PREVALENCE AND RISK FACTORS OF ATROPHIC GLOSSITIS AMONG ADULTS LIVING WITH HIV: AN ANALYTICAL CROSS-SECTIONAL STUDY IN KWAEBIBIREM.

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ABSTRACT

BACKGROUND: Atrophic glossitis (AG), characterized by loss of filiform papillae, is associated with nutritional deficiencies and systemic disease. However, evidence among people living with HIV (PLHIV) in sub-Saharan Africa remains limited. This study assessed the prevalence, severity, and associated factors of AG among PLHIV receiving routine HIV care.

METHODS: An analytical cross-sectional study was conducted among 234 HIV-positive adults attending hospital care between October 2023 and March 2024. AG was clinically graded on a 0–4 scale. Sociodemographic, clinical, nutritional, laboratory, and behavioral data were collected through interviews and clinical assessment. Associations with AG were evaluated using bivariable and logistic regression analyses, with results reported as odds ratios (ORs) and 95% confidence intervals (Cis).

RESULTS: The prevalence of AG was 25.5% (95% CI: 20.1–31.6%). Among affected participants, 67.8% had mild disease, while 22.1% had severe to profound AG. AG was significantly associated with male sex (OR 2.44; 95% CI: 1.31–4.55), lower educational attainment (OR 2.55; 95% CI: 1.20–5.41), and poor oral hygiene (brushing ≤once daily; OR 4.51; 95% CI: 2.08–9.77). Severe anemia and recent weight loss were also associated with markedly higher AG prevalence.

CONCLUSION: AG affects approximately one in four PLHIV and is associated with indicators of nutritional and systemic compromise. Integrating routine oral examination, nutritional assessment, anemia screening, and oral health promotion into HIV care may improve early detection and patient outcomes.

KEYWORDS: Atrophic glossitis; HIV; Oral manifestations; Prevalence; Risk factors; Anemia; Ghana.

INTRODUCTION

Atrophic glossitis (AG) is characterized by partial or complete loss of the filiform papillae on the dorsal surface of the tongue, resulting in a smooth, often erythematous appearance that may be accompanied by pain, burning sensation, and taste dysfunction[1,2]. AG is widely recognized as a clinical indicator of underlying systemic conditions, particularly nutritional and metabolic disorders. Its pathophysiology is multifactorial, with strong associations reported for deficiencies of several essential micronutrients, including B-complex vitamins, iron, zinc, and vitamin E1,[3–5]. In addition, AG has been linked to protein–energy malnutrition, oral candidiasis, Helicobacter pylori infection, xerostomia, and diabetes mellitus[1,6–9]. Evidence also suggests a possible autoimmune contribution, as patients with AG have demonstrated elevated frequencies of gastric parietal cell, thyroglobulin, and thyroid microsomal antibodies[1]. Importantly, the relationship between AG and nutritional deficiencies appears bidirectional: micronutrient deficits may precipitate the development of AG, while the resulting mucosal changes may further compromise oral intake and nutrient utilization, thereby exacerbating existing deficiencies[2–4].

Population-based studies have reported wide variation in the prevalence of AG, reflecting differences in study populations and clinical settings. Among community-dwelling elderly individuals, AG prevalence has been reported at 13.2% in men and 5.6% in women, while substantially higher rates have been observed in hospitalized elderly populations (26.6% in men and 37% in women)[6]. In specific disease contexts, AG affects approximately 26.9% of individuals with diabetes mellitus and up to 70.2% of vitamin B12-deficient infants aged 6–24 months[3,20]. Although AG is estimated to affect about 10% of the general population, it frequently remains underrecognized in routine clinical practice, potentially delaying identification of underlying systemic conditions[12]. Increasing evidence supports its role as an early clinical marker of severe anemia and as a possible extraintestinal manifestation of celiac disease, extending its diagnostic relevance beyond nutritional deficiency alone[11,15]. Furthermore, emerging research on the oral microbiome has demonstrated reduced bacterial and fungal diversity in AG, with specific microbial signatures implicated in disease pathogenesis and progression[8].

In the context of HIV infection, oral manifestations are common and provide important clinical insights into immune status and disease progression. People living with HIV (PLHIV) are particularly vulnerable to nutritional deficiencies as a result of medication-related side effects, malabsorption, increased metabolic demands, and socioeconomic constraints that may limit access to adequate nutrition[11,12]. These factors plausibly increase susceptibility to AG; however, systematic data on AG prevalence and associated risk factors among PLHIV remain scarce, especially in sub-Saharan Africa where the HIV burden is highest. Beyond serving as a marker of nutritional deficiency, AG may have broader clinical relevance in HIV care. Early detection could enable timely nutritional and supportive interventions, while improved understanding of its epidemiology may inform the integration of targeted screening and preventive strategies into routine HIV care frameworks.

