, Okawa S, Yem S, Chhoun P, et al. Dental caries in association with viral load in children living with HIV in Phnom Penh , Cambodia : a cross - sectional study. BMC Oral Health. 2021;159(21):1–8.
18. Chen F, Cheng Y, Xie T. Oral Health Status of Young People Infected with HIV in High Epidemic Area of China. J Multidiscip Healthc ©. 2021;14:831–7.
19. Malekipour MR, Messripour M, Shirani F. Buffering capacity of saliva in patients with active dental caries. Asian J Biochem. 2008;3(5):280–3.
20. Umeizudike KA, Ayanbadejo PO, Savage KO, Nwhator SO, Akanmu AS, Ogunleye O. Comparative periodontal status of human immunodeficiency virus - positive patients and controls in a dedicated human immunodeficiency virus clinic in Nigeria. 2016;19(1):35–40.
21. Berniyanti T, Setijanto RD, Hariani N, Romadhoni SF. Relationship Between HIV / AIDS and Periodontal Health Status among Population at High Risk of HIV / AIDS. 2019;(47).
22. Monserrat S, Alicia L, Jes A De, Arturo M, Yolanda S, Esther A, et al. Oral Manifestations Associated with HIV / AIDS Patients. Medecina. 2022;58(1214):1–14.
23. Sahbandar I, Terakubo J, Pattison RJ, Park E, Oishi MK, Oishi MM, et al. Anti-Periodontopathic Antibody Response in Chronic HIV Infection. J HIV AIDS I. 2020;6(2):1–5.
24. Morgan JP, Isyagi M, Ntaganira J, Gatarayiha A, Pagni SE. Building oral health research infrastructure : the first national oral health survey of Rwanda. Glob Health Action [Internet]. 2018;11(1):1–10. Available from: https://doi.org/10.1080/16549716.2018.1477249
25. World Health Organization. *Oral Health Country Profile Programme*. WHO Health Technology Assessment and Health Benefit Package Surveyhttps://cdn.who.int/media/docs/default-source/country-profiles/oral-health/oral-health-rwa-2022-country-profile.pdf?sfvrsn=821cb1a2_7&download=true (2022).
26. Mutamuliza J, Rulisa S, Ntaganira J. Prevalence and Associated Risk Factors of Periodontal Disease among Adults Attending Dental Department in Rwanda Military Hospital (Rwanda): A Cross Sectional Study. Open Dent J. 2015;2(4):105–11.
27. Kaguru G, Ayah R, Mutave R, Mugambi C. Integrating Oral Health into Primary Health Care: A Systematic Review of Oral Health Training in Sub-Saharan Africa. J Multidiscip Healthc [Internet]. 2022 Jun;Volume 15(June):1361–7. Available from: https://www.dovepress.com/integrating-oral-health-into-primary-health-care-a-systematic-review-o-peer-reviewed-fulltext-article-JMDH
28. Abid A, Maatouk F, Berrezouga L, Azodo C, Uti O, El-Shamy H, et al. Prevalence and Severity

of Oral Diseases in the Africa and Middle East Region. Adv Dent Res [Internet]. 2015 Jul 22;27(1):10–7. Available from: http://journals.sagepub.com/doi/10.1177/0022034515582062

29. Thorpe S. Oral health issues in the African region: current situation and future perspectives. J Dent Educ. 2006;70(11 suppl):8–15.

30. MOH. National Oral Health Strategic Plan 2019-2024. 2019.

31. Lipsky MS, Su S, Crespo CJ, Hung M. Men and Oral Health: A Review of Sex and Gender Differences. Am J Mens Health [Internet]. 2021 May 15;15(3):155798832110163. Available from: http://journals.sagepub.com/doi/10.1177/15579883211016361

32. Rajeh MT. Gender Differences in Oral Health Knowledge and Practices Among Adults in Jeddah, Saudi Arabia. Clin Cosmet Investig Dent [Internet]. 2022 Aug;Volume 14(August):235–44. Available from: https://www.dovepress.com/gender-differences-in-oral-health-knowledge-and-practices-among-adults-peer-reviewed-fulltext-article-CCIDE

33. Al-Abdaly MMAA, AlQahtani HSH, Al-Qahtani SSH. The Impact of Age and Gender on Severity and Types of Periodontal Diseases among Patients from Two Regions in Saudi Arabia. Open J Stomatol [Internet]. 2019;09(03):39–53. Available from: http://www.scirp.org/journal/doi.aspx?DOI=10.4236/ojst.2019.93005

34. Tadjoedin FM, Fitri AH, Kuswandani SO, Sulijaya B, Soeroso Y. The correlation between age and periodontal diseases. J Int Dent Med Res. 2017;10(2):327–32.

35. Mulligan R, Seirawan H, Alves ME, Navazesh M, Phelan JA, Greenspan D, et al. Oral health-related quality of life among HIV-infected and at-risk women. Community Dent Oral Epidemiol [Internet]. 2008 Dec;36(6):549–57. Available from: https://onlinelibrary.wiley.com/doi/10.1111/j.1600-0528.2008.00443.x

36. Rocha Trindade RTVM, Marques JROF, Veiga MAG da, Marques DN da S, Mata ADSP da. HIV-1 impact on oral health-related quality of life: a cross-sectional study. AIDS Care [Internet]. 2021 Oct 3;33(10):1321–8. Available from: https://doi.org/10.1080/09540121.2020.1798866

37. Birungi N, Fadnes LT, Engebretsen IMS, Tumwine JK, Åstrøm AN. The prevalence and socio-behavioural and clinical covariates of oral health related quality of life in Ugandan mothers with and without HIV-1. Health Qual Life Outcomes [Internet]. 2021 Dec 23;19(1):201. Available from: https://doi.org/10.1186/s12955-021-01844-3

38. Ueno M, Ohara S, Inoue M, Tsugane S, Kawaguchi Y. Association between parity and dentition status among Japanese women: Japan public health center-based oral health study. BMC Public Health [Internet]. 2013 Dec 22;13(1):993. Available from: BMC Public Health

39. Cozier YC, Heaton B, Bethea TN, Freudenheim JL, Garcia RI, Rosenberg L. Predictors of self-reported oral health in the Black Women's Health Study. J Public Health Dent [Internet]. 2020 Jan 16;80(1):70–8. Available from: https://onlinelibrary.wiley.com/doi/10.1111/jphd.12351
40. Bukhari OM. Dental Caries Experience and Oral Health Related Quality of Life in Working Adults. Saudi Dent J [Internet]. 2020 Dec;32(8):382–9. Available from: https://doi.org/10.1016/j.sdentj.2019.11.003
41. de Sousa PCB, Mendes FM, Pettorossi Imparato JC, Ardenghi TM. Differences in responses to the Oral health impact profile (OHIP14) used as a questionnaire or in an interview. Braz Oral Res. 2009;23(4):358–64.
42. Vieira C, Lins L, Sarmento VA, Netto EM, Brites C. Oral health and health-related quality of life in HIV patients. BMC Oral Health. 2018;1–7.
43. Pesaressi E, Villena RS, Frencken JE. Dental caries and oral health-related quality of life of 3-year-olds living in Lima, Peru. Int J Paediatr Dent [Internet]. 2020 Jan 31;30(1):57–65. Available from: https://onlinelibrary.wiley.com/doi/10.1111/ipd.12582
44. Gholami M, Pakdaman A, Virtanen JI. Common Perceptions of Periodontal Health and Illness among Adults: A Qualitative Study. ISRN Dent [Internet]. 2012 Sep 17;2012:1–6. Available from: https://www.hindawi.com/journals/isrn/2012/671879/
45. Anup N, Sikka M, Biswas G, Shravani G, JAin P, Sontakke P. Oral health-related quality of life among HIV patients at antiretroviral therapy center government hospital, Jaipur. J Indian Assoc Public Heal Dent [Internet]. 2015;13(2):148. Available from: http://www.jiaphd.org/text.asp?2015/13/2/148/159051

CHAPTER 9: CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion on dental caries and associated risk factors

Overall, the prevalence of dental caries was higher in HIV-positive than in HIV-negative participants. The reported higher prevalence of caries in HIV-positive persons was associated with being female, detectable viral load, and frequent dental visits. Therefore, there is a need for effective oral health interventions specific to HIV-positive individuals in Rwanda to raise awareness of the risk of dental caries and provide preventive oral health services among this population. There is a need for effort from policymakers and stakeholders to integrate oral health care services within HIV treatment programmes in Rwanda. We furthermore recommend further prospective studies that will analyze in depth the strength of the association of caries with different factors among HIV-positive persons in comparison to HIV- negative individuals.

9.2 Conclusion on periodontal diseases and associated risk factors

This study also revealed poorer periodontal health among HIV-positive participants 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 HIV-positive people in Rwanda. There is also a need to develop community-based oral health education programmes to encourage oral hygiene practice and regular dental visits for periodontal screening among the Rwandan population. Further studies are recommended for the rural population in Rwanda.

9.3 Conclusion on Oral Health-Related Quality of Life and associated risk factors

Our study revealed poor OHRQoL among HIV-positive and HIV-negative adults. A higher prevalence of HIV-positive persons had poor OHRQoL compared to their HIV counterparts. Dental caries was significantly associated with poorer OHRQoL among HIV-positive and HIV-negative individuals. There is a need for oral health programmes that aim to improve the OHRQoL in Rwanda, especially among HIV-positive individuals.

Further similar studies are needed in Rwanda, especially among rural people and HIV-positive Rwandan adolescents. Furthermore, we recommend further studies that will consider the assessment of OHRQoL in people with other chronic diseases in Rwanda.

As suggested by other researchers, it is also essential to include oral health care as one of the components of the medical health care programmes for HIV-positive persons in Rwanda.

9.4 Conclusion about perceptions on paussible causes and effect of oral diseases among HIV-positive and HIV-negative adults in Kigali, Rwanda.

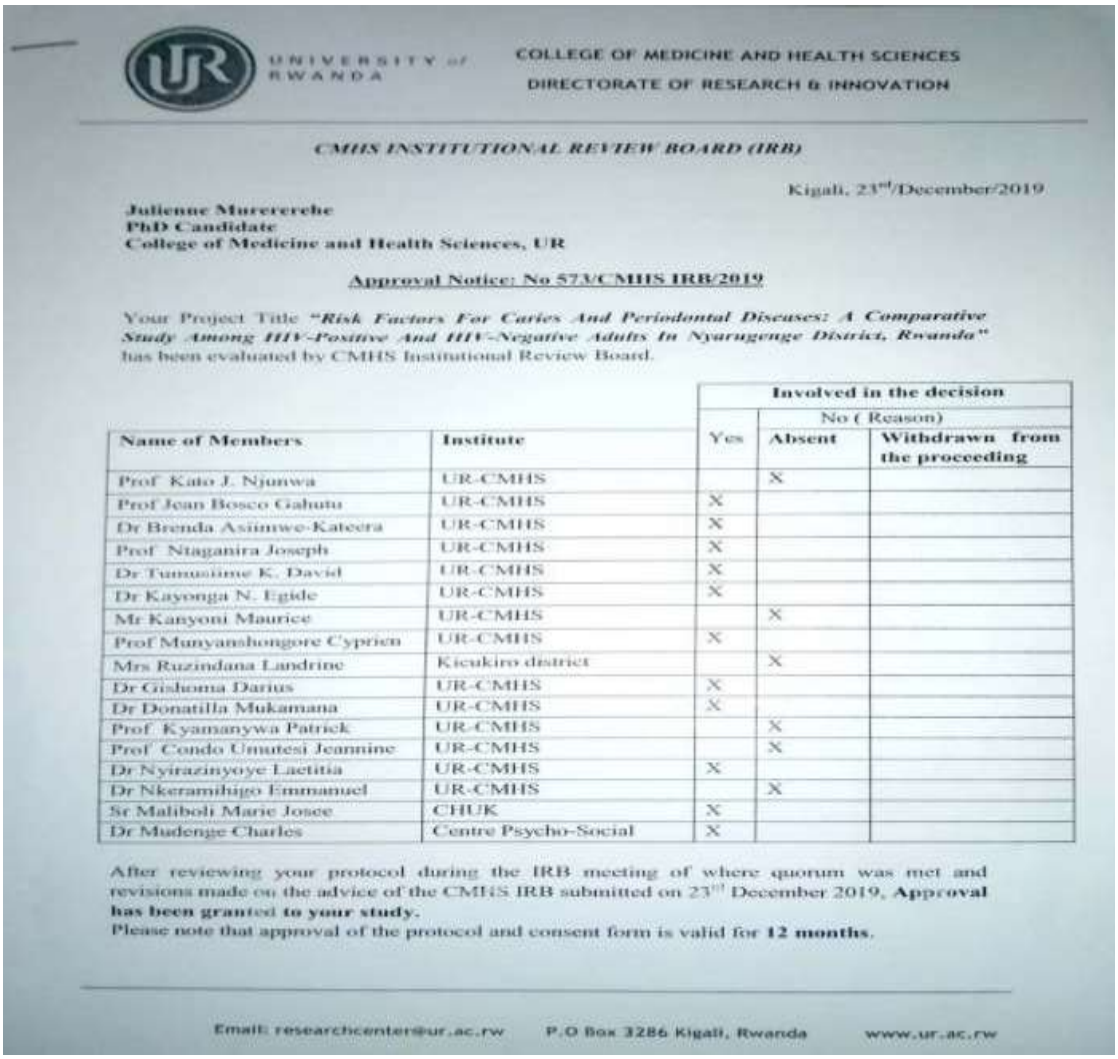
According to study results, HIV-positive and HIV-negative adults perceived various individual level and external level factors for caries and periodontal diseases development. Also, HIV-positive and HIV-negative interviewees experienced physical/functional, psychological, and social effects due to having oral diseases with more patterns in HIV-positive interviewees. Interventions are needed to prevent caries and periodontal diseases at the individual and external levels to improve oral health-related quality of life for HIV-positive people and Rwandese at more prominent.

Overall, the Rwandan Health service lack baseline data for planning for oral health and incorporating the plans into general health. Therefore, this study was important to provided baseline data to fill the knowledge gap on the status of common oral diseases (caries and periodontal diseases) and associated factors among HIV-positive adults compared to HIV-negative individuals. This baseline information was also important because it informed policymakers and other stake holders and gave them insights to ensure oral health strategies and programs that can promote oral health for HIV-positive people in Rwanda. Moreover, this study gives insights to other oral health researchers in Rwanda to do more oral health researches that can positively impact oral health policies in Rwanda."

APPENDICES

Appendix 1: Ethical Clearances

Appendix 1.1: Ethical clearance from the University of Rwanda-College of Medicine and Health Sciences Institutional review board.



UNIVERSITY of RWANDA

COLLEGE OF MEDICINE AND HEALTH SCIENCES
DIRECTORATE OF RESEARCH & INNOVATION

CMHS INSTITUTIONAL REVIEW BOARD (IRB)

Kigali, 23rd/December/2019

Julienne Murererehe
PhD Candidate
College of Medicine and Health Sciences, UR

Approval Notice: No 573/CMHS IRB/2019

Your Project Title *"Risk Factors For Caries And Periodontal Diseases: A Comparative Study Among HIV-Positive And HIV-Negative Adults In Nyarugenge District, Rwanda"* has been evaluated by CMHS Institutional Review Board.

Name of Members	Institute	Involved in the decision		
		Yes	No (Reason)	
			Absent	Withdrawn from the proceeding
Prof Kato J. Njunwa	UR-CMHS		X	
Prof Jean Bosco Gahutu	UR-CMHS	X		
Dr Brenda Asiimwe-Kateera	UR-CMHS	X		
Prof Ntaganira Joseph	UR-CMHS	X		
Dr Tumusiime K. David	UR-CMHS	X		
Dr Kayonga N. Egide	UR-CMHS	X		
Mr Kanyoni Maurice	UR-CMHS		X	
Prof Munyanshongore Cyprien	UR-CMHS	X		
Mrs Ruzindana Landrine	Kicukiro district		X	
Dr Gishoma Darius	UR-CMHS	X		
Dr Donatilla Mukamana	UR-CMHS	X		
Prof Kyamanywa Patrick	UR-CMHS		X	
Prof Condo Umutesi Jeannine	UR-CMHS		X	
Dr Nyirazinyoye Laetitia	UR-CMHS	X		
Dr Nkeramihigo Emmanuel	UR-CMHS		X	
Sr Maliboli Marie Josee	CHUK	X		
Dr Mudenge Charles	Centre Psycho-Social	X		

After reviewing your protocol during the IRB meeting of where quorum was met and revisions made on the advice of the CMHS IRB submitted on 23rd December 2019, **Approval has been granted to your study.**
Please note that approval of the protocol and consent form is valid for **12 months**.

