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ORIGINAL RESEARCH

Epidemiological Factors of Periodontal Disease Among South Indian Adults

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Introduction: Oral conditions exist worldwide, and are related with astounding morbidity. Indian adults' incidence of mild and moderate periodontal conditions was nearly 25%, while about 19% of adults experience severe periodontitis.

Objective: The aim of this study was to analyse epidemiological factors of periodontal disease among a south Indian population based on the role of sociodemographic factors, habitual factors and set of oral health knowledge, attitude, and behaviour measures.

Methods: A sample of 288 participants above 18 years of age residing in Tamil Nadu, India took part in this cross-sectional study. Based on WHO criteria, periodontal disease was measured in our study. Age, ethnicity, smoking, education, and oral health behavior were found to be the covariates. Ordinal logistic regression analysis using R version 3.6.1 was utilized to study the various factors that influence periodontal disease among south Indian adults.

Results: Various demographic factors such as age between 25 and 34 years (AOR = 2.25; 95% CI 1.14–4.55), 35–44 years (AOR = 1.80; 95% CI 0.89–3.64), ≥ 45 years old (AOR = 2.89; 95% CI 1.41–6.01), ethnicity (AOR = 2.71; 95% CI 1.25–5.81), smoking (AOR = 0.38; 95% CI 0.16–0.65), primary level education (AOR = 0.07; 95% CI 0.01–0.50) high school level education (AOR = 0.06; 95% CI 0.01–0.27), university level education (AOR = 0.08; 95% CI 0.01–0.36) and an individual's oral health behavior (AOR = 0.59; 95% CI 0.32–1.08) were found to be related with periodontal disease among the south Indian population. The maximum log likelihood residual deviance value was 645.94 in the final model.

Conclusion: Based on our epidemiological findings, sociodemographic, habitual factors and oral health behavior play a vital role in an individual's periodontal status among south Indian adults. An epidemiological model derived from the factors from our study will help to bring better understanding of the disease and to implement various preventive strategies to eliminate the causative factors.

Keywords: periodontal disease, epidemiology, modelling, socio-demography, habits

Introduction

Oral conditions exist worldwide, and are related with astounding morbidity. Disparity on oral care is the major reason for poor oral hygiene; people from the Indian sub-continent especially undergo substantial disparity in care towards oral health.[1] Considering Indian adults' oral conditions, the incidence of mild and moderate periodontal conditions was nearly 25%, while about 19% of adults experience severe periodontitis.[2] Periodontal disease causes destruction of tissues around the teeth,[3] has a negative influence on self-esteem and affects the quality of life of an individual.[4–6]

Periodontal conditions should be investigated in an extensive manner as there is a firm indication on association of various systemic diseases such as diabetes, cardiovascular conditions, and metabolic syndrome with periodontal disease.[7,8] Based on earlier studies, factors such as sociodemography and habits should be assessed in relation with

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periodontal disease as they influence an individual's oral hygiene. It has been well established that there are oral hygiene disparities between people from divergent socioeconomic backgrounds.[9,10] In addition, sociodemographic factors such as ethnicity and level of education also influence an individual's oral health status.[11]

A person's apprehension towards oral health is based on awareness towards their oral hygiene.[12] Considering the Indian population, information on oral health is very much limited.[13,14] It is well established that almost all conditions that are related with oral health could be reduced by providing ideal knowledge and awareness towards oral health.[15] Professionals from dental background can play a role as an oral health educator by educating individuals, which can have a major impact on individual and community levels. However, it is good to know about a person's knowledge, attitude, and behavior towards oral health before educating them.[16] Though there is ample evidence on oral health and risk factors there is a no documentation of epidemiological data of periodontal disease in India.[2]

In the event of disease development, epidemiological disease models often help to address the growing concern about the disease by considering the data from study centres, meta-analyses, experimental studies, and the opinion of experts to better understand the disease's dynamics. An epidemiological model derived from the epidemiological factors represents a program or a system created to understand the influence of several external outputs on the system for representative purposes and communication between the behaviors of the system. Epidemiological models are usually defined as mathematical and/or logical representations of the epidemiology of disease transmission and its associated processes. They can include a wide range of statistical/mathematical tools that view all potential confounding factors, in addition to what they were designed for.[17] Epidemiological models help to study and research disease dynamics,[18] to formulate hypotheses on factors that have a role in diseases,[17] to explain and suggest precautionary measures and risks related to infectious diseases and pathogens and their contagious patterns,[19] to evaluate the economic toll the diseases have on the community/state/nation, to investigate and implement various preventive and control strategies,[20] to evaluate the efficacy of ongoing surveillance control programs and initiatives taken by officials,[21] and to provide inputs and scenarios for training activities.[17] Hence, we aimed to find out various epidemiological factors that influence periodontal disease by analysing the relationship between sociodemographic factors, habits, and oral health knowledge, attitude, and behavior among south Indian adults.

