ORIGINAL RESEARCH

Prevalence and Risk Factors for Periodontal Disease Among Women Attending Antenatal Care in Public Hospitals, Southwest Ethiopia, 2022: A Multicenter Cross-Sectional Study

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Background: Periodontal disease is characterized by the inflammation of all tissues that surround and support the teeth, and it is the most common public health problem worldwide. It has many different contributing factors, such as poor oral hygiene, smoking, anemia, bacterial plaque, poor economic status, and nutritional deficiency. It also causes different feto-maternal complications like preeclampsia, gestational diabetes, preterm labor, low birth weight, and early abortion. Thus, this study aimed to assess the prevalence and associated factors of periodontal disease among pregnant women.

Methods: A cross-sectional study was conducted among 618 women at public hospitals in the Southwest Ethiopia. Data were collected using a systematic random sampling method and a structured interviewer administered questionnaire. The data were entered into Epi-Data Manager 4.2 and then transferred to a statistical package for social science (SPSS) version 21 for analysis. The logistic regression analysis was done to see the significant association between each predictor with periodontal disease by considering a p-value of <0.05 and a CI of 95%.

Results: A total of 618 women attending ANC with a 100% response rate were enrolled in this study. The mean and standard deviation of the age of the study participants was 31.07 ± 7.8 years. The periodontal disease was observed among 240 (38.8%) of the total participants with 95% C.I of (35%, 43%). Predictors like rural residency, women who could not read and write, women with poor wealth index, nutritional status of underweight, had no information about periodontal disease, depression, history of diabetes mellitus, self-perceived halitosis, no history of ANC, and lower gestational age were found to be significantly associated with periodontal disease.

Conclusion: In this study, the prevalence of periodontal disease was found to be significantly higher. Therefore, in order to minimize the burden of periodontal disease among pregnant women, oral, medical, and mental health education should be promoted.

Keywords: prevalence, factors, periodontal disease, antenatal care

Background

Periodontal disease (PD) is the most common public health problem worldwide that can affect up to 90%[1,2] of populations, and it is characterized by an inflammation of all the tissues that surround the teeth including the gingiva (gum tissue), cementum (outer layer of the roots of teeth), alveolar bone (sockets into which the teeth are anchored), and periodontal ligaments (connective tissue fibers between the cementum and the alveolar bone).[3]

It is a common oral infection that comprises gingivitis and periodontitis.[4] Gingivitis (gum inflammation) is a mild, early form of periodontitis (gum disease) that occurs when bacteria and plaque build-up in the mouth and lead to infection. It is also characterized by bleeding, swollen gums, and pain, whereas if these conditions are left untreated and progress to loss of periodontal attachment and supporting bone, it is said to be periodontitis.[5]

Oral diseases affect nearly 3.5 billion people worldwide.[6] Of these, untreated dental caries (tooth decay) in permanent teeth is the most common health condition. If the dental caries are left untreated early, it will proceed to severe periodontal (gum) disease. Severe periodontal disease was the 11th most prevalent condition in the world,[7] in which its prevalence was ranged from 20% to 50% around the world.[8] In most high-income countries, dental treatment averages 5% of total health expenditure.[9]

The prevalence of the periodontal disease is varied across different settings and populations, for instance, the reported prevalence of PD in the United States (US),[10] Latin America,[11] and India[12] was 50%, 40–80%, and 96.3%, respectively. The prevalence of periodontitis among pregnant women is also varied across different parts of the world[13–15] such as 11% in Brazil,[10] 60.5% in Rwanda,[16] 24.0% in Sudan,[17] and 42.4% in Northwest Ethiopia.[18]

Periodontal diseases are highly common during pregnancy and lactation,[19] due to hormonal factors (high concentration of estrogen and progesterone) and the subsequent impact on the gingival arteries compared with non-pregnant and non-lactating women.[20] Periodontal disease is more prevalent at eight months of pregnancy and its rate begins to return to normal during two months postpartum.[21,22] Pregnant women with periodontal disease are more susceptible to poor maternal and perinatal outcomes, such as preeclampsia,[23] gestational diabetes,[24] vulvovaginitis, preterm labor (gestational age of <37 weeks), fetal growth restriction,[25] low birth weight (<2500 g),[26] perinatal mortality,[27] early abortion, and a higher risk of early neonatal infection.[28] Therefore, different studies suggested that scaling and root planning during the second trimester of pregnancy reduce the risk of periodontal disease complications.[29–31]

There are different contributing factors, such as age, parity, lower level of education, and anemia were identified as risk factors for periodontal disease.[32] Moreover, poor oral hygiene,[33] smoking,[33–35] ethnicities,[1,3] body mass index, bacterial plaque,[10] lower gestational age,[17] residency, systemic disease,[18] psychosocial factors (depression, anxiety, and stress),[36,37] and poor economic status[1,3,38–40] have been reported as risk factors for periodontal disease. Due to different factors, PD is complicated with tooth loss which can compromise intake of food, aesthetics, self-confidence, and quality of life.[41] This condition also negatively affects the nutritional status and the general health of the women.[41,42] Conversely, nutritional deficiencies, specifically the shortage of vitamin D groups: vitamins D_2 (cholecalciferol) and D_3 (ergocalciferol), were found to be a cause of periodontal inflammation and a delay in post-surgical periodontal healing.[43,44] In addition to nutritional deficiency, obesity can also be associated with periodontitis through the decrement of antioxidant substances in the periodontal tissues and excessive production of reactive oxygen species (ROS), which in turn causes chronic activation of inflammation and tissue destruction.[45] This condition further contributed to the development of Insulin Resistance (IR), which is known to cause periodontitis.[46]

Periodontal disease (PD) is a cause for the release of metalloproteinase and prostaglandins (PgE2),[47] which stimulates the production of cytokines and pharmacologically active mediators, such as interleukin 1-beta, interleukin-6, alpha tumor necrosis factor.[48] The spread of these infectious agents from dental plaque and inflammatory mediators from periodontal tissues to other organs of the body across the junctional epithelium is believed to cause different systemic diseases like; Alzheimer's disease,[49] diabetes, cardiovascular disease, feto-maternal complications, rheumatoid arthritis, and chronic obstructive pulmonary disease.[50–56]

