

# Risk Indicators Associated With Tooth Loss among Indian Adults

Bushranaaz Fathima Jaleel<sup>1</sup>, Ramesh Nagarajappa<sup>2</sup>, Ashok Kumar Mohapatra<sup>3</sup>, Gayathri Ramesh<sup>4</sup>

<sup>1</sup>MDS, Reader, Department of Public Health Dentistry, The Oxford Dental College, Hospital and Research Centre, Hosur Road, Bangalore - 560068, India. <sup>2</sup>MDS, Professor and Head, Department of Public Health Dentistry, Rama Dental College and Hospital, Lakhanpur, Kanpur - 208024, India. <sup>3</sup>MDS, Professor and Head, Department of Public Health Dentistry, Indraprastha Dental College and Hospital, Sahibabad, Ghaziabad - 201010, India. <sup>4</sup>MDS, Associate Professor, Department of Oral and Maxillofacial Pathology, Rama Dental College and Hospital, Lakhanpur, Kanpur - 208024, India.

## Abstract

**Aim:** To assess the prevalence of tooth loss and to evaluate and compare the risk indicators associated with tooth loss among adults in urban and rural areas of Davangere taluk, India.

**Methods:** A cross-sectional study was conducted among 1200 adults (632 males, 568 females) aged 35-74 years in urban and rural areas of Davangere taluk, India. Data was collected by an interview followed by clinical examination (number of missing teeth). Demographic and socioeconomic factors, life style, self perceived oral health and utilization of dental services were the independent variables assessed. One way Analysis of Variance (ANOVA), post hoc test (Bonferroni), chi square test, student's *t*-test and logistic regression analysis were used for statistical analysis.

**Results:** Mean number of missing teeth per person was  $4.2 \pm 7.4$ . At least one tooth missing was observed among 51.8% of subjects and 5.2% were completely edentulous. Tooth loss was higher in rural ( $4.7 \pm 7.8$ ) than urban ( $3.5 \pm 6.8$ ) adults. Individuals (62.8%) who thought that tooth loss was inevitable had significantly higher mean number of missing teeth ( $4.8 \pm 7.9$ ) ( $p < 0.001$ ). Lack of dental treatment facilities in the vicinity was reported by 95% of rural adults. The odds of tooth loss in older adults and illiterates were nearly 1.2 and 1.1 times higher respectively. The lower income subjects presented nearly twice higher odds for tooth loss than the higher income group. Similarly, 94% odds were observed in smokers than non smokers.

**Conclusion:** The insights gained illustrate that tooth loss was highly prevalent in this rural Davangere population and the significant risk indicators identified were age, education, socio-economic status and cigarette smoking.

*Key Words: Age, Adults, Education, Smoking, Tooth Loss*

## Introduction

One of the most important oral health indicators is the ability to retain more number of teeth throughout life. Oral health goals recommended by World Health Organization for the year 2020 has stated that there should be an increase in the number of individuals with functional dentitions (21 or more natural teeth) at ages 35-44 and 65-74 years [1]. Tooth loss is the result of complex interaction of factors, of which the clinical condition of the tooth like caries, periodontal disease or trauma may only be the triggering factors, rather than the one single reason for loss of teeth. It is said to vary by age, gender, race, education, income and by geographic region [2]. Cultural factors, accessibility and availability of care, cost of care, individual's attitudes and beliefs about perceived need for dental care and importance of maintaining the dentition interplay in the decisions of whether or when to extract a tooth. It is an outcome of treatment decision as well as disease [3].

Tooth loss impairs the quality of life, often substantially and affects the well being of the person. Missing teeth can interfere with chewing ability, diction, and esthetics. Low self-esteem related to tooth loss can hinder an individual's ability to socialize, hamper the performance of work and daily activities, and lead to absence from work [4]. Hence, preservation of natural dentition should be the ultimate goal of the dental profession.

Information about the frequency of tooth loss and its risk factors in developing countries is sparse, particularly in Brazil and other Latin American countries. A study conducted in 2001 surveyed major metropolitan area in Brazil and estimated

a mean tooth loss of 11.2 teeth, which varied between 5.5 and 20.2 teeth in the 30-39 and 60+ years age groups, respectively [5]. Prevalence of edentulism was 39.5%, and mean tooth loss was 20.2 (SE=0.6). Older individuals [Odds Ratio (OR)=2.2], women (OR=2.3), white people (OR=5.9), individuals of lower socioeconomic status (OR=5.6) and smokers (OR=3.5) had higher likelihood of being edentulous [6]. Tooth loss accounts for a high frequency among subjects aged over 60 years in Sri Lanka ( $20.7 \pm 10.7$ ) [7]. Low education and low income were moderately [Relative Risks (RR) between 1.6 and 2.0] associated with tooth loss among both women and men in Germany [8].