Materials and Methods

Study Participants, Sample Size Determination, and Sampling Method

A cross-sectional study was done among 288 adults of south India who live in Tamil Nadu. Participants in our study were from a residential community, who reside in Chennai, Tamil Nadu and participated in a health camp. Individuals who were above the age of 18 years and volunteered themselves to be a part of our study were included. Individuals who were mentally, physically, and legally incapacitated, pregnant ladies and individuals with medical complications were not included in our research. These criteria were based on the recommendations given by Palmer in his study on adults with periodontal disease disparities.[22] The participants were selected from the total residents list in the study location and included by utilizing systematic sampling method with selected interval based on the total sample size as it assures that the sample population are evenly selected in our study.

Ethics Approvals

Before carrying out our study, we obtained ethics approvals from the Human Research Ethics Committee – Universiti Sultan Zainal Abidin (UHREC) and RIPON independent ethics committee – Chennai. Participants who were willing to participate in this study were asked to fill out the informed consent forms. Our study purpose, procedure, and confidentiality were explained to the participants. Our study complies with the Declaration of Helsinki.

Data Collection Procedures

Data were collected during February 2021. Oral investigation was done by the primary investigator, a dental public health specialist who has complete knowledge about periodontal conditions. Professionals from a healthcare background have high possibility to get Covid-19 infection. Dentists have high potential to get Covid-19 while contacting patients face-to-face during oral examination.[23,24] Oral investigation was carried out following SOP guidelines provided by the state health department. The primary investigator investigated the periodontium utilizing artificial light and dental explorer, a Community Periodontal Index

(CPI) probe and wearing disposable gloves. Instruments employed during our oral investigation were sterilized. CPI was adopted to examine periodontal profile subjected to WHO recommendations on periodontal disease diagnostic criteria, in which score 0 was given to healthy gums with absence of periodontal disease, score 1 for bleeding on probing, score 2 for presence of calculus during probing, score 3 for presence of periodontal pocket with depth between 3.5–5.5 mm and score 4 denoting presence of periodontal pocket with depth 6 mm or more.[25]

All six sites of tooth were examined using a CPI probe. Bleeding on probing (BOP) and probing pocket depth (PPD) were examined to assess the gingival sulcus depth to ascertain of the periodontal status of an individual.[26]

Content of the Questionnaire

The validated questionnaire[1,27] contains of nine questions on sociodemographic and habitual profile and 26 questions to investigate oral health knowledge, attitude, and behavior of south Indian adults. The study participants were asked to answer this questionnaire. Responses on oral health knowledge, attitude, and behavior were categorised into poor, average, and good. In knowledge domain, those who answered correctly for <4 knowledge-based questions were considered to have poor knowledge. The individuals who could correctly answer >4 to ≤7 questions were considered to have average knowledge and those who were able to give the right answers for ≥8 questions were said to have good knowledge towards oral health.

In the attitude and behavior domain, individuals who could provide right answers for ≤2 questions were categorized into poor attitude and behavior towards oral health. Furthermore, individuals who could provide correct answers for >2 to <5 questions were considered to possess average attitude and behaviour towards oral health and individuals who were able to give right answers for ≥5 questions were said to have good knowledge towards oral health. The participants took 5–10 minutes to complete the questionnaire given to them.

Questions Towards Oral Health Knowledge

The knowledge domain of the validated questionnaire contains 11 items that covers various factors such as symptoms of oral diseases, etiology of oral conditions, treatment procedures, clinical manifestation of oral diseases, and oral health preventive measures.

Questions Towards Oral Health Attitude

The attitude domain of the validated questionnaire accommodates 8 items based on oral health maintenance attitudes that cover an individuals' oral health attitudes based on health belief model.

Questions Towards Oral Health Behavior

The behavior domain of the validated questionnaire incorporates 7 items based on individuals' measures on oral hygiene that might have consequence towards their oral health.

Statistical Analysis

In the current study, the association of different factors such as socioeconomic and socio-demographic characteristics, habits, oral health knowledge, attitude, and behavior (KAB), collected using a structured questionnaire and survey procedure and the ordinal outcome of periodontal disease (0–4 different levels of severity) was studied with the help of the ordinal regression model.

