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Clustering of risk indicators for periodontal disease: A population-based study

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Background: To assess the prevalence of clustering of risk indicators for periodontal disease and association of clustering of the risk indicators with sociodemographic factors and the prevalence of moderate/severe periodontal disease in rural Indian 35-54 year-olds. ***Basic research design:*** A multi-stage cluster random sampling design was used for this population-based cross-sectional study. ***Method:*** Data were collected through in-person interviews relating to sociodemographic factors and habits. Plaque index and periodontal findings were recorded from oral examination. Clustering of risk indicators such as smoking, tobacco chewing, alcohol and plaque were assessed for association with periodontal disease and various other sociodemographic indicators using logistic regression models. ***Results:*** Of 1,401 people approached, 873 completed data; a response rate of 62.3%. Clustering of two or more risk indicators was present in 31% of the population. Prevalence of moderate-severe periodontal disease was 46.6%. Simultaneous presence of two/more risk indicators was strongly associated with sociodemographic factors and periodontal disease. ***Conclusions:*** Clustering of two or more of the factors plaque, smoking, chewing tobacco and alcohol, was strongly associated with periodontitis.

Key words: *periodontal disease, risk indicators, clustering, plaque, smoking, tobacco chewing, alcohol, lifestyle factors, India*

Introduction

The periodontium is necessary for optimal masticatory function and maintenance of oral health. Any insult or injury to the periodontium can result in inflammation that is characterised by destruction of the hard and soft tissues. Chronic periodontitis is a slowly progressing disease and one of the most commonly occurring diseases in middle-aged adults, the socially disadvantaged and people of certain ethnic groups (Albandar, 2005; Tonetti and Van Dyke, 2013). Important risk factors which have been studied and known to be associated with periodontitis are older age, low socioeconomic status (SES), tobacco, and poor oral hygiene (Genco, 1996). The occurrence of two or more risk factors in clusters /bundles is known as "clustering" (Spring *et al*., 2012). The clustering of risk factors has been shown to contribute synergistically and multiplicatively towards the disease process (Poortinga, 2007). The lifestyle factors such as smoking, excessive alcohol drinking, lack of fruits and vegetables in the di*et al*ong with physical inactivity have been studied in a British population and have shown clustering in various combinations (Poortinga, 2007). The same lifestyle factors, when investigated in a Brazilian population showed two or more lifestyle factors to cluster in more than half of the study participants (Silva *et al*., 2012). Unfavourable lifestyle factors are more common and cluster/co-occur in people of lower SES, and poor general health (Fine et al., 2004; Schuit et al., 2002). Studies have assessed clustering of risk factors pertaining to general health and risky oral health behaviours among Korean adolescents, and this co-occurrence was related to the underlying socioeconomic environment (Park *et al*., 2010).

Further, social, economic conditions and education have shown a strong association with oral health compromising behaviours such as smoking, infrequent tooth brushing, symptomatic dental attendance and high sugar consumption (Singh *et al*., 2013). Risk factors such as smoking have shown a negative association while alcohol has shown an equivocal association with oral health behaviours (Park *et al*., 2010). Several studies have explored the independent effects of these risk indicators on periodontal disease. Major risk factors such as tobacco smoking and tobacco chewing have shown association with periodontal disease (Amarasena *et al*., 2002b; Do *et al*., 2003; Mohamed and Janakiram, 2013). Tobacco smoking has shown to be a well-established risk factor for clinical periodontitis (Tonetti, 1998). Further, other risky behaviours such as excessive alcohol consumption have shown a positive association with periodontal disease (Pitiphat et al., 2003; Shepherd, 2011). The earliest known risk indicators such as poor oral hygiene and plaque have shown association with periodontal disease in a recent study (Amarasena *et al*., 2002a). However, no studies have been identified from published literature regarding the association of clustering of these risk indicators with periodontal disease. Hence, the present study aimed to assess the prevalence of clustering of risk indicators for periodontal disease and association of clustering of the risk indicators with sociodemographic factors and the prevalence of moderate/severe periodontal disease in a rural Indian population.

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Methods

A population-based cross-sectional study was conducted for a larger project focusing on the oral health of a rural Indian population. Data collected for the larger project between July 2011 and August 2012 were used for this study. A multi-stage cluster random sampling design was followed. Participants were recruited from two of the three coastal districts in Karnataka state, India. All the coastal sub provinces (taluks) from both districts were selected in the second stage. In the third stage, villages were randomly chosen from every taluk. From each of the coastal villages, men and women of agricultural and fishing communities (main occupations of coastal villagers) between 35 and 54 years were randomly selected. The study protocol was approved by the Human Research Ethics Committee, the University of Adelaide (H-015-2011). Permission to conduct the study was obtained from the local leaders of the rural communities. Written informed consent was obtained from each participant.