Despite the World Health Organization (WHO) recommending the inclusion of oral health in a political declaration on universal health coverage in 2019, the periodontal disease remained disproportionately affecting poor and socially disadvantaged group of society.[57] Due to the nature of the disease also, the early stages of periodontitis usually remain asymptomatic,[58] and so that most women are complicated by feto-maternal complications associated with severe periodontitis. Therefore, studies related to periodontal disease will contribute for the maintenance of periodontal health through an early diagnosis and treatment. Moreover, there is a paucity of data regarding periodontal disease and there are high rates of maternal and perinatal adverse outcomes in Ethiopia, particularly in Southwest Ethiopia.[59] Hence, determining the prevalence of the periodontal disease and identifying the factors associated with periodontal disease is useful for policy development and the allocation of financial and human resources for preventive measures and the provision of treatment. Therefore, this study aimed to assess the prevalence of periodontal disease and its associated factors among pregnant women attending antenatal care (ANC) in public hospitals, Southwest Ethiopia.

Methods and Materials

Study Design and Period
A cross-sectional study was conducted among women attending ANC clinics at public hospitals in Southwest Region, Ethiopia, from December 1st, 2021 to February 30th, 2022.

Study Setting
This study was carried out in three public hospitals of Southwest Ethiopia: Mizan-Tepi University Teaching Hospital (MTUTH), Tepi General Hospital (TGH), and Gebretsadik Shawo General Hospital (GSGH). These hospitals are located in Benchi-Sheko Zone, Sheka Zone, and Kefa Zone, respectively.

Mizan Tepi University Teaching Hospital was established in 1986 GC. Previously during the Derg regime, this hospital was named "Mizan-Teferi General Hospital". Then, until 2016 GC, it was named "Mizan Aman General Hospital". Then, during the 2016 GC, this hospital was incorporated into Mizan-Tepi University & named "Mizan Tepi University Teaching Hospital". This hospital was located in a town called Mizan Teferi (recently named Mizan-Aman Town) which is the capital town of the Bench Sheko Zone (previously the capital of the Bench Maji Zone). It is located 565 km away from Addis Ababa, the Capital City of Ethiopia. Currently, Mizan-Tepi University Teaching Hospital is expected to provide services to more than one million people.

Tepi General Hospital is also one of the hospitals in the southwest region, which is about 615 km away from Addis Ababa, the Capital City of Ethiopia. This hospital serves more than 500,000 people. While Gebretsadik Shawo General Hospital was first established in the 1990 EC and named "Gebretsadik Shawo Primary Hospital". Then, in 2005 EC, this hospital was named "Gebretsadik Shawo General Hospital". Currently, the Gebretsadik Shawo General Hospital is expected to provide care for more than 500,000 people.[60] In the last one year, about 2640, 1344, and 1824 women attended ANC clinic in Mizan-Tepi University Teaching Hospital, Tepi General Hospital, and Gebretsadik Shawo General Hospital, respectively (Unpublished reports).

Population
The source population was all pregnant women attending ANC at the public hospitals, and all selected pregnant women attending ANC at public hospitals during the study period were the study populations.

Inclusion and Exclusion Criteria
All pregnant women with a history of at least one child pregnancy were included in the study. Those who were seriously ill (unable to respond to an interview), on orthodontic treatment, on periodontal treatment, and had incomplete ANC follow-up charts (anthropometric measurement at early pregnancy) were excluded from the study.

Sample Size Determination
The sample size was estimated using Epi Info™ 7 software and considering assumptions of double population proportion formulas such as ratio = 1:1, confidence interval (CI = 95%), power (P = 80%), and using the proportions of outcome in unexposed group and odds ratio of different risk factors of previous research[18] such as income (p = 29.3% and OR = 3.12), tooth brushing (p = 69.2% and OR = 4.85), carbohydrate intake (p = 56.36% and OR = 2.16), self-perceived halitosis (p = 36.44% and OR = 1.64), and systemic disease (p = 40.78% and OR = 1.96), the final sample size with 10% non-response rate would be 130, 125, 288, 618, and 334, respectively. Therefore, in order to increase the generalizability, its precession, and minimize the error, a larger sample size of 618 was taken.