Key evidence gaps include limited data on the prevalence of AG among PLHIV in resource-limited settings, an incomplete understanding of HIV-specific risk factors for AG, and insufficient evidence on the relationship between AG severity and HIV disease markers such as viral load and immune status. Although prior studies have examined individual nutritional deficiencies in HIV

populations, AG has not been adequately evaluated as an integrated clinical marker reflecting the combined effects of nutritional, systemic, and behavioral factors. This study therefore aimed to estimate the prevalence of AG among adults living with HIV in Kwaebibirem, identify associated demographic, clinical, and behavioral risk factors, and characterize the distribution of AG severity within this population. By addressing these gaps, the study seeks to strengthen evidence on oral health manifestations in HIV care and support the development of context-appropriate screening and management strategies for PLHIV in similar resource-constrained settings.

MATERIALS AND METHODS

Study design and setting: This analytical cross-sectional study was conducted at Kade Government Hospital, the primary referral facility for the Kwaebibirem Municipal Area in Ghana's Eastern Region. The hospital serves an estimated population of 126,869 residents (2023 census) and provides antiretroviral therapy (ART) through a dedicated HIV clinic.

Study population and sampling strategy: The study population comprised adults aged ≥18 years with confirmed HIV infection who were receiving care at the study facility. Eligible participants were individuals attending routine ART clinic visits or outpatient consultations during the study period who were able to provide informed consent and agreed to undergo an oral examination. Individuals with acute oral infections requiring immediate treatment, suspected active oral malignancies, cognitive impairment preventing effective communication, or those who declined oral examination were excluded.

In the absence of prior data on the prevalence of AG among people living with HIV in Ghana, convenience sampling was employed. All eligible and consenting patients presenting during the study period were recruited.

Sample size adequacy was assessed post hoc using the standard formula for prevalence estimation. Based on an observed AG prevalence of 25.5% and a final sample of 234 participants, the study achieved a precision of ±5.7% at a 95% confidence level, which was considered acceptable for prevalence estimation.

Data collection procedures: Data were collected between October 2023 and March 2024 using a structured questionnaire consisting of six sections that captured demographic characteristics and potential risk factors related to AG. The questionnaire was pretested at a neighboring district hospital and revised to improve clarity prior to the study. Trained ART clinic nurses administered the questionnaire through face-to-face interviews in a private setting during routine clinic visits. The interviewer-administered approach was adopted to accommodate varying literacy levels and ensure completeness of responses. Prior to data collection, participating nurses received standardized training on the study protocol and questionnaire administration.

Clinical assessment and outcome measurement: The primary outcome was the presence and severity of AG, assessed through standardized oral examination. AG was defined as partial or complete loss of filiform papillae on the dorsal surface of the tongue, resulting in a smooth appearance compared with normal papillary texture. Severity was graded using a modified five-point scale adapted from Nakamura et al. (2013): Grade 0 (normal papillae), Grade 1 (mild localized atrophy), Grade 2 (moderate atrophy with <50% papillary loss), Grade 3 (severe atrophy with >50% papillary loss), and Grade 4 (complete loss of filiform papillae).

Oral examinations were conducted by trained ART clinic nurses under adequate lighting conditions using a pictorial reference guide to standardize grading. Cases with diagnostic uncertainty were reviewed in consultation with the principal investigator. Among participants diagnosed with AG, associated symptoms were assessed using structured questions, including pain frequency (usually painful, occasionally painful, or painless), burning sensation, taste dysfunction, tongue numbness, and tingling. [Fig. 1.0]

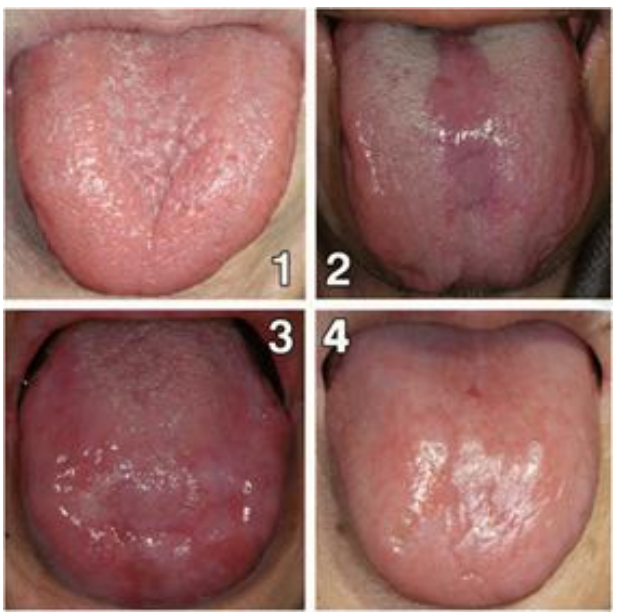

Fig. 1.0: The grades of atrophic glossitis. 0, none; 1 (mild), the lingual papillae in the affected area of the tongue were smaller in size than those in the intact area; 2 (moderate), partial loss (<50%) of the lingual papillae on the dorsum of the tongue; 3 (severe), partial loss (>50%) of the lingual papillae on the dorsum of the tongue; and 4 (profound loss) (from Nakamura S, Okamoto MR, Yamamoto K, et al.) [14].