Email: researchcenter@ur.ac.rw P.O Box 3286 Kigali, Rwanda www.ur.ac.rw

You are responsible for fulfilling the following requirements:

1. Changes, amendments, and addenda to the protocol or consent form must be submitted to the committee for review and approval, prior to activation of the changes.
2. Only approved consent forms are to be used in the enrolment of participants.
3. All consent forms signed by subjects should be retained on file. The IRB may conduct audits of all study records, and consent documentation may be part of such audits.
4. A continuing review application must be submitted to the IRB in a timely fashion and before expiry of this approval
5. Failure to submit a continuing review application will result in termination of the study
6. Notify the IRB committee once the study is finished

Sincerely,

Date of Approval: The 23rd December 2019

Expiration date: The 23rd December 2020

Professor GAHUTU Jean Bosco
Chairperson Institutional Review Board,
College of Medicine and Health Sciences, UR

Cc:

- Principal College of Medicine and Health Sciences, UR
- University Director of Research and Postgraduate Studies, UR

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Appendix 1.2. Ethical clearance from the University Witwatersrand

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

Office of the Deputy Vice-Chancellor (Research & Post Graduate Affairs)

TO: Ms J Murererehe
School of Oral Health Sciences
Department of Community Dentistry
Dental School
University

E-mail: jmurererehe@cartafrica.org

CC: Supervisor: Professor V Yengopal and Dr Y Kolisa
<Veerasamy.Yengopal@wits.ac.za>
and <HREC-Medical.ResearchOffice@wits.ac.za>

FROM: Iain Burns
Human Research Ethics Committee (Medical)
Tel: 011 717 1252

E-mail: Iain.Burns@wits.ac.za

DATE: 2020/07/15

REF: *R14/49*

PROTOCOL NO: **M200351** *(This is your ethics application study reference number. Please quote this reference number in all correspondence relating to this study)*

PROJECT TITLE: *Risk factors for caries and periodontal diseases: A comparative study among HIV-Positive and HIV-Negative adults in Nyarugenge District, Rwanda*

Please find attached the Clearance Certificate for the above project. I hope it goes well and that an article in a recognized publication comes out of it. This will reflect well on your professional standing and contribute to the Government funding of the University.

MSWorks2000/Iain0007/Clearscan.wps

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R14/49 Ms J Murererehe

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M200351

NAME: (Principal Investigator)	Ms J Murererehe
DEPARTMENT:	School of Oral Health Sciences Department of Community Dentistry Dental School University
PROJECT TITLE:	Risk factors for caries and periodontal diseases: A comparative study among HIV-Positive and HIV-Negative adults in Nyarugenge District, Rwanda
DATE CONSIDERED:	2020/03/27
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Professor V Yengopal and Dr Y Kolisa
APPROVED BY:	CB Penny Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2020/07/15

This clearance certificate is valid for 5 years from the date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the 3rd Floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **March** and will therefore reports and re-certification will be due early in the month of **March** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Ms Julienne Murererehe — 31/7/2020

Principal Investigator Signature — Date

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Appendix 2. Permission to collect data from study site

Appendix 2.1. Ethical clearance from the Ethics committee of Kigali Teaching Hospital (CHUK)

CENTRE HOSPITALIER UNIVERSITAIRE
UNIVERSITY TEACHING HOSPITAL

Quality Health Care Training & Research

Ethics Committee / Comité d'éthique

24,Apr,2020 *Ref. EC/CHUK/026/2020*

Review Approval Notice

Dear Julienne Murererehe,

Your research project: ***""Risk factors for caries and periodontal diseases: A comparative study among HIV-positive adults in Nyarugenge District, Rwanda". "***

During the meeting of the Ethics Committee of University Teaching Hospital of Kigali (CHUK) that was held on 24,Apr,2020 to evaluate your request for ethical approval of the above mentioned research project, we are pleased to inform you that the Ethics Committee/CHUK has approved your research project.

You are required to present the results of your study to CHUK Ethics Committee before publication by using this link:www.chuk.rw/research/fullreport/?appid=89&&chuk

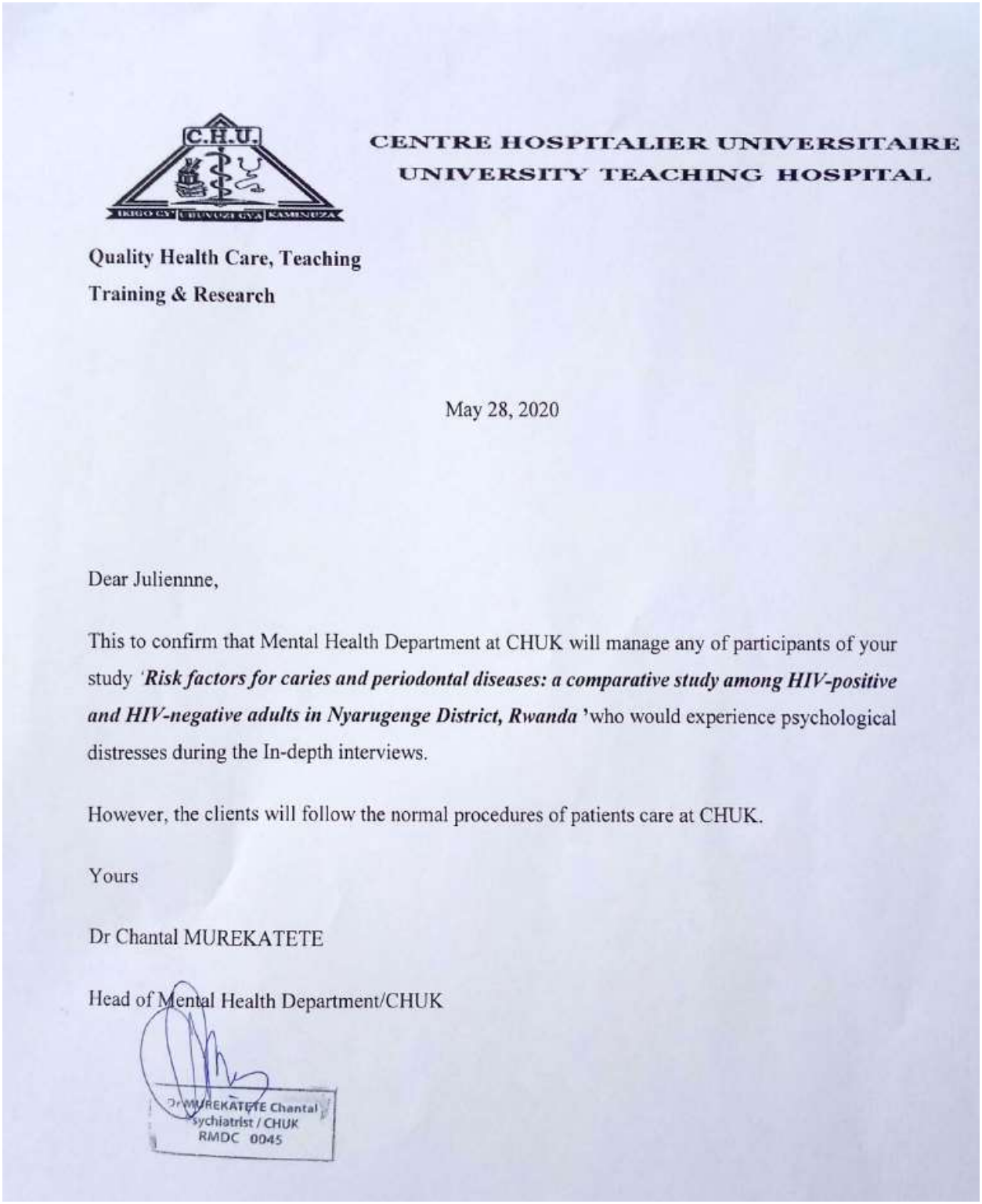
PS: Please note that the present approval is valid for 12 months.

Yours sincerely,

Dr Emmanuel Rusingiza Kamanzi
The Chairperson, Ethics Committee,
University Teaching Hospital of Kigali

ETHICS COMMITTEE
CHUK

Appendix 2.2. Confirmation from CHUK mental health department to support in case of psychological distress.



CENTRE HOSPITALIER UNIVERSITAIRE
UNIVERSITY TEACHING HOSPITAL

Quality Health Care, Teaching
Training & Research

May 28, 2020

Dear Juliennne,

This to confirm that Mental Health Department at CHUK will manage any of participants of your study '***Risk factors for caries and periodontal diseases: a comparative study among HIV-positive and HIV-negative adults in Nyarugenge District, Rwanda*** 'who would experience psychological distresses during the In-depth interviews.

However, the clients will follow the normal procedures of patients care at CHUK.

Yours

Dr Chantal MUREKATETE

Head of Mental Health Department/CHUK

Dr MUREKATETE Chantal
Psychiatrist / CHUK
RMDC 0045

Appendix 3. Faculty Approval of the thesis title

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Private Bag 3 Wits, 2050

Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

31 August 2020
Person No: 2273759
PAG

Miss J Murererehe
KG 11 Ave Remera
KN 4 Ave Nyarugenge
4285
Rwanda

Dear Miss Julienne Murererehe

Doctor of Philosophy: Approval of Title

We have pleasure in advising that your proposal entitled *Risk factors for caries and periodontal diseases: A comparative study among HIV-Positive and HIV-Negative adults in Nyarugenge District, Rwanda* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Appendix 4: Questionnaire

I. Clinical Examination data collection Sheet

A. SOCIODEMOGRAPHIC DATA

A.1. Participant Identification number **A.2 Examiner number**

☐☐☐☐ ☐☐

A.3 Sex

1. Male ☐ 2. Female ☐

A.4 Residence

☐ Urban ☐ Peri-urban ☐ Rural

4.5 Date of Birth:

☐☐☐☐

A.6 Level of Education:

1. No formal schooling ☐
2. Less than primary school ☐
3. Primary school completed ☐
4. High school completed ☐
5. College/university completed ☐
6. Postgraduate degree ☐
7. Other, Mention……..

A.7 Occupation:

1. Unemployed …… ☐
2. Government employed…… ☐

3. Employed in private sector…… ☐

4. Doing business…… ☐

5. Farmer…….. ☐

6. A student…….. ☐

7. Retailed …….. ☐

8. Other, mention……..

A.9. Insurance

Do you have Health Insurance ☐ Yes No ☐

A.10 Ubudehe category

1. **Category 1**: (Families who do not own a house and can hardly afford basic needs) …… ☐

2. **Category 2** (Those who have a dwelling of their own or are able to rent one but rarely get full time jobs) …… ☐

3. **Category 3**: Those who have a job and farmers and go beyond subsistence farming to produce a surplus which can be sold. Also include those with small and medium enterprises who can provide employment to dozens of people……. ☐

4. **Category 4**: Those who own large-scale business, individuals working with international organizations and industries as well as public servants……. ☐

A.11. Health conditions and medication:

a. Chronic disease……. ☐ Yes ☐ No

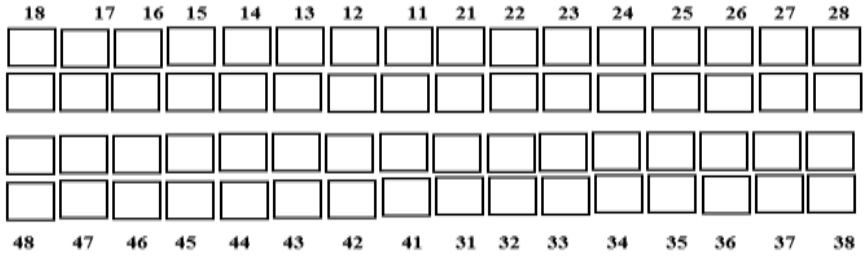
b. If yes, mention……..

c. Dry mouth experience…... Yes ☐ No ☐

d. If you are taking any medication, please mention the type……

B. TOOL TO DETERMINE CARIES AND PERIODONTAL STATUS AMONG PARTICIPANTS

B1. Dental caries status



Score

0: Sound
1: Caries
2: Filled with caries
3: Filled without caries
4: Missing due to caries

.

B2. 1 Assessment of dental plaque using Plaque index (PI)by Silness &Loe

Score

0: No plaque
1: Plaque recognized only after application of disclosing agent or after passing the probe on gingival margin
2: Moderate accumulation of soft deposits within the gingival pocket or on the tooth and gingival margin that can be seen with naked eye.
3: Abundance of soft matters within the gingival pocket and or on tooth and gingival margin

Each surface/ area (buccal, lingual, mesial, distal) is scored from 0 to 3.
To calculate PI for each tooth, scores for each area are summed and divided by 4
PI for individual is obtained by adding the scores for each tooth and divided by the number of teeth examined.

The range of score for participant reference will be:

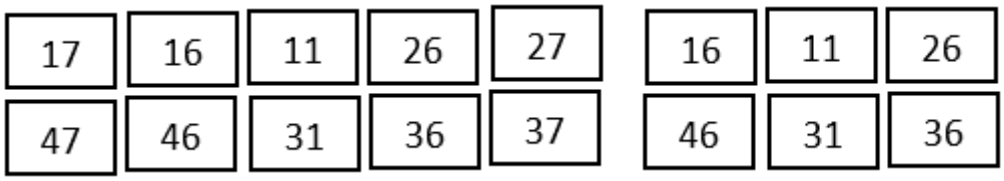
0: excellent)
0.1-0.9: good,
1.0-1.9: fair
2.0-3,0: poor.

The range of score for participant reference will be:

0: excellent)
0.1-0.9: good,
1.0-1.9: fair
2.0-3,0: poor.

B3. Community Periodontal Index of Treatment Needs (CPITN)

Ten teeth index score (20years old and above). Six index teeth (18-19 years old)



Gingival bleeding and Pocket

Scores:

0: Absence of condition (no bleeding, no calculus, no pathological pocket)

1: Bleeding upon gentle probing (no calculus, no pathological pocket)

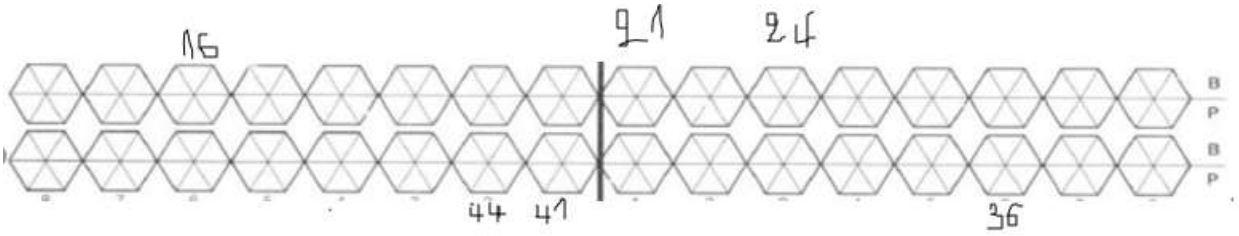
2: Presence of supra and /or sub gingival calculus or other plaque retentive factors with or without bleeding, no pathological pocket)

3: 4 or 5 mm deep periodontal pockets (with or without bleeding and calculus)

4: 6mm or deeper periodontal pockets (with or without bleeding and calculus)

B4

Clinical attachment loss (CAL): Rumford's teeth (16, 21, 24, 36, 41, and 44) were considered for CAL assessment.



1-2 mm: Slight CAL
3-4mm: moderate CAL
5mm and above: severe CAL

In case of gingival recession, CAL will be calculated by adding probing depth to the marginal margin level. Gingival margin coronal to the CEJ will be subtracted to gingival margin level to get CAL. Gingival margin closer to the CEJ will not require calculation, probing depth and clinical attachment are equal.

C. TOOL TO ASSESS SOCIOCULTURAL RISK FACTORS TO CARIES AND PERIODONTAL DISEASES

C.1 Do you brush your teeth? ☐ Yes ☐ No

C.2How often do you brush your teeth?

Never	1
Once a month	2
2–3 times a month	3
Once a week	4
2–6 times a week	5
Once a day	6
Twice or more a day	7

C.3 Do you use any of the following to clean your teeth?

		Yes	No
Toothbrush.....	1		
Wooden toothpicks	2		
Plastic toothpicks?	3		
Thread (dental floss)	4		
Charcoal	5		
Chewstick/miswak.....	6		
Other	7		

Please specify ..... ……

C.4 Do you use toothpaste to brush your teeth?

1. Yes 2. Sometimes 3. No

C.5 How long you last visited a dentist?

Less than 6 months	1
6-12 months	2
More than 1 year but less than 2 years	3

2 years or more but less than 5 years ..... ☐ 4

5 years or more ..... ☐ 5

Never received dental care ..... ☐ 6

C.6 What was the reason of your last visit to the dentist?

Consultation/advise.....… 1 ☐

Pain or trouble with teeth, gums or mouth ..... 2 ☐

Treatment/ follow-up treatment ..... 3 ☐

Routine check-up/treatment ..... 4 ☐

Don't know/don't remember ..... 5 ☐

Other (Specify)……. ☐

C.7 If never visited a dentist, what are the reason of not visiting? Choose more than 1 option.

1. Dental diseases are not a problem
2. I can relieve dental pain myself
3. Traditional healers may easily help me with dental problems
4. Dental problems are expensive
5. Other, mention…….

C. 8 Have you ever experienced any discrimination related to your oral conditions?

1.Yes
2. No

C.9 If yes, from whom? (use V sign)

1. A family member
2. A friend or a colleague
3. A partner
4. A dental practitioner
5. Other, mention……..

C.10 Do you disclose your sero-status to dental practitioners (If the dentists ask so)?