Sampling Procedure
A systematic random sampling method was applied to select study participants. First, the average three-month report was taken from a yearly report of women attending ANC in each hospital (660 from MTUTH, 336 from TGH, and 456 from GSGH). Then, the sample size was proportionally allocated to each hospital (46 from MTUTH, 23 from TGH, and 31 from GSGH). The sampling interval (kth) was calculated as the total number of women attending ANC in the three
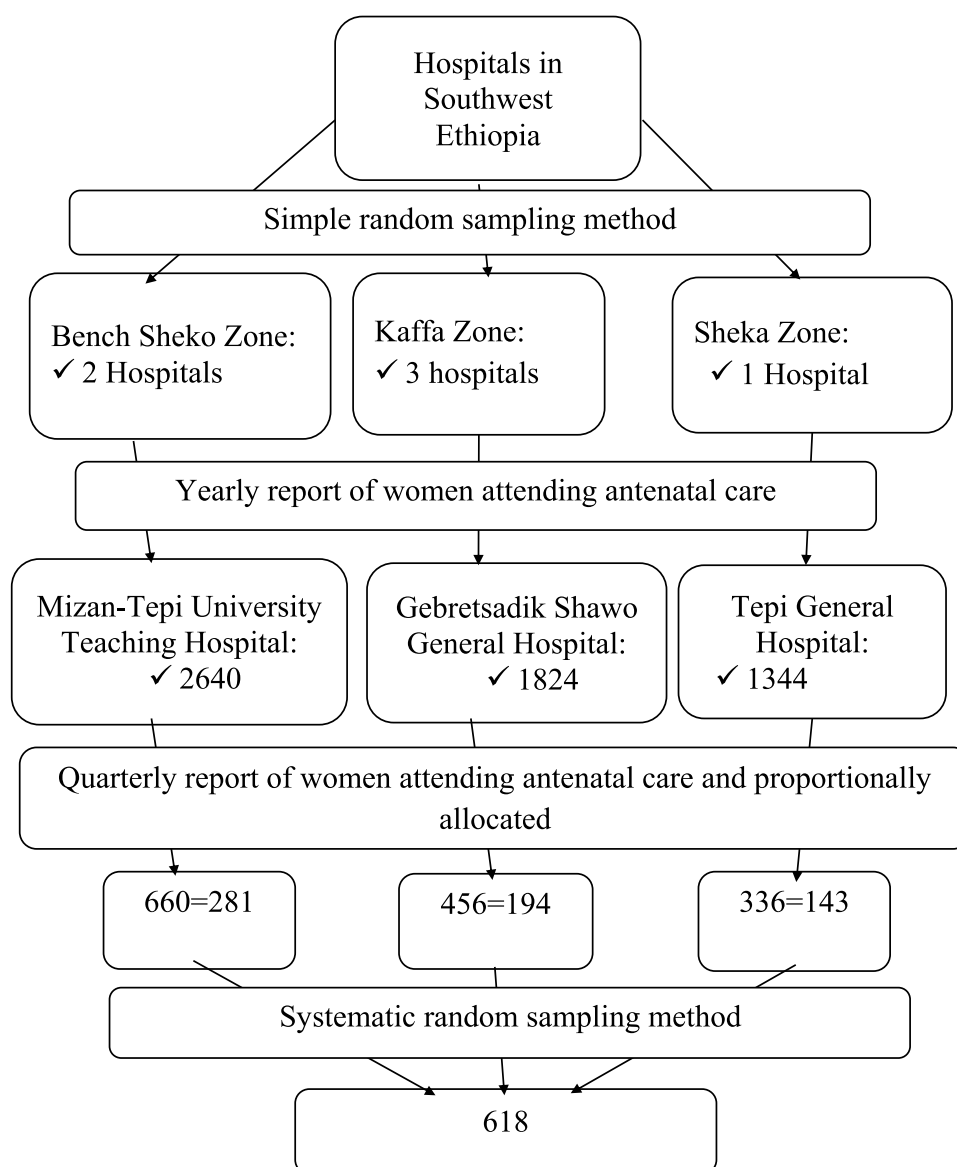
Figure 1 Schematic presentation of sampling procedure for assessing periodontal disease among pregnant women attending ANC in public hospitals, Southwest Ethiopia, 2022.

hospitals divided by the sample size (1452/618=2). Then, every 2nd participant was selected after the first eligible participant was selected by the lottery method [Figure 1].

Data Collection Tool, Procedures, and Quality Control

The data were collected using a structured interviewer-administered questionnaire adopted from the World Health Organization (WHO) tool,[61,62] and other socioeconomic, behavioral, obstetrical, and nutritional variables are adapted from different reviewed literatures.[14,17,18,35]

WHO proposed the use of community periodontal index (CPI).[61,62] CPI has also been provided by the American Academy of Periodontology (the "Periodontal Screening Record", PSR), and the British Society of Periodontology (the "Basic Periodontal Examination", BPE).[63–65]

The household wealth index was assessed by a measurement tool for wealth index adopted from Ethiopian DHS-2016.[66]

Data on household food insecurity was measured using the Household Food Insecurity Access Scale (HFIAS), a structured, standardized, and validated tool developed by Food and Nutrition Technical Assistance (FANTA) which has

nine questions with nine frequency of occurrence questions.[67] If a participant responds no to all question items 1–9 or responds yes to question item 1, and rarely experience in the past four weeks, it indicates for food secured household, whereas if household heads respond at least yes to question item 1 and sometimes experience in the past four weeks, it indicates for food insecured household.[68]

Substance use was assessed using alcohol, smoking, and substance involvement screening tool (ASSIST), and if an individual used at least one of a specific substance (Alcohol, Khat, Cigarette and Others) for nonmedical purposes within the last 3 months, it is said to be current substance use, whereas if an individual used at least one of any specific substance (Alcohol, Khat, Cigarette and Others) for the nonmedical purpose at least once in a lifetime according to ASSIST, it is said to be lifetime substance use.[69]

Depression, anxiety, and stress were assessed using the DAS scale and a score of 10 and above in DASS-D indicates the presence of depression, a score of 8 and above in DASS-A indicates the presence of anxiety, and a score of 15 and above in DASS-S indicates the presence of stress.[70]

Body mass index (BMI) was computed using height, and weight measurement is taken at early pregnancy or first trimester. Accordingly, underweight, normal weight, overweight and obesity were defined as a body mass index (BMI) of <18.5 kg/m^2, 18.5–24.9 kg/m^2, 25–29.9 kg/m^2 and ≥30 kg/m^2, respectively.[71]

Intra-Oral Examination

First, gingival tissues were assessed for the presence or absence of gingival inflammation. Then, the probing depth and clinical attachment loss were assessed using the World Health Organization (WHO) Community Periodontal Index (CPI) probe. The WHO-CPI probe is a 0.5 mm ball tip (help to detect the calculus and reduce soft tissue injury), a black band between 3.5 and 5.5 mm, and rings at 8.5 and 11.5 mm.[72]

For study subjects whose age were 20 years and above, the ten permanent index teeth (17, 16, 11, 26, 27, 37, 36, 31, 46, and 47) were evaluated, whereas, for study subjects whose ages were adolescent (16, 11, 26, 36, 31, and 46) were evaluated.[73] Then, depending on the most affected teeth, the highest scores were assigned to each sextant (mesio-buccal /facial, mid-buccal/facial, disto-buccal/facial, mesio-lingual/palatal, mid-lingual/palatal, disto-lingual/palatal) excluding the third molar. Following probing, the gingival bleeding index (GBI) was recorded as present or absent at each examination by observing bleeding on probing (BOP).[74]