Initial statistical analyses included the descriptive statistics of the different periodontal disease groups (0–4) for each variable. Comparison of variables between groups was carried out using chi-square test. For ordinal regression analysis, each variable was first separately analyzed (univariate analysis), and those showing a P value <0.20 were further considered for multivariate analysis. Forward stepwise method was chosen for obtaining the final model. Ordinal regression analysis was conducted according to the cumulative proportionality method.[28] For all the logistic regression models, parameter estimates, standard error of estimates, odds ratios, 95% confidence intervals and P-values of each factor were computed. Goodness of fit of multivariate and final ordinal logistic regression models were determined by the Lipsitz and the Pulkstenis–Robinson tests.[29] Akaike information criterion (AIC) and Residual Deviance of models were

compared to establish the fit of the model. In addition, fit of binary logit models was determined by Hosmer–Lemeshow and Pearson chi-square tests. All statistical tests were performed using R software program. Statistical significance was set at 5% level of significance (P<0.05).

Results

A total of 288 patients were included in this study. Out of 288 participants, 167 (57.99%), 49 (17.01%), 30 (10.42%), 22 (7.64%), and 20 (6.94%) participants were with periodontal profile 0, 1, 2, 3 and 4 respectively. The descriptive statistics for the study population are presented in Table 1. Comparison of periodontal disease profile with oral health knowledge, attitude and behavior profile are presented in Table 2.

Table 1 Comparison of Sociodemographic, Habitual Factors and Periodontal Profile Among Adults, Tamil Nadu, India, 2021 (n = 288).

Variable		n = 288	Periodontal Disease					P value
			0 n = 167 (57.99%)	1 n = 49 (17.01%)	2 n = 30 (10.42%)	3 n = 22 (7.64%)	4 n = 20 (6.94%)	
Gender	Male	147(51.04%)	83(49.7%)	23(46.94%)	15(50%)	15(68.18%)	11(55.00%)	0.46
	Female	141(48.96%)	84(50.3%)	26(53.06%)	15(50%)	7(31.82%)	9(45.00%)	
Age	18–24 years	68(23.61%)	48(28.74%)	14(28.57%)	3(10%)	2(9.09%)	1(5.00%)	<0.001
	25–34 years	65(22.57%)	29(17.37%)	19(38.78%)	11(36.67%)	5(22.73%)	1(5.00%)	
	35–44 years	84(29.17%)	54(32.34%)	5(10.2%)	10(33.33%)	6(27.27%)	9(45.00%)	
	≥ 45 years	71(24.65%)	36(21.56%)	11(22.45%)	6(20%)	9(40.91%)	9(45.00%)	
Marital	Yes	192(66.67%)	110(65.87%)	33(67.35%)	16(53.33%)	14(63.64%)	19(95%)	0.04
Status	No	96(33.33%)	57(34.13%)	16(32.65%)	14(46.67%)	8(36.36%)	1(5%)	
Religion	Hindu	237(82.29%)	140(83.83%)	40(81.63%)	24(80%)	16(72.73%)	17(85%)	0.43
	Muslim	15(5.21%)	6(3.59%)	2(4.08%)	3(10%)	3(13.64%)	1(5%)	
	Christian	30(10.42%)	19(11.38%)	4(8.16%)	3(10%)	2(9.09%)	2(10%)	
	Others	6(2.08%)	2(1.2%)	3(6.12%)	0(0%)	1(4.55%)	0(0%)	
Ethnicity	Tamil	264(91.67%)	161(96.41%)	42(85.71%)	26(86.67%)	17(77.27%)	18(90%)	<0.001
	Others	24(8.33%)	6(3.59%)	7(14.29%)	4(13.33%)	5(22.73%)	2(10%)	
Diet	Vegetarian	37(12.85%)	23(13.77%)	4(8.16%)	4(13.33%)	6(27.27%)	0(0%)	0.20
	Non-vegetarian	47(16.32%)	23(13.77%)	8(16.33%)	7(23.33%)	4(18.18%)	5(25%)	
	Mixed	204(70.83%)	121(72.46%)	37(75.51%)	19(63.33%)	12(54.55%)	15(75%)	
Smoking	Yes	40(13.89%)	15(8.98%)	9(18.37%)	2(6.67%)	10(45.45%)	4(20%)	<0.001
	No	248(86.11%)	152(91.02%)	40(81.63%)	28(93.33%)	12(54.55%)	16(80%)	
Alcohol	Yes	35(12.15%)	14(8.38%)	8(16.33%)	2(6.67%)	9(40.91%)	2(10%)	<0.001
	No	253(87.85%)	153(91.62%)	41(83.67%)	28(93.33%)	13(59.09%)	18(90.00%)	
Education	Illiterate	7(2.43%)	0(0%)	1(2.04%)	1(3.33%)	1(4.55%)	4(20.00%)	<0.001
	Primary	12(4.17%)	7(4.19%)	0(0%)	2(6.67%)	1(4.55%)	2(10.00%)	
	High school	93(32.29%)	6(3.59%)	19(38.78%)	7(23.33%)	9(40.91%)	2(10.00%)	
	University	176(61.11%)	104(62.28%)	29(59.18%)	20(66.67%)	11(50%)	12(60.00%)	
Employment	Employed	186(64.58%)	101(60.48%)	38(77.55%)	20(66.67%)	12(54.55%)	15(75.00%)	0.65
	Unemployed	23(7.99%)	14(8.38%)	2(4.08%)	2(6.67%)	3(13.64%)	2(10.00%)	
	Student	46(15.97%)	32(19.16%)	5(10.2%)	5(16.67%)	3(13.64%)	1(5.00%)	
	Homemaker	33(11.46%)	20(11.98%)	4(8.16%)	3(10.00%)	4(18.18%)	2(10%)	
Income	Below 10K ₹	98(34.03%)	63(37.72%)	15(30.61%)	8(26.67%)	4(18.18%)	8(40%)	0.45
	10K ₹ −20 K ₹	50(17.36%)	25(14.97%)	13(26.53%)	5(16.67%)	5(22.73%)	2(10%)	
	20K ₹- 30K ₹	72(25.00%)	41(24.55%)	11(22.45%)	11(36.67%)	6(27.27%)	3(15%)	
	Above 30K ₹	68(23.61%)	38(22.75%)	10(20.41%)	6(20%)	7(31.82%)	7(35%)	
House	Owned	178(61.81%)	103(61.68%)	30(61.22%)	17(56.67%)	11(50%)	17(85%)	0.18
	Rented	110(38.19%)	64(38.32%)	19(38.78%)	13(43.33%)	11(50%)	3(15%)	
Vehicle	Yes	183(63.54%)	105(62.87%)	28(57.14%)	19(63.33%)	15(68.18%)	16(80%)	0.48
	No	105(36.46%)	62(37.13%)	21(42.86%)	11(36.67%)	7(31.82%)	4(20%)	