1. Yes
2. No

C.11 If no, what are the reasons of your non disclosing. (use V sign)

1. Confidentiality
2. Fear of not being treated well
3. Fear of being discriminated
4. I do not want to lose my relationship with the dentist
5. Other, mention……..

……

C.12 How often do you eat or drink any of the following foods, even in small quantities??
(Read each item)

Frequency / Food type	Several times a day	Every day	Several times a week	Once a week	Several times a month	Seldom/ never	Don't remember
Fresh fruit							
Biscuit, cakes							
Sweet pies, buns							
Jam or Honey							
chewing gum containing sugar							
Sweets/ candy							
Lemonade, Coca Cola or other soft drink							
Tea with sugar							
Coffee with sugar							

C.13 a. Do you smoke? ☐ Yes ☐ No

C.13. b. If yes, how often do you use any of the following types of tobacco?
(Read each item)

Frequency / Type of tobacco	6.Several times a day	5.Every day	4.Several times a week	3.Once a week	2.Several times a month	1.Seldom/ never
Cigarettes						
Cigars						
A pipe						
Chewing tobacco						
chewing gum containing sugar						
Sweets/ candy						

Use snuff						
Other, mention……						

C.14. a. Do you drink alcohol? ☐ Yes ☐ No

C.14.b. If yes, how many drinks did you usually drink per day during the past 30 days, on the days you drank alcohol,

Less than 1 drink……0

1 drink……1

2 drinks……..2

3 drinks……..3

4 drinks…….....4

More than 5 drinks……....5

Did not drink alcohol during past 30 days……6

II. HIV DATA CAPTURE SHEET

Entry date:……..

Data elements

	1	**2**
HIV status code	☐	☐
	Yes	No

Other information available	Yes	No
	☐	☐

Information regarding HIV status

Duration of HIV in years: /Date of diagnosis…….

HIV RNA Viral load: ……

CD4 cell counts :…….

Type of anti-retroviral treatment:/ARV regimen……

ARV start date…… ☐

a. Less than 6 months …… ……. ☐

b. More than 6 months but less than 2 years …… ☐

c. More than 2 years but less than 5 years…….. ☐

d. More than 5 years…… ☐

WHO HIV staging:

……

Information regarding comorbidities:

Hypertension (HT)**:** ☐ Yes ☐ No

Date of HT……

Diabetes:Yes No ☐ ☐

Type of diabetes:……

Date of diabetes: ……..

Patient is pregnant ☐ Yes ☐ No

Other comorbidities: Yes ☐ No ☐

If yes, mention……..

Date ……..

III. ORAL HEALTH IMPACT PROFILE (OHIP-14)

Dimensions	QUESTIONS	Scale				
Functional limitation	Have you had trouble pronouncing any words because of problems with your teeth or mouth?	0(never)	1(hardly ever)	2(occasionally)	3(Fairly often)	4(Very often)
	Have you felt that your sense of taste has worsened because of problems with your teeth or mouth?					
Physical pain	Have you had painful aching in your mouth?					
	Have you found it uncomfortable to eat any foods because of problems with your teeth or mouth?					
Psychological discomfort	Have you been self-conscious because of your teeth or mouth?					
	Have you felt tense because of problems with your teeth or mouth?					
Psychological disability	Has been your diet been unsatisfactory because of problems with your teeth of mouth?					
	Have you had to interrupt meals because of problems with your teeth or mouth?					
Physical disability	Have you found it difficult to relax because of problems with your teeth or mouth?					
	Have you been a bit embarrassed because of problems with your teeth or mouth?					
Social handicap	Have you been a bit irritable with other people because of problems with your teeth or mouth?					
	Have you had difficulty doing your usual jobs because of problems with your teeth or mouth?					
Handicap	Have you felt that life, in general, was less satisfying because of problems with your teeth or mouth?					
	Have you been totally unable to function because of problems with your teeth or mouth?					

Appendix 5. Interview guide

I invite you to participate in the study that is being conducted by MURERE REHE Julienne, a lecturer at University of Rwanda in school of Dentistry and who is also doing a PhD (Doctor of philosophy) in Community Dentistry at University of Witwatersrand/ South Africa. The study is about "**Risk factors for caries and periodontal diseases: A comparative study among HIV-positive adults in Nyarugenge district, Rwanda''.**

Before we start, I would like to remind you that there are no right or wrong answers in this discussion. We are interested in knowing what you think, feel and your experiences. Please feel free and be frank to share your point of view. It is very important that we hear your opinion.

Participants will be encouraged to expand on their replies and probed further by asking: 'Tell me more.; how do you feel…

1. Tell me your experience of living with oral diseases. Tell me more

2. What can you tell me about the condition of your teeth, gums and mouth? 'Tell me more…

3. How do you feel about the condition of your teeth, gums and mouth? (Probe for ….

a. distress, self and public stigma,

-How does the public think or treat you? (family member, dentists,
-Health practitioners, friends) (probe for public stigmatization)

-How does oral diseases affect your general health and well being

-Probe for: expenses, health conditions

4. What do you think are risk factors to your oral diseases?

Tell me more about: -socio or cultural practices that you think to be associated with your oral problems? (probe for Education occupation, income, lifestyles, economic status, traditional practices, beliefs, customs)

-Use of oral health services factors (probe for Reason for visits, demand for oral health care, frequency of visits)

-Behaviors factors (Oral hygiene practice, diet habit, smoking Smoking, drinking alcohol)

5. Is there any health condition that you think is associated with your gum problems oral teeth cavities?

-Probe for HIV clinical markers (HIV RNA viral load, CD4 cell counts, WHO HIV staging, HIV infection duration, ART regimen

Appendix 6. Information leaflet for participants

Study title: RISK FACTORS FOR CARIES AND PERIODONTAL DISEASES: A COMPARATIVE STUDY AMONG HIV-POSITIVE AND HIV-NEGATIVE ADULTS IN NYARUGENGE DISTRICT, RWANDA.

Greetings,

I Julienne Murererehe, am doing a research on "**Risk factors for caries and periodontal diseases: A comparative study among HIV-positive adults in Nyarugenge district, Rwanda'.** Research is a process used in seeking new knowledge. In this study we want to assess risk factors for common oral diseases (teeth cavities and gum diseases). The reason I am doing this study is to contribute to the improvement of good oral health and wellbeing of the community.

Invitation to Participate: We inviting you to take part in a research study

What are the benefits of the study?

There are no direct benefits to the participants, however the study will have an impact on the prevention of oral diseases and improvement of quality of life among Rwandan population especially those who are HIV-positive.

What is my role in this study?

We will examine your mouth to check for caries and or periodontal diseases and we will also ask you to answer questionnaire of 30 minutes to assess risk factors to caries and periodontal diseases and its effect on your oral health related quality of life.

We will also request a number of participants to participate in one to one interviews to explore your perceptions and lived experiences on oral diseases. The interview will be recorded. The recording will be transcribed and any information that could identify you will be removed. We will destroy the recordings in two years of the publication of the research findings, or six years, if no publications arise from this research. Anyone wishing to access the recording information in the future will first have to obtain the approval of the Human Research Ethics Committee

(Medical) of the University of the Witwatersrand, Johannesburg. Also direct quotes from your interview, without any information that could identify you, may be cited in the research report or other write-ups of research.

The interview will last 30 to 45 minutes.

We provide to you this information so that you can voluntary decide whether you can or not participate in this study. It is up to you and you can withdraw from the study at any stage without any negative consequence.

What are the possible risks if I participate in this study?

We are not anticipating any risk or harm from this study. However, you may have physical discomfort during oral examination and psychological distress during interviews. We will do our best to minimize those risks. In addition, the researcher's contact information is provided and you may contact her for any question, issue or if you want to withdraw from the study. We have also attached the contact detail that you can use if you need confidential support for your welfare.

Who are the participants?

The study will include all adults people. We will consider both HIV-positive and HIV- negative people to better understand these risk factors.

Is there any reward for me to participate?

There is no reward for participating in the study.

How will you keep my data confidential?

We will keep any information from this study confidentially. We will use codes to avoid the names of participants on information sheet. Researchers are the only people who will be able to access original data. We will keep all information in rocket cabinet or a code protected computer. We will avoid to share identifiable participants 'information with anyone.

How will you Share the results of the study?

We will inform you about the findings of this study. In addition, we will share the findings of the study with health care practitioners at HIV clinic of Kigali teaching hospital. We will also publish

the results of the study in academic journals. The information you provide will only be used for scientific purpose. We will always avoid any appearance of your names to keep your information confidential. Your information will not be breached at any time.

University of Witwatersrand contact:

If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Other contacts

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Phone: +250788593017

University of Rwanda

The CMHS Institutional Review Board
Phone: +250788490522 or +250783340040
Email: undayfrax@gmail.com

Thank you for reading this Study Information Sheet.

Date:

Appendix 7: Participants' consent form

Project Title

Risk factors for caries and periodontal diseases: a comparative study among HIV-positive and HIV-negative adults in Nyarugenge District, Rwanda.

1. I have been given a Participant Information Sheet which explains the nature and processes involved in this study, which is attached hereto;
2. I was given time to read it, or had it read to me, in the language I best understand;
3. I was given time to ask any questions I wanted to and found any answers given to me to be reasonable and satisfactory;
4. I believe I fully understand why the study is being conducted and what the intended outcomes will be;
5. I understand that there will be no immediate benefit to me, should I agree to participate, nor will I receive any payment; conversely, participation will not cost me anything but my time;
6. I understand that, even if I initially consent to take part in the study, I may subsequently withdraw at any time and would not be required to give any reasons; if that happened, any data collected about me for the purposes of the study would immediately be destroyed, unless I give consent for it to be retained
7. I have been given a range of contact details, listed below. If I require further information or become concerned about any aspect of this study, I am free to speak to any of these contacts.

Name of Participant: _____
Date: _____
Place: _____
Signature or mark _____

Contact details:

Mrs Julienne Murererehe, Principal Investigator, telephone no.+250788593017, or by e-mail at jmurererehe@cartafrica.org

Professor Veerasamy. Yengopal, Supervisor, on telephone no. +27837800907, or by e-mail at veerasamy.yengopal@wits.ac.za

Professor CB Penny, Chairperson of the Human Research Ethics Committee (Medical) at the University of Witwatersrand, on telephone no.011 717 2301, or by e-mail at Clement.Penny@wits.ac.za.
Ms. Z Ndlovu or Mr RhulaniMkansi, Committee Secretariat, telephone nos.: 011 717 2700 or 1234, or by e-mail at: Zanele.Ndlovu@wits.ac.za or Rhulani.Mkansi@wits.ac.za

appendix 8: Consent form for audio recording of study participation

Project Title

Risk factors for caries and periodontal diseases: a comparative study among HIV-positive and HIV-negative adults in Nyarugenge District, Rwanda.

I hereby consent to audio recording of the interview
.
I understand that:

- The recording will be stored in a secure location (a locked cupboard or password protected computer) with restricted access to the researcher and the research supervisor.
- The recording will be transcribed and any information that could identify me will be removed,
- The recordings will be erased within either (a) two (2) years of the publication of the research findings, or (b) six (6) years, if no publications arise from this research
- Anyone wishing to access this information in the future will first have to obtain the approval of the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg
- Direct quotes from my interview, without any information that could identify me, may be cited in the research report or other write-ups of research.

Name of Participant: _____
Date: _____
Place: _____
Signature or mark _____

Appendix 9: Original published paper 1

PLOS ONE

RESEARCH ARTICLE

Prevalence of dental caries and associated risk factors among People Living with HIV/AIDS and HIV uninfected adults at an HIV clinic in Kigali, Rwanda

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Abstract

Background

Dental caries is among the most frequent oral conditions in People Living with HIV/AIDS (PLWHA). There is a lack of baseline information on dental caries prevalence and associated risk factors among PLWHA in comparison to HIV uninfected people in Rwanda.

Objective

This study was conducted to determine the prevalence of dental caries and associated risk factors among PLWHA and HIV uninfected adults at an HIV clinic of Kigali Teaching Hospital (CHUK) in Kigali, Rwanda.

Methods

A comparative cross-sectional study was conducted among 200 PLWHA and 200 HIV uninfected adults aged 18 years and above attending an HIV clinic of CHUK. An oral examination was performed by a calibrated examiner. Dental caries were assessed using the WHO Decayed (D), Missing (M), and Filled Teeth (F) index (DMFT). Descriptive statistics, Chi-square, t-tests, and multiple binary logistic regression were used to analyze data.

Results

Overall, a higher prevalence (50.5%) of PLWHA had experienced dental caries (DMFT>0) compared to HIV uninfected counterparts (40.5%) ($p = 0.045$). The prevalence of Decayed teeth (D) was also higher (23.5%) among PLWHA compared to HIV uninfected persons (13.6%) ($p = 0.011$). The Mean(SD) DMFT scores among PLWHA and HIV uninfected participants were 2.28 (3.68) and 1.29 (2.21) respectively ($p = 0.001$). After performing multiple binary logistic regression analysis, the predictors of dental caries in PLWHA were being

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Competing interests: The authors have declared that no competing interests exist.

female (OR = 2.33; 95%CI = 1.14–4.75), frequent dental visits (OR = 4.50; 95% CI = 1.46–13.86) and detectable RNA viral load (OR = 4.50; 95% CI = 1.46–13.86). In HIV uninfected participants, the middle age range (36–45 years), and frequent dental visits were significantly associated with dental caries (OR = 6.61; 95%CI = 2.14–20.37) and (OR = 3.42; 95% CI: 1.337–8.760) respectively.

Conclusion

The prevalence of dental caries was higher in PLWHA than in HIV uninfected counterparts. The reported higher prevalence of caries in PLWHA was associated with being female, detectable viral load, and frequent dental visits. Therefore, there is a need for effective oral health interventions specific to PLWHA in Rwanda to raise awareness of the risk of dental caries and provide preventive oral health services among this population. To ensure timely oral health care amongPLWHA, there is a need for an effort from policymakers and other stakeholders to integrate oral health care services within the HIV treatment program in Rwanda.

Introduction

Oral health is an integral part of overall health and it is strongly associated with systemic conditions [1] including Human Immunodeficiency Virus (HIV) [2], Alzheimer's disease [3], cardiovascular diseases, diabetes and obesity [4]. The prevalence of caries is higher among People Living with HIV/AIDS (PLWHA) than among the general population [2,5–7]. Therefore, effective treatment of PLWHA should include oral diseases management.

Acquired Immune Deficiency Syndrome is considered an important public health problem in developed and developing countries [8]. More than 1.5 million people globally became newly infected with HIV in 2020 [9]. The WHO African region is the most affected region, accounting for more than two-thirds of PLWHAworldwide [8]. In Rwanda, HIV prevalence is higher in urban areas (7.1%) compared to rural settings (2.3%) [10].

Since the introduction of highly active antiretroviral treatment (HAART) in 1996, the life expectance of PLWHA has considerably increased [11,12]. HAART has also significantly reduced the occurrence of HIV related oral lesions [13]. As PLWHA live longer, it is imperative to promote their good oral health and access to quality dental care.

Dental care is reported as the least frequently met healthcare need among PLWHA [14]. Poor dental function resulting from oral diseases such as dental caries affect the general health of PLWHA [15,16]. Moreover, dental decay negatively affects the physical, mental, and social life of affected people [17]. In addition, oral diseases can affect adherence to antiretroviral therapy (ART) among PLWHA [17]. Also, dental problems among PLWHA are known to be more severe and difficult to manage compared to oral problems among HIV uninfected people [15]. Thus, oral health care should not be ignored and should form an important component of comprehensive treatment available for PLWHA.

There is a high burden of oral diseases in Rwanda according to the latest Rwandan National Oral Health Survey. Nearly 65% of participants in the survey had dental caries with more than 54% untreated caries [18]. Data on caries prevalence and associated risk factors among PLWHA is lacking in Rwanda. This study was conducted to provide baseline information on the prevalence of dental caries and associated risk factors among PLWHA in comparison to

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HIV uninfected individuals at an HIV clinic of Kigali Teaching hospital (CHUK). The information from this study will enable us to inform policymakers and other stakeholders on the best strategies to prevent oral diseases, specifically dental caries among PLWHA thereby contributing to the improvement of their oral health-related quality of life.

Materials and methods

Study design and participants

This was a comparative cross-sectional study. The study population consisted of People Living with HIV/AIDS (PLWHA) and HIV uninfected adults attending the HIV clinic of Kigali Teaching Hospital (CHUK). All PLWHA, aged 18 years and older, and diagnosed with HIV infection at least 3 months prior to recruitment were included in the study. We also included all HIV uninfected attendees aged 18 years and above who came for HIV voluntary testing and who were diagnosed as HIV negative.

Sample size and sample size calculation

The sample size for comparative cross-sectional study objectives was calculated using Stata software version 15. Assuming a study power of 80%, considering that the prevalence of caries is 60% in PLWHA and 45% in HIV uninfected persons and considering a ratio of 1 [19]. The minimum study sample estimated was 346 participants. Our study included PLWHA with the challenge regarding responsiveness especially in studies related to oral health that are not frequently done in Rwanda. For that reason, we decided to increase the calculated minimum sample by 20% to account for potential none respondents [20]. The study target became 415 participants of whom we successful collected data for 400 participants.