Some 1,401 people across 50 villages from the two coastal districts were approached. Data were collected through face to face interviews at the participants' houses or places of work. Specific information related to habits, SES, age and gender were sought. This was followed by an oral examination which was done by a single examiner (MB) trained by the gold standard examiner (KRT). Examinations used a powered headlamp with the participant in a supine position. Dental assessment armamentarium included mirror handles, disposable mirrors heads (Mirrorlite™ Defend, NY, USA) and a periodontal probe (PCP2, Hu-Friedy). The plaque accumulation on tooth surfaces was scored using the Plaque Index (Löe, 1967). Periodontal examination was done according to National Survey for Adult Oral Health (NSAOH) protocol (Slade *et al*., 2007) to record the gingival recession (GR) and probing pocket depth (PPD) for mesio-buccal, mid-buccal and disto-buccal sites of each tooth. Third molars were excluded from the periodontal examination. The kappa values for intra-examiner reliability were 0.83 for PPD and 0.96 for GR.

Risk indicators for periodontal disease included habits pursued at any time in life such as smoking, tobacco chewing and alcohol consumption, which were dichotomised as 'Yes' or 'No.' The highest level of education was recorded for each participant and was later dichotomised as 'secondary school level or less' or 'post-secondary school'. Per capita income was used to classify SES according to the BG Prasad rural socioeconomic scale revised annually according to the All India Consumer Price Index (Prasad, 1961). Age was dichotomised into '35-44' and '45-54' year age groups.

Plaque accumulation was dichotomised as 'none or minimal' if all sextants had the highest score ≤1 and 'moderate to heavy' if one or more sextants had a score of 2 or higher. Periodontal disease was defined according to the CDC-AAP case definition (Eke and Genco, 2007; Page and Eke, 2007). While other case definitions have been introduced during the European workshop of periodontology (Tonetti and Claffey, 2005) the CDC-AAP case definition was used to enable comparison with NSAOH estimates (Slade *et al* 2007). According to the case-definition, periodontal disease was considered to be present if it was in the moderate or severe category.

Clustering of risk indicators such as smoking, tobacco chewing, alcohol and plaque, which are plausible causative factors, and various sociodemographic indicators, were assessed for association with periodontal disease. The prevalence of risk indicators individually or in combination (two, three or four risk indicators) were compared by age, gender, education, income and periodontal disease. Multinomial logistic regression models were used to determine the strength of association of clustering of risk indicators with age, gender, education and income as indicators. Only four risk indicators were considered as adding more risk indicators would reduce the frequency of observations in each cell reducing the power. Hence the authors considered only the biologically plausible risk indicators in the study. The association between the co-occurrence of two or more risk indicators and periodontal disease was examined using odds ratios (OR) obtained from a multivariable logistic regression model controlling for other covariates. Multinomial logistic regression models were built to determine the predictors of clustering. Age, gender, education and income were entered as independent variables in the models. For every independent variable, the other three variables were adjusted. Binary logistic regression was used to estimate the strength of association between the clustering of risk indicators and periodontitis adjusting for age, gender, education and income using the 'Enter' method. Complex sample plan was employed in accordance with the sampling design. The statistical software SPSS v20 was used for the analyses.

Results

Of 1,401 people approached 873 participated in the study; a response rate of 62.3%. Among those 397, 45.8%, were females. Medical contraindications excluded four from the periodontal examination leaving 869 examined.

Table 1 shows the distribution of clustering of risk indicators for periodontal disease in the study sample. No risk indicators for periodontal disease were found in 29% of those examined. Two risk indicators were simultaneously present in more than 18% while 3-4 risk indicators clustered in nearly 13% of the population.

Table 1. Distribution of risk indicators of periodontal disease in the rural population (n=869)

Risk indicators	*Smoking*	*Chewing*	*Alcohol*	*Plaque*	*n*	*%*
0	-	-	-	-	254	29.2
1	+	-	-	-	2	0.2
	-	+	-	-	21	2.4
	-	-	+	-	42	4.8
	-	-	-	+	277	31.9
2	+	+	-	-	2	0.2
	+	-	+	-	4	0.5
	+	-	-	+	4	0.5
	-	+	+	-	24	2.8
	-	+	-	+	82	9.4
	-	-	+	+	46	5.3
3	+	+	+	-	7	0.8
	+	-	+	+	30	3.5
	-	+	+	+	46	5.3
	+	+	-	+	6	0.7
4	+	+	+	+	22	2.5

+ Present; - Absent

Table 2 presents the periodontal and dentition status of the study sample. Clinical attachment loss (CAL) ≥4mm was present in more than half of the population. Nearly 40% of them had CAL ≥5mm and about 30% of them had CAL ≥6mm. Greater proportion (30.2%) had PPD of ≥4mm and very less proportion of the population (1-5%) had PPD of ≥5/6mm. On an average 28.5 teeth were present (95%CI 28.21,28.77).