The clinical attachment loss is determined using the distance from the cementoenamel junction (CEJ) to the base of sulcus/pocket (junctional epithelium), or this can also be determined by adding the probing depth measurements with recession measurements.[75] Probing depth (PD) was also determined using the distance from the gingival margin to the base of the sulcus or pocket.[76]

Accordingly, periodontal disease is determined. Then, the severity of periodontal disease was determined using the CPI score. CPI score ranges from 0 to 4 and a score 0; healthy periodontal conditions or no periodontal disease (black band completely visible or probing depth <3.5 mm); score 1; gingival bleeding (black band completely visible or probing depth <3.5 mm); score 2; calculus and bleeding (black band completely visible or probing depth <3.5 mm); score 3; probing depth of 3.5–5.5 mm (black band partially visible, indicating pocket of 4–5 mm); and a score 4; Probing depth >5.5 mm (black band entirely within the pocket, indicating pocket of 6 mm or more).[77] Then, study subjects with CPI 1 and 2 scores were identified as having "gingivitis", and study subjects with CPI 3 and 4 scores were considered as having "periodontitis".[78]

Furthermore, periodontitis can be classified into; mild periodontitis: when there are two or more interproximal sites with attachment loss of ≥3 mm and probing depths of ≥4 mm, not on the same tooth, moderate periodontitis: when there are two or more interproximal sites with attachment loss of ≥4 mm, and probing depths of ≥5 mm, not on the same tooth, and severe periodontitis: when there are two or more interproximal sites with attachment loss of ≥6 mm and probing depth of ≥5 mm.[79,80]

Generally, to maintain the quality of the result, three days of training was given for data collectors and supervisors regarding study objectives, content, context and filling of questionnaires, interviewing technique, confidentiality issues, study participants' rights, consenting, respondents approaching technique, and anthropometric measurement and reading. Moreover, pretest, close supervision of data collection, and double-entry of data were done.

Data Processing and Analysis

The data were checked for their completeness, and then the data were entered into Epi-Data Manager 4.2 and then transferred to a statistical package for social science (SPSS) version 21 for analysis. Descriptive statistics (frequency, percentage, mean and standard deviation) were used to describe the socio-demographic variables, behavioral variables, obstetrical variables, nutritional variables, and clinical and anthropometric measurements.

Multicollinearity among independent predictors was checked; a predictor with a variance inflation factor (VIF) of >2 was dropped from the analysis.

Binary logistic regression analysis was done to see the significant association between each predictor and periodontal disease. Then, predictors with a p-value of <0.05 were included in a multivariable logistic regression model to control all possible confounders and to identify the strong predictors significantly associated with periodontal disease. The model fitness was checked using the Hosmer–Lemeshow goodness-of-fit test and a p-value of >0.05 was considered as a good fit. Then, after computing for the measure of association both before and after adjusting for potential confounding factors and if there is a 10% or more difference between the two measures of association, the predictor is considered as a confounder. Finally, significant predictors associated with periodontal disease were determined at a p-value of <0.05 and a CI of 95%.

Results

Socio-Demographic Characteristics of the Respondents

A total of 618 women attending ANC with a 100% response rate were enrolled in this study. The mean (±SD) age of the study participants was 31.07 ± 7.8 years with most 160 (25.9%) of participants were in the age range of 18–24 years. More than half 336 (54.4%) and 338 (54.7) of the total participants were urban residents and married, respectively. Regarding their ethnicity, 158 (25.6%), 146 (23.6%), and 126 (20.4%) of the total participants were Bench, Kaffa, and Amhara, respectively. Nearly half of the participants, 279 (45.1%) could not read and write. Regarding participants' economic status, a poor wealth index was observed among 230 (37.2%) of the total participants [Table 1].

Oral Hygiene and Nutritional Status Related Characteristics

Of the total participants, about 237 (38.3%) were received health education regarding oral hygiene, and most of them, 104 (16.8%) were received health education from nurses. About 233 (37.7%) of the participants ever visited a dental clinic or dentist, of which 84 (13.6%), and 65 (10.5%) of participants have visited a dentist due to toothache and decayed teeth, respectively. Concerning tooth care, about 415 (67.2%) of the participants have been practicing brushing of teeth. Of those who practiced tooth brushing, 248 (40.1%) participants were brushed their teeth two or fewer times per day. Regarding their nutritional status, most of the participants 456 (73.8%) had normal weight, whereas 85 (13.8%) and 59 (9.5%) had overweight and underweight, respectively [Table 2].

Substance, Obstetrical, and Psychosocial Related Characteristics

Of the total participants, half of the participants 314 (50.8%) were ever used substances. Regarding their obstetrical characteristics, about 347 (56.1%) of participants have a history of gravida one, whereas 354 (57.3%) of participants have a history of para one and less. Concerning their psychosocial related characteristics, about 138 (22.3%), 158 (25.6%), and 174 (28.2%) of participants had depression, anxiety, and stress, respectively [Table 3].

Prevalence of Periodontal Disease

Periodontal disease was observed among 240 (38.8%) of the total participants with 95% C.I of (35%, 43%), and among these, gingivitis, mild periodontitis, moderate periodontitis, and severe periodontitis were observed among 86 (35.8%), 66 (27.5%), 64 (26.7%), and 24 (10%) of participants, respectively. Of the total study participants, healthy participants, participants with gingivitis, mild periodontitis, moderate periodontitis, and severe periodontitis were observed among 378 (61.2%), 86 (13.9%), 66 (10.7%), 64 (10.4%), and 24 (3.9%) of participants [Figure 2].

