AN EPIDEMIOLOGICAL INVESTIGATION IN RELATIVE IMPORTANCE OF FACTORS ASSOCIATED WITH DENTAL CARIES

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Aim: To identify key discriminating factors associated with dental caries status by linear discriminant function analysis. A cross sectional study design was employed using clinical examination and questionnaire method. Dental caries examinations based on WHO criteria and questionnaire method was performed on 500 subjects aged 14-40 years were selected randomly. These were separately classified according to increasing individual DMFT scores and combined into positively and negatively health oriented group. A stepwise discriminant function analysis was used to identify the important discriminant factors associated with dental caries and also to segregate the subjects as those who were poor and good dental caries status.

The subjects with low DMFT index scores reported that they brushed their teeth most frequently, they change their toothbrush within three months period, users of vertical & circular method of brushing and they rinse the mouth with water frequently. The subjects with high DMFT index scores reported who have frequent sweet consumption for longer duration, living in a larger family with higher income. The discriminant function analysis showed that 98.14% of subjects were found to be positively health oriented and corresponding percentage for the negatively health oriented towards dental caries (DMFT) was 93.47%. Frequent tooth brushing, vertical & circular methods of brushing and mouth rinsing habit with water are important discriminant factors associated with lower dental caries. Duration of sweet consumption and frequency of sweet consumption are important discriminant factors associated with higher dental caries.

Key Words: Dental Caries, DMFT index, Positively and Negatively Health Oriented, Step-wise Discriminant Function Analysis.

Oral health is an integral part of general health and very much important for the achieving & maintaining the same. Oral diseases are characterized by their chronicity, ubiquitous nature and hence constitute a health problem of considerable public health importance[1]. Dental caries is one of the major oral diseases, which impairs the quality of life of people. Changes in our knowledge of etiology of oral health especially dental caries and the recognition of the potential importance of susceptibility factors as they affect initiation and progression of oral diseases, led to intense study of specific factors of these oral diseases.

In the developed countries, decline in dental caries prevalence has been attributed to population-based preventive programs with use of fluoride, improved participation in oral health programs and changes in oral hygiene and sugar intake habits. On the other hand, in many developing countries, an increase in dental caries has resulted from unhealthy dietary habits, limited use of fluoride and poor access to oral health service. Most oral health services provide symptomatic treatment with little priority given to prevention. The urbanization and adoption of Western lifestyles into many developing countries in the absence of public health preven-

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tion programs have also caused a sudden increase in dental caries[2].

Oral diseases are connected to lifestyles, and multiple risk factors may affect oral health habits and oral health[3]. It has been established that dental caries is a multifactorial disease that is particularly related to the presence of cariogenic microorganisms, fermentable carbohydrates in the diet, susceptible tooth and host, and the time [2,4,5]. Some factors such as socioeconomic status, parental education level and the maternal flora are also essential for the initiation and the progression of the disease[6,7].

The prevention of dental caries depends mainly on the manner in which individuals conduct their lives[8]. The presence of dental plaque on the teeth and oral tissues is recognized as being a requirement for the initiation of dental caries[9]. Thus frequent removal of plaque or the prevention of its formation may be considered effective for the prevention of dental caries. A better understanding of the factors which influence the pattern of behavior would greatly aid health educators in their efforts to establish sensible socio-economic-demographic patterns, eating habits, oral hygiene habits, and other deleterious habits.

A countable number of studies have been conducted to ascertain the socio-economic-demographic and other factors related to dental caries[10, 11, 12, 13]. Hence, the present study was conducted to obtain further information about myriad factors associated with good oral health status, especially in relation to dental caries. The primary purpose was to analyze the factors related to dental caries and to identify key discriminating factors associated with dental caries was studied.

Materials and methods

Study area

The present study was carried out during June 2007 to October 2007 in SDM College of Dental Sciences and Hospital, Dharwad, Karnataka, India. Dharwad is situated in North Karnataka and is one of the educational centres.

Study population and sampling procedure

A total of 500 subjects aged between 14-40 years were selected by simple random sampling procedure with replacement, Dharwad, Karnataka, India. The mean age of the subjects was 34.32 ±13.63 years.

Clinical Examination

The data on dental caries was collected by clinical examination, which was carried out by two qualified dentists by using DMFT index with plane mouth mirror, dental explorer, disposable gloves and sterilized instruments under artificial light followed by WHO diagnostic criteria. It measures the degree of caries experience and represents the cumulative severity of dental caries of a subject or population. It is defined as the sum of the number of decayed (D), missing (M) due to caries and filled teeth (F). Before the start of the actual study, a pilot study was conducted on 50 subjects to assess the intra and inter examiner agreement for recording DMFT index scores. The intra-examiner and inter examiner agreement found to be respectively 0.8619 and 0.9018.