Table 3 presents the prevalence of risk indicators individually and co-occurring in various groups. Prevalence of clustering of risk indicators was greater in people of the older age group compared to those in the younger group. Clustering was prevalent in a lower proportion of females than males. People with low educational attainment (secondary level or less) exhibited a greater prevalence of clustering than people with post-secondary education. Presence of two and three or four risk indicators was greater among the groups with lower income vs higher income, and those with moderate-severe periodontal disease vs none or mild periodontitis.

In Table 4 age, gender, education and per-capita income were strongly associated with clustering of risk indicators. Highest ORs were observed for gender, and 95%CIs were wide.

The prevalence of periodontal disease was 46.6%. Moderate-severe periodontal disease was strongly associated with simultaneous occurrence of two or more risk indicators. People with two risk indicators were more than twice as likely, and those with three or more risk indicators had 3.7 times the odds of moderate moderate-severe periodontal disease compared to those without any risk indicators or having one risk indicator after adjusting for other covariates (Table 5).

Table 2. Periodontal status of the study population

	n	*%*	*95%CI*
Prevalence of CAL ≥4mm	461	53.0	(49.7, 56.3)
Prevalence of CAL ≥5mm	346	39.8	(36.6, 43.1)
Prevalence of CAL ≥6mm	252	29.0	(26.0, 32.0)
Prevalence of PD ≥4mm	264	30.2	(27.2, 33.3)
Prevalence of PD ≥5mm	41	4.7	(3.3, 6.1)
Prevalence of PD ≥6mm	15	1.7	(0.9, 2.6)

Table 3. Prevalence (95%CI) of risk indicators of periodontal disease individually and in combination according to age, gender, education, income and periodontal disease

		n †	*No or 1 risk indicator % (95%CI)*	*2 risk indicators % (95%CI)*	*3 or 4 risk indicators % (95%CI)*	*Sig. p*
Age (years)	35-44	524	75.8 (70.9, 80.0)	14.7 (11.4, 18.8)	9.5 (6.9, 13.1)	*
	45-54	345	57.7 (51.1, 64.0)	24.6 (19.9, 30.1)	17.7 (13.3, 23.1)	
Gender	Male	472	47.9 (42.2, 53.6)	29.2 (24.4, 34.5)	22.9 (18.4, 28.1)	*
	Female	397	93.2 (89.0, 95.9)	6.0 (3.7, 9.7)	0.8 (0.2, 2.5)	
Education	Secondary/less	706	66.0 (60.2, 71.4)	19.4 (16.1, 23.2)	14.6 (11.2, 18.7)	*
	Post-secondary	162	79.6 (71.6, 85.8)	15.4 (9.5, 24.1)	4.9 (2.7, 8.8)	
Income (per-capita)	Low-middle	397	60.2 (52.7, 67.2)	22.7 (18.4, 27.6)	17.1 (12.5, 23.0)	*
	High	420	75.2 (69.8, 80.0)	16.2 (12.5, 20.6)	8.6 (5.9, 12.4)	
Periodontal disease	None/mild	464	82.1 (77.3, 86.1)	12.1 (9.0, 16.0)	5.8 (3.7, 9.1)	*
	Moderate/severe	402	53.0 (46.4, 59.5)	26.1 (21.4, 31.4)	20.9 (16.1, 26.6)	

* Non-overlapping 95%CI indicates significance; † n values may not sum to 873 due to missing data

Table 4. Multinomial logistic regression models for clustering of risk indicators as outcome with age, gender, education and income as predictors

	Reference category	*2 vs ≤1 risk indicator† OR (95%CI)*	*3 or 4 vs ≤1 risk indicators† OR (95%CI)*
Age (years), 45-54[a]	35-44	2.7 (1.9, 4.0)	3.2 (1.9, 5.4)
Gender, Male[b]	Female	11.9 (7.1, 20.0)	81.4 (26.6, 249.1)
Education, Secondary or less[c]	Post-secondary	2.5 (1.6, 3.9)	5.7 (2.5, 13.0)
Per-capita income, Low or Middle[d]	High	2.2 (1.5, 3.2)	3.1 (1.7, 5.6)