Table 2 Comparison of Periodontal Disease Profile with Oral Health KAB Among Adults, Tamil Nadu, India, 2021 (n = 288).

Variables		n = 288	Periodontal Disease					P value
			0 n = 167 (57.99%)	1 n = 49 (17.01%)	2 n = 30 (10.42%)	3 n = 22 (7.64%)	4 n = 20 (6.94%)	
Knowledge								
1.There are two sets of teeth during lifetime	0	36(12.5%)	20(11.98%)	9(18.37%)	4(13.33%)	1(4.55%)	2(10%)	0.56
	1	252(87.5%)	147(88.02%)	40(81.63%)	26(86.67%)	21(95.45%)	18(90%)	
2. Tooth infection causes gum bleeding	0	52(18.06%)	28(16.77%)	7(14.29%)	7(23.33%)	5(22.73%)	5(25%)	0.69
	1	236(81.94%)	139(83.23%)	42(85.71%)	23(76.67%)	17(77.27%)	15(75%)	
3. Replacement of missing tooth improves oral hygiene	0	57(19.79%)	28(16.77%)	9(18.37%)	11(36.67%)	3(13.64%)	6(30%)	0.08
	1	231(80.21%)	139(83.23%)	40(81.63%)	19(63.33%)	19(86.36%)	14(70%)	
4. Dental caries of deciduous teeth need not be treated	0	204(70.83%)	125(74.85%)	33(67.35%)	18(60%)	15(68.18%)	13(65%)	0.44
	1	84(29.17%)	42(25.15%)	16(32.65%)	12(40%)	7(31.82%)	7(35%)	
5. Bacteria is one of the reasons to cause gingival problems	0	87(30.21%)	48(28.74%)	15(30.61%)	11(36.67%)	7(31.82%)	6(30%)	0.93
	1	201(69.79%)	119(71.26%)	34(69.39%)	19(63.33%)	15(68.18%)	14(70%)	
6. Fizzy soft drinks affect the teeth adversely	0	71(24.65%)	43(25.75%)	8(16.33%)	8(26.67%)	6(27.27%)	6(30%)	0.66
	1	217(75.35%)	124(74.25%)	41(83.67%)	22(73.33%)	16(72.73%)	14(70%)	
7. Loss of teeth can interfere with speech	0	59(20.49%)	34(20.36%)	7(14.29%)	7(23.33%)	4(18.18%)	7(35%)	0.41
	1	229(79.51%)	133(79.64%)	42(85.71%)	23(76.67%)	18(81.82%)	13(65%)	
8. Irregularly placed teeth can be moved into correct position	0	58(20.14%)	32(19.16%)	10(20.41%)	6(20%)	4(18.18%)	6(30%)	0.85
	1	230(79.86%)	135(80.84%)	39(79.59%)	24(80%)	18(81.82%)	14(70%)	
9. Decayed teeth can affect appearance	0	57(19.79%)	27(16.17%)	10(20.41%)	9(30%)	6(27.27%)	5(25%)	0.34
	1	231(80.21%)	140(83.83%)	39(79.59%)	21(70%)	16(72.73%)	15(75%)	
10. Tobacco chewing or smoking cause oral cancer	0	35(12.15%)	14(8.38%)	8(16.33%)	8(26.67%)	3(13.64%)	2(10%)	0.05
	1	253(87.85%)	153(91.62%)	41(83.67%)	22(73.33%)	19(86.36%)	18(90%)	
11. White patch are called dental plaque	0	45(15.63%)	27(16.17%)	4(8.16%)	8(26.67%)	2(9.09%)	4(20%)	0.20
	1	243(84.38%)	140(83.83%)	45(91.84%)	22(73.33%)	20(90.91%)	16(80%)	
Attitude								
1. Keeping your teeth clean and healthy is beneficial to your health	0	235(81.6%)	140(83.83%)	36(73.47%)	24(80%)	19(86.36%)	16(80%)	0.53
	1	53(18.4%)	27(16.17%)	13(26.53%)	6(20%)	3(13.64%)	4(20%)	
2. Scaling is harmful for gums	0	265(92.01%)	150(89.82%)	46(93.88%)	30(100%)	21(95.45%)	18(90%)	0.35
