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Determinants of periodontitis among a rural Indian population: A case control study

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Objectives: Identify the determinants of periodontitis in a rural Indian population aged 35-44 years. ***Basic Research Design:*** Case-control clinical and questionnaire study in a cluster sample of 50 villages. ***Methods:*** A total of 3000 persons were screened for the presence of periodontitis using the CDC case definition in full mouth examination. Equal numbers of cases (604 persons with periodontitis) and controls (604 without periodontitis) were recruited and interviewed with a piloted questionnaire. Univariate and multivariate analysis estimated crude and adjusted odds ratios (aOR) respectively with 95% confidence limits. ***Results:*** **S**ix factors were determined by multivariate analysis to predict periodontitis: education less than or equal to twelve years of schooling (aOR=2.51, 95% CI=1.18-5.34), alcohol consumption (aOR= 1.7, 95% CI=1.16-2.49), consuming a non-vegetarian diet (aOR=1.38, 95% CI=1.08-1.76), not drinking milk (aOR=1.7, 95% CI= 1.29-2.24), not using a toothbrush for cleaning of teeth (aOR=2.98, 95% CI =1.71-5.21) and not cleaning teeth at least once a day (aOR=2.13, 95% CI=1.58-2.87). ***Conclusion:*** Risk factors for periodontitis in a rural Indian population were identified. Further studies should validate these findings and appropriate recommendations should be developed to decrease the prevalence and burden of periodontitis in this population.

Keywords: *Case control study; epidemiology; periodontitis; risk factors; rural.*

Introduction

Periodontitis is a chronic infection that causes destruction of the supporting tissues of a tooth and ultimately, if unchecked, leads to tooth loss (Kinane, 2001). The destruction is characterized by the formation of periodontal pockets, loss of clinical attachment, alveolar bone loss or a combination of these changes (Kinane, 2001). The etiology of periodontitis is multifactorial. Accumulation of bacterial plaque consisting of pathogenic bacteria such as *Aggregatibacter actinomycetemcomitans, Porphymonas gingivalis and Prevotella intermedia* are considered essential for the initiation of periodontitis (Timmerman and Weijden, 2006). However bacterial plaque accumulation alone does not lead to expression of disease. Host susceptibility is a determining factor for a person to be affected. In addition, several risk factors specific to populations further influence the development and progression of periodontitis (Timmerman and Weijden, 2006). Identification of the risk factors in a population is important to identify targets to be modified in health promotion.

Risk factors seem to modulate the immune response of the host to the periodontal infection and determine the level of its susceptibility to it (Van Dyke and Sheilesh, 2005). As well as plaque, two major risk factors for periodontitis in many populations are smoking and diabetes mellitus (Van Dyke and Sheilesh, 2005). Other risk factors include oral hygiene practices, gender, race/ethnicity, genetics, socio-economic status, osteoporosis and psychological factors (Van Dyke and Sheilesh, 2005). However, different populations have developed different practices which can become risk factors and influence the development and progression of periodontitis (Pulikkotil, 2012). It is essential for researchers to understand this complex relationship between risk factors and disease in a population.

The prevalence of periodontitis varies in different regions of the world due to variations in risk factors and case definitions used (Pulikkotil, 2012; Shaju *et al*., 2011). Chhattisgarh is one of the least developed parts of India (World Bank Group, 2016). A literature search did not reveal any studies of the risk factors of periodontitis among the rural population of Chhattisgarh. More than 80% of the rural households in Rajnandgaon district have been recorded as being in the 'below the poverty line' category (World Bank Group, 2016). Alcohol consumption and tobacco smoking (23%, 30%) were reported to be high, especially in males. As Chhattisgarh is relatively undeveloped and the population has a high prevalence of poor oral hygiene practices, smoking, alcohol consumption and diabetes, the risk of periodontitis may be increased (Shaju *et al*., 2011). In India, most studies on the aetiology of periodontitis are hospital-based rather than population-based (Apoorva *et al*., 2013; Mohamed and Janakiram, 2013). Hospital-based studies are not representative of the population and thus here is a need for a large-scale community-based study. The primary aim of this study was to identify risk factors for periodontitis among a rural Indian population aged between 35-44 years.