[a] adjusted for gender, education and per-capita income; [b] adjusted for age, education and per-capita income;
[c] adjusted for age, gender and per-capita income; [d] adjusted for age, gender and education;
†reference category for the outcome in the multinomial logistic regression models

Table 5. Association between clustering of risk indicators and prevalence of periodontal disease

	Reference category	*Crude OR (95%CI)*		*Adjusted OR (95%CI)*	
Clustering of risk indicators					
2 risk indicators	≤1 risk indicator	**3.4**	**(2.3-4.9)***	**2.41**	**(1.5-3.8)***
3 or 4 risk indicators		**5.6**	**(3.3-9.5)***	**3.73**	**(2.0-6.9)***
Age (years), 45-54	35-44	4.3	(3.3-5.5)	**4.02**	**(3.0-5.4)***
Gender, Male	Female	1.9	(1.5-2.5)	1.21	(0.9-1.7)
Education , Secondary or Less	Post-secondary	1.8	(1.3-2.6)	**1.61**	**(1.1-2.4)***
Per-capita income, Low/Middle	High	1.3	(1.0-1.7)	1.19	(0.9-1.6)

*95%CIs not including 1 indicate statistical significance

Discussion

In this cross-sectional study, the aim was to assess clustering of common risk indicators of periodontal disease such as smoking, chewing, alcohol and plaque and association of clustering with the prevalence of periodontal disease. The study has indicated evidence of strong clustering of risk indicators with nearly 20% of the rural population showing clustering of two and three or four risk indicators.

Biases due to non-response, recall and social desirability could have occurred in the study. There could be some degree of measurement error because of unavoidable under-reporting of habits and income, but to address this potential source of error three socioeconomic indicators were used in the study. Furthermore, loss of information would result from categorisation of variables

The findings emphasise that when two or more risk indicators are present in an individual, the risk indicators could exert a combined effect to increase the risk for periodontal disease. Age, gender and SES were strongly associated with clustering. People in the older age group, males with lower education, and people with low income had higher odds for the clustering of two risk indicators and much greater odds for clustering of three or four indicators compared to those in the younger age group. People in the older age group had a greater clustering of risk indicators. The possible reasons could be age, low income, education and poor life style oriented behaviours. Males, those with low education and low income had higher odds for clustering of risk indicators than females, those with better education or higher income. The reason for males showing more clustering could be due to the greater prevalence of habits among males compared to females. Very few females reported habits such as tobacco and alcohol use as these habits are culturally unacceptable in rural India. In addition, tobacco chewing was more common than smoking in this population. The findings of the present study are contrary to the findings observed in an adult English population where females showed a greater clustering for risk factors such as smoking and drinking (Poortinga, 2007). Further, oral health compromising behaviours have been shown to cluster in adults (Singh *et al*., 2013). Multiple risk factors were present among those who were economically inactive and of lower social class in an English population (Poortinga, 2007). In the present study population, more were less educated. People in the low-middle income category and those with lower levels of education had greater clustering of two and three or four risk indicators, the findings are supported by other studies (Poortinga, 2007; Silva *et al*., 2012). The current study found that clustering of habits such as smoking, chewing tobacco and alcohol along with poor oral hygiene were associated with periodontal disease. Risk indicators of periodontal disease can be highly correlated. The estimated variance inflation factors in the multivariable models were fewer than five so multicollinearity was not considered a potential problem. Presence of plaque was more common in people with clustering of risk indicators. This suggests that it is important for clinicians to emphasise both the importance of oral hygiene and healthy lifestyle behaviours as these could act synergistically in the disease process. Diabetes has been shown to be associated with periodontal disease (Oliver and Tervonen, 1994; Acharya *et al*., 2010). A small number of studies have linked obesity with periodontal disease but there is need for further epidemiological studies to confirm the association (Borell and Papapanou, 2005). Clinical assessment of obesity and diabetes were not conducted in this study because of complexity and cultural sensitivity. The present study assessed clustering of the behavioural etiological factors of periodontal disease.

The present study is an important population-based study that examined the clustering of risk indicators for periodontal disease among rural Indian adults. The study used a robust sampling method. To the best of authors' knowledge this is the first report that has explored the clustering of risk indicators for periodontal disease.

Conclusions

Clustering of risk indicators were strongly associated with periodontitis in this study. The information obtained from this study shows that the co-occurrence of these indicators is linked to both oral and general health and could be addressed using the common risk factor approach (Singh *et al*., 2013). The findings may also help in developing appropriate preventive and intervention strategies in high risk rural populations for improving health.

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