Table 1 Socio-Demographic Characteristics of Women Attending ANC (n = 618) in Public Hospitals, South West Ethiopia, 2022

Variables	Healthy N (%)	Gingivitis N (%)	Periodontitis N (%)	Total N (%)
Place of residence				
Urban	244(72.6)	33(9.8)	59(17.6)	336(54.4)
Rural	134(47.5)	53(18.8)	95(33.7)	282(45.6)
Age of participants (Years)				
18–24	117(73.1)	13(8.1)	30(18.8)	160(25.9)
25–29	69(67.0)	15(14.6)	19(18.4)	103(16.7)
30–34	69(65.7)	17(16.2)	19(18.1)	105(17.0)
35–39	55(50.0)	22(20.0)	33(30.0)	110(17.8)
≥40	68(48.6)	19(13.6)	53(37.9)	140(22.7)
Mean (±SD)				31.07±7.8
Marital status				
Married	208(61.5)	43(12.7)	87(25.7)	338(54.7)
Single	106(62.4)	22(12.9)	42(24.7)	170(27.5)
Divorced	38(60.3)	9(14.3)	16(25.4)	63(10.2)
Widowed	26(55.3)	12(25.5)	9(19.1)	47(7.6)
Religion				
Orthodox	166(61.0)	40(14.7)	66(24.3)	272(44.0)
Protestant	128(63.1)	29(14.3)	46(22.7)	203(32.8)
Muslim	74(60.2)	16(13.0)	33(26.8)	123(19.9)
Others*	10(50.0)	1(5.0)	9(45.0)	20(3.2)
Ethnicity				
Bench	99(62.7)	26(16.5)	33(20.9)	158(25.6)
Kaffa	88(60.3)	15(10.3)	43(29.5)	146(23.6)
Amhara	71(56.3)	24(19.0)	31(24.6)	126(20.4)
Sheka	46(63.0)	8(11.0)	19(26.0)	73(11.8)
Tigre	32(65.3)	4(8.2)	13(26.5)	49(7.9)
Oromo	27(60.0)	6(13.3)	12(26.7)	45(7.3)
Other**	15(71.4)	3(14.3)	3(14.3)	21(3.4)
Respondent's educational status				
Cannot read and write	159(57.0)	41(14.7)	79(28.3)	279(45.1)
Can read and write	92(59.0)	22(14.1)	42(26.9)	156(25.2)
Primary (1–8)	53(62.4)	12(14.1)	20(23.5)	85(13.8)
Secondary (9–12)	30(71.4)	5(11.9)	7(16.7)	42(6.8)
Certificate and above	44(78.6)	6(10.7)	6(10.7)	56(9.1)
Respondent's occupational status				
Farmer	134(63.8)	24(11.4)	52(24.8)	210(34.0)
Merchant	59(57.8)	13(12.7)	30(29.4)	102(16.5)
Housewife	57(53.3)	21(19.6)	29(27.1)	107(17.3)
Government employee	39(69.6)	4(7.1)	13(23.2)	56(9.1)
Student	31(66.0)	5(10.6)	11(23.4)	47(7.6)
Daily workers	24(55.8)	10(23.3)	9(20.9)	43(7.0)
NGO workers	34(64.2)	9(17.0)	10(18.9)	53(8.6)
Partner educational status				
Cannot read and write	139(61.8)	32(14.2)	54(24.0)	225(36.4)
Can read and write	107(62.2)	22(12.8)	43(25.0)	172(27.8)
Primary (1–8)	57(55.9)	16(15.7)	29(28.4)	102(16.5)
Secondary (9–12)	36(60.0)	7(11.7)	17(28.3)	60(9.7)
Certificate and above	39(66.1)	9(15.3)	11(18.6)	59(9.5)

Table 1 (Continued).

Variables	Healthy N (%)	Gingivitis N (%)	Periodontitis N (%)	Total N (%)
Partner occupational status				
Farmer	134(62.3)	25(11.6)	56(26.0)	215(34.8)
Merchant	113(56.2)	33(16.4)	55(27.4)	201(32.5)
Student	34(64.2)	9(17.0)	10(18.9)	53 (8.6)
Daily worker	39(69.6)	4(7.1)	13(23.2)	56(9.1)
Government employee	34(68.0)	5(10.0)	11(22.0)	50(8.1)
NGO workers	24(55.8)	10(23.3)	9(20.9)	43(7.0)
Wealth index				
Poor	109(47.4)	40(17.4)	81(35.2)	230(37.2)
Medium	131(63.0)	33(15.9)	44(21.2)	208(33.7)
Rich	138(76.7)	13(7.2)	29(16.1)	180(29.1)

Note: *Catholic, and Jehova's witness, **Gurage, Hadiya, and Wolayita.
Abbreviations: SD, standard deviation; NGO, non-governmental organization.

Predictors Associated with Periodontal Disease

In bivariate logistic regression analysis, the association of different predictors related to socio-demographic characteristics, chronic medical illnesses, anthropometric measurements, and obstetrical characteristics with periodontal disease among pregnant women were checked. Then, predictors, such as the age of participant, residence, educational status, wealth index, nutritional status, heard about periodontal disease, frequency of toothbrush, lifetime use of chat, depression, history of diabetes mellitus, self-perceived halitosis, history of ANC, gestational age, and gravidity, was found to be significantly associated with the periodontal disease among pregnant women.

These eligible predictors were adjusted for possible confounders using multivariate logistic regression analysis. Accordingly, women who were rural residents were almost three times more likely to develop PD compared to those who lived in urban (AOR = 3.01, 95% CI = [1.79–5.08]). Similarly, those women who could not read and write (AOR = 5.05, 95% CI = [1.67–15.31]) and those women with poor wealth index (AOR = 3.12, 95% CI = [1.66–5.87]) were 5.05 and 3.12 times more likely to develop the periodontal disease compared to women with educational status of the certificate and above, and rich wealth index, respectively. Those women with nutritional status of underweight (AOR = 4.67, 95% CI = [2.12–30.59]), and those who had no information about periodontal disease (AOR = 2.79, 95% CI = [1.39–5.59]) were also 4.67, and 2.79 times more likely to develop the periodontal disease compared to women with nutritional status of obesity and women who had information about PD, respectively.

Moreover, women who had depression (AOR = 2.37, 95% CI = [1.33–4.22]), had history of diabetes mellitus (AOR = 3.99, 95% CI = [1.08–14.81]), had self-perceived halitosis (AOR = 2.28, 95% CI = [1.15–4.52]), were 2.37, 3.99, and 2.28 times more likely to develop periodontal disease compared to their counterparts, respectively. Obstetrical variables like; women who had no history of ANC (AOR = 2.25, 95% CI = [1.34–3.77]), and women had gestational age at second trimester (AOR = 1.71, 95% CI = [1.00–2.92]) were also 2.25, and 1.71 times more likely to have periodontal disease among pregnant women compared with their counterparts, respectively [Table 4].