Data collection tools and procedures

Participants were informed about the study and recruited at the two sites of the clinic as they attended for care on the recruitment day. All PLWHA and HIV uninfected participants at the HIV clinic of CHUK were outpatients. The first site of recruitment was at the Voluntary HIV Counselling and Testing (VCT) and it was for the recruitment of HIV uninfected adults. The second site was next to the physicians' rooms, and it was for recruiting eligible PLWHA at HIV clinic of CHUK. We worked hand in hand with physicians and practitioners who provided HIV results to the patients. To get HIV uninfected persons, respondents were first given their HIV status results by the nurse. After providing the results, the nurse informed people whose HIV results were negative about the ongoing research. HIV uninfected adults who showed interest to participate in the study, were sent to a data collection room to get informed consent. To recruit PLWHA, physicians/ nurses also first informed them about the ongoing study. PLWHA who showed interest to participate in the study were sent to the researchers'-room for consent signature before starting data collection.

Consecutive sampling method was used to select study participants. For data related to HIV infection (CD4 cell count, viral load, WHO staging, anti-retroviral treatment information), we used data extraction sheet to record the information needed from electronic medical record at HIV clinic. All consenting participants were examined for caries. The Clinical oral examination was performed by a calibrated experienced dental professional working at the University of Rwanda using the WHO (DMFT) index. Participants were seated in a semi-supine position and examined under natural light.

Statistical analysis

Descriptive statistics including frequencies, percentages and means scores of oral diseases (DMFT mean cores) were computed. The Chi-square test was used to test the relationships between the presence of caries and categorical variables. A t-test was used for data associations between continuous variables. Binary logistic regression tests were done to determine the relationship of dental caries (dichotomous outcome) with various factors. A separate analysis was done with HIV related factors (CD4 counts, RNA viral load, type and duration on HIV treatment, WHO staging) as independent variables and adjusted for the sociodemographic, nutritional, and behavioral variables. Stata version 15 was used for the regression analysis. Kappa score statistical analysis was used to evaluate the intra-examiner reliability during examiner calibration and the kappa score value found was 0.74. The level of significance was set at 5%.

Ethical consideration

The ethical clearances to conduct the study were received from Human Research Ethics Committee (No M200351) from the University of Witwatersrand, Institutional Review Board (No 573/CMHSIRB/2019) from University of Rwanda and Research ethics committee of Kigali Teaching Hospital (No EC/CHUK/026/2020). The informed written consents were given to all participants before data correction. To obtain informed consent, we first provided adequate information to participants through information sheet that explained in detail the nature and processes involved in the study, the reason for the study, and the intended outcomes. We gave participants opportunity to ask questions and we responded to each question. We ensured participants comprehended the provided information. Then, participants who agreed to participate in our study voluntarily signed the consent form. The confidentiality of patients was observed by using an anonymous questionnaire.

Results

Demographic characteristics

The demographic characteristics of People Living with HIV/AIDS (PLWHA) and HIV uninfected adults are presented in Table 1. The results revealed a statistically significant difference in age group among PLWHA compared to HIV uninfected individuals ($p = <0.001$). The mean age was significantly higher in PLWHA (43.51, 95%CI:41.51–45.51) than the mean age in HIV uninfected persons (36.53, (95% CI: 34.72–38.33) ($p<0.001$). Also, the majority of PLWHA were living in urban areas (81.5%) ($n = 163$) compared to HIV uninfected adults (63%) ($p<0.001$). More PLWHA completed primary (40%) and secondary school (34%) compared to HIV uninfected individuals who completed primary (37%) and secondary school level (25%) ($p = 0.020$). In addition, significantly ($p = 0.024$) more PLWHA were unemployed (32%) compared to unmployed HIV uninfected persons (22%). The prevalence of PLWHA in ubudehe (socio-economic status) category 3 and 4 was significantly higher (67.5%) compared to the prevalence of HIV uninfected respondents in ubudehe category 3 and 4 (51,5%) ($p = 0.005$).

Comparison of dental caries among participants according to HIV infection status

The results in Table 2 show that PLWHA experienced significantly more caries than HIV uninfected individuals [(Decay (D) 47 (23.5%) vs. 27 (13.6%)]; $p< 0.01$]. The mean (SD) DMFT scores for PLWHA and HIV uninfected persons were 2.28 (3.68) and 1.29 (2.21) respectively, ($p = 0.001$).

Table 1. Comparison of Socio demographic characteristics of participants.

Social demographic characteristics	PLWHA n(%); n = 200	HIV uninfected n(%); n = 200	P value
Age			**<0.001***
18–24	30(15)	39(19.5)	
25–35	31(15.5)	77(38.5)	
36–45	34(17.0)	39(19.5)	
46–55	57(28.5)	23(11.5)	
56+	54(24.0)	21(12.0)	
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)*			
Category1	18(9.0)	24(12.0)	**0.005**
Category2	47(23.5)	73(36.5)	
Category3 and 4	135(67.5)	103(51.5)	

*Category 1: (Families who do not own a house and can hardly afford basic needs); Category 2: (Those who have a dwelling of their own or can rent one but rarely get one; Category 3: Those who have a job and farmers and go beyond subsistence farming to produce a surplus which can be sold. Also include those with small and medium enterprises who can employ dozens of people; Category 4: Those who own large-scale business, individuals working with international organizations and industries as well as public servants.

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Comparison of factors associated with dental caries among PLWHA and HIV uninfected adults

The results in Table 3 showed that females living with HIV/AIDS were 2.33 times more likely than males living with HIV/AIDS to have dental caries (95% CI = 1.142–4.252). Although not significant, HIV uninfected females were also 1.37 times more likely than HIV uninfected males to have dental caries 1.37 (95%CI = 0.680–2.774).

Amongst HIV uninfected adults, participants aged 36–45 years were 6.61 times more likely than the younger age group (18–14) to develop dental caries (95% CI = 2.146–20.370), the result was statistically significant (p = 0.001). The remaining age categories were not statistically significant.

HIV uninfected respondents who have visited a dentist within less than 6 months to 1-year period were 3.24 times more likely to have dental caries (95%CI = 1.34–8.76) compared to

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4979

Table 2. Distribution of dental caries according to HIV infection status.

Variable	PLWHA (n = 200)		HIV uninfected (n = 200)		P-value
	n(%)Yes	n(%) No	Yes N(%)	n(%) No	**0.011***
D	47(23.5)	153(76.5)	**27(13.6)**	172(86.4)	
M	80(40)	120(60)	69(34.5)	131(65.5)	0.255
F	23(11.6)	176(88.4)	14(7)	186(93)	0.117
DMFT	101(50.5)	99(49.5)	81(40.5)	119(59.5)	**0.045***
	Mean	**SD**	**Mean**	**SD**	**P value**
D	0.57	1.42	0.17	0.47	**<0.001***
M	1.36	2.78	**0.96**	1.84	0.091
F	0.37	1.31	**0.17**	0.78	0.069
DMFT	2.28	3.68	1.29	2.21	**0.001***

https://doi.org/10.1371/journal.pone.0276245.t002

HIV uninfectedadults who never visited dentists. The difference was statistically significant. Participants who visited dentists within 5 years were approximately twice more likely to have dental caries (95%CI = 0.75–5.76) than the research participants who never received dental care. Those who visited dentist after 5 years were 1.30 times less likely to have dental caries (95% CI = 0.329–1.805) than those who never visited a dentist.

Multiple binary logistic regression analysis of HIV related factors associated with dental caries among PLWHA

After adjusting for all factors not related to HIV infection (gender, age, residence, education, occupation, ubudehe (income status), dental visit, frequency of eating fruits, frequency of drinking tea with sugar and alcohol consumption), the results in Table 4 revealed that PLWHA with detectable RNA-Viral Load (≥20) were 2.69 times more likely (95% CI = 1.004–7.208) to have dental caries than participants with undetectable RNA-Viral Load and the results were statically significant (p = 0.049).

Discussion

The findings of this study revealed a significantly higher prevalence of dental caries in People Living with HIV/AIDS (PLWHA) compared to HIV uninfected individuals. Amongst PLWHA, cohort females, frequent dental visits, and detectable RNA-viral load were significantly associated with dental caries. In HIV uninfected participants, caries prevalence was associated with frequent dental visits and the age range of 36–45. The findings of this study are in line with growing evidence of a higher prevalence and risk of dental caries among PLWHA compared to the general population [5,21,22].

The higher prevalence of caries in PLWHA than in HIV uninfected individuals is similar to results by other scholars in developed and developing countries [2,5–7]. Untreated dental caries or decay (D) was also more prevalent in PLWHA 47(23.5%) than in HIV uninfected individuals 27(13.6%). This may be explained by the unavailability of oral health education and inaccessibility to dental care at HIV clinics. In addition, the lack of knowledge on oral health or low priority given to effect of oral conditions on the general health in Rwanda's HIV clinics can explain the higher prevalence of untreated dental caries among PLWHA. This is because, without knowledge, practitioners at HIV clinics cannot motivate or timely refer PLWHA to look for oral health services. Moreover, the shortage of oral health personnel, the lack of adequate dental infrastructures and unavailability of caries preventive programs for throughout

Table 3. +Comparison of factors associated with dental caries among participants according to HIV status.

Variables	Subgroups	PLWHA OR (95% CI)	P value	HIV uninfected OR (95% CI)	P value
Gender	male	1		1	
	Female	2.33(1.142–4.752)	**0.020**	1.37(0.680–2.774)	0.375
Age (years)	18–24	1		1	
	25–35	0.62(0.184–2.051)	0.429	1.52(0.575–3.995)	0.400
	36–45	0.50(0.160–1.577)	0.239	6.61(2.146–20.370)	**0.001***
	46–55	0.74(0.261–2.068)	0.561	3.48(0.953–12.689)	0.059
	56+	2.04(0.650–6.412)	0.221	2.66 (0.698–10.120)	0.152
Residence	Rural	1		1	
	Urban	0.95(0.239–3.787)	0.944	1.39(0.577–3.341)	0.463
	Peri-urban	1.18(0.230–6.060)	0.840	1.03(0.324–3.287)	0.955
Education					
	Tertiary	1		1	
	No or less than primary school	0.93(0.244–3.557)	0.919	1.92(0.575–6.415)	0.288
	Primary school completed	0.92(0.329–2.581)	0.877	0.93(0.294–2.951)	0.905
	Secondary school	1.41(0.500–4.005)	0.513	1.30(0.388–4.376)	0.667
Occupation	Not employed	1		1	
	Employed	0.98(0.478–2.007)	0.957	2.12(0.860–5.220)	0.102
Ubudehe	Category1	1		1	
	Category 2	0.69(0.300–1.596)	0.389	1.12(0.367–3.419)	0.841
	Category 3 and 4	0.92(0.285–2.994	0.896	1.07(0.357–3.189)	0.907
Dental visit	Never received dental care	1		1	
	less than 6 months to 1 year	4.50(1.460–13.865)	**0.009***	3.42(1.337–8.760)	**0.010***
	more than 1 year but less than 5 years	4.58(1.901–11.010)	**0.001***	2.08(0.754–5.761)	0.157
	5 years and more	1.53(0.694–3.358)	0.292	0.77(0.329–1.805)	0.550
Frequency of eating fruits	several times a day or every day	1		1	
	several times a week or once a week	0.59(0.239–1.466)	0.258	1.24(0.455–3.398)	0.669
	several times a month or seldom/never	0.73(0.265–2.015)	0.546	1.59(0.518–4.880)	0.417
Frequency of drinking tea with sugar	several times a month or seldom/never	1		1	
	several times a day or every day	2.02(0.891–4.590)	0.092	1.85(0.770–4.344)	0.169
	several times a week or once a week	2.37(0.889–6.290)	0.084	1.01(0.360–2.834)	0.984
Alcohol consumption	No	1		1	
	Yes	1.59(0.748–3.393)	0.227	1.63(0.785–3.373)	0.190
Fitting test result		X		XX	

+The indicator of dental caries that we used in comparison with factors associated with dental caries was prevalence.

X Pseudo R2 = 0.131.

XX pseudo R2 = 0.141.

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HIV clinics in the country can be associated with a higher prevalence of untreated dental caries among PLWHA.

Although Rwanda has shown remarkable improvement in HIV services and PLWHA can easily access ARVs, counseling services, regular checkups for non-communicable and other infectious diseases [23], no oral health services available at these specialized sevices. In addition, there are no regular prevention services, no program to raise awareness about dental caries and to inform PLWHA about dental caries risks and effect in existing HIV services or at the community level. This may contribute to a higher prevalence of dental caries among

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Table 4. √Logistic regression analysis of HIV related factors associated with dental caries among PLWHA.

Variable	Subgroups	OR (95% CI)	P value
CD4	Group I (≥ 500)	1	
	Group II (200–499)	0.904(0.440–1.856)	0.784
	Group III (<200)	2.150(0.572–8.075)	0.257
RNA-Viral Load	Undetectable	1	
	Detectable	2.691(1.004–7.208)	**0.049***
WHO staging	Stage I	1	
	Stage II To IV	2.130(0.658–6.895)	0.207
Types of ART	classII and III	1	
	Class I	1.707(0.703–4.143)	0.237
Duration on ARVs	11–15 years	1	
	1–5 years	1.089(0.313–3.788)	0.893
	6–10 years	0.988(0.436–2.237)	0.978
Duration of HIV-infection	1–8 years	1	
	9–16 years	0.566(0.1552.059)	0.388
	17+ years	1.176(0.281–4.909)	0.824
Fitting test result		•	

√Adjusted for gender, age, residence, education, occupation, ubudehe (SES), dental visit, frequency of eating fruits, frequency of drinking tea with sugar and alcohol consumption.

• pseudo R2 = 0.174.

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PLWHA than HIV uninfected persons. In their research, Feng and colleagues emphasized that oral health programs that target PLWHA should consider affordable dental care, a stigma-free setting, care delivered safely, and an accessible locations [24]. Thus, the need for an oral health program that can benefit PLWHA in Rwanda.

In contrast to the present study, in a research by Malele-Kolisa and colleagues, in South Africa, younger adolescents living with HIV had reported lower caries prevalence (D) than those of undiagnosed schools children [25]. This may be explained by contextual factors where there were oral health strategies and programs that targeted HIV infected adolescents and allowed them to have timely access to regular oral health education and preventive services in South Africa.

The Rwandan first National oral health strategic plan has highlighted barriers that may be associated with the burden of oral diseases in the country. The major part of oral health services is provided in District and referral hospitals. Very few primary health posts and centers can provide dental services. Many private dental clinics are mostly located in the City of Kigali and some other secondary cities. Primary oral health service is only provided in the form of analgesics for pain release in health posts and health centers and all patients are referred to hospitals for oral health care [26].

Since oral healthcare is provided in hospitals, it is not easy for the majority of Rwandans (who normally access primary health care at health posts and health centers level) to access oral health care due to the long distance to the hospitals. These issues result in the abandonment of oral health care for many patients. In addition, there is an overload of patients in hospitals with a shortage of oral health providers [26].

Moreover, in Rwanda District hospitals, there is a shortage of infrastructure including the lack of adequate space and functional dental equipment such as dental chairs to provide oral health services [26]. Apart from the recent and very first National strategic plan, there is no specific policy or plan that is specifically dedicated to oral health in Rwanda. Oral health is

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integrated into different policy and regulatory documents related to None Communicable Diseases (NCDs) and there is no focal person in charge of oral health at the Ministry of health level to ensure the coordination and address issues related to oral health care in the country [26]. All those problems related to oral health services in Rwanda are not exceptional to PLWHA and since this group is more exposed to oral health problems including dental caries, it is very important to develop oral health interventions specific to PLWHA in Rwanda.

The results of our study also revealed a significant association between detectable HIV RNA-viral load and caries among PLWHA after adjusting for the other factors not related to HIV-infection. Similar to the results of our study, different researchers have also found an association between HIV RNA-viral load with dental caries [11,25,27,28]. These findings may suggest that dental caries can affect the immunity of PLWHA. However, based on the design of our study, it is not possible to determine the causal relationship between dental caries and higher RNA viral load among PLWHA. Thus, further studies are needed to give more clarifications on the mechanism of this relationship. On the other hand, PLWHA with immune suppression are reported to experience a reduction of saliva flow (xerostomia) [5]. The decreased saliva flaw contributes to easy development of dental caries due to lack saliva buffering capacity that controls the PH of mouth environment [29]. Based on the relationship of RNA viral load and dental caries, there is a need for oral health strategies to provide oral health education and early preventive dental services among PLWHA in Rwanda.

In our study, dental caries was significantly associated with being a female among PLWHA. These findings are similar to recent results of a study done in Uganda by Kalanzi and colleagues where HIV infected females had a higher prevalence of dental caries than HIV infected males [30]. Although not significant, HIV uninfected females were also more affected by dental caries than HIV uninfected males. The literature highlights different factors that expose women to dental caries than males in the general population. Women's family role has been shown as one of the factors for the higher prevalence of dental caries compared to males. Commonly, women have been family member with the responsibility for food preparation. This allows them to have access to foods and snacks between meals more frequently than males, which increases their chance of caries development compared to men [31,32]. For that reason, there is a need to develop vivacious oral health strategies that will target women in particular, especially in high-risk groups such as PLWHA.