Apart from dental caries status, the data on 25 independent variables related to socio-economic-demographic, food habits, eating habits, oral hygiene practices and deleterious habits were obtained by structured questionnaire and interview method. The DMFT index (Dental Caries) data was considered as a response variable. The multiple regression analysis was performed to identify the significant factors associated with dental caries and showed that 13 independent variables were found to be significant relationship with dental caries. These significant variables were included in the final discriminant analysis (Table 1).

Data Analysis

The investigators are interested in differentiating the positively and negatively health oriented subjects and establishing the discriminating covariates of dental caries (DMFT index). For convenience of fitting discriminant model, the DMFT index data

Table 1: Variables included in discriminant analysis

No	Independent variables	Codes
1	Gender	Male, Female
2	Area of residence	Urban, Rural
3	Family size	£5, >5 members
4	Family income	£ Rs.5000, >Rs.5000
5	Materials use to cleaning a teeth	Paste/powder, others
6	Methods of brushing	Vertical, circular, horizontal
7	Duration of change of toothbrush	1-3 months, >4 months
8	Frequency of brushing	Once, Twice or more
9	Timings of sweet consumption	During meals, between meals, both during and between
10	Sources of Drinking water	Pond/river, Pipe tap/tube well/hand pump
11	Types of toothpaste	Fluoridated, non-fluoridated
12	Frequency of sweet consumption	Once, Twice, More than twice
13	Rinsing habit	Always, sometimes, never

Table 2: Mean clinical readings (DMFT) of 500 study subjects divided into three quartiles classified by DMFT index.

Quartiles	Classifier DMFT
Q_1 quartile I	1.6244±0.4854
Q_2 – quartile II	3.0057±0.6001
Q_3 – quartile III	5.2057±1.4145

was treated as a response variable. Further more, for analytical purpose the study subjects were divided into quartiles groups according to increasing individual clinical values[12, 14]. This was done for DMFT index scores (Table 2). According to this classification of subjects of the first quartile (Q1) with the lowest index values were combined into the positively health oriented group (+). The subjects of the last quartile (Q3) with greatest index values were combined to form a group called negatively health oriented (-).

The mean and SD were determined for DMFT index values separately for positively and negatively health oriented groups. A step-wise multiple discriminant function analysis was used in order to obtain scores of positively and negatively health oriented group subjects. The 13 variables included in the final analyses (Table 1) which were significant relationship with dental caries in multiple regression analysis (Table 4). The following procedure was employed in step-wise discriminant function and multiple regression analysis.

Initially, the variable having greatest power of discrimination was selected. Later, the effect of this variable was eliminated from the information content of all the other variables. The variable which then has the highest power of discrimination after the above elimination procedure was ranked as the second and similar procedure was continued. Thus, the variables are listed in decreasing order those have the probability of the additional information gained from entering further variable was less than 0.05.

Lastly, the variables having the weaker influence power of discrimination may drop from the final analysis. Therefore, there may be some factors out side the final list, which in fact have greater individual discrimination power.

In order to weigh the significance of each chosen variable in discrimination, its correlation with discrimination function was also computed. The total discriminatory power of the whole set of variables was measured with Wilk's Lambda criteria, which is a generalization of univariate F-test used in analysis of variance and as a whole was measured with eigen values and canonical correlation[15]. Lastly, chi-square test and odds ratios were calculated to assess the association between independent variables and dental caries (DMFT index). A statistical analysis was performed by using statistical software i.e. Intercooled STATA[16] and statistical significance set at 5% level of significance ($p<0.05$).

Results

The mean score of DMFT index for the total subjects studied was 3.3981±2.0787. The mean score of DMFT index in positively health oriented group and negatively health oriented group was 1.6244±0.4854 and 5.2057±1.4145 respectively. The bivariate analysis reveals that, a significant higher number of negatively health-oriented subjects were seen among, who were living with more than 5 members in a family (OR: 7.92, 95% CI: 4.08 to 15.37), who belongs to higher income (OR: 9.35, 95% CI: 5.88 to 4.88), individuals brushing their teeth other than paste and powder (OR: 35.93, 95% CI: 16.88 to 6.47), brushing their teeth only once in a day (OR: 3.73, 95% CI: 2.18 to 5.62), who are changing their toothbrush after four months (OR: 2.04, 95% CI: 1.39 to 3.01) , individuals eating sweets two or more times in a day (OR: 7.21, 95% CI: 4.29 to 12.12), who drink water from pipe tap / tube well / hand pump as source (OR: 11.48, 95% CI: 7.14 to 18.46) and who are rinsing the mouth some times after meal (OR: 1.85, 95% CI: 1.06 to 3.24) as compared to their counterparts.