Variable definitions and data collection domains: Variables were grouped into sociodemographic, clinical, HIV-related, lifestyle/nutritional, oral health, and psychosocial domains. Sociodemographic variables included age, sex, marital status, educational level, occupation, and area of residence. Clinical and laboratory variables comprised hemoglobin concentration, total white blood cell count, neutrophil and lymphocyte percentages, body mass index, and self-reported weight loss during the preceding six months.

HIV-related variables included duration since HIV diagnosis, duration on antiretroviral therapy, medication adherence, most recent viral load, ART-related side effects, and use of traditional or herbal medicines. Lifestyle and nutritional factors assessed included tobacco smoking, alcohol consumption, fruit and vegetable intake, dietary supplement use, and food insecurity. Oral health practices included tooth brushing frequency, mouthwash use, history of dental procedures, and receipt of oral health counseling. Psychosocial variables included family support, difficulty accessing healthcare services, and participation in community support groups.

Data quality assurance and management: Data quality was ensured through standardized training of data collectors on questionnaire administration and oral examination procedures, with ongoing supervision during the data collection period. Completed questionnaires were reviewed

for completeness and consistency. Digital photographs were obtained for cases of AG with diagnostic uncertainty to facilitate consensus review. Data were entered into Epi Info version 7.2.5 by the principal investigator and underwent cleaning procedures including range checks, logic checks, duplicate identification, and assessment of missing data.

Statistical analysis: Data analysis began with descriptive statistics to characterize the study population and summarize key outcomes. Categorical variables were presented as frequencies and percentages, while continuous variables were summarized using means and standard deviations. The overall prevalence of AG was calculated as the proportion of participants presenting with any grade of AG (Grades 1–4), with 95% confidence intervals (CI) estimated using the Wilson score method. Prevalence estimates were further stratified by AG severity (mild, moderate, severe, and profound).

Bivariable analyses were conducted to assess associations between potential risk factors and AG presence (any AG versus no AG). Pearson's chi-square test was used for categorical variables, with Fisher's exact test applied when expected cell counts were <5. Odds ratios (ORs) with 95% confidence intervals were calculated to quantify the strength of associations.

To examine relationships between continuous variables and AG severity, linear regression analyses were performed with AG severity as the outcome and selected demographic, clinical, and laboratory parameters as predictors. Comparisons were made between moderate versus mild AG and severe–profound versus mild AG to assess potential dose–response relationships. Model fit was evaluated using R^2 and F-statistics.

For bivariable analyses, selected continuous variables were categorized using clinically relevant thresholds: age (18–29, 30–44, 45–59, ≥60 years), hemoglobin concentration (≤6.9 g/dL, 7.0–10.9 g/dL, ≥11.0 g/dL), and educational attainment (≤Junior High School vs ≥Senior High School). Statistical significance was defined as $p<0.05$. All analyses were conducted using Epi Info version 7.2.6.0.

Ethical Considerations: Participants provided written informed consent after receiving explanations of study procedures, potential risks and benefits, and their right to withdraw without affecting their medical care; consent materials were available in local languages for participants with limited literacy. Confidentiality was ensured through signed confidentiality agreements and restricted data access, and participants with significant oral findings were referred for appropriate follow-up through existing facility pathways. The protocol complied with the Declaration of Helsinki and Good Clinical Practice guidelines, and ethical approval was obtained from the Ghana Health Service Ethics Review Committee (GHS-ERC: 032/10/23).

RESULTS

Of the 234 participants included in the analysis, 59 (25.5%) had atrophic glossitis (AG), while 175 (74.5%) showed no evidence of the condition. Among those with AG, mild disease predominated (40/59; 67.8%), followed by profound (8/59; 13.6%), moderate (6/59; 10.2%), and severe AG (5/59; 8.5%). The study population was predominantly female (61.5%), largely engaged in non-formal sector employment (89.3%), and had junior high school education or less (69.7%). Anemia was common, with 128 participants having hemoglobin concentrations <11.0 g/dL. AG prevalence varied across subgroups, with higher rates observed among participants aged 45–59 years (37.7%), males (35.6%), those with lower educational attainment (30.1%), and individuals with severe anemia (hemoglobin ≤6.9 g/dL; 66.7%) compared with those with hemoglobin ≥11.0 g/dL (28.6%). [Table 1]

Table 1. Atrophic glossitis prevalence by severity grade according to sociodemographic, clinical, and laboratory characteristics (Kwaebibirem, Ghana).