	1	23(7.99%)	17(10.18%)	3(6.12%)	0(0%)	1(4.55%)	2(10%)	
3. Dentist care only about treatment and not prevention	0	240(83.33%)	142(85.03%)	34(69.39%)	26(86.67%)	18(81.82%)	20(100%)	0.02
	1	48(16.67%)	25(14.97%)	15(30.61%)	4(13.33%)	4(18.18%)	0(0%)	
4. Sweet retention leads to tooth decay	0	92(31.94%)	61(36.53%)	12(24.49%)	9(30%)	5(22.73%)	5(25%)	0.37
	1	196(68.06%)	106(63.47%)	37(75.51%)	21(70%)	17(77.27%)	15(75%)	

(*Continued*)

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Table 2 (Continued).

Variables		n = 288	Periodontal Disease					P value
			0 n = 167 (57.99%)	1 n = 49 (17.01%)	2 n = 30 (10.42%)	3 n = 22 (7.64%)	4 n = 20 (6.94%)	
5. Brushing with fluoridated toothpaste prevent tooth decay	0	71(24.65%)	46(27.54%)	15(30.61%)	6(20%)	1(4.55%)	3(15%)	0.09
	1	217(75.35%)	121(72.46%)	34(69.39%)	24(80%)	21(95.45%)	17(85%)	
6. Brushing teeth twice a day improves oral hygiene	0	89(30.9%)	52(31.14%)	16(32.65%)	7(23.33%)	7(31.82%)	7(35%)	0.90
	1	199(69.1%)	115(68.86%)	33(67.35%)	23(76.67%)	15(68.18%)	13(65%)	
7. Gum bleeding denotes gum infection	0	92(31.94%)	49(29.34%)	15(30.61%)	14(46.67%)	8(36.36%)	6(30%)	0.43
	1	196(68.06%)	118(70.66%)	34(69.39%)	16(53.33%)	14(63.64%)	14(70%)	
8. Improper brushing leads to gum disease	0	80(27.78%)	49(29.34%)	10(20.41%)	11(36.67%)	6(27.27%)	4(20%)	0.50
	1	208(72.22%)	118(70.66%)	39(79.59%)	19(63.33%)	16(72.73%)	16(80%)	
Behaviour								
1. I have bleeding gums during brushing	0	196(68.06%)	99(59.28%)	33(67.35%)	25(83.33%)	21(95.45%)	18(90%)	<0.001
	1	92(31.94%)	68(40.72%)	16(32.65%)	5(16.67%)	1(4.55%)	2(10%)	
2. I do routine dental check-up	0	90(31.25%)	51(30.54%)	13(26.53%)	7(23.33%)	11(50%)	8(40%)	0.22
	1	198(68.75%)	116(69.46%)	36(73.47%)	23(76.67%)	11(50%)	12(60%)	
3. I give importance to my teeth as much as any part of my body	0	88(30.56%)	48(28.74%)	14(28.57%)	8(26.67%)	11(50%)	7(35%)	0.32
	1	200(69.44%)	119(71.26%)	35(71.43%)	22(73.33%)	11(50%)	13(65%)	
4. I brush my teeth twice daily	0	98(34.03%)	58(34.73%)	14(28.57%)	8(26.67%)	9(40.91%)	9(45%)	0.56
	1	190(65.97%)	109(65.27%)	35(71.43%)	22(73.33%)	13(59.09%)	11(55%)	
5. I use teeth to open cap of bottled drink	0	166(57.64%)	91(54.49%)	31(63.27%)	19(63.33%)	13(59.09%)	12(60%)	0.97
	1	122(42.36%)	76(45.51%)	18(36.73%)	11(36.67%)	9(40.91%)	8(40%)	
6. I have sensitive teeth	0	162(56.25%)	99(59.28%)	20(40.82%)	19(63.33%)	14(63.64%)	10(50%)	0.14
	1	126(43.75%)	68(40.72%)	29(59.18%)	11(36.67%)	8(36.36%)	10(50%)	
7. I experience toothache while chewing food	0	147(51.04%)	75(44.91%)	26(53.06%)	20(66.67%)	13(59.09%)	13(65%)	0.10
	1	141(48.96%)	92(55.09%)	23(46.94%)	10(33.33%)	9(40.91%)	7(35%)	