Based on their exposure, women, especially those living with HIV/AIDS have to be given greater attention when planning preventive and oral health education interventions to decrease the risk of dental caries among this group. To increase the number of women who access dental services, previous interventions have considered home visits and oral health programs to provide oral education, and preventive oral health services [33]. Therefore, to increase accessibility to preventive oral health care among women living with HIV/AIDAS, there is a need for contextual oral health models among this population in Rwanda.

The results of our study revealed that a higher prevalence of PLWHA and HIV uninfected adults who frequently visited dentists experienced more caries compared to participants who less frequently visited dentists. Consistent results were reported in the literature [34,35]. As highlighted by other researchers, the DMFT index takes into account the past treatment history. Therefore, the DMFT index is affected by extracted teeth (M) and the fillings done due to dental caries (F). In our study, the M (Missing teeth due to caries) was the most prevalent component of DMFT in the group of PLWHA and HIV uninfected people. Having a higher prevalence of people with M component (extracted teeth) along with higher untreated caries among participants who frequently visited dentists suggests that participants in our study mostly received treatment for advanced dental caries leaving out caries that could be saved. This may suggest sub-optimal dental treatment in areas where our study participants visited dentists.

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The sub-optimal dental care may be associated with a lack of conservative dental services in those areas or an overload of practitioners due to a shortage of dental personnel and lack of adequate infrastructure as highlighted in the recent first National oral health strategic plan in Rwanda [26]. Thus, there is a need to do further study to better understand factors associated with caries among participants who frequently visited dentists in Rwanda. To minimize the risk of progression of caries, there is a need to raise awareness and enforce caries risk assessment strategies for every dental patient in Rwanda especially among PLWHA.

Amongst HIV uninfected adults, middle age (36–45 years) was significantly associated with dental caries experience. A study from four countries (England and Wales, the United States, Japan, and Sweden) revealed a larger increase in DMFT in adulthood compared to the young group [36]. A recent study done in Ethiopia has also highlighted that age increase is significantly associated with caries experience [37]. However, some researchers had reported contrasting results where young age was associated with increased dental caries compared to adulthood [38]. These findings may be explained by various factors accross different community. For example, in many of developing countries, factors such as increase of sugary diet in young people, inavailability of preventive services, lack of awareness on how to do good oral hygiene and high cost of dental treatments expose young adults to caries than adults [37].

Strength of the study

In Rwanda, this is the first study to look at the prevalence of dental caries and associated risk factors among PLWHA in comparison to HIV uninfected individuals. It is also among the few studies that compared PLWHA and HIV uninfected adults in regards to caries and its associated risk factors in Sub-saharan Africa.

Limitations

The results of the study may not be generalizable to the general population of Rwanda because the study was done in an urban HIV clinic in Kigali city which could not represent the whole country. In addition, a cross-sectional study design makes it difficult to establish causality. Large longitudinal studies are needed to better understand the nature of the associations between caries and various risk factors. Our study was a comparative cross-sectional study that did not consider matching factors among two group of PLWHA and HIV uninfected participants. Although we adjusted for factors that were significantly different among the two group, we highly recommend further studies that will match key factors among the two groups to certainly compare PLWHA and HIV uninfected adults.

Conclusion

After adjusting for key factors that were differenciating PLWHA and HIV uninfected participants, the prevalence of dental caries remained higher in PLWHA than in HIV uninfected participants. The reported higher prevalence of caries in PLWHA was associated with being female, detectable viral load, and frequent dental visits. Therefore, there is a need for effective oral health interventions specific to PLWHA in Rwanda to raise awareness of the risk of dental caries and provide preventive oral health services among Rwandan population especially PLWHA. To ensure timely oral health care among PLWHA, there is a need for effort from policymakers and stakeholders to integrate oral health care services within HIV treatment programs in Rwanda. Also, we recommend further studies that will consider the matching of key factors among PLWHA and HIV uninfected persons to ascertain the difference in dental caries among the two groups. Furthermore, there is a need to do further prospective studies that can

analyze in depth the strength of the association of caries with different factors among PLWHA in comparison to HIV uninfected individuals.

Supporting information

S1 Table. Description of participants' behaviors factors.
(PDF)

S2 Table. Description of other underlying conditions reported by participants.
(PDF)

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References

1. Sabbah W, Folayan MO, El Tantawi M. The Link between Oral and General Health. Int J Dent [Internet]. 2019 May 29; 2019:1–2. Available from: https://www.hindawi.com/journals/ijd/2019/7862923/. https://doi.org/10.1155/2019/7862923 PMID: 31275387
2. Birungi N, Fadnes LT, Marie I, Stadskleiv E, Tumwine JK, Lie SA, et al. Caries experience by socio-behavioural characteristics in HIV-1-infected and uninfected Ugandan mothers–a multilevel analysis.

Acta Odontol Scand [Internet]. 2022; 80(2):91–8. Available from: https://doi.org/10.1080/00016357.2021.1942544 PMID: 34176405

3. Tsuneishi M, Yamamoto T, Yamaguchi T, Kodama T, Sato T. Association between number of teeth and Alzheimer's disease using the National Database of Health Insurance Claims and Specific Health Checkups of Japan. Mogi M, editor. PLoS One [Internet]. 2021 Apr 30; 16(4):e0251056. Available from: https://doi.org/10.1371/journal.pone.0251056 PMID: 33930067
4. Sabharwal A, Stellrecht E, Scannapieco FA. Associations between dental caries and systemic diseases: a scoping review. BMC Oral Health [Internet]. 2021 Dec 25; 21(1):472. Available from: https://doi.org/10.1186/s12903-021-01803-w PMID: 34563194
5. Palupi R, Sosiawan A, Gilang R, Ramadhani A. Factors Influencing Dental Caries in HIV / AIDS Patients. Acta Med Philipp. 2019; 53(5):412–6.
6. Kumar S, Mishra P, Warhekar S, Airen B, Jain D, Godha S. Oral Health Status and Oromucosal Lesions in Patients Living with HIV/AIDS in India: A Comparative Study. AIDS Res Treat [Internet]. 2014; 2014:480247. Available from: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=25215229. https://doi.org/10.1155/2014/480247 PMID: 25215229
7. Cavasin Filho JC, Giovani EM. Xerostomy, dental caries and periodontal disease in HIV+ patients. Braz J Infect Dis [Internet]. 2009; 13:13–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19578624. https://doi.org/10.1590/s1413-86702009000100005 PMID: 19578624
8. WHO. THE GLOBAL HEALTH OBSERVATORY. 2021.
9. WHO. Global HIV Epidemic. 2020.
10. Ministry of Health. NATIONAL HIV/AIDS TARGETS 2018-2020-2030. 2015;1–29.
11. Kikuchi K, Yasuoka J, Tuot S, Okawa S, Yem S, Chhoun P, et al. Dental caries in association with viral load in children living with HIV in Phnom Penh, Cambodia: a cross - sectional study. BMC Oral Health. 2021; 159(21):1–8. https://doi.org/10.1186/s12903-021-01441-2 PMID: 33765997
12. Weiss RA. Special Anniversary Review: Twenty-five years of human immunodeficiency virus research: successes and challenges. Br Soc Immunol Clin Exp Immunol. 2008; 152:201–10. https://doi.org/10.1111/j.1365-2249.2008.03645.x PMID: 18373700
13. Nicolatou-Galitis O, Velegraki A, Paikos S, Economopoulou P, Stefaniotis T, Papanikolaou IS. HIV Disease / Oral Medicine Effect of PI-HAART on the prevalence of oral lesions in HIV-1 infected patients. A Greek study. Oral Dis. 2004; 10(July 2003):145–50.
14. Adedigba MA, Adekanmbi T, Asa S. Pattern of Utilisation of Dental Health Care Among HIV-positive Adult Nigerians. 2016; 14(3):215–25.
15. Brondani MA, Phillips JC, Kerston RP, Moniri NR. Stigma Around Hiv in Dental Care: Patients' Experiences. J Can Dent Assoc (Tor) [Internet]. 2016;(December):g1–g1. Available from: http://search.ebscohost.com/login.aspx?direct=true&db=ccm&AN=113676385&site=ehost-live. PMID: 27548661
16. Yengopal V, Naidoo S. Do oral lesions associated with HIV affect quality of life? Oral Surgery, Oral Med Oral Pathol Oral Radiol Endodontology. 2008; 106(1):298–309. https://doi.org/10.1016/j.tripleo.2007.12.024 PMID: 18417383
17. Dios PD, Scully C. Antiretroviral therapy: effects on orofacial health and health care. Oral Dis. 2014; 20 (January 2013):136–45.
18. Morgan JP, Isyagi M, Ntaganira J, Gatarayiha A, E.Pagni S, Roomian TC, et al. Building oral health research infrastructure: the first national oral health survey of Rwanda. Glob Health Action [Internet]. 2018; 11(1):298–309. Available from: https://doi.org/10.1080/16549716.2018.1477249 PMID: 29860930
19. Ashagrie M. Which formula to use to calculate the sample size for a cross sectional comparative study? 2020.
20. Ntampaka P, Nyaga PN, Niragire F, Gathumbi JK, Tukei M. Knowledge, attitudes and practices regarding rabies and its control among dog owners in Kigali city, Rwanda. Arez AP, editor. PLoS One [Internet]. 2019 Aug 20; 14(8):e0210044. Available from: https://doi.org/10.1371/journal.pone.0210044 PMID: 31430285
21. Nugraha AP, Mensana MP, Soebadi B, Husada D, Astha E, Prasetyo RA, et al. Correlation of Low CD4 + Counts with High Dental Caries Prevalence in Children Living with Perinatal HIV / AIDS Undergoing Antiretroviral Therapy. 2019;1–7.
22. Rajonson N, Meless D, Ba B, Faye M, Diby JS, N'zore S, et al. High prevalence of dental caries among HIV-infected children in West Africa compared to uninfected siblings. J Public Health Dent. 2017; 77 (3):234–43. https://doi.org/10.1111/jphd.12203 PMID: 28233316
23. Nsanzimana S, Kanters S, Remera E, Forrest JI, Binagwaho A, Condo J, et al. HIV care continuum in Rwanda: A cross-sectional analysis of the national programme. Lancet HIV [Internet]. 2015; 2(5):e208–15. Available from: https://doi.org/10.1016/S2352-3018(15)00024-7 PMID: 26423003

24. Feng I, Brondani M, Bedos C, Donnelly L. Access to oral health care for people living with HIV / AIDS attending a community-based program. Can J Dent Hyg. 2020; 54(1):7–15. PMID: 33240359

25. Kolisa YM, Yengopal V, Shumba K, Igumbor J. The burden of oral conditions among adolescents living with HIV at a clinic in Johannesburg, South Africa. PLoS One. 2019; 14(10):1–14.

26. MinistryofHealth. National Oral Health trategic Plan 2019–2024. 2019.

27. Souza AJ de, Gomes-Filho IS, Silva CAL da, Passos-Soares J de S, Cruz SS da, Trindade SC, et al. Factors associated with dental caries, periodontitis and intra-oral lesions in individuals with HIV / AIDS*. AIDS Care—Psychol Socio-Medical Asp AIDS/HIV. 2017; 0121:1–8. https://doi.org/10.1080/09540121.2017.1400640 PMID: 29124950

28. Chen F, Cheng Y, Xie T. Oral Health Status of Young People Infected with HIV in High Epidemic Area of China. J Multidiscip Healthc ©. 2021; 14:831–7. https://doi.org/10.2147/JMDH.S301236 PMID: 33907411

29. Malekipour MR, Messripour M, Shirani F. Buffering capacity of saliva in patients with active dental caries. Asian J Biochem. 2008; 3(5):280–3.

30. Kalanzi D, Mayanja-kizza H, Nakanjako D, Mwesigwa CL, Ssenyonga R, Amaechi BT. Prevalence and factors associated with dental caries in patients attending an HIV care clinic in Uganda: a cross sectional study. 2019;1–8. https://doi.org/10.1186/s12903-019-0847-9 PMID: 31324242

31. Ferraro M, Vieira AR. Explaining Gender Differences in Caries: A Multifactorial Approach to a Multifactorial Disease. 2 Int J Dent. 2010;1–5. https://doi.org/10.1155/2010/649643 PMID: 20339488

32. Kessler JL. A Literature Review on Women's Oral Health Across the Life Span. Nurs Womens Health. 2017; 21(2):108–21. https://doi.org/10.1016/j.nwh.2017.02.010 PMID: 28388996

33. Lam SC, Traylor DO, Anderson EE. Primary Care Recommendations for Oral Health Care in HIV + Patients [Internet]. 2014. Available from: https://www.centerfororalhealth.org/wp-content/uploads/2018/11/Oral-Health-Policy-HIV-2014-6-27-14.pdf.

34. Costa SM, Vasconcelos M, Haddad JPA, Henrique M, Abreu NG. The severity of dental caries in adults aged 35 to 44 years residing in the metropolitan area of a large city in Brazil: a cross-sectional study. BMC Oral Health. 2012; 12(25). https://doi.org/10.1186/1472-6831-12-25 PMID: 22849537

35. Varenne B, Paris F, Petersen PE, Geneva S, Ouattara S. Oral health behaviour of children and adults in urban and rural areas of Burkina Faso, Africa. Int Dent J. 2006; 56(2):61–70. https://doi.org/10.1111/j.1875-595x.2006.tb00075.x PMID: 16620033

36. Bernabé E, Sheiham A. Age, Period and Cohort Trends in Caries of Permanent Teeth in Four Developed Countries. Am J Public Health [Internet]. 2014 Jul; 104(7):e115–21. Available from: https://ajph.aphapublications.org/doi/full/10.2105/AJPH.2014.301869. PMID: 24832427

37. Bogale B, Engida F, Hanlon C, Prince MJ, Gallagher JE. Dental caries experience and associated factors in adults: a cross-sectional community survey within Ethiopia. BMC Public Health [Internet]. 2021 Dec 21; 21(1):180. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-021-10199-9, https://doi.org/10.1186/s12889-021-10199-9 PMID: 33478460

38. Oscarson N, Espelid I, Jönsson B. Is caries equally distributed in adults? A population-based cross-sectional study in Norway–the TOHNN-study. Acta Odontol Scand [Internet]. 2017 Nov 17; 75(8):557–63. Available from: https://doi.org/10.1080/00016357.2017.1357080 PMID: 28754061

Appendix 10: Original published paper 2

Article

PAMJ Clinical Medicine

Research

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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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

References

1. Brondani MA, Phillips JC, Kerston RP, Moniri NR. Stigma Around Hiv in Dental Care: Patients´ Experiences. J Can Dent Assoc. 2016 Feb;82: g1. **PubMed| Google Scholar**
2. Fricke U, Geurtsen W, Staufenbiel I, Rahman A. Periodontal status of HIV-infected patients undergoing antiretroviral therapy compared to HIV-therapy naive patients: a case control study. Eur J Med Res. 2012 Jan 30;17(1): 2. **PubMed| Google Scholar**

3. Kinane DF, Stathopoulou PG, Papapanou PN. Periodontal diseases. Nat Rev Dis Primers. 2017 Jun 22;3: 17038. **PubMed| Google Scholar**
4. Shahoumi LA, Saleh MHA, Meghil MM. Virulence Factors of the Periodontal Pathogens: Tools to Evade the Host Immune Response and Promote Carcinogenesis. Microorganisms. 2023 Jan 1;11(1): 115. **PubMed| Google Scholar**
5. Fokam J, Geh BKN, Sosso SM, Takou D, Ngufack ES, Nka AD *et al*. Determinants of periodontitis according to the immunological and virological profiles of HIV-infected patients in Yaoundé, Cameroon. BMC Oral Health. 2020 Dec 11;20(1): 359. **PubMed| Google Scholar**
6. Ryder MI, Nittayananta W, Coogan M, Greenspan D, Greenspan JS. Periodontal disease in HIV/AIDS. Periodontol 2000. 2012 Oct;60(1): 78-97. **PubMed| Google Scholar**
7. Morgan JP, Isyagi M, Ntaganira J, Gatarayiha A, Pagni SE, Roomian TC *et al*. Building oral health research infrastructure?: the first national oral health survey of Rwanda. Glob Health Action. 2018;11(1): 1477249. **PubMed| Google Scholar**
8. Noordzij M, Dekker FW, Zoccali C, et al. Sample Size Calculations. Nephron Clin Pract. 2011;118(4): c319-23. **PubMed| Google Scholar**
9. Karmakar S, Prakash S. Clinical Attachment Level: an Unsung Hero in Periodontal Diagnosis. Int J Adv Res. 2019;7: 106-111.
10. Umeizudike KA, Ayanbadejo PO, Savage KO, Nwhator SO, Akanmu AS, Ogunleye O. Comparative periodontal status of human immunodeficiency virus-positive patients and controls in a dedicated human immunodeficiency virus clinic in Nigeria. Niger J Clin Pract. 2016 Jan-Feb;19(1): 35-40. **PubMed| Google Scholar**
11. Berniyanti T, Setijanto RD, Hariani N, Romadhoni SF. Relationship Between HIV/AIDS and Periodontal Health Status among Population at High Risk of HIV/AIDS. Acta Medica Phillipina. 2019;53(5). **Google Scholar**
12. Lomelí-Martínez SM, González-Hernández LA, Ruiz-Anaya AJ, Lomelí-Martínez MA, Martínez-Salazar SY, Mercado González AE *et al*. Oral Manifestations Associated with HIV/AIDS Patients. Medecina. 2022 Sep 3;58(9): 1214. **PubMed| Google Scholar**
13. Sahbandar I, Terakubo J, Pattison RJ, Park EY, Oishi MK, Oishi MM *et al*. Anti-Periodontopathic Antibody Response in Chronic HIV Infection. J HIV AIDS. 2020;6: 1-5. **Google Scholar**
14. Rulisa S. Prevalence and Associated Risk Factors of Periodontal Disease among Adults Attending Dental Department in Rwanda Military Hospital (Rwanda): A Cross Sectional Study Prevalence and Associated Risk Factors of Periodontal Disease among Adults Attending Den. Open Dent J. 2015;2(4): 105-111. **Google Scholar**
15. Kaguru G, Ayah R, Mutave R, Mugambi C. Integrating Oral Health into Primary Health Care: A Systematic Review of Oral Health Training in Sub-Saharan Africa. J Multidiscip Healthc. 2022;15: 1361-1367. **PubMed| Google Scholar**
16. Abid A, Maatouk F, Berrezouga L, Azodo C, Uti O, El-Shamy H *et al*. Prevalence and Severity of Oral Diseases in the Africa and Middle East Region. Adv Dent Res. 2015 Jul;27(1): 10-7. **PubMed| Google Scholar**
17. Thorpe S. Oral health issues in the African region: current situation and future perspectives. J Dent Educ. 2006;70: 8-15. **Google Scholar**
18. Ministry of Health (MOH), Republic of Rwanda. National Oral Health Strategic Plan. MOH. 2019-2024. 2019.