Characteristics	Total n (%)	No AG n (%)	Any AG n (%)	Severity n (%)		
				Mild	Moderate	Severe/profound
Age group						
18–29 years	64 (27.35)	52 (81.3)	12 (18.7)	9 (75.00)	1 (8.33)	2 (16.67)
30–44 years	91 (38.89)	71 (78.0)	20 (22.0)	10 (50.00)	4 (20.00)	6 (30.00)
45–59 years	53 (22.65)	33 (62.3)	20 (37.7)	15 (75.00)	1 (5.00)	4 (20.00)
≥ 60 years	26 (11.11)	19 (73.1)	7 (26.9)	6 (85.71)	0 (0.00)	1 (14.29)
Sex						
Male	90 (38.46)	58 (64.44)	32 (35.56)	24 (75.00)	3 (9.38)	5 (15.63)
Female	144 (61.54)	117 (81.25)	27 (18.75)	16 (59.26)	3 (11.11)	8 (29.63)
Marital status						
Married/cohabiting	113 (48.29)	81 (71.68)	32 (28.32)	23 (71.88)	2 (6.25)	7 (21.88)
Single	121 (51.71)	94 (77.69)	27 (22.31)	17 (62.96)	4 (14.81)	6 (22.22)
Single status						
Never married	70 (58.33)	59 (84.29)	11 (15.71)	6 (54.55)	2 (18.18)	3 (27.27)
Divorced	29 (24.17)	16 (55.17)	13 (44.83)	9 (69.23)	2 (15.58)	2 (15.38)
Widowed	21 (17.50)	18 (85.71)	3 (14.29)	2 (66.67)	0 (0.00)	1 (33.33)
Live-in couple						
Yes	105 (94.59)	75 (71.43)	30 (28.57)	21 (70.00)	2 (6.67)	7 (23.33)
No	6 (5.41)	3 (50.00)	3 (50.00)	3 (100.00)	0 (0.00)	0 (0.00)
Occupation						
Formal	25 (10.73)	20 (80.00)	5 (20.00)	5 (100.00)	0 (0.00)	0 (0.00)
Non-formal	208 (89.27)	154 (74.04)	54 (25.96)	65 (64.81)	6 (11.11)	13 (24.07)
Area of residence						
Urban	137 (60.62)	107 (78.10)	30 (21.90)	20 (66.67)	3 (10.00)	7 (23.33)
Rural	89 (39.38)	61 (68.54)	28 (31.46)	19 (67.86)	3 (10.71)	6 (21.43)
Educational background						
≤ Junior High	163 (69.66)	114 (69.94)	49 (30.06)	31 (63.27)	6 (12.24)	12 (24.49)
≥Senior High	71 (30.34)	61 (85.92)	10 (14.08)	9 (90.00)	0 (0.00)	1 (10.00)
Hemoglobin concentration						
≤6.0 g/dL	12 (6.52)	4 (33.33)	8 (66.67)	4 (50.00)	1 (12.50)	3 (37.50
7-9.9 g/dL	68 (36.96)	51 (75.00)	17 (25.00)	10 (58.82)	3 (17.65)	4 (23.53)
10-10.9 g/dL	48 (26.09)	38 (79.17)	10 (20.83)	7 (70.00)	1 (10.00)	2 (20.00)
≥11.0 g/dL	56 (30.43)	40 (71.43)	16 (28.57)	13 (81.25)	0 (0.00	3 (18.75)
Smoke						
Yes	11 (4.74)	7 (63.64)	4 (36.36)	4 (100.00)	0 (0.00)	0 (0.00)
No	221 (95.26)	167 (75.57)	54 (24.43)	35 (64.81)	6 (11.11)	13 (24.07)
Alcohol						
Yes	47 (20.33)	30 (63.83)	17 (36.17)	10 (58.82)	3 (17.65)	4 (23.53)
No	184 (79.65)	143 (77.72)	41 (22.28)	29 (70.73)	3 (7.32)	9 (21.95)

AG = Atrophic glossitis.

Further assessment of clinical, nutritional, behavioral, and oral health–related characteristics showed substantial variation in AG prevalence. Participants reporting weight loss in the preceding six months had markedly higher AG prevalence than those without recent weight loss (45.9% vs. 11.9%). Higher prevalence was also observed among participants with lower fruit and vegetable intake, poorer oral hygiene practices (34.0% among those brushing once daily vs. 10.2% among those brushing twice or more), and herbal medicine use (55.6% vs. 22.5%). In contrast, AG prevalence was lower among dietary supplement users (14.6% vs. 27.4%). AG prevalence also varied by food insecurity status and access to oral health counseling. [Table 2.0]

Table 2. Atrophic glossitis prevalence by severity grade according to nutritional, behavioral, and oral health factors (Kwaebibirem, Ghana).