Univariate regression analysis revealed that the factors age, ethnicity, education, smoking, alcohol consumption, and oral health behavior were found to be statistically significant factors associated with different periodontal profiles with P value <0.05 (Table 3). The multivariate analysis further was performed considering the significant variables obtained from univariate analysis. The results are in the form of parameter estimates, standard error of estimates, odds ratios, 95% confidence intervals and P-values. In the multivariate ordinal logistic regression, age, ethnicity, education, and oral health behavior were found to be significant. For the final best model, the step-wise forward method was considered with reference to the multivariate model. The factors selected in the final model to assess the effect on ordinal outcome of periodontal disease (0–1 different levels of severity) were age, ethnicity, smoking, education, and oral health behavior. All the factors (Table 4) considered were significant in the model (P-value <0.05). Age was the most strongly associated factor with periodontal profiles of participants, with overall odds ratios ranging from OR = 2.25 (95% CI 1.14–4.55) for subjects 25–34 years old to OR = 2.89 (95% CI 1.41–6.01) for subjects ≥45 years old. Participants with non-Tamil ethnicity showed relatively higher odds of having periodontal diseases than participants with Tamil ethnicity with overall OR = 2.71 (95% CI 1.25–5.81). Non-smokers in the study group were found to be less likely to have periodontal diseases with overall OR = 0.38 (95% CI 0.16–0.65) when compared with smokers. Education levels of participants were found to

Table 3 Univariable Ordinal Logistic Regression of Sociodemographic, Habitual Factors and Oral Health KAB Profile Among Adults, Tamil Nadu, India, 2021 (n = 288).

Variable		Estimate ± SE	OR (95% CI)	P value
Gender	Female	−0.2±0.23	0.82 (0.52–1.28)	0.39
Age groups	25–34 years	0.94±0.34	2.55 (1.32–5.02)	0.01
	35–44 years	0.56±0.34	1.76 (0.90–3.48)	0.10
	≥ 45 years	1.07±0.35	2.91 (1.49–5.80)	<0.001
Marital status	Unmarried	−0.17±0.24	0.84 (0.52–1.34)	0.47
Religion	Muslim	0.79±0.49	2.20 (0.84–5.57)	0.10
	Christian	−0.14 ± 0.39	0.87 (0.39–1.8)	0.71
	Others	0.49 ± 0.69	1.6 (0.39–6.30)	0.47
Ethnicity	Non-Tamil	1.15±0.37	3.14 (1.52 −6.47)	<0.001
Diet	Non-vegetarian	0.51±0.43	1.67 (0.73 −3.91)	0.23
	Mixed	0.06±0.36	1.06 (0.54 −2.18)	0.87
Smoking	Yes	−0.97±0.31	0.38 (0.2 −0.7)	<0.001
Alcohol	Yes	−0.78±0.33	0.46 (0.24 −0.88)	0.02
Education	Primary	−2.64±0.95	0.07 (0.01 −0.43)	0.01
	High school	−3.15±0.77	0.04 (0.01 −0.18)	<0.001
	University	−3.03±0.76	0.05 (0.01 −0.2)	<0.001
Employment	Unemployed	−0.07±0.44	0.93 (0.38 −2.17)	0.87
	Student	−0.6±0.34	0.55 (0.27 −1.06)	0.08
	Home maker	−0.14±0.37	0.87 (0.41 −1.78)	0.71
Income	10K ₹ −20 K ₹	0.42±0.33	1.53 (0.8 −2.92)	0.20
	20K ₹- 30K ₹	0.28±0.31	1.32 (0.72 −2.4)	0.37
	Above 30K ₹	0.42±0.31	1.52 (0.82 −2.81)	0.18
House	Rented	−0.07±0.23	0.93 (0.58 −1.47)	0.75
Vehicle	No	−0.18±0.24	0.83 (0.52 −1.32)	0.44
Knowledge				
Average	> 4 to ≤ 7	−1.45±0.72	0.24 (0.06 −0.99)	0.04
Good	≥ 8	−1.50±0.69	0.22 (0.06 −0.89)	0.03
Attitude				
Average	> 2 to < 5	0.06±0.34	1.08 (0.92–1.28)	0.08
Good	≥ 5	0.14±0.32	1.16 (0.62–2.20)	0.07
Behaviour				
Average	> 2 to < 5	−0.49±0.30	0.61 (0.34 −1.11)	0.01
Good	≥ 5	−1.12±0.34	0.33 (0.17 −0.64)	<0.001