19. Karuveettil V, Krishna K, Ramanarayanan V. Is gender a risk factor for oral diseases in India? A metadata exploration. Public Heal Toxicol. 2022;2(1): 7. **Google Scholar**
20. Ioannidou E. The sex and gender intersection in chronic periodontitis. Front Public Heal. 2017 Aug 4;5: 189. **PubMed| Google Scholar**
21. Lipsky MS, Su S, Crespo CJ, Hung M. Men and Oral Health: A Review of Sex and Gender Differences. Am J Mens Health. 2021 May-Jun;15(3): 15579883211016361. **PubMed| Google Scholar**
22. Rajeh MT. Gender Differences in Oral Health Knowledge and Practices Among Adults in Jeddah, Saudi Arabia. Clin Cosmet Investig Dent. 2022 Aug 4;14: 235-244. **PubMed| Google Scholar**
23. Al-Abdaly MMAA, AlQahtani HSH, Al-Qahtani SSH. The Impact of Age and Gender on Severity and Types of Periodontal Diseases among Patients from Two Regions in Saudi Arabia. Open J Stomatol. 2019;9(3): 39-53. **Google Scholar**
24. Tadjoedin FM, Fitri AH, Kuswandani SO, Sulijaya B, Soeroso Y. The correlation between age and periodontal diseases. J Int Dent Med Res. 2017;10(2): 327-332. **Google Scholar**
25. Clark D, Radaic A, Kapila Y. Cellular Mechanisms of Inflammaging and Periodontal Disease. Front Dent Med. 2022;3: 844865. **PubMed| Google Scholar**
26. Yamamoto T, Tanaka M, Kuribayashi N, Okuguchi F, Isotani H, Iwamoto M *et al.* Low education is associated with poor periodontal status in patients with type 2 diabetes mellitus: A cross?sectional study. Clin Exp Dent Res. 2021 Aug;7(4): 419-428. **PubMed| Google Scholar**
27. Srinarupat J, Oshiro A, Zaitsu T, Prasertsom P, Niyomsilp K, Kawaguchi Y *et al.* Inequalities in periodontal disease according to insurance schemes in Thailand. Int J Environ Res Public Health. Int J Environ Res Public Health. 2021 Jun 1;18(11): 5945. **PubMed| Google Scholar**
28. Maya RJC, Sánchez LN, Posada LA, Agudelo-Suárez AA, Enrique BJ. Periodontal disease and its relationship with clinical and sociodemographic variables in adult patients treated in a service/teaching institution. Rev Odont Mex 2017;21(3). **Google Scholar**
29. Boillot A, El Halabi B, Batty GD, Rangé H, Czernichow S, Bouchard P. Education as a Predictor of Chronic Periodontitis?: A Systematic Review with Meta-Analysis Population-Based Studies. PLoS One. 2011;6(7): e21508. **PubMed| Google Scholar**
30. Al-Sudani FY, Vehkalahti MM, Suominen AL. The association between current unemployment and clinically determined poor oral health. Community Dent Oral Epidemiol. 2015 Aug;43(4): 325-37. **PubMed| Google Scholar**
31. Quinn BC, Catalano RA, Felber E. The Effect of Community-Level Unemployment on Preventive Oral Health Care Utilization. Health Serv Res. 2009 Feb;44(1): 162-81. **PubMed| Google Scholar**

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%)	
Good	121(60.5%)	128(64%)	0.008*
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(%)	
CPITN=0 (Healthy periodontium)	27(13.50%)	9 (4.55%)	
CPITN=1 (Bleeding upon gentle probing)	2(1.00%)	4(2.02%)	0.022*
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%)	
Slight CAL	80(40%)	60(30%)	0.063
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 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

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					

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Oral health-related quality of life among people living with HIV and HIV-negative adults in Kigali, Rwanda: a comparative cross-sectional study

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Abstract

Background Assessing health-related quality of life has become integral to people living with HIV (PLHIV) follow-up. However, there is a lack of data regarding the impact of oral health on quality of life, known as Oral health-related quality of life (OHRQoL) among PLHIV compared to HIV-negative individuals in Rwanda.

Aim The study aimed to assess OHRQoL among PLHIV compared to HIV-negative counterparts in Kigali, Rwanda.

Methods The Oral Health Impact Profile short version (OHIP-14) questionnaire was interviewer-administered to 200 PLHIV and 200 HIV-negative adults (≥ 18 years old) at an HIV clinic of Kigali Teaching Hospital (CHUK). Socio-demographic characteristics, including age, sex, occupation, and socioeconomic status (SES) of participants, were collected using a survey questionnaire. A 4-point Likert scale was used to assess the frequency of oral impacts for all 14 items within 7 domains of the OHIP tool. The descriptive statistics were used to see frequencies and percentages of OHRQoL among PLHIV and HIV-negative persons, respectively. The Chi-square test was used to determine the association of OHRQoL with caries (DMFT) and periodontal disease (CPITN) among PLHIV compared to HIV-negative individuals.

Results The results revealed a higher prevalence of PLHIV with poor OHRQoL than HIV-negative individuals in 5 domains and almost all items of OHIP-14 except for the OHIP 3 (found it uncomfortable to eat any foods because of problems with teeth or mouth) and OHIP-14 (being totally unable to function because of problems with teeth or mouth). The findings showed statistically significant results ($p \leq 0.05$) for the OHIP1 item "trouble pronouncing any word," with a prevalence of 2.5% ($n = 11$) and 2.25% ($n = 9$) in PLHIV and HIV-negative, respectively. Also, PLHIV had a significantly higher prevalence, 2.75% ($n = 11$) for the OHIP 13 item "life not satisfying due to teeth and mouth problems compared to HIV-negative individuals 2% (8) $p \leq 0.05$. Moreover, dental caries was significantly associated with poor OHRQoL among PLHIV and HIV-negative adults and for all 14 items of the OHIP tool. Periodontal disease was not significantly associated with OHRQoL among PLHIV and HIV-negative adults.

Conclusion This study revealed poor OHRQoL among PLHIV compared to HIV-negative adults. There is a need for further longitudinal studies to investigate the OHRQoL in Rwanda, especially among PLHIV. It is essential to include oral health care as one of the components of the medical health care programs for PLHIV in Rwanda.

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Keywords HIV, Oral health-related quality of life, Oral health impact profile, Adult, Rwanda

Background

Human Immune Deficiency Virus (HIV) infections remain a global health crisis [1]. About 680,000 people died from AIDS-related causes in 2020 [2]. Although overshadowed by the more recent COVID-19 pandemic, almost 4000 new HIV infections are reported worldwide [3]. Among those, 60% of daily new HIV infections occur in Sub-Saharan Africa [3]. Recently, the 90–90-90 targets (by 2020, (1) 90% of all people living with HIV will know their HIV status; (2) 90% of all people diagnosed with HIV infection will receive sustained antiretroviral therapy; (3) 90% of all people receiving antiretroviral therapy will have viral suppression) have contributed to an increased number of HIV-infected individuals with suppressed viral load [3] and having an increased life expectancy [2]. As People Living with HIV (PLHIV) live longer, controlling other chronic diseases, such as oral diseases, that hinder their quality of life is paramount.

Good oral health is crucial to a better quality of life. The World Health Organization (WHO) distinguishes the Oral Health Related Quality of Life (OHRQoL) concept as essential to general and oral health [4]. Also, WHO recognizes oral health as a significant part of the Global Oral Health Program [4]. For years, the impact of oral diseases on quality of life was ignored, and more effort was put into evaluating oral diseases clinically [5]. However, oral conditions, mostly caries and periodontal disease, are reported as a highly prevalent group of pathologies globally [6], and have been shown to affect the ability to eat, speak, smile, and psychological status [4].

The literature defines OHRQoL as "a multidimensional construct that reflects people's comfort when eating, sleeping, and engaging in social interaction, their self-esteem, and their satisfaction concerning their oral health" [7, 8]. The definition of OHRQoL is mostly based on its constructs: functional factors (mastication, speaking); psychological factors (appearance, self-esteem); social factors (intimacy, communication) and experience of pain (acute or chronic) or discomfort [8].

Caries and periodontal diseases negatively affect patients' OHRQoL and well-being. Oral conditions affect OHRQoL through interference with daily activities such as chewing, swallowing, speaking, sleeping, choosing what to eat, schooling social interaction, and more [4]. Poor oral health negatively affects the quality of life generally [5], and especially among people with other chronic diseases such HIV-infection [9]. For example, pain and discomfort caused by dental caries and periodontal diseases an interfere with nutritional intake among PLHIV and, therefore, can affect their immunity and general well-being [10].

Assessing the health-related quality of life became integral to PLHIV follow-up [11]. However, there is a lack of data regarding the impact of oral health on quality of life among PLHIV compared to HIV-negative individuals in Rwanda. Elsewhere, studies have reported poorer OHRQoL especially among high risk group such as PLHIV [12].

Thus, this study aimed to assess Oral health related quality of life among PLHIV compared to HIV-negative adults in Kigali, Rwanda. The results from this study will provide much-needed data for stakeholders to contribute to improvement of oral health generally and for PLHIV in Rwanda. It may also guide other researchers in Rwanda to include an OHRQoL component in their future oral health research.

Methods

Study design and participants

This study used a comparative cross-sectional design comprising People living with HIV (PLHIV) and HIV-negative adults aged ≥18. Study participants were recruited from an HIV Clinic of Kigali Teaching Hospital (CHUK) from August 2020 to December 2021.

Study setting

The study was conducted at an HIV clinic in the University Teaching Hospital of Kigali (CHUK). CHUK is the largest tertiary national referral hospital located in Kigali City, Rwanda. It is also one of the biggest referral hospitals in the country. According to the records, around 3150 PLHIV were seen monthly for routine treatment and management of their condition. Also about 106 HIV-negative persons were received for HIV voluntary testing.

Recruitments process

A consecutive sampling method was used to select study participants. PLHIV were recruited next to the physicians' rooms after being informed about the ongoing study by the nurse or physician. The PLHIV signed the consent form before data collection process. HIV-negative adults were recruited in the room next to the Counselling and Testing site (VCT). HIV-negative participants were first given results by their physicians or nurses, and they were informed about the ongoing study. Only HIV-negative people who agreed to participate were guided

to data collectors to sign the consent before starting data collection.

Sample size

The sample for this study was delivered from a broader PhD study that sought to assess risk factors for caries and periodontal diseases among PLHIV and HIV-negative adults in Rwanda. The sample size calculation for the comparative cross-sectional study was done using Stata software version 15. Assuming a study power of 80%, considering that the prevalence of common oral diseases is 60% in PLHIV and 45% in HIV-negative individuals, and considering a ratio of 1 [13], the minimum study sample was estimated to be 346. Four hundred patients, 200 PLHIV and 200 HIV-negative adults, were recruited and agreed to participate in the study.

Data collection tools and procedure

To assess OHRQoL, oral health impact profile short version (OHIP-14) tool [14] was interviewer-administered to study participants in the language they could understand. The OHIP tool uses seven variable dimensions developed from an oral health model by Locker and consists of 49 questions subdivided into seven dimensions [14]. Slade and Spencer later developed the OHIP-14, a short version instrument to assess OHRQoL [14]. The OHIP-14 instrument is the most widely used and comprises seven domains (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap) and each dimension has 2 items [14].

We used 4-point Likert scale responses to assess the frequency of oral impacts during the previous 3 months for all domains. The coding for 4-point Likert was '0' for 'never,' '1' for 'hardly ever,' '2' for 'occasionally,' '3' for 'fairly often,' and '4' for 'very often. A 4-point Likert scale was used to assess the frequency of oral impacts during the previous 3 months for all domains.

To facilitate the interpretation of our results, participants' responses on the OHIP-14 questionnaire for "fairly often" (coded 3) and "very often" (coded 4) were combined to present high impact. "Occasionally" (coded 2) was counted on its own as neutral, while "hardly ever" (coded 1) and "never" (coded 0) were also added together to represent low impact. Higher impact indicates worse OHRQoL. The training of data collector on how to use OHIP-14 tool was provided before data collection.

Socio-demographic characteristics, including age, sex, occupation, and socioeconomic status (SES) of participants, were also collected using a survey questionnaire. In Rwanda context socio-economic status is already known because it is pre-determined by the government criteria and every Rwandese knows the category he or she belongs too. Those categories are defined as follow:

> *Category 1*: Families who do not own a house and can hardly afford basic needs.
> *Category 2* Those who have a dwelling of their own or are able to rent one but rarely get full time jobs.
> *Category 3*: Those who have a job and farmers and go beyond subsistence farming to produce a surplus which can be sold. Also include those with small and medium enterprises who can provide employment to dozens of people.
> *Category 4*: Those who own large-scale business, individuals working with international organizations and industries as well as public servants.

Age was stratified as 18–24; 25–34; 36–45; 46–55 and 56+. For easy of comparison, we based on existing literature to categorize participants' age [15]. Age was assessed through strata.

We also used two clinical indices: DMFT (Decayed, Missing, and filled) index following WHO guidance [16] and CPITN (Community Periodontal Index of Treatment Need) [17] to determine and compare the association of caries (DMF) and periodontal disease (CPITN) with OHRQoL among PLHIV and HIV-negative adults. Clinical data (DMF and CPITN) information were delivered from the broader PhD project that aimed to assess risk factors for caries and periodontal diseases among PLHIV and HIV-negative persons in Kigali, Rwanda.

DMFT and CPITN were categorized as yes or no. Yes, indicates participants who experienced dental caries /in need of periodontal treatment and no expressed those who did not experience dental caries/no need of periodontal treatment. The explanatory variables were age, sex, education, residence, socio-economic status (SES), caries experience, and periodontal disease (CPITN). The outcome variable was Oral health-related quality of life (OHRQoL).

Statistical analysis

The descriptive statistics were used determine frequencies and percentages of OHRQoL among study participants. The chi-square test was done to assess and compare the association between OHRQoL and participants' characteristics, caries (DMFT), and periodontal disease (CPITN). The Cronbach alpha test was performed to test the internal consistency of the OHIP-14 tool in Rwanda, and the alpha coefficient scored 0.914. Stata version 15 was used to analyze data.

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Results

Demographic characteristics of participants

According to results in Table 1, majority of people living with HIV (PLHIV) showed higher prevalence in older age categories of 46–55 [28,5% ($n=57$)] and 56+ [24% ($n=54$)] compared to HIV-negative participants in 46–55 [(11.5% ($n=23$)] and 56+ [12% ($n=21$)] age categories. In addition, 32% ($n=64$) of PLHIV were unemployed, whereas in the HIV-negative group this percentage was 22% ($n=44$) ($p=0.024$). Furthermore, the prevalence of PLHIV in socioeconomic status categories 3 and 4 (considered as having enough income) was significantly higher (67.5%) than the prevalence of HIV-negative respondents in the same socioeconomic status (51.5%) ($p=0.005$).