Discussion

Periodontal disease is a public health problem that causes morbidity and mortality of all age groups.[81,82] In the current study, we have assessed the prevalence of periodontal disease and its contributing factors. The findings could be beneficial for policymakers and programmers to minimize the burden of periodontal disease. Therefore, the aim of this study was to determine the prevalence of periodontal disease and its predictors among women attending ANC in public hospitals, southwest Ethiopia.

According to this study, the overall prevalence of periodontal disease was 240 (38.8%) with 95% C.I of (35%, 43%). This finding was found to be higher than the studies conducted in Sudan, 24.0%,[17] in Tanzania, 14.2%,[14] in Brazil,

Table 2 Oral Hygiene and Nutritional Status-Related Characteristics of Women Attending ANC in Public Hospitals, South West Ethiopia, 2022

Variables	Frequency	%
Health education on oral hygiene		
No	381	61.7
Yes	237	38.3
Health education provider		
HEW	76	12.3
Nurse	104	16.8
Dentist	57	9.2
Ever heard of PD		
No	405	65.5
Yes	213	34.5
Source of information related to PD		
Radio	25	4.0
Television	34	5.5
Friends	38	6.1
HEWs	62	10.0
HPs	54	8.7
Ever visited dental clinic		
No	385	62.3
Yes	233	37.7
Reason of visiting dental clinic or dentist		
Toothache	84	13.6
Gum bleeding	40	6.5
Swollen gum	44	7.1
Decayed Teeth	65	10.5
Practice of tooth brushing		
No	203	32.8
Yes	415	67.2
Frequency of tooth brushing		
≤2 Times per day	248	40.1
≥3 Times per day	167	27.0
Tooth brushing means		
Always water with tooth brushing soap	69	11.2
Not always water with tooth brushing soap	208	33.7
Sometimes wash only with water	138	22.3
Ways of tooth brushing		
Horizontal stroke	117	18.9
Vertical stroke	181	29.3
Semi-circular	117	18.9
Use of dental flossing		
No	334	54.0
Yes	284	46.0
Frequency of dental flossing		
≤2 Times per day	172	27.8
≥3 Times per day	112	18.1
Use of charcohol		
No	311	50.3
Yes	307	49.7
Frequency of charcohol use		
≤2 Times per day	188	30.4
≥3 Times per day	119	19.3

(*Continued*)

Table 2 (Continued).

Variables	Frequency	%
Use of salt		
No	287	46.4
Yes	331	53.6
Frequency of salt use		
≤2 Times per day	205	33.2
≥3 Times per day	126	20.4
Nutritional status (BMI)		
Underweight (<18.5)	59	9.5
Normal weight (18.5–24.9)	456	73.8
Overweight (25–29.9)	85	13.8
Obesity (≥30)	18	2.9
Household food insecurity		
Food Secure	473	76.5
Mild food insecure	24	3.9
Moderate food insecure	81	13.1
Severe food insecure	40	6.5
Self-perceived halitosis		
No	339	54.9
Yes	279	45.1

Abbreviations: PD, periodontal disease; HEWs, health extension workers; HPs, health professionals (nurse, dentist, midwives); BMI, body mass index.

17.24%,[83] and in Jordan, 31%.[15] In contrast to this, this study was found to be lower as compared with the studies conducted in Amsterdam, 67%,[84] in India, 54.8%,[13] and in China, 84.7%.[85] This discrepancy might be due to different populations, study designs, variation in sample size, and the use of different tools that may contribute to the differences observed. This study was also found to be consistent with the studies conducted in Northwest Ethiopia, 42.4%.[18] This similarity might be due to the similar oral health care practice and health care system availability in Ethiopia.

Accordingly, in this study, women who were rural residents were almost three times more likely to develop PD compared to those who lived in urban areas. This study is consistent with the studies conducted in India,[86] and in Northwest Ethiopia.[18] This is due to the fact that individuals from rural areas do not pay attention to oral health due to lack of awareness, inadequate availability of dental health services, and lack of an organized healthcare system.[87]

Similarly, this study also found that predictors such as low educational status, poor wealth index, and no information about periodontal disease were more likely to develop periodontal disease. The study's findings are in line with the studies conducted in the United States,[88] and Northwest Ethiopia.[18] These disparities in socio-economic status indicators (ie, education and income) are known to affect periodontal health in which individuals' educational status could determine their employment status, job position, and earned income and even affect their awareness and behaviors towards periodontal disease and periodontal health service utilization.[89]

In this study, those women with poor nutritional status were more likely to develop periodontal disease. This study is corroborated with the studies conducted in Southeast Queensland, Australia,[90] and in Germany.[91] This situation is justified by the reason that being malnourished, or having a lack of proper nutrients like vitamin D, can negatively affect oral health (eg, teeth, gums, and bone that support the tooth) leading to increased risk of periodontal disease and other oral health-related problems.[92]

Moreover, psycho-social factors like women with self-reported scoring of depression are associated with periodontal disease. This study is supported by the studies conducted in the Finger Lakes region, New York State,[93] and in India.[94] This biological plausibility for an association between depression and periodontal disease is due to the fact that depression affects the immune system due to the disturbance in the hypothalamic-pituitary-thyroid system.[95] Similarly, factors related to medical illness like a history of diabetes mellitus are associated with periodontal disease. This finding is

Table 3 Substance, Obstetrical, and Psychosocial-Related Characteristics of Women Attending ANC in Public Hospitals, South West Ethiopia, 2022