Characteristics	Total n (%)	No AG, n (%)	Any AG n (%)	Severity n (%)		
				Mild	Moderate	Severe/profound
Observed weight loss over the past 6 months						
Yes	85 (40.82)	46 (54.12)	39 (45.88)	24 (61.54)	4 (10.26)	11 (28.21)
No	126 (59.72)	111 (88.10)	15 (11.90)	12 (80.00)	2 (13.33)	1 (6.67)
Frequency of brushing						
Once	144 (62.07)	95 (65.97)	49 (34.03)	32 (65.31)	4 (8.16)	13 (26.53)
Twice or more	88 (37.93)	79 (89.77)	9 (10.23)	7 (77.78)	0 (0.00)	2 (22.22)
Mouthwash usage						
Yes	13 (5.63)	11 (84.62)	2 (15.38)	2 (100.00)	0 (0.00)	0 (0.00)
No	218 (94.37)	163 (74.77)	55 (25.23)	36 (65.45)	6 (10.91)	13 (23.64)
Have a family support system						
Yes	38 (16.38)	27 (71.05)	11 (28.95)	9 (81.82)	1 (9.09)	1 (9.09)
No	194 (83.62)	147 (75.77)	47 (24.23)	30 (63.83)	5 (10.46)	12 (25.53)
Use of medicinal herbal preparations						
Yes	18 (7.79)	8 (44.44)	10 (55.56)	3 (50.00)	5 (9.62)	2 (33.33)
No	213 (92.21)	165 (77.46)	48 (22.54)	36 (69.23)	5 (9.62)	11 (21.15)
Frequency of fruits and vegetables						
Daily	20 (8.66)	18 (90.00)	2 (10.00)	2 (100.00)	0 (0.00)	0 (0.00)
Weekly	111 (48.05)	90 (81.08)	21 (18.92)	14 (66.67)	3 (14.29)	4 (19.05
Rarely	94 (40.69)	62 (65.96)	32 (34.04)	20 (62.50)	3 (9.38)	9 (28.13)
Never	6 (2.60)	3 (50.00)	3 (50.00)	3 (100.00)	0 (0.00)	0 (0.00)
Dietary supplement						
Yes	41 (17.75)	35 (85.37)	6 (14.63)	6 (100.00)	0 (0.00)	0 (0.00)
No	190 (82.25)	138 (72.63)	52 (27.37)	33 (63.46)	6 (11.45)	13 (25.00)
Counselling/education on oral health						
Yes	51 (22.17)	39 (76.47)	12 (23.53)	10 (83.33)	1 (8.33)	1 (8.33)
No	179 (77.83)	133 (74.30)	46 (25.70)	34 (73.91)	0 (0.00)	12 (26.09)
Difficulty accessing care services						
Yes	68 (29.75)	47 (69.12)	21 (30.88)	3 (14.29)	0 (0.00)	6 (28.57)
No	162 (70.43)	125 (77.16)	37 (22.84)	3 (8.11)	2 (5.41)	7 (18.92)
Food insecurity over the last 6 months						
Yes	37 (23.13)	25 (67.57)	12 (32.43)	1 (16.67)	1 (16.67)	2 (33.33)
No	123 (76.88)	99 (80.49)	24 (19.51)	5 (9.62)	4 (7.69)	11 (21.15)

AG = Atrophic glossitis.

Linear associations between continuous demographic, clinical, and laboratory variables and AG severity were assessed using regression models comparing moderate vs. mild and severe–profound vs. mild AG. Age was not significantly associated with AG severity in either comparison (moderate vs. mild: $\beta = -8.33$, $p = 0.15$; severe–profound vs. mild: $\beta = -2.96$, $p = 0.48$) and explained little variance ($R^2 = 0.04$). In contrast, hematological parameters showed stronger associations. Total white blood cell count was positively associated with severe–profound AG ($\beta = 42{,}809.6$; $F = 9.05$; $p = 0.004$; $R^2 = 0.16$), and neutrophil percentage was similarly associated ($\beta = 10.15$; $F = 4.10$; $p = 0.049$; $R^2 = 0.11$), whereas lymphocyte percentage was not ($R^2 = 0.06$). Body mass index was not significantly associated with AG severity in either comparison (moderate vs. mild: $\beta = 2.84$, $p = 0.10$; severe–profound vs. mild: $\beta = -0.69$, $p = 0.60$; $R^2 = 0.06$). Viral load also showed no significant linear association with AG severity ($R^2 = 0.11$). [Table 3]

Table 3. Linear regression analysis of continuous clinical and laboratory variables with atrophic glossitis severity (HIV-positive adults)..