Table 4 Final Ordinal Logistic Regression Model of Sociodemographic, Habitual Factors and Oral Health KAB Profile Among Adults, Tamil Nadu, India, 2021 (n = 288).

Variable		Estimate ± SE	OR (95% CI)	P value
Age	25–34 years	0.81±0.35	2.25 (1.14–4.55)	0.01
	35–44 years	0.58±0.36	1.80 (0.89–3.64)	0.10
	≥ 45 years	1.06±0.37	2.89 (1.41–6.01)	<0.001
Ethnicity	Non-Tamil	0.99±0.39	2.71 (1.25–5.81)	0.01
Smoking	Yes	−0.98±0.32	0.38 (0.16–0.65)	<0.001
Education				
	Primary	−2.59±1.00	0.07 (0.01–0.50)	<0.001
	High school	−2.90±0.82	0.06 (0.01–0.27)	<0.001
	University	−2.58±0.82	0.08 (0.01–0.36)	<0.001
Behaviour				
Average	> 2 to < 5	−0.76±0.30	0.59 (0.32–1.08)	0.01
Good	≥ 5	−0.59±0.44	0.33 (0.16–0.65)	0.18

Table 5 Goodness of Fit Statistics of Sociodemographic, Habitual Factors and Oral Health KAB Profile Among Adults, Tamil Nadu, India,2021. (n=288)

Model	Lipsitz Test	Pulkstenis-Robinson Tests	AIC	Residual Deviance	p-value
Multivariate model	0.05	0.05	687.05	657.07	<0.001
Final model	0.006	0.04	683.07	657.05	<0.001

be strongly associated with periodontal profiles where the higher education level was seen to have lesser periodontal diseases. Overall OR = 0.07 (95% CI 0.01–0.50), OR = 0.06 (95% CI 0.01–0.27), and OR = 0.08 (95% CI 0.01–0.36) for primary, high school, and university respectively with reference to illiterate participants indicate that the higher the education level then the lesser would be the risk of periodontal diseases. Average behavior of an individual towards oral health was also related to the periodontal disease indication among south Indian adults in which the overall OR = 0.59 (95% CI 0.32–1.08), indicating less risk of having periodontal problems when compared with the participants with inadequate oral health practice.

Statistics for the goodness of fit calculated for multivariate model as well as final model (forward model) is tabulated (Table 5). Reduced AIC and Residual Deviance with significant Pulkstenis–Robinson tests (P-value <0.05) for the final model suggests that the model is better model to fit (Table 5).

Discussion

Periodontal disease is one of the primary and widely prevalent oral pathologies which affects the majority of people throughout their life.[30,31] Generally periodontal disease outcome is measured on the ordinal scale and ordinal logistic regression is used to analyze the influence of independent variables, the direction of the relationship between the ordinal outcomes.[32] Thus, in the current study, the association of different factors such as socioeconomic and socio-demographic characteristics, food habits, oral health knowledge, attitude, and behavior (KAB), collected using a structured questionnaire and survey procedure and the ordinal outcome of periodontal disease (0–4 different levels of severity) was studied with the help of the ordinal logistic regression model.