Multiple Regression Analysis

The step-wise regression estimates from multiple regression model are presented in Table 3. Out of 25 independent variables, thirteen factors included in the model and they emerged as statistically significant ($R=0.9035$, $F=29.3960$, $p<0.05$). In these significant variables, the dental caries (DMFT data) is significant and positively associated with six independent variables such as materials use to cleaning teeth, timings for cleaning teeth, sources of drinking water, desired family size, frequency of sweet consumption and rinsing habit. These significant independent variables exhibited positive regression coefficients, indicating that these are likely to increase the prevalence of dental caries. In other words, these are increases the non-zero DMFT counts.

On the other hand, the dental caries is significantly negatively associated with seven covariates namely methods of brushing, duration of change of toothbrush, frequency of brushing, duration of sweet consumption, Types of toothpaste, area of residence and gender. These significant independent variables exhibited negative regression coefficients, indicating that they are likely to decrease the prevalence dental caries. In other words, these are decreases the non-zero DMFT counts.

Discriminant Function Analysis

A total of 25 independent variables were taken for possible relationships with dental caries (DMFT index) and results are presented in the proceeding section.

Out of 25 independent variables, 17 independent variables were significantly related to the dependent variable i.e. dental caries (DMFT index) with magnitudes ranging from low scores (positively health oriented group) and high scores (negatively health oriented group). The step-wise discriminant function analysis was used to determine if a linear combination of 17 independent variables could be used to predict dental caries. Further more, out of 17 associated independent variables, only 11 vari-

Table 3: Step-wise regression estimates with dental caries experience (DMFT index) as dependent variable.

No	Independent variables	Regression estimates	SE of regression estimates	t-value
	Intercept	-2.4660	0.5047	-4.8900*
1	Materials use to cleaning a teeth	1.2010	0.1140	10.5300*
2	Area of residence	-0.9644	0.1189	-8.1100*
3	Family size	0.8939	0.1043	8.5700*
4	Frequency of sweet consumption	0.3591	0.0561	6.4100*
5	Timings of sweet consumption	0.3973	0.0638	6.2200*
6	Rinsing habit	0.2657	0.0565	4.7000*
7	Sources of Drinking water	0.3896	0.1037	3.7600*
8	Family income	0.3529	0.0951	3.7100*
9	Types of toothpaste	0.3601	0.1021	3.5300*
10	Duration of change of toothbrush	0.2777	0.0847	3.2800*
11	Methods of brushing	0.1931	0.0610	3.1600**
12	Gender	0.1771	0.0854	2.0700**
13	Frequency of brushing	-0.1999	0.0974	-2.0531**
$R=0.9179$, $R^2=0.8426$, Adjusted $R^2=0.8376$, $F(13, 408) = 168.0000$*, Root MSE 0.83774, SE of estimate=10.6777				

* Significant at 1% level, ** Significant at 5% level of significance

ables were found have good discrimination power on dental caries (Table 4).

The discriminant function analysis resulted in an overall classification rate of 96.00%, in which 98.14% of the study subjects were correctly placed in the group of positively health oriented subjects and 93.47% of the subjects were correctly placed in the group of negatively health oriented subjects. The mean discriminant score for positively health-oriented subjects (0.2933) was significantly lower than that of the negatively health-oriented subjects (0.4220) (Wilk's Lambda=0.7110, chi-square=128.3716 with 11 degrees of freedom). The analysis resulted in an eigen value of 3.3020 and canonical correlation of 0.8773. The most distinguishing characteristics of positively health oriented group, when compared with negatively health oriented group can be determined by examining the standardized discriminant function coefficients.

As the results in the above table indicate, the variables namely frequency of brushing, materials used to clean the teeth, duration of change of tooth brush, methods of brushing and gender exhibited negative and significant discriminant coefficients. It means that, these are emerged as significant discriminant variables among positively health oriented subjects. However, the duration of sweet consumption, frequency of sweet consumption, family size,

family income, area of residence and types of tooth paste exhibited positive and significant discriminant coefficients. It means that these are emerged as significant discriminant variables among negatively health oriented subjects. Therefore, we conclude that, the factors duration of sweet consumption (0.7562), frequency of sweet consumption (0.7542), family size (0.7451), family income (0.7401), frequency of brushing (0.7301), area of residence (0.7282), materials used to clean the teeth (0.7247), duration of change of tooth brush (0.7237), methods of brushing (0.7225), gender (0.7202) and type of toothpastes (0.7187) are important discriminant factors of dental caries into positively and negatively health oriented subjects.