Characteristic	Variable	Coefficient	Std Error	F-test	P-Value
Age	AG Moderate/Mild	-8.33	5.74	2.10	0.15
Age	AG Severe/Mild	-2.96	4.18	0.50	0.48
Age	CONSTANT	43.50	2.07	440.23	0.00
Age	Correlation Coefficient	R2 = 0.04	R2 = 0.04	R2 = 0.04	R2 = 0.04
Total white blood cell count	AG Moderate/Mild	19774.42	20343.20	0.94	0.33
Total white blood cell count	AG Severe/Mild	42809.59	14234.18	9.04	0.004
Total white blood cell count	CONSTANT	24994.57	7192.40	12.07	0.001
Total white blood cell count	Correlation Coefficient	R2 = 0.16	R2 = 0.16	R2 = 0.16	R2 = 0.16
Neutrophil percent	AG Moderate/Mild	-6.65	7.15	0.86	0.35
Neutrophil percent	AG Severe/Mild	10.14	5.01	4.09	0.04
Neutrophil percent	CONSTANT	55.25	2.56	465.47	0.00
Neutrophil percent	Correlation Coefficient	R2 = 0.11	R2 = 0.11	R2 = 0.11	R2 = 0.11
Lymphocyte percent	AG Moderate/Mild	-4.49	9.01	0.24	0.62
Lymphocyte percent	AG Severe/Mild	-10.81	6.32	2.92	0.09
Lymphocyte percent	CONSTANT	39.62	3.22	150.68	0.00
Lymphocyte percent	Correlation Coefficient	R2 = 0.06	R2 = 0.06	R2 = 0.06	R2 = 0.06
Body Mass Index	AG Moderate/Mild	2.84	1.71	2.74	0.10
Body Mass Index	AG Severe/Mild	-0.68	1.29	0.28	0.59
Body Mass Index	CONSTANT	21.70	0.62	1197.59	0.00
Body Mass Index	Correlation Coefficient	R2 = 0.06	R2 = 0.06	R2 = 0.06	R2 = 0.06
Viral load	AG Moderate/Mild	-16037.69	80565.52	0.039	0.84
Viral load	AG Severe/Mild	55161.35	44689.71	1.52	0.23
Viral load	CONSTANT	16500.69	22344.85	0.54	0.47
Viral load	Correlation Coefficient	R2 = 0.11	R2 = 0.11	R2 = 0.11	R2 = 0.11

AG = Atrophic glossitis.

Bivariable analyses identified several factors associated with AG occurrence. Male sex (OR = 2.39; 95% CI: 1.31–4.35; p = 0.004), lower educational attainment (≤ junior high school: OR = 2.55; 95% CI: 1.23–5.64; p = 0.01), and infrequent tooth brushing showed the strongest associations. Participants brushing once daily or less had higher odds of AG compared with those brushing twice or more (OR = 4.49; 95% CI: 2.13–10.25; p < 0.001). Alcohol consumption showed a marginal association (OR = 1.94; 95% CI: 0.96–3.87; p = 0.05). Rural residence, age ≥35 years, and lack of fruit and vegetable consumption were associated with elevated but non-significant odds of AG. Occupation, marital status, mouthwash use, family support, herbal medicine use, oral health counseling, healthcare access difficulties, and food insecurity were not associated with AG. [Table 4]

Table 4. Bivariable analysis of sociodemographic, clinical, and behavioral risk factors for atrophic glossitis: crude odds ratios and 95% confidence intervals (Kwaebibirem, Ghana).