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Method

This study adopted an unmatched case control design in the Rajnandgaon block of Rajnandgaon district in the state of Chhattisgarh, India. Rajnandgaon, a district South-west of Chhattisgarh, is primarily an agrarian rural area. Data were collected from March, 2012 to December 2014. The study proposal was approved by the Chhattisgarh Dental College Ethics Committee (protocol number CDCEC/11/2011/01/RF). The study information sheet and voluntary written informed consent form were prepared in the local language (Hindi) and written informed consent was obtained from all who were willing to participate. All participants were assured of confidentiality and their right to withdraw from the study at any time without any repercussions to their rights to treatment or other benefits as per the study. The study was part of the PhD degree and the publication was delayed due to required regulations.

An odds ratio (OR) of 2.0 was selected for any risk factor in a case control ratio of 1:1. The sample size was calculated to be 559 per group for 95% confidence and a power of 80%. After allowing for a 10% non-response rate, the sample size was calculated to 604 participants per group.

There were no previous oral health data for the study population. A pilot study revealed the probable prevalence of periodontitis to be 20.8%. Thus, a total of 3000 persons were needed to be screened to identify sufficient persons with periodontitis to be recruited as cases. Cluster sampling was used to identify a representative sample from the selected block of 183 villages. Through population proportional to sampling (pps), 50 villages were selected as clusters and 60 persons screened in each cluster. Persons with medical conditions for whom periodontal examination was contraindicated were excluded. A total of 851 cases with periodontitis were identified at a prevalence of 28.37%.

All persons fulfilling the case definition for severe periodontitis as per the CDC definition at screening were eligible to be included as cases. All cases had ≥2 interproximal sites with clinical attachment loss (CAL) ≥4mm (not on same tooth) and ≥ 1 interproximal site with probing depth (PD) ≥ 5mm; was used as the case definition for periodontitis (Page and Eke, 2007). Lists of cases and controls were prepared, and 604 cases and 604 controls were selected using random number tables. Persons who declined to participate were replaced.

All participants were interviewed to collect information on the following factors; education, economic status, occupation and income, tobacco smoking and chewing, diabetes, alcohol consumption, diet including consumption of various foods and milk, exposure to sunlight, dental health seeking behaviour, availability of dental health facility, personal and oral hygiene practices. The interview schedule was translated by a local language expert to Hindi and back translated to English to ensure no loss of meaning and interpretation. This was followed by a full mouth periodontal examination, measuring the PD and CAL on all teeth except the third molars. All recordings were taken from six sites on each tooth. PD, and CAL were measured to the nearest millimetre. All the clinical measurements were taken with UNC-15 periodontal probe (Hu-Friedy® Inc., Chicago, Illinois, USA). Participants who required further treatment were referred to the government district hospital for treatment free of cost. Data were collected by three dentists previously trained and calibrated to the principle examiner. To estimate intra-examiner reliability, five patients were examined twice, 24 hours apart before the study. All the repeated measures had Kappa scores >0.85. The principal investigator reassessed every 10th participant blinded to the diagnosis by the examiners. The agreement of the examiners to the principal investigator was high (Kappa > 0.85).

Data were analysed using the software Epi Info (EPI Info 7.0®, Centres for Disease Control and Prevention, Atlanta, GA.). Univariate and multivariate analysis estimated crude odds ratios (OR) and adjusted odds ratios (aOR) and 95% confidence intervals (CI) to identify the risk factors.

Results

A total of 1208 persons were recruited following screening and consented to participate as cases or controls in the ratio of 1:1.

Demographic and economic characteristics of participants are summarised in Table 1. Cases and controls were similar with respect to age, gender and income.

Several factors were associated with periodontitis in univariate analysis: (i) education less than or equal to twelve years of schooling, (ii) having diabetes, (iii) consuming alcohol, (iv) consuming a non-vegetarian diet, (v) not eating any fruits, (vi) not eating citrus fruits, (vii) not eating carotene containing foods, (viii) not drinking milk, (ix) not using a toothbrush to cleaning one's teeth and (x) not cleaning teeth at least once a day (Table 2).