Comparison of OHIP frequency in PLHIV and HIV-negative adults

Based on the "high impact" category for all 14 items of OHIP, the results in Table 2 revealed a higher percentage of high impact among PLHIV than HIV-negative people in 5 domains (functional limitation, psychological discomfort, physical disability, psychological disability, social disability) and almost all items of OHIP-14 except for OHIP 3 (found it uncomfortable to eat any foods because of problems with teeth or mouth) and OHIP-14 (being totally unable to function because of problems with teeth or mouth) that were within the domain of physical pain and Handicap, respectively. The findings revealed statistically significant results ($p \leq 0.05$) for the OHIP1 item "trouble pronouncing any word," with a prevalence of 2.5% ($n=11$) and 2.25% ($n=9$) in PLHIV and HIV-negative persons, respectively. Also, considering the OHIP 13 item "life not satisfying due to teeth and mouth problems", the results showed a higher prevalence of impact among PLHIV (2.75%) when compared to HIV-negative individuals (2%). The difference was statistically significant $p \leq 0.05$.

Table 1 Demographic characteristics of participants

Social demographic characteristics	PLHIV n(%)	HIV-negative n(%)	*P* value
Age			**< 0.001***
18–24	30 (15)	39 (19.5)	
25–35	31 (15.5)	77 (38.5)	
36–45	34 (17.0)	39 (19.5)	
46–55	57 (28.5)	23 (11.5)	
56+	54 (24.0)	21 (12.0)	
Sex			
Male	88 (44.0)	89 (44.5)	0.920
Female	112 (56.0	111 (55.5)	
Occupation			
Unemployed	64 (32.0)	44 (22.0)	**0.024***
Employed	136 (68.0)	156 (78.0)	
Socio-economic status			
Category1	18 (9.0)	24 (12.0)	**0.005***
Category2	47 (23.5)	73 (36.5)	
Category3 and 4	135 (67.5)	103 (51.5)	

* Indicator of statistical significant results with a significance level of 0.05

Association of Oral Health-Related Quality of life (OHRQoL) with demographic characteristics among PLHIV adults in comparison to HIV-negative persons

Females living with HIV reported significantly higher OHIP-14 impact (25%) when compared to males (9.09%). Although not statistically significant, HIV-negative females (10.81%) reported a higher OHIP impact than HIV-negative males (8.99%) as shown in Table 3. In addition, PLHIV (17.99%) and HIV-negative participants (13.10%) in the older age group (36+ years) reported a slightly higher OHIP-14 impact compared to young aged (18–35 years) PLHIV (18.03%) and HIV-negative adults (7.76%). Moreover, employed PLHIV (21.88%) reported significantly higher OHIP-14 impact compared to unemployed PLHIV (16.18%) ($p=0,031$) as shown in Table 3.

Comparisons of OHIP-14 among PLHIV and HIV-negative adults according to dental caries (DMFT index)

Having experienced dental caries (DMFT>0) was significantly associated with poorer OHRQoL in all domains of OHIP-14 among PLHIV and HIV-negative adults (Table 4). None of the OHIP-14 items was significantly associated with CPITN as shown in Table 4.

Discussion

The results revealed poorer OHRQoL among PLHIV than HIV-negative people in almost all items of OHIP 14. Similar results were reported in the literature [18, 19]. HIV infection is known to have a detrimental effect on OHRQoL and this effect may be explained by the HIV infection role in higher prevalence of severe common oral diseases (mostly caries and periodontal disease), as reported by various researchers [20–22]. However, another study done in Uganda, reported no difference in OHRQoL among mothers living with HIV compared to HIV-negative counterparts [23]. This finding may be explained by the fact that pregnant women, regardless of their HIV status, are exposed to oral health problems because of pregnancy changes [24].

They also give less importance to oral health care, mainly because they fear the impact that dental services might have on pregnancy outcomes [18, 25].

Also, in PLHIV and HIV-negative adults, dental caries was significantly associated with poorer OHRQoL.

Table 2 Comparison of OHIP frequency among study participants according to HIV status

7 domain	Items of OHIP	Categories impact in terms of OHRQoL	HIV-negative n(%)	PLHIV n(%)	*p*-value
Functional limitation	OHIP1: Had trouble pronouncing any words	low impact	195 (48.75)	180 (45)	**0.008**
		neutral impact	3 (0.75)	11 (2.75)	
		high impact	2 (0.5)	9 (2.25)	
	OHIP2: Felt sense of taste has worsened	low impact	173 (43.25)	158 (39.5)	0.091
		neutral impact	16 (4)	20 (5)	
		high impact	11 (2.75)	22 (5.5)	
Physical pain	OHIP3: Had painful aching	low impact	99 (24.75)	91 (22.75)	0.559
		neutral impact	45 (11.25)	54 (13.5)	
		high impact	56 (14)	55 (13.75)	
	OHIP4: Find it uncomfortable to eat any foods	low impact	124 (31)	105 (26.25)	0.06
		neutral impact	41 (10.25)	41 (10.25)	
		high impact	35 (8.75)	54 (13.5)	
Psychological discomfort	OHIP5: Been self-conscious	low impact	143 (35.75)	122 (30.5)	0.082
		neutral impact	25 (6.25)	36 (9)	
		high impact	32 (8)	42 (10.5)	
	OHIP6: Felt tense	low impact	140 (35)	123 (30.75)	0.173
		neutral impact	27 (6.75)	31 (7.75)	
		high impact	33 (8.25)	46 (11.5)	
Physical disability	OHIP7: Felt diet has been unsatisfactory	low impact	138 (34.5)	131 (32.75)	0.619
		neutral impact	34 (8.5)	34 (8.5)	
		high impact	28 (7)	35 (8.75)	
	OHIP8: Had to interrupt meal	low impact	151 (37.75	136 (34)	0.173
		neutral impact	27 (6.75)	30 (7.5)	
		high impact	22 (5.5)	34 (8.5)	
Psychological disability	OHIP9: Found it difficult to relax	low impact	137 (34.25)	133 (33.25)	0.669
		neutral impact	36 (9)	34 (8.5)	
		high impact	27 (6.75)	33 (8.25)	
	OHIP10: Been a bit embarrassed	low impact	161 (40.25)	154 (38.5)	0.469
		neutral impact	19 (4.75)	18 (4.5)	
		high impact	20 (5)	28 (7)	
Socio disability	OHIP11: Been a bit irritable	low impact	168 (42)	164 (41)	0.139
		neutral impact	19 (4.75)	13 (3.25)	
		high impact	13 (3.25)	23 (5.75)	
	OHIP12: Had difficult doing usual jobs	low impact	163 (40.75)	155 (38.75)	0.216
		neutral impact	24 (6)	22 (5.5)	
		high impact	13 (3.25)	23 (5.75)	
Handicap	OHIP13: Felt life not satisfying	low impact	183 (45.75)	162 (40.5)	**0.005**
		neutral impact	9 (2.25)	27 (6.75)	
		high impact	8 (2)	11 (2.75)	
	OHIP14: Being totally unable to function	low impact	181 (45.25)	179 (44.75)	921
		neutral impact	12 (3)	14 (3.5)	
		high impact	7 (1.75)	7 (1.75)	

in all items of OHIP-14. Consistently with our study, previous researchers revealed the association of dental caries with poorer OHRQoL regardless of HIV status [11, 19, 23, 26–28]. Experiencing dental caries is linked to experiencing various physical, psychological, and social problems, mostly based on the severity of dental caries. For example, untreated caries may lead to aching, inability to eat and rest, and inability to do daily activities or socialize normally [29, 30].

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Table 3 Association of OHRQoL with demographic characteristics PLHIV in comparison to HIV-negative individuals

Variables	PLHIV			*P* value	HIV-negative			*P* value
	High impact n(%)	Neutral impact n(%)	Low impact n(%)		High impact n(%)	Neutral impact n(%)	Low impact n(%)	
AGE								**0.001**
18–35	11 (18.03)	25 (40.98)	25 (40.98)	0.645	9 (7.76)	41 (35.34)	66 (56.90)	
36+	25 (17.99)	66 (47.48)	48 (34.53)		11 (13.10)	48 (57.14)	25 (29.76)	
SEX								
Male	8 (9.09)	42 (47.73)	38 (43.18)	**0.011**	8 (8.99)	35 (39.33)	46 (51.69)	**0.0290**
Female	28 (25.00)	49 (43.75)	35 (31.25)		12 (10.81)	54 (48.65)	45 (40.54)	
-UBUDEHE (SES)								
Cat 1&2 (poor)	12 (18.46)	29 (44.62)	24 (36.92)	0.984	9 (9.28)	43 (44.33)	45 (46.39)	0.936
Cat 3& 4 (Rich)	24 (17.78)	62 (45.93)	49 (36.30)		11 (10.68))	46 (44.66)	46 (44.66)	
OCCUPATION								
employed	14 (21.88)	35 (54.69)	15 (23.44)	**0.031**	4 (99.09)	20 (45.45)	20 (45.45)	0.971
unemployed	22 (16.18)	56 (41.18)	58 (42.65)		16 (10.26)	69 (44.23)	71 (45.51)	

• UBUDEHE: mean socio-economic status in Rwanda and its categories are defined as follow:

Category 1: Families who do not own a house and can hardly afford basic needs

Category 2 Those who have a dwelling of their own or are able to rent one but rarely get full time jobs

Category 3: Those who have a job and farmers and go beyond subsistence farming to produce a surplus which can be sold. Also include those with small and medium enterprises who can provide employment to dozens of people

Category 4: Those who own large-scale business, individuals working with international organizations and industries as well as public servants

Moreover, dental caries interferes with communication or speaking, social functional, aesthetic, and social damage [28]. In addition, caries may lead to psychological disturbances such as low self-esteem and undermined self-image [28]. In summary, if one can't eat properly, sleep, perform daily activities, or socialize due to severe dental caries, then general well-being is affected. Therefore, since dental caries touches every single domain of OHIP-14 and leads to poorer OHRQoL, it is essential for the oral health team and all stakeholders to ensure strategies to improve OHRQoL in the Rwandan population, especially among PLHIV.

Similar to our study, previous studies have also reported effect of oral diseases on various OHIP domains among PLHIV compared to general population [12, 26, 31]. For example, a study in Nigeria reported the same domain of physical pain to have the highest impact among PLHIV [12]. Another study in Saudi Arabia reported physical pain as the most affected dimension of OHRQoL [26]. Greater impact on the physical pain and psychological discomfort dimensions may be explained by the impact of DMF experience, which was found to affect significantly PLHIV and HIV-negative adults in this study.

Issues such as aching, lack of comfort to eat, feeling nervous, and being self-consciousness due to oral problems were reported by participants and are linked to dental caries experience among PLHIV and HIV-negative individuals. These results call for a combined effort from policymakers, oral health, and general health teams to ensure oral health programs and strategies to promote oral health and raise awareness on prevention measures to improve population oral health-related quality of life in general and specifically for PLHIV.

Females living with HIV and HIV-negative reported poorer OHRQOL than males". The literature highlights that males ignore their oral health and rarely visit dentists for prevention services compared to women [32, 33]. These findings suggest that males do not worry much or see dental problems as an important issue for their quality of life.

Surprisingly, none of the 14 oral health impact profile items was significantly associated with periodontal disease assessed through the Community Periodontal Index of Treatment Need (CPITN). Contrary to dental caries, periodontal disease is silent. Regarding periodontal conditions, pain is present, in general, only in cases of severe periodontitis. Since OHRQoL results are the outcome of the self-reported impact of oral conditions on quality of life, this may be why people with painless periodontal disease do not feel concerned about oral issues and do not report the impact on their oral health. As reported for most other non-communicable conditions, it is rare to look for medical help if there is no pain [29]. This issue can lead to late dental visits; in this case, it is when there is advanced periodontal destruction that cannot be reversible even

Table 4 Comparisons of OHIP-14 among PLHIV and HIV-negative adults according to DMFT index and CPITN

OHIP items	PLHIV							HIV-negative						
	+DMFT							+DMFT						
	Yes n(%)			No n(%)				Yes n(%)			No n(%)			
	High impact	Neutral impact	Low impact	High impact	Neutral impact	Low impact	*P* value	High impact	Neutral impact	Low impact	High impact	Neutral impact	Low impact	*P* value
OHIP1	8 (7.92)	11 (10.89)	82 (81.19)	1 (1.01)	0 (0.00)	98 (98.99)	**0.000**	2 (2.47)	3 (3.70)	76 (93.83)	0 (0.00)	0 (0.00)	119 (100.00)	**0.023**
OHIP2	17 (16.83)	15 (14.85)	69 (68.32)	89 (89.90)	5 (5.05)	5 (5.05)	**0.001**	7 (8.64)	11 (13.58)	63 (77.78)	4 (3.36)	5 (4.20)	110 (92.44)	**0.011**
OHIP3	43 (42.57)	40 (39.60)	18 (17.82)	12 (12.12)	14 (14.14)	73 (73.74)	**0.000**	34 (41.98)	31 (38.27)	16 (19.75)	22 (18.49)	14 (11.76)	83 (69.75)	**0.000**
OHIP4	42 (41.58)	30 (29.70)	29 (28.71)	12 (12.12)	11 (11.11)	76 (76.77)	**0.000**	25 (30.86)	28 (34.57)	28 (34.57)	10 (8.40)	13 (10.92)	96 (80.67)	**0.000**
OHI 5	32 (31.68)	26 (25.74)	43 (42.57)	10 (10.10)	10 (10.10)	79 (79.80)	**0.000**	21 (25.93)	15 (18.52)	45 (55.56)	11 (9.24)	10 (8.40)	98 (82.35)	**0.000**
OHIP 6	35 (34.65)	25 (24.75)	41 (40.59)	11 (11.11)	6 (6.06)	82 (82.83)	**0.000**	23 (28.40)	16 (19.75)	42 (51.85)	10 (8.40)	11 (9.24)	98 (82.35)	**0.000**
OHIP 7	29 (28.71)	26 (25.74)	46 (45.54)	6 (6.06)	8 (8.08)	85 (85.86)	**0.000**	19 (23.46)	25 (30.86)	37 (45.68)	9 (7.56)	9 (7.56)	101 (84.87)	**0.000**
OHIP 8	27 (26.73)	26 (25.74)	48 (47.52)	7 (7.07)	4 (4.04)	88 (88.89)	**0.000**	15 (18.52)	22 (27.16)	44 (54.32)	7 (5.88)	5 (4.20)	107 (89.92)	**0.000**
OHIP 9	29 (28.71)	28 (27.72)	44 (43.56)	4 (4.04)	6 (6.06)	89 (89.90)	**0.000**	19 (23.46)	26 (32.10)	36 (44.44)	8 (6.72)	10 (8.40)	101 (84.87)	**0.000**
OHIP 10	20 (19.80)	12 (11.88)	69 (68.32)	8 (8.08)	6 (6.06)	85 (85.86)	**0.012**	14 (17.28)	16 (19.75)	51 (62.96)	6 (5.04)	3 (2.52)	110 (92.44)	**0.000**
OHIP 11	19 (18.81)	10 (9.90)	72 (71.29)	4 (4.04)	3 (3.03)	92 (92.93)	**0.000**	8 (9.88)	17 (20.99)	56 (69.14)	5 (4.20)	2 (1.68)	112 (94.12)	**0.000**
OHIP 12	21 (20.79)	18 (17.82)	62 (61.39)	2 (2.020	4 (4.04)	93 (93.94)	**0.000**	8 (9.88)	19 (23.46)	54 (66.67)	5 (4.20)	5 (4.20)	109 (91.60)	**0.000**
OHIP 13	8 (7.92)	18,917.82)	75 (74.26)	3 (3.03)	9 (9.09)	87 (87.88)	**0.046**	6 (7.41)	6 (7.41)	69 (85.19)	291.68)	3 (2.52)	114 (95.80)	**0.029**
OHIP 14	6 (5.94)	10 (9.90)	85 (84.16)	1 (1.01)	4 (4.04)	94 (94.95)	**0.037**	5 (6.17)	12 (14.81)	64 (79.01)	2 (1.68)	0 (0.00)	117 (98.32)	**0.000**
	CPITN						***P* value**	**CPITN**						***P* value**
	Yes n(%)			**No n(%)**				**Yes n(%)**			**No n(%)**			
OHIP1	9 (5.20)	10 (5.78)	154 (89,02)	0 (0.00)	1 (3.70)	26 (96.30)	0.422	2 (1.06)	3 (1.59)	184 (97.35)	0 (0.00)	0 (0.00)	9 (100.00)	0.885
OHI2	20 (11.56)	16 (9.25)	137 (79.19)	2 (7.41)	4 (14.81)	21 (77.78)	0.578	9 (4.76)	16 (8.47)	164 (86.77)	1 (11.11)	0 (0.00)	8 (88.89)	0.484
OHIP3	48 (27.75)	46 (26.59)	79 (45.66)	7 (25.93)	8 (29.63)	12 (44.44)	0.944	50 (26.46)	44 (23.28)	95 (50.26)	4 (44.44)	1 (11.11)	4 (44.44)	0.441
OHIP4	47 (27.17)	34 (19.65)	92 (53.18)	7 (25.73)	7 (25.73)	13 (48.15)	0.750	32 (16.93)	40 (21.16)	117 (61.90)	3 (33.33)	1 (11.11)	5 (55.56)	0.410
OHIP5	36 (20.81)	31 (17.92)	106 (61.27)	6 (22.22)	5 (18.52)	16 (59.26)	0.979	30 (15.87)	23 (12.17)	136 (71.96)	2 (212.22)	2 (22.22)	5 (55.56)	0.542
OHIP6	39 (22.54)	27 (15.61)	16 (59.26)	7 (25.93)	4 (14.81)	16 (59.26)	0.927	30 (15.87)	25 (13.23)	134 (70.90)	3 (33.33)	2 (22.22)	4 (44.44)	0.229
OHIP7	29 (16.76)	29 (16.76)	115 (66.47)	6 (22.22)	5 (18.52)	16 (59.26)	0.731	25 (13.23)	32 (16.93)	132 (69.84)	3 (33.33)	2 (22.22)	4 (44.44)	0.182
OHIP8	30 (17.34)	23 (13.29)	120 (69.36)	4 (14.81)	7 (25.93)	16 (59.26)	0.232	20 (10.58)	25 (13.23)	114 (76.19)	2 (22.22)	2 (22.22)	5 (55.56)	0.360
OHIP9	28 (16.18)	30 (17.34)	115 (66.47)	5 (18.52)	4 (14.81)	18 (66.67)	0.921	24 (12.70)	35 (18.52)	130 (68.78)	1 (11.11)	3 (33.33)	5 (55.56)	0.206
OHIP10	25 (14.45)	15 (8.67)	133 (76.88)	3 (11.11)	3 (11.11)	21 (77.78)	0.842	20 (10.58)	17 (8.99)	152 (80.42)	0 (0.00)	2 (22.22)	7 (77.78)	0.283
OHIP11	19 (10.98)	11 (6.36)	143 (82.66)	4 (14.81)	2 (7.41)	21 (77.78)	0.816	12 (6.35)	18 (9.52)	159 (84.13)	1 (11.11)	1 (11.11)	7 (77.78)	0.835