Characteristic	Variables	AG Yes (%)	AG No (%)	Crude OR (95% CI), p -value
Age	≤35 years (Ref.)	20 (19.80)	81 (80.20)	1.73, (0.52-3.21), 0.07
Age	vs ≥35 years	39 (30.00)	91 (70.00)	1.73, (0.52-3.21), 0.07
Sex	Male (Ref.)	32 (35.96)	57 (64.04)	0.41, (0.22-0.76), 0.04
Sex	Female	27 (19.01)	115 (80.99)	0.41, (0.22-0.76), 0.04
Marital status	Married	32 (28.57)	80 (71.43)	1.36, (0.75-2.46), 0.30
Marital status	Single (Ref.)	27 (22.69)	92 (77.31)	1.36, (0.75-2.46), 0.30
Live-in couple	Yes (Ref.)	30 (28.85)	74 (71.15)	2.46, (0.47-12.91), 0.27
Live-in couple	No	3 (50.00)	3 (50.00)	2.46, (0.47-12.91), 0.27
Occupation	Formal	5 (20.83)	19 (79.17)	0.74, (0.26-2.08), 0.29
Occupation	Informal (Ref.)	54 (26.21)	152 (73.79)	0.74, (0.26-2.08), 0.29
Residence	Urban (Ref.	30 (22.39)	104 (104)	1.59, (0.86-2.91), 0.13
Residence	Rural	28 (31.46)	61 (68.54)	1.59, (0.86-2.91), 0.13
Education	≤Junior high	49 (30.25)	113 (69.75)	2.55, (1.20-5.41), 0.01
Education	≥Senior high	10 (14.49)	59 (85.51)	2.55, (1.20-5.41), 0.01
Hemoglobin concentration	≤11.9 g/dL	40 (26.32)	112 (73.68)	0.68, (0.30-1.53), 0.35
Hemoglobin concentration	≥12.0 g/dL (Ref.)	11 (34.38)	21 (65.63)	0.68, (0.30-1.53), 0.35
Smoking	Yes	4 (36.36)	7 (63.64)	1.74, (0.49-6.19), 0.38
Smoking	No (Ref.)	54 (24.66)	165 (75.34)	1.74, (0.49-6.19), 0.38
Alcohol	Yes	17 (36.17)	30 (63.83)	1.94, (0.97-3.88), 0.05
Alcohol	No Ref.)	41 (22.53)	141 (77.47)	1.94, (0.97-3.88), 0.05
Frequency of brushing	Once daily	49 (34.27)	94 (65.73)	4.51, (2.08-9.77), 0.00005
Frequency of brushing	Twice daily (Ref.)	9 (10.34)	78 (89.66)	4.51, (2.08-9.77), 0.00005
Mouthwash	Yes	2 (15.38)	11 (84.62)	0.53, (0.11-2.47), 0.32
Mouthwash	No (Ref.)	55 (25.46)	161 (74.54)	0.53, (0.11-2.47), 0.32
Family/social supportive network	Yes	11 (28.95)	27 (71.05)	1.25, (0.57-2.72), 0.56
Family/social supportive network	No (Ref.)	47 (24.48)	145 (75.52)	1.25, (0.57-2.72), 0.56
Herbal preparations alongside ARVs	Yes	6 (33.33)	12 (66.67)	1.52, (0.54-4.27), 0.41
Herbal preparations alongside ARVs	No (Ref.)	52 (24.64)	159 (75.36)	1.52, (0.54-4.27), 0.41
Fruits and vegetables	Yes	55 (24.66)	168 (75.34)	3.05, (0.59-15.57), 0.15
Fruits and vegetables	No (Ref.)	3 (50.00)	3 (50.00)	3.05, (0.59-15.57), 0.15
Counselling on oral health/hygiene	Yes	12 (24.00)	38 (76.00)	0.90, (0.43-1.88), 0.79
Counselling on oral health/hygiene	No (Ref.)	46 (25.84)	132 (74.16)	0.90, (0.43-1.88), 0.79
Difficulty accessing healthcare	Yes	21 (30.88)	47 (69.12)	1.48, (0.78-2.79), 0.21
Difficulty accessing healthcare	No (ref.)	37 (23.13)	123 (76.88)	1.48, (0.78-2.79), 0.21
Occasional food insecurity	Yes	6 (31.58)	13 (68.42)	1.41, (0.51-3.90), 0.50
Occasional food insecurity	No (Ref.)	52 (24.64)	159 (75.36)	1.41, (0.51-3.90), 0.50

OR = odds ratio; CI = confidence interval; Ref. = reference category; ARVs = antiretrovirals.
Odds ratios represent unadjusted bivariable associations between sociodemographic, clinical, behavioral, and nutritional characteristics and the presence of atrophic glossitis among adults living with HIV.

DISCUSSIONS

In this cross-sectional study, 25.5% of adults living with HIV had AG, indicating that it is a relatively common oral manifestation in this population. This prevalence is comparable to that reported in other conditions, such as diabetes mellitus (26.9%)[20], but lower than rates observed among vitamin B12–deficient infants (70.2%)[3]. These findings suggest that AG in people living with HIV may reflect combined nutritional, immunological, and metabolic disturbances rather than a single dominant cause, while also contributing to the limited literature on AG in sub-Saharan Africa.

Mild AG predominated (67.8% of cases), which may indicate detection at earlier stages, potentially before severe nutritional depletion or following partial immune and metabolic stabilization after initiation of antiretroviral therapy. Nonetheless, 13.6% of affected participants had profound AG, reflecting marked papillary atrophy that may be associated with more severe nutritional deficiencies[1,2] and possible effects on oral intake, quality of life, and adherence to dietary and medication regimens. The grading system adapted from Nakamura et al.[14] provides a standardized framework for severity classification, facilitating cross-study comparisons and helping guide the intensity of nutritional interventions.

Male sex was a significant risk factor for AG in bivariable analysis, with males showing 35.6% prevalence compared to 18.8% in females. When examined as odds ratios with females as the reference category, the protective effect of female sex yielded an OR of 0.41 (95% CI: 0.22-0.76; p = 0.04), corresponding to approximately 2.4 times higher odds of AG among males. This aligns with population studies reporting higher AG prevalence among elderly men (13.2%) than women (5.6%), and even higher rates in hospitalized elderly populations (26.6% vs. 37%)6. The mechanisms remain unclear but may involve sex differences in nutrition, healthcare-seeking behavior, preventive practices, or biological factors such as hormonal effects on mucosal integrity and immune function. Lower educational attainment was significantly associated with AG, with participants completing junior high school or less having 2.55 times the odds (95% CI: 1.20-5.41; p = 0.01) compared with those with senior high school or higher. This likely reflects broader socioeconomic gradients, including reduced income, limited health literacy, restricted access to nutrient-rich foods, and challenges navigating healthcare. These findings suggest the need to tailor nutritional and oral health interventions to individuals with lower literacy.