Multivariate logistic regression analysis included all factors that were associated with periodontitis in the univariate analyses. The six predictors of periodontitis in the multivariate model were: (i) education less than or equal to twelve years of schooling; (ii) alcohol consumption; (iii) consuming a non-vegetarian diet; (iv) not drinking milk; (v) not using a toothbrush to clean one's teeth; and (vi) not cleaning teeth at least once a day (Table 3).

Discussion

To best of our knowledge this was the first large scale community-based case control study to predictors of periodontitis in a rural population of India. Estimates from hospital/clinic-based studies on periodontitis fail as the studies are not representative of the wider population because the recruitment solely of hospital patients will lead to selection bias (Chen *et al*., 2014). In addition, persons undiagnosed with periodontitis will not be represented in a hospital-based sample. Population-based studies on risk factors for periodontitis are difficult due to the lack of a complete list of cases (persons with periodontitis). Risk estimates by prevalence ratios (PR) of factors from prevalence surveys are inaccurate as the PR indicates the ratio of prevalence between persons with and without the factor of interest (Tomar and Asma, 2000). PR can indicate possible risk factors, but not risk estimates of those identified factors. This population-based study determined risk factors representative of the population by identifying suitable cases and controls from the community. This is helpful in formulating policy decisions to reduce the prevalence of periodontitis and its impact on the selected population.

Table 1. Demographic and Economic characteristics of cases and controls.

	Cases (%) (n=604)	*Control (%) (n= 604)*
Sex		
Male	63.4	66.0
Female	36.5	33.9
Age		
35-39 years	42.8	40.5
40-44 years	57.2	59.5
Religion		
Hindu	98.3	98.3
Others	1.6	1.6
Caste		
Other Backward castes (OBC)	54.3	52.2
Scheduled Caste (SC)	8.9	9.9
Scheduled Tribe (ST)	33.9	34.1
Others	2.9	3.8
Education		
Illiterate	32.1	30.4
Primary Schooling (1 - 5th standard)	26.9	26.7
Secondary schooling (6th to 8th standard)	19.9	20.8
High School	18.9	18.0
Above School level (College)	2.1	4.1
*Economic status according to poverty line**		
Below Poverty line* (INR 1500)	46.1	43.5
Above Poverty line (INR 1500)	53.9	56.5
Economic status according to household income		
Rs. 0-5000	86.9	84.7
Rs. 5001-10000	11.0	12.7
Rs. 10001-15000	1.3	1.7
Rs. >15000	0.7	0.8
Occupation		
Unskilled	52.9	53.9
Skilled/Semiskilled	25.9	28.0
Salaried/Self Employed	14.5	13.6
Housewife/Unemployed	6.8	5.4
Family type		
Nuclear	69.4	69.7
Joint and Extended	30.5	30.3
Type of Housing		
Roof and Walls of good materials	15.4	14.9
Only walls of good material	32.4	30.1
Roof and Walls of less weather proof materials	52.1	54.9

*http://www.mospi.nic.in/ecs_Ins_Manual_part_I_two.htm

This CDC definition of periodontitis is considered as an appropriate and accurate definition to be used in a case control study to identify risk factors (Jacob, 2011). Risk factors and their risk magnitude are population dependent, however variation in risk estimates may occur with different case definitions. Many reported case control studies have used periodontal indices or different definitions using PD and CAL (Jacob, 2011; Page and Eke, 2007). The CDC case definition consisted of both PD and CAL as they evaluate cumulative tissue destruction. Variations in the case definition used by other studies may hamper their comparability. Another variation that can cause misclassification is the mouth examination strategy. In this study full mouth recording during screening identified the presence of periodontitis. Partial recording may introduce bias by omitting potential cases and thus affecting the representativeness of the sample for a case control analysis (Costa *et al*., 2009).

Given the relatively few case control studies on risk factors of periodontitis, it is necessary to compare these data on those from other studies irrespective of study design. Our study showed that persons with less than twelve years of formal schooling had greater odds of getting periodontitis than those with higher education. Zhang et al. (2014) found that persons with less than six years of education had a greater probability for having periodontitis and attaining an education of less than high school increased the odds for periodontitis in a US national survey (Dye *et al*., 2009). Incorporation of dental care and awareness in early school education may improve oral and periodontal health among the general population on a long term. Kapadia et al. (1999) showed improvement in the oral hygiene status when dental care was incorporated in the curriculum of the school. Lower educational attainment leads to more poverty conditions. Other studies have contrary findings on the link with education. Australians

Table 2. Frequency of selected exposures among cases and controls and associated crude odds ratio.