Table 4 (continued)

OHIP12	19 (10.98)	17 (9.83)	137 (79.19)	4 (14.81)	5 (18.52)	18 (66.67)	0.305	12 (6.35)	21 (11.11)	156 (82.54)	1 (11.11)	3 (33.33)	5 (55.56)	0.102
OHIP13	11 (6.36)	25 (14.45)	137 (79.19)	0 (0.00)	2 (7.42)	25 (92.59)	0.213	8 (4.23)	8 (4.23)	173 (91.53)	0 (0.00)	1 (11.11)	8 (88.89)	0.527
OHIP14	7 (4.05)	13 (7.51)	153 (88.44)	0 (0.00)	1 (3.70)	26 (96.30)	0.419	7 (3.70)	11 (5.82)	171 (90.48)	0 (0.00)	1 (11.11)	y (88.89)	0.693

+DMFT and *CPITN: DMF and CPITN were delivered from the broader PhD project. DMF Stands for Decayed, missing teeth due to caries and Filled teeth index. CPITN Stands for Community periodontal index of Treatment needs. They were expressed under yes or no. Yes, indicates participants who experienced caries and periodontal problems respectively and no expressed those who did not experienced dental caries and periodontal problem respectively

*CPITN: CPITN was also provided from the broader PhD project and it Stands for Community periodontal index of Treatment needs. Yes, indicates participants who needed any periodontal treatment and no expressed study participants without any need of periodontal treatment

after the treatment. Therefore, oral health education and awareness about periodontal disease and its impact on general health should be key to the general population in Rwanda.

The burden of oral diseases is at high in Rwanda. According to the Rwanda National Oral Health Survey, nearly 65% participants of oral health survey have experienced dental caries with more than 54% untreated caries. In addition, periodontal diseases were found among 60% of participants. Surprisingly, more than 70% of this population have never visited dentists [34]. There should be strategies to engage the Rwandan people to do dental check-ups on time. To ensure healthy dental and periodontium, interventions that tackle oral hygiene practice and engage timely dental visits are needed in Rwanda, especially among high-risk populations such as PLHIV.

The literature reports scarce research regarding OHRQoL of PLHIV and emphasizes the importance of doing so [19, 35]. To the best of our knowledge, there is no single study done in Rwanda on OHRQoL among PLHIV. In addition, there is still a lack of oral health prevention and promotion strategies unique to this high-risk group of PLHIV. This lack of oral health strategies is a major concern to the overall management of PLHIV in Rwanda because oral diseases, mostly caries and periodontal disease, had a significant impact on the general well-being of affected individuals. Oral diseases may negatively affect social interaction, leading to chronic distress, depression, heart disease, and stroke [36]. Moreover, vital functions such as breathing, speaking, selection of what to eat, swallowing, daily work, schooling, and family interaction can all be altered by dental problems [29, 30].

Lacking data regarding OHRQoL in Rwanda is a barrier to adopting strategies to promote oral health and improve the quality of life among Rwandese, especially those living with other chronic diseases, including HIV infection. In addition, the results of this study are essential to inform practice change regarding HIV services by incorporating oral health components to treat PLHIV in Rwanda comprehensively.

Strength of the study

To our knowledge, this is the first study to look at OHRQoL among PLHIV in Rwanda. In addition, this study considered a comparison group of HIV-negative adults, which is essential to understanding the oral health status of PLHIV in relation to their HIV-negative counterparts, and the comparison component is scarce in previous literature.

Limitation

This study may have recall bias due to the self-reporting of OHIP data. So, we considered oral impact that occurred within previous 3 months to minimize the recall bias. Also, a cross-sectional study design cannot establish a causal relationship. Moreover, OHRQoL may have suffered influence of HIV-related factors such as HIV infection duration and CD4+ cell counts. We recommend future studies to investigate the influence of HIV-related factors on OHRQoL. Lastly, the study did not look at the association of OHRQoL with other ulcerations or infections or HIV other than caries and periodontal diseases which may affect OHRQoL. We recommend future studies to look at the effect of other ulcerations and infections on OHRQoL.

Conclusion

Our study revealed poorer OHRQoL among PLHIV than HIV-negative adults. In addition, dental caries was significantly associated with poorer OHRQoL among PLHIV and HIV-negative individuals. Oral health programs are needed to improve the OHRQoL in Rwanda, especially among people at high risk of developing oral disease, like PLHIV. More attention should be given to common oral diseases, such as caries and periodontal diseases. Further similar longitudinal studies and those that consider people with other chronic diseases are needed in Rwanda.

Furthermore, it is essential to consider OHRQoL assessment for further dental research in Rwanda to plan dental public health better. As suggested by other researchers, it is vital to include oral health care as one of the components of the medical health care programs for PLHIV.

Abbreviations

DMFT	Decayed, Missing due to caries, and Filled Teeth (in the permanent dentition)
CHUK	Kigali Teaching Hospital
CPITN	Community periodontal Index of Treatment Needs
HIV	Human Immunodeficiency virus
OHIP	Oral Health Impact Profile
OHRQL	Oral Health related Quality of Life
PLHIV	People Living with Human immunodeficiency virus
WHO	World Health Organization

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Authors' contributions

JM, YMC, and VY participated in the study conception and design. JM corrected the data and drafted the manuscript. JM, YMC, VY, and FN reviewed the manuscript and supported data analysis, data interpretation, and discussions. All authors revised and approved the final version of the manuscript.

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Availability of data and materials
The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by the Human Research Ethics Committee from the University of Witwatersrand (reference no M200351), the Institutional Review Board from the University of Rwanda (reference no 573/CMHSIRB/2019), and the Research Ethics Committee of Kigali Teaching Hospital (reference no EC/CHUK/026/2020). Our study participants were informed and signed the written informed consent before data collection. The confidentiality of patients was observed by using an anonymous questionnaire.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. WHO. HIV and AIDS, Internet. 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/hiv-aids
2. Kikuchi K, Yasuoka J, Tuot S, Okawa S, Yem S, Chhoun P, et al. Dental caries in association with viral load in children living with HIV in Phnom Penh, Cambodia: a cross - sectional study. BMC Oral Health. 2021;159(21):1–8.
3. UNAIDS. UNAIDS data 2021. In Joint United Nations Programme on HIV/AIDS. 2021. p. 4–38. Retrieved from https://www.aidsdatahub.org/sites/default/files/resource/unaids-aids-data-book-2021.pdf.
4. Shaghaghian S, Saranjam E, Homayooni M. Oral health - related quality of life in patients infected with HIV, Iran: a cross - sectional study. BMC Oral Health. 2021:1–8. Internet, Available from. https://doi.org/10.1186/s12903-021-01660-7.
5. Spanemberg JC, Cardoso JA, Slob EMGB, López-López J. Quality of life related to oral health and its impact in adults. J Stomatol Oral Maxillofac Surg. 2019;120(3):234–9. Internet, Available from: https://linkinghub.elsevier.com/retrieve/pii/S2468785519300473
6. Kassebaum NJ, Smith AGC, Bernabé E, Fleming TD, Reynolds AE, Vos T, et al. Global, Regional, and National Prevalence, Incidence, and Disability-Adjusted Life Years for Oral Conditions for 195 Countries, 1990–2015: A Systematic Analysis for the Global Burden of Diseases, Injuries, and Risk Factors. J Dent Res. 2017;96(4):380–7.
7. US department of Health and Human Services. National institute of dental and Cranialfacial research, National institute of health. Oral health in America: a report of the surgeon general. J Calif Dent Assoc. 2000:1–308. Internet, Available from: http://www.ncbi.nlm.nih.gov/pubmed/11324049
8. Darshana B, Reddy CVK. Health-related quality of life. J International Soc Prev Community Dent. 2013;3(1):735–47.
9. Anna Thereza Thome Leao AKB. Evaluation of quality of life in HIV-infected children and children with Cancer. Dentistry. 2015;05(01):1–7.
10. Singh S, Talmale P. Impact of dental caries and nutritional status on oral health related quality of life in young Indian adolescents. J Oral Biol Craniofacial Res. 2023;13(4):506–10. Internet, Available from. https://doi.org/10.1016/j.jobcr.2023.05.002.
11. Vieira C, Lins L, Sarmento VA, Netto EM, Brites C. Oral health and health-related quality of life in HIV patients. BMC Oral Health. 2018;18:1–7.
12. Adesola Umeizudike K, Bamidele Osagbemiro B, Oluwayemisi Daramola O, Adenike AT. Oral health related quality of life among HIV positive patients attending two HIV outpatient clinics in Nigeria - a cross sectional study. Afr Health Sci. 2021;21(2):566–75. Internet, Available from: https://www.ajol.info/index.php/ahs/article/view/211706
13. Ashagrie M. Which formula to use to calculate the sample size for a cross-sectional comparative study? [Internet]. ResearchGate. 2020. p. 1–7. Available from: https://www.researchgate.net/post/which_formula_to_use_to_calculate_the_sample_size_for_a_cross_sectional_comparative_study.
14. Nurulasmak M, Norkhafizah S, Azizah Y, Anilawati MJ. Association among oral symptoms, oral health-related quality of life, and health-related quality of life in a sample of adults living with HIV/AIDS in Malaysia. BMC Oral Health. 2017;17(1):298–309.
15. Kalanzi D, Mayanja-kizza H, Nakanjako D, Mwesigwa CL, Ssenyonga R, Amaechi BT. Prevalence and factors associated with dental caries in patients attending an HIV care clinic in Uganda: a cross sectional study. BMC Oral Health. 2019;19:1–8.
16. Mitiche A, Ayed I Ben. WHO Oral health survey Basic Methods. In: Springer Topics in Signal Processing. 2010. p. 33–58. Internet, Available from: https://doi.org/10.1007/978-3-642-15352-5_3
17. Badeia RA, Ali SM. Periodontal health status and treatment need among Iraqi orthodontic patients wearing fixed appliance. Mustansiria Dent J. 2013;10(1):43–51. Internet, Available from: https://mdj.uomustansiriyah.edu.iq/index.php/mdj/article/view/183
18. Mulligan R, Seirawan H, Alves ME, Navazesh M, Phelan JA, Greenspan D, et al. Oral health-related quality of life among HIV-infected and at-risk women. Community Dent Oral Epidemiol. 2008;36(6):549–57. Internet, Available from. https://doi.org/10.1111/j.1600-0528.2008.00443.x.
19. Rocha Trindade RT, Marques JR, Veiga MA, Marques DN, Mata AD. HIV-1 impact on oral health-related quality of life: a cross-sectional study. AIDS Care. 2021;33(10):1321–8. Internet, Available from. https://doi.org/10.1080/09540121.2020.1798866.
20. Palupi R, Soslawan A, Gilang R, Ramadhani A. Factors influencing dental caries in HIV / AIDS patients. Acta Med Philipp. 2019;53(5):412–6.
21. Rajonson N, Meless D, Ba B, Faye M, N'Diaye C, Aka EA, et al. High prevalence of dental caries among HIV-infected children in West Africa compared to uninfected siblings. J Public Health Dent. 2017;3(77):234–43.
22. Nugraha AP, Mensana MP, Soebadi B, Husada D, Triyono EA, Prasetyo RA, et al. Correlation of Low CD4+ Counts with High Dental Caries Prevalence in Children Living with Perinatal HIV/AIDS Undergoing Antiretroviral Therapy. Pesqui Bras Odontopediatria Clin Integr [Internet]. 2019;19(1):1–7. Available from: http://revista.uepb.edu.br/index.php/pboci/article/view/4819/pdf.
23. Birungi N, Fadnes LT, Engebretsen IMS, Tumwine JK, Åstrøm AN. The prevalence and socio-behavioural and clinical covariates of oral health related quality of life in Ugandan mothers with and without HIV-1. Health Qual Life Outcomes. 2021;19(1):201. Internet, Available from. https://doi.org/10.1186/s12955-021-01844-3.
24. Ueno M, Ohara S, Inoue M, Tsugane S, Kawaguchi Y. Association between parity and dentition status among Japanese women: Japan public health center-based oral health study. BMC Public Health. 2013;13(1):993. Internet, Available from: BMC Public Health
25. Cozier YC, Heaton B, Bethea TN, Freudenheim JL, Garcia RI, Rosenberg L. Predictors of self-reported oral health in the black Women's health study. J Public Health Dent. 2020;80(1):70–8. Internet, Available from. https://doi.org/10.1111/jphd.12351.

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26. Bukhari OM. Dental caries experience and Oral health related quality of life in working adults. Saudi Dent J. 2020;32(8):382–9. Internet, Available from. https://doi.org/10.1016/j.sdentj.2019.11.003.
27. de Sousa PCB, Mendes FM, Pettorossi Imparato JC, Ardenghi TM. Differences in responses to the Oral health impact profile (OHIP14) used as a questionnaire or in an interview. Braz Oral Res. 2009;23(4):358–64.
28. Pesaressi E, Villena RS, Frencken JE. Dental caries and oral health-related quality of life of 3-year-olds living in Lima, Peru. Int J Paediatr Dent. 2020;30(1):57–65. Internet, Available from. https://doi.org/10.1111/ipd.12582.
29. Pitts NB, Mayne C. A Global Consensus for achieving a dental cavity-free future [Internet]. 2021. Available from: https://www.acffglobal.org/wp-content/uploads/2021/04/A-Global-Consensus-for-achieving-a-cavity-free-future-2-2.pdf.
30. Santos PS, Martins-Júnior PA, Paiva SM, Klein D, Torres FM, Giacomin A, et al. Prevalence of self-reported dental pain and associated factors among eight- to ten-year-old Brazilian schoolchildren. PLoS One. 2019;14(4):e0214990. Internet, Available from. https://doi.org/10.1371/journal.pone.0214990.
31. Muralidharan S, Mahendrakar S, Nara A, Talekar A, Kanitkar AA, Kanitkar A. Oral health-related quality of life in HIV: a systematic review. J Contemp Dent Pract. 2020;21(5):585–92. Internet, Available from. https://doi.org/10.5005/jp-journals-10024-2833.
32. Thompson AE, Anisimowicz Y, Miedema B, Hogg W, Wodchis WP, Aubrey-Bassler K. The influence of gender and other patient characteristics on health care-seeking behaviour: a QUALICOPC study. BMC Fam Pract. 2016;17(1):38. Internet, Available from. https://doi.org/10.1186/s12875-016-0440-0.
33. Lipsky MS, Su S, Crespo CJ, Hung M. Men and Oral health: a review of sex and gender differences. Am J Mens Health. 2021;15(3):15579883211016367. Internet, Available from: http://www.ncbi.nlm.nih.gov/pubmed/33993787
34. Morgan JP, Isyagi M, Ntaganira J, Gatarayiha A, Pagni SE. Building oral health research infrastructure : the first national oral health survey of Rwanda. Glob Health Action. 2018;11(1):1–10. Internet, Available from. https://doi.org/10.1080/16549716.2018.1477249.
35. Anup N, Sikka M, Biswas G, Shravani G, JAin P, Sontakke P. Oral health-related quality of life among HIV patients at antiretroviral therapy center government hospital, Jaipur. J Indian Assoc Public Heal Dent. 2015;13(2):148. Internet, Available from: http://www.jiaphd.org/text.asp?2015/13/2/148/159051
36. Silva MF, Batista MJ, da Luz Rosário de Sousa M. Risk factors for tooth loss in adults: a population-based prospective cohort study. PLoS One. 2019;14(7):1–14.

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