Hematological findings support an association between anemia and AG. Participants with severe anemia (hemoglobin ≤6.9 g/dL) had markedly higher AG prevalence (66.7%) compared to those with hemoglobin ≥11.0 g/dL (28.6%). Additionally, both total white blood cell count (β = 42,809.6; F = 9.05; p = 0.004; R^2 = 0.16) and neutrophil percentage (β = 10.15; F = 4.10; p = 0.049; R^2 = 0.11) were positively associated with severe-profound AG in linear regression analyses. These findings align with evidence linking AG to iron, vitamin B12, and folate deficiencies, which impair erythropoiesis and oral epithelial turnover. AG has been shown to reflect severe anemia and micronutrient deficiency, underscoring the diagnostic value of oral examination. Recent weight loss was strongly associated with AG prevalence, with 45.9% of participants reporting weight loss in the past six months having AG compared to only 11.9% of those without weight loss. This substantial difference likely reflects inadequate intake, increased energy expenditure from HIV and opportunistic infections, and catabolic effects of systemic inflammation. Bøhmer and Mowé[6] similarly linked AG to protein-calorie malnutrition in elderly and hospitalized populations, supporting its role as a marker of nutritional compromise. In PLHIV, weight loss signals disease progression, and its association with AG suggests oral changes may accompany or precede clinically significant wasting.

Oral hygiene was strongly associated with AG in bivariable analysis: participants brushing once daily or less had 4.5[1] times the odds (95% CI: 2.08-9.77; p < 0.001) compared with those brushing twice daily or more. Poor oral hygiene may promote microbial dysbiosis, inflammation, and secondary infections, contributing to papillary atrophy[7,14,18]. Candida species have been implicated in AG pathogenesis, and mechanical brushing may help maintain tongue papillae. Behavioral and nutritional factors showed variable associations with AG. Alcohol use showed a marginal association with AG prevalence (36.2% in consumers vs. 22.3% in non-consumers; OR 1.94; 95% CI: 0.97-3.88; p = 0.05), consistent with its effects on nutritional status, mucosal integrity, and micronutrient absorption. Dietary supplement use was associated with lower AG prevalence (14.6% vs. 27.4% in non-users), though this difference was not statistically significant (OR 0.53; 95% CI: 0.21-1.43), suggesting potential benefit of targeted micronutrient supplementation, particularly for vitamin B12[3,13], zinc[4], and vitamin E[5]. Herbal medicine use alongside antiretroviral therapy was associated with higher AG prevalence (55.6% vs. 22.5%), though not statistically significant (OR 1.52; 95% CI: 0.54-4.27; p = 0.41), raising concerns about potential interactions or effects on nutrient absorption, though causality cannot be inferred.

Etiological factors merit exploration. Helicobacter pylori colonization has been linked to AG and burning mouth syndrome[8], celiac disease has been diagnosed following AG[15], and elevated autoantibodies (gastric parietal cell, thyroglobulin, thyroid microsomal) have been reported1, suggesting autoimmune contributions that may be relevant in PLHIV. The absence of significant associations for factors such as food insecurity, oral health counseling, and family support should be interpreted cautiously. Self-reported binary measures may not capture nuanced aspects of food access, social support quality, or counseling effectiveness. These factors could also influence AG indirectly through mediators such as nutritional intake, medication adherence, or healthcare engagement, which would require more sophisticated analyses to detect.

These findings support practical recommendations for HIV care. Routine oral examination, including assessment for tongue papillary atrophy, should be incorporated to prompt nutritional evaluation, hemoglobin testing, and counseling on oral hygiene and diet. Low-cost oral health education, such as promotion of twice-daily brushing, may reduce AG burden, while systematic anemia screening and treatment should emphasize correction of underlying nutritional deficiencies rather than symptomatic management alone. Future research should prioritize longitudinal studies to establish causal relationships, assess the impact of nutritional interventions on AG resolution, and explore associations with patient-reported outcomes such as pain, taste, and quality of life. The role of micronutrient deficiencies, including vitamin B12[3,13,21], folate[19], iron[2,19], zinc[4], and vitamin E[5,] warrants investigation using biomarkers alongside clinical assessments. Chen et al.[13] provide a model for studying B[12]-related AG grading in HIV populations. Integrating oral microbiome analysis[18] and conducting cost-effectiveness studies of screening and nutritional support would inform mechanisms, therapy, and policy in resource-limited settings.

CONCLUSION

This study shows that AG affects one in four adults living with HIV in this Ghanaian setting and is associated with modifiable risk factors such as severe anemia, recent weight loss, poor oral hygiene, and lower educational attainment. Male sex was also identified as a significant risk factor. Integrating oral examination, anemia screening, nutritional assessment, and oral health promotion into routine HIV care offers a patient-centered strategy to identify at-risk individuals, initiate timely interventions, and improve quality of life. Recognizing AG as a marker of nutritional vulnerability underscores its clinical and programmatic relevance.

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