Variables	Frequency	%
Ever use of substance		
No	304	49.2
Yes	314	50.8
Chronic medical history		
No	457	73.9
Yes	161	26.1
Age at first pregnancy		
≤20 Years	232	37.5
21–22 Years	121	19.6
23–25 Years	128	20.7
> 25 Years	137	22.2
Gravidity		
1 Gravida	347	56.1
≥2 Gravida	271	43.9
Parity		
≤ 1 Para	354	57.3
≥ 2 Para	264	42.7
Gestational age		
2nd Trimester	410	66.3
3rd Trimester	208	33.7
ANC follow-up during last child pregnancy		
No	215	34.8
Yes	403	65.2
Depression		
No	480	77.7
Yes	138	22.3
Anxiety		
No	460	74.4
Yes	158	25.6
Stress		
No	444	71.8
Yes	174	28.2

Abbreviation: ANC, antenatal care.

consistent with the studies conducted in Sudan,[96] and in Indonesia.[97] This could be explained by the fact that diabetes contributes to the development of periodontal disease, due to an increase in the levels of inflammatory mediators, such as interleukin-1β (IL-1β) and tumor necrosis factor-α (TNF-α).[98]

In this study, self-perceived halitosis is also associated with periodontal disease. This finding is supported by the study conducted in Ilala and Temeke municipals, Dar-es-Salaam, Tanzania,[99] and in Spain.[100] This is due to the reason that halitosis arising from the oral cavity might be due to causative organisms residing deep in periodontal pockets and on the dorsal part of the tongue. Therefore, this film of bacteria called plaque can cause halitosis, irritate the gums, and cause inflammation to the periodontium, which finally causes periodontal disease.[101]

In this study, obstetrical variables like women who had no history of ANC and women with lower gestational age were more likely to have periodontal disease. This finding is consistent with the studies conducted in Nigeria,[102] and in Khartoum, Sudan.[17] This is explained by the reason that the regular ANC visit provides an opportunity for women to be screened for different medical problems associated with oral health problems, especially during an early stage of
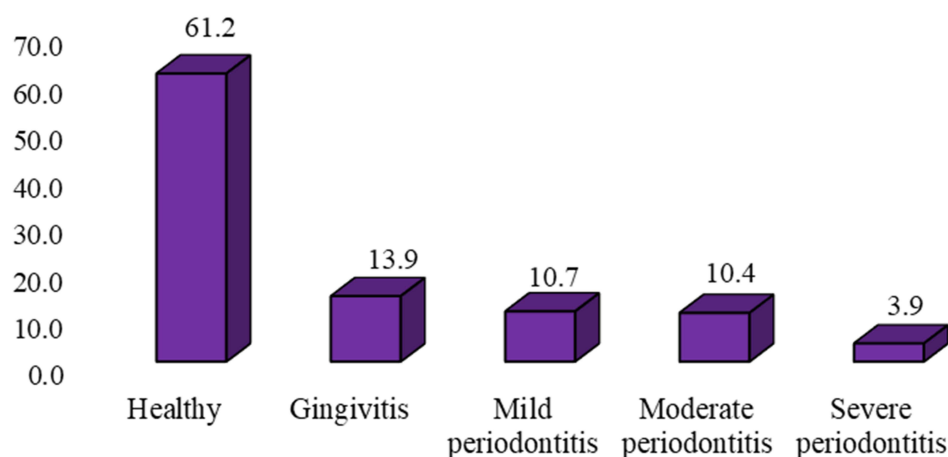
Participants dental health status

Figure 2 Dental health status of women attending ANC in public hospitals, Southwest Ethiopia, 2022.

pregnancy. Therefore, early, regular, and repeated visits of ANC could minimize the risk of periodontal disease associated with hormonal change during lower gestational age.[103]

This study has its own strengths. First, since this study was conducted in the three public hospitals, it increases the probability of generalizability of periodontal disease among pregnant women. Second, this study was done using the modified version of the Community Periodontal Index of Treatment Need (CPITN) which is the Community Periodontal Index (CPI) tool by the inclusion of measurement of "Loss of attachment". Third, this study also identified factors related to substance, obstetrical, and psychosocial characteristics of the respondents associated with the periodontal disease, which were not included in the previous studies conducted in Ethiopia. However, this study has its own limitations. First, this study did not examine the pattern and extent of alveolar bone loss using radiographic assessment but simply relied on detection of the signs of periodontal disease using periodontal probes. Second, since this study was a cross-sectional study, it did not show the cause and effect relationship of variables, and therefore, this study's results should be interpreted with caution. Furthermore, since this study was conducted for the epidemiological purpose, it only examines the index teeth (do not examine all teeth just like for clinical purposes) and records the highest score in each sextant. Therefore, it could probably result in an underestimation of the prevalence of the disease.

Conclusion

In this study, the prevalence of periodontal disease was found to be significantly higher. Different predictors such as residence, educational status, wealth index, nutritional status, information about periodontal disease, depression, history of diabetes mellitus, self-perceived halitosis, history of ANC, and gestational age were also found to be significantly associated with the periodontal disease among pregnant women. Therefore, in order to minimize the burden of periodontal disease among pregnant women, oral, medical, and mental health education and dental examination should be included as an integral part of preconception care and antenatal care. The clinical features and feto-maternal complications associated with periodontal disease and its risks associated with medical and mental illness have to be investigated to provide appropriate management to the women attending ANC and the community at large. Moreover, comprehensive oral health cares such as promoting healthy eating habits and tooth-brushing activities, preventing tobacco/alcohol abuse in pregnant women, and promoting oral health screening programs in schools, market places and other health care institutions should be practiced among pregnant women and general population.