Discussion

The present study was conducted to determine the discrimination factors associated with dental health status i.e. dental caries. The classification of the subjects into two groups (positively and negatively health oriented) by DMFT index values seemed to be a good method to differentiate subjects into groups of good and poor dental health status. The findings of the study demonstrate that some factors are significantly related to dental caries experience. These findings provided some support for the argument that dental caries experience is biologically programmed in life, like other chronic diseases[17]. These findings confirm the conception that there is neither directly synergistic nor directly an-

Table 4: Multiple discriminant analysis of statistically significant variables ($p<0.05$) among 213 positively (+) and 209 negatively (-) health oriented subjects as classified by DMFT index

Independent variables	Mean±SD Standard		Correlation coefficients discriminating function	F value of with information	additional
	+ ve	- ve			
Family size	1.46±0.50	1.51±0.50	0.6057	0.6114	161.0007*
Family income	1.80±0.40	1.02±0.14	-0.4824	-0.3767	84.7528*
Methods of brushing	1.07±0.25	1.67±0.47	-0.3550	-0.3467	41.4717*
Duration of change of toothbrush	1.15±0.36	1.63±0.48	-0.3423	-0.3598	37.0361*
Materials use to cleaning a teeth	1.04±0.19	1.58±0.49	-0.2637	-0.2645	23.6979*
Timings of sweet consumption	1.53±0.70	2.58±0.69	-0.2941	0.1558	23.1633*
Types of toothpaste	1.58±0.50	1.27±0.44	-0.2656	-0.2930	20.9612*
Frequency of sweet consumption	1.49±0.72	2.06±0.64	-0.2333	-0.2102	16.0900*
Area of residence	1.33±0.47	1.85±0.36	0.1889	-0.0245	11.1508*
Rinsing habit	1.14±0.34	1.52±0.50	-0.1800	-0.1957	9.7424*
Sources of Drinking water	1.73±0.71	2.37±0.84	-0.1028	-0.1976	3.1672**

* Significant at 1% level of significance, ** Significant at 5% level of significance

tagonistic correlation among dental caries experience (DMFT index) and its associated variables[12]. The inability of the factors to make an important contribution towards explaining the variations in the dental caries status indicators was of the same direction as found in other studies[12, 13, 14, 18].

Frequent sweet consumption was seen more in negatively health oriented group and frequent tooth brushing was commonly seen in the group of positively health oriented study subjects. Regular tooth brushing is accepted as a key determinant in the prevention of dental caries. This is in accordance with those observed in studies conducted by Javali et al [11], Chestnut[19], and O'mullane et al.[20]. There is some literature to suggest that poor oral hygiene does not increase an individual's risk of dental caries[21, 22, 23, 24, 25], yet other studies suggest that poor oral hygiene increases an individual's risk of dental caries[26, 27, 28, 29, 30, 31]. Therefore, it can be observed that, the relationship between dental caries and frequency of brushing is still ambiguous.

It can also be observed in the present study that dental caries has strong association with sweet consumption. In variety of brushing methods, some methods have been described in greater detail in dental literature. Proponents of one method or another have traditionally been vehement about decreased efficiencies of other methods. The relationship between methods of brushing with dental caries was found to be negative and significant. Vertical method and circular method of brushing was observed more commonly in positively health oriented group. Sangness et al.[32] and Rajala M.[33] have also reported similar findings.

Age is one of most important determinants of dental caries. But surprisingly, no significant relationship was observed between age and dental caries in the present study. However, some studies have shown that the relationship of age with dental caries was found positive and statistically significant[34, 35]. Dental caries was seen more commonly in urban subjects as compared to rural subjects due to the easy availability of sticky foods in urban areas. Similar findings were reported by Javali and Pandit[13] and Eleni P. et al.[36].

Discriminant function analysis can be taken to a one of the important and useful descriptive method when many predictor factors are studied simultaneously[14]. According to discriminant function analysis, duration of sweet consumption and frequency of sweet consumption were the most important factors related to lower DMFT scores; where as family size, income of a family, frequency of brushing were related to higher DMFT scores. Similarly, the multiple regression analysis showed that the materials used for cleaning their teeth, timings for cleaning teeth, sources of drinking water, desired family size, frequency of sweet consumption and rinsing habit are significant factors associated positively with dental caries. However, the methods of brushing, duration of change of toothbrush, frequency of brushing, duration of sweet consumption, types of toothpaste, area of residence and gender are significant factors associated negatively with dental caries.

Conclusions

The results of the present study confirm that the frequency of brushing, materials used to clean the teeth, duration of change of toothbrush, methods of brushing and gender are important discriminant factors related to subjects with lower DMFT scores. Similarly, the duration of sweet consumption, frequency of sweet consumption, family size, family income, area of residence and type of toothpaste are important discriminant factors related to subjects with higher DMFT scores.

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