Exposures	*Cases (n=604)*	*Controls (n=604)*	*Odds ratio*	*95% CI*
Socio Demographic Exposures				
Age 40-44 years	311	289	1.03	0.82-1.30
Sex Males	364	236	1.17	0.93-1.47
Education ≤ to twelve years of schooling*	833	816	1.48	1.03-2.17*
Occupation (unskilled)	312	332	0.87	0.70-1.10
Personal Income ≤ Rs.1500	384	385	0.99	0.78-1.26
Household Income ≤ Rs.1500	392	370	1.17	0.93-1.48
Family size < 7 members	297	297	1.00	0.80-1.25
Family type (Joint & Extended)	260	258	1.01	0.81-1.27
Housing (non pucca)	502	501	1.01	0.75-1.37
Health Exposure				
Diabetes*	11	2	5.58	1.23-25.30*
Lifestyle Factors				
Current Tobacco use	147	150	0.97	0.75-1.27
Current Smoking	74	62	1.22	0.85-1.75
Current tobacco Chewing	85	89	0.95	0.69-1.31
Current Alcohol consumption*	100	65	1.65	1.18-2.30*
Non exposure to Sunlight	18	17	1.06	0.54-2.08
Dietary Factors				
Non vegetarian diet*	358	300	1.48	1.18-1.86*
Non-Consumption of Fruit*	53	35	1.56	1.01-2.44*
Non-Consumption of Citrus Fruits*	58	36	1.68	1.09-2.58*
Non-Consumption of Carotene fruits*	58	33	1.84	1.18-2.86*
Non-Consumption of Vegetables	21	19	1.11	0.59-2.08
Non-Consumption of Carotene vegetables	35	31	1.14	0.69-1.87
Non-Consumption of Milk*	231	164	1.66	1.30-2.12*
Oral Hygiene Practices				
Non toothbrush user*	374	276	2.00	1.58-2.52*
Non toothpaste/powder user*	231	169	1.60	1.25-2.03*
Not cleaning teeth even once a day*	64	20	3.46	2.07-5.80*

* Factors associated with risk of periodontitis by univariate analysis. CI: Confidence Interval

Table 3. Unadjusted/crude and adjusted odds ratio (OR) risk factors of periodontitis.

Risk Factors	*Crude OR*	*95% CI*	*Adjusted OR*	*95% CI*
Education less than or equal to twelve years of schooling	1.48	1.03-2.17	2.51	1.18-5.34
Current Alcohol consumption	1.65	1.18-2.30	1.70	1.16-2.49
Non vegetarian diet	1.48	1.18-1.86	1.38	1.08-1.76
Non-Consumption of Milk	1.66	1.30-2.12	1.70	1.29-2.24
Not cleaning teeth even once a day	3.46	2.07-5.80	2.98	1.71-5.21
Non toothbrush user	2.00	1.58-2.52	2.13	1.58-2.87

OR: Odds Ratio, CI: Confidence Interval

with less than a diploma or degree education had similar diseases compared to well-educated persons and education was not a significant factor for periodontitis in the Korean National Oral Health Survey (Brennan *et al*., 2007; Han *et al*., 2012). However, these studies were in developed countries with better periodontal health where the balance of risk factors may differ.

Drinking alcohol was a risk factor for periodontitis, although only 12% of our participants did so. Finnish adults who consumed alcohol regularly compared to non-consumers and in a US study alcohol consumption increased the risk for periodontitis (Sakki *et al*., 1995; Tezal *et al*., 2001). However, Okamoto *et al*. (2006) did not find an association. Long-term use of excessive alcohol is reported to affect bone metabolism and may play an important role in extensive bone loss (Okomoto *et al*., 2006). Poor oral hygiene among alcohol consumers also appears to be associated with periodontitis. Tezal et al. (2001) suggested that alcohol affects hard and soft tissue, with the strongest effect on the gingiva, followed by the periodontal ligament and finally alveolar bone.