Table 4 Independent Factors Associated with Periodontal Disease Among Women Attending ANC in Public Hospitals, South-West Ethiopia, 2022

Variables	Periodontal Disease		Logistic Regression Analysis	
	No N (%)	Yes N (%)	COR (95% CI)	AOR (95% CI)
Age of participant (Years)				
18–24	117(73.1)	43(26.9)	1.00[+]	1.00[+]
25–29	69(67.0)	34(33.0)	1.34(0.78–2.29)	0.97(0.46–2.05)
30–34	69(65.7)	36(34.3)	1.42(0.83–2.42)	1.29(0.59–2.87)
35–39	55(50.0)	55(50.0)	2.72(1.63–4.54)*	1.86(0.75–4.62)
≥40	68(48.6)	72(51.4)	2.88(1.78–4.66)*	2.11(0.86–5.19)
Residence				
Urban	244(72.6)	92(27.4)	1.00[+]	1.00[+]
Rural	134(47.5)	148(52.5)	2.93(2.09–4.09)*	3.01(1.79–5.08)*
Educational status				
Cannot read and write	159(57.0)	120(43.0)	2.77(1.40–5.47)*	5.05(1.67–15.31)*
Able to read and write	92(59.0)	64(41.0)	2.55(1.25–5.21)*	3.62(1.13–11.55)*
Primary (1–8)	53(62.4)	32(37.6)	2.21(1.02–4.80)*	4.14(1.21–14.14)*
Secondary (9–12)	30(71.4)	12(28.6)	1.47(0.58–3.69)	3.22(0.79–13.17)
Certificate and above	44(78.6)	12(21.4)	1.00[+]	1.00[+]
Wealth index				
Poor	109(47.4)	121(52.6)	3.65(2.37–5.62)*	3.12(1.66–5.87)*
Medium	131(63.0)	77(37.0)	1.93(1.24–3.02)*	1.85(0.97–3.53)
Rich	138(76.7)	42(23.3)	1.00[+]	1.00[+]
Nutritional status				
Underweight	13(22.0)	46(78.0)	9.20(2.77–30.58)*	4.67(2.12–30.59)*
Normal weight	293(64.3)	163(35.7)	1.45(0.51–4.13)	4.61(0.79–26.54)
Overweight	59(69.4)	26(30.6)	1.15(0.37–3.55)	2.34(0.37–14.84)
Obesity	13(72.2)	5(27.8)	1.00[+]	1.00[+]
Heard about periodontal disease				
No	236(58.3)	169(41.7)	1.43(1.01–2.03)*	2.79(1.39–5.59)*
Yes	142(66.7)	71(33.3)	1.00[+]	1.00[+]
Frequency of tooth brush				
≤2 times per a day	147(59.3)	101(40.7)	1.52(1.00–2.29)*	0.74(0.45–1.23)
≥3 times per a day	115(68.9)	52(31.1)	1.00[+]	1.00[+]

(*Continued*)

Table 4 (Continued).

Variables	Periodontal Disease		Logistic Regression Analysis	
	No N (%)	Yes N (%)	COR (95% CI)	AOR (95% CI)
Lifetime use of chat				
No	301(63.8)	171(36.2)	1.58(1.08–2.29)*	1.48(0.81–2.73)
Yes	77(52.7)	69(47.3)	1.00+	1.00+
Depression				
No	314(65.4)	166(34.6)	1.00+	1.00+
Yes	64(46.4)	74(53.6)	2.19(1.49–3.21)*	2.37(1.33–4.22)*
History of Diabetes Mellitus				
No	370(62.9)	218(37.1)	1.00+	1.00+
Yes	8(26.7)	22(73.3)	4.67(2.04–10.66)*	3.99(1.08–14.81)*
Self-perceived halitosis				
No	232(68.4)	107(31.6)	1.00+	1.00+
Yes	146(52.3)	133(47.7)	1.98(1.42–2.74)*	2.28(1.15–4.52)*
History of ANC				
No	99(46.0)	116(54.0)	2.64(1.87–3.71)*	2.25(1.34–3.77)*
Yes	279(69.2)	124(30.8)	1.00+	1.00+
Gestational Age				
Second trimester	231(56.3)	179(43.7)	1.87(1.31–2.67)*	1.71(1.00–2.92)*
Third trimester	147(70.7)	61(29.3)	1.00+	1.00+
Gravidity				
≤ 1	230(66.3)	117(33.7)	1.00+	1.00+
≥2	148(54.6)	123(45.4)	1.63(1.18–2.27)*	0.91(0.47–1.77)

Notes: *Adjusted for all significant variables p <0.05. +Reference Category.

Abbreviations

ANC, Antenatal Care; AOR, Adjusted Odd Ratio; ASSIST, Alcohol, Smoking and Substance Involvement Screening Tool; BMI, Body mass index; BOP, Bleeding on Probing; BPE, Basic Periodontal Examination; CEJ, Cemento-Enamel Junction; COR, Crude Odd Ratio; CPI, Community Periodontal Index; CPITN, Community Periodontal Index of Treatment Need; DAS-S, Depression, Anxiety and Stress Scale; FANTA, Food and Nutrition Technical Assistance; GBI, Gingival Bleeding Index; GSGH, Gebretsadik Shawo General Hospital; HEWs, Health extension Workers; HFIAS, Household Food Insecurity Access Scale; HPs, Health professionals; IR, Insulin Resistance; MTUTH, Mizan-Tepi University Teaching Hospital; NGO, Non-governmental Organization; PD, Periodontal Disease; PSR, Periodontal Screening Record; ROS, Reactive Oxygen Species; SD, Standard Deviation; SPSS, Statistical Package for Social Science; TGH, Tepi General Hospital; US, United States; VIF, Variance Inflation Factor; WHO, World Health Organization.

Data Sharing Statement

All relevant data are included within the manuscript, but any additional data required are available from the corresponding author upon reasonable request; Email: Alex.sayihalem2018@gmail.com.

Ethical Approval and Consent to Participate

This study was conducted in accordance with the Declaration of Helsinki, and after ethical clearance was obtained from the research directorate office of the Mizan Tepi University (Ref No: MTU/CHS/12/1619/21/14). Written consent was obtained from each study participant after explaining the purpose and objectives of the study. For those participants who were illiterate, a fingerprint was used as a signature after trained interviewers had carefully explained the purpose, benefits, and potential risks before consent was obtained. The interview with study participants was conducted with strict privacy and confidentiality. The intra-oral examination using the periodontal probe and anthropometric measurements was also performed following the manufacturer's instructions and interpreted accordingly. Then, all necessary information and the results of each study participant were communicated with their physicians for further investigations and management.

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Author Contributions

Both authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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The authors report no conflicts of interest in relation to this work.

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