Less than half of the population (121 individuals) were experiencing periodontal disease in the current study. Univariate ordinal logistic regression analysis revealed that the incidence of periodontal disease among 288 participants was highly associated with age, ethnicity, education, smoking, alcohol consumption, and oral health behavior. Further in the multivariate ordinal logistic regression, age, ethnicity, education, and oral health behavior factors were found to be significant. The factors selected in the final model by applying forward method to assess the effect on

ordinal outcome of periodontal disease (0–4 different levels of severity) were age, smoking, education, and oral health behavior. In a different study, multiple logistic regression model found significant increased association between the socioeconomic factors such as smoking, primary education, male gender, and age.[33] In the current study, the age groups of 25–34 years and ≥45 years showed higher association with periodontal disease. Our current finding is in line with previous findings that the prevalence and severity of periodontal disease tends to increase with age of patients.[2,34] A study by Figueiredo[35] showed that periodontal disease is associated with higher age among Indian adults from north-east Brazil where it was found that individuals aged ≥35 years experienced periodontal disease. It is also reported in a study by Tadjoedin,[36] that there are differences in the prevalence of periodontal disease in different age groups. In the current study a significant effect of ethnicity on periodontal profile of participants was discovered. It was relatively high among non-Tamil ethnic group, which indicates the higher chance of periodontal problems in people with non-Tamil ethnicity than with Tamil ethnicity. In previous research the presence of considerable ethnic differences in periodontal disease between and within different ethnicity was reported.[2,37] Non-smokers in the present study indicated that people who do not smoke had less risk of periodontal problems. Studies have found periodontal diseases are associated with current smoking and smoking is a well-established factor causing periodontal diseases.[38–40] It was reported that tobacco increases periodontal disease severity.[41] Education had shown a significant effect on the periodontal profiles of participants. Participants with high school and university level of education had lesser risk of periodontal severity than participants who were illiterate. Having primary, high school, and university education progressively decreases the risk of periodontal severities. This specifies the importance and role of education in oral health. Similar findings were reported in several other studies.[42–45] In the current study, neither knowledge nor attitude of participants showed any effect on periodontal disease. Only oral health behavior had a significant association with periodontal disease of individuals. This indicated that the mere knowledge of oral health does not necessarily influence positive attitude and adequate behavior among people.

This study has some limitations, as all epidemiological factors of periodontal disease were not taken into consideration due to the Covid-19 pandemic. Investigation on the periodontal disease association with systemic conditions was excluded, as it was not within the scope of the study, though there is a significant relationship between periodontal disease with metabolic syndrome, diabetes mellitus, and cardiovascular disease.[46] Hence, it can be considered as a predominant limitation of this study. Additionally, individuals with absence of teeth were not included in our study which has possible association with periodontal disease. There are conceivable interconnections between various factors such as sociodemographics, habits of an individual and oral health KAB, which might have a role in oral health inequality among various individuals from different backgrounds. Having said that, wellbeing of an individual can be achieved with proper analysis of the risk factors of the disease. Based on our epidemiological model of periodontal disease we have explored and come up with salient enlightenment on the various modifiable and non-modifiable risk factors of periodontal disease among south Indian adults which would help to aggrandize the oral health status by planning an ideal oral health policy with the help of relevant authorities based on our study findings.

Conclusions

Based on our study results, we found that the age, ethnicity, smoking habit, education, and certain oral health behavior of a person were found to have notable association with periodontal status of south Indian adults. Our study sheds light on the oral health inequalities based on various influencing factors which can be altered. Our epidemiological model towards periodontal disease among south Indian adults could pave a path to introduce an overall oral health policy based on our study findings.

Conclusively, our study findings will be an ideal tool to eliminate the oral health inequalities of south Indian adults and gives the required outlook on various risk factors of periodontal disease.

Abbreviations

KAB, Knowledge Attitude Behaviour; SOP, Standard Operating Procedure; WHO, World Health Organization; CPI, Community Periodontal Index; PPD, Probing Pocket Depth; BOP, Bleeding on Probing; AIC, Akaike Information Criterion.

Data Sharing Statement

The datasets used in this study are obtainable from the corresponding author on request.

Institutional Review Board Statement

Ethical approvals were obtained from the Human Research Ethics Committee of Universiti Sultan Zainal Abidin [ref no: UniSZA/UHREC/2020/197] and RIPON independent ethics committee – Chennai [ref no: RIPON/NOV30/2020/800]. The questionnaire was designed to be anonymous, and informed written consent was obtained from every respondent. The data were kept confidential, and the results could not identify the respondents personally.

Informed Consent Statement

The study was designed to be anonymous, and informed written consent was obtained from every respondent. The data were kept confidential, and the results could not identify the respondents personally.

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Disclosure

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