Consumption of non-vegetarian diet and non-consumption of milk were significant risk factors of periodontitis. Very few studies have estimated the risk for periodontitis associated with diet. Americans who ate a diet rich in meat and fried foods had increased risk for periodontitis in a secondary analysis of NHANES III data, which may have been attributed to the greater lipid deposition and higher levels

of systemic circulatory inflammatory molecules (Al-Zahrani *et al*., 2004). Low meat and fat diets may be associated with decreased production of reactive oxygen species, reduced oxidative damage of mitochondrial DNA, lower cytokine production, and improved metabolic parameters such as blood glucose and insulin sensitivity, which may be protective against periodontitis (Branch-Mays *et al*., 2008). Al-Zahrani et al. (2006) found that Americans who included more dairy products in their diet were protected against periodontitis. Conversely, milk consumption was not associated with periodontitis among Japanese adults (Shimazaki *et al*., 2008).

Dental plaque is considered as the main etiologic agent in the initiation and progression of gingival and periodontal disease. Using a toothbrush for cleaning and not cleaning one's teeth at least once a day were significant risk factors for periodontitis. Similar findings have been found among Jewish mothers and among hospital patients (Zini *et al*., 2011; Teng *et al*., 2003).

Factors such as smoking and diabetes did not predict periodontitis although they are important risk factors in many populations (Pulikkotil, 2012; Timmerman and Weijden, 2006; Van Dyke and Sheilesh, 2005). The use of bidis (locally produced cigarette made with rolled leaf and tobacco) by 88% of the smokers and the low frequency of smoking among our participants may explain why smoking was not a risk factor compared to other studies (Han *et al*., 2012). The average tobacco content in a bidi is lower (215 grams) than in a cigarette (738 grams) and could also be a factor (Malson *et al*., 2001).

The relatively young age of our study population (35-44 years) is one of the reasons why diabetes was less prevalent (0.7%) in this population. Similar findings were reported by Hugoson et al. (1989), who found that extensive and severe periodontal destruction was found only in people who had had diabetes for a long time.

The population examined were in a rural setting where the health awareness was low. Other systemic diseases associated with periodontitis (including genetic conditions, osteoporosis, cardiovascular disease, respiratory disease, endocrine and metabolic diseases, skin diseases and psychological factors) were not assessed, which is a limitation of the study. Logistic and resource constraints also restricted the data collected. Another limitation was that periodontitis could not be subclassified into subgroups. The study aimed to assess the risk factor for severe periodontitis and hence the subgroups were not considered. A variety of aetiological models for periodontitis are still debated (Bouchard *et al.,* 2017). The variables and measures identified in the current study were based on the National Family Health Survey-3 and in the reported literature on periodontitis (NFHS-3, 2008). No specific model was used to validate our findings or to guide statistical modelling in the analysis.

The major risk factors we identified reflect the highly rural and less developed characteristics of this population. Therefore, developing and implementing effective interventions to reduce periodontitis in this population assumes a high priority. Until recently the dominant approaches for oral health promotion were to reduce the bacterial plaque overload through clinical intervention and oral hygiene instructions/education rather than focusing on behaviour and environmental risk factors. The Ottawa Charter developed by the WHO has been used as a basis for developing health promotion models (Mariotti and Hefti, 2015). The Charter recommends the development of any health promotion programme around the five areas of public health policy, supportive environments, community actions, personal skills and health services (Mariotti and Hefti, 2015). The finding of the current study should influence the development of public policy on educating people on oral health practices at school and community levels as well on the common risk factors of alcohol consumption and tobacco smoking. The present study found that non-vegetarian diet and reduced milk consumption as potential risk factors. This warrants further investigation on the overall role of diet in bringing oral and general health and wellness as diet might be a residual confounder of other risk factors. The role of oral hygiene and its association in periodontal health has been emphasized.

In conclusion, this case control study from a representative sample has identified important risk factors of periodontitis specific to a rural population in India. The risk factors differ from the determinants seen in other population. This difference can be attributed to the type of study population and their practices.

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Conflict Of Interest

The authors declare no conflict of interest in the conduct of the study and the preparation of the manuscript.

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