Relatively very few studies have been conducted to know the risk indicators associated with tooth loss among Indian adults [9,10]. They reported that perceived need and attitudes towards dental care had an important influence on use of care. The older people prompted to have a fatalistic attitude and were least likely to attend the dentist.

Missing teeth are a common manifestation in patients reporting to the outpatient department of Bapuji Dental College and Hospital, Davangere, India; however, to our knowledge from indexed literature, there are no studies that have investigated the prevalence of tooth loss and its associated risk factors among individuals from rural and urban Davangere, India.

## Aim

To assess the prevalence of tooth loss which can establish baseline data among adults of Davangere taluk, India and also

Corresponding author: Ramesh Nagarajappa, Professor and Head, Department of Public Health Dentistry, Rama Dental College and Hospital, Lakhanpur, Kanpur - 208024, India; Tel: +91-9621168883; e-mail: rameshpcd@yahoo.co.in

to evaluate and compare the risk indicators associated with tooth loss among urban and rural adults.

## Materials and Methods

### Study design and setting

A descriptive, cross-sectional study was conducted to evaluate the risk indicators associated with tooth loss in urban and rural adult population of Davangere taluk, India, during August to October 2011. Davangere district comprises of 6 taluks: Davangere, Harihar, Channagiri, Honnali, Harapanahalli and Jagalur. Davangere taluk has an area of 936.1 sq kms, population density is 644 persons/sq km, population of 602,523 people (309,642 males and 292,881 females) and literacy rate 73.8%, according to census 2011 report. It has 178 villages and 60 Gram panchayats [11].

### Ethical considerations

The research protocol on the assessment of tooth loss prevalence and its associated risk indicators among Davangere adults was evaluated and approved by the Institutional Review Board of the Bapuji Dental College and Hospital, Davangere, India. Subjects who agreed to participate signed a written informed consent form.

### Pilot survey

Prior to instigation of the main study, a pilot survey was conducted on 60 individuals. Subjects were interviewed in their local language to access the clarity of the questions asked and necessary modifications were made in the dialect for effective communication, so that all the interviews would be conducted in a uniform manner, in particular the wording and phrasing of questions. Depending on the prevalence obtained (25%), 95% confidence level and 10% allowable error, the sample size determined was 1152 which was rounded off to 1200.

### Sampling design and study population

A total of 1293 subjects were approached to participate in the study but 93 declined citing a variety of reasons (response rate 92.8%). Study sample of 1200 adults were recruited by a multistage stratified random sampling procedure.

### Selection of urban area

Davangere city was divided geographically into 5 areas; North-East, North-West, South-East, South-West and Central. Approximately 7 wards came under each of these geographic areas. In the first stage, 1 ward was randomly selected from each geographic area. List of all the blocks from the 5 selected wards was obtained from Census Enumeration Areas Data. In the second stage, 3 blocks were selected randomly from each ward. In the third stage, door to door survey was conducted and around 40 individuals, aged 35-74 years were interviewed and examined from each block.

### Selection of rural area

Davangere taluk was divided geographically into 4 areas; North-East, North-West, South-East and South-West. In the first stage, from each of the geographical areas, 4 villages were randomly selected. In the second stage, each village was divided into 2 halves. In the third stage, from each half of the village around 20 individuals, aged 35-74 years were interviewed and examined during the door to door survey.

### Methodology (Data collection)

Data regarding the subject's personal details, socio-

demographic characteristics, diet, oral hygiene practices (materials used and frequency of cleaning), habits (smoking/chewing tobacco and alcohol consumption), oral health knowledge, availability and utilization of dental services and self perceived oral health and need for treatment were recorded on a specially designed proforma. On an average 15-20 subjects were interviewed and examined per day. Amongst the sample of 1200 study subjects, 632 were males and 568 were females. Single investigator who was trained and calibrated performed all oral examinations (kappa value=0.90).

### Examination criteria

- Teeth were considered as missing, if they were missing on examination and also indicated for extraction like root stumps, grossly destructed teeth and mobile teeth and even in the presence of fixed or removable prosthesis.
- Supernumerary teeth and bilateral maxillary and mandibular third molars were excluded.

Since only the socio-demographic and behavioural risk indicators for tooth loss were investigated, the precise reason for tooth loss i.e. caries, periodontal disease, trauma, congenital absence of teeth, therapeutic extraction and effects of medications and systemic diseases/immunocompromised individuals were not considered in the study.

The study population was categorized into 4 age groups; 35-44, 45-54, 55-64 and 65-74 years. Socio-economic status based on Per capita income was classified according to B.J. Prasad's classification using the All India Consumer Price Index for October 2005 as follows [12]; Social class I ( $\geq$  Rs 2001), Social class II (Rs 1001-2000), Social class III (Rs 601-1000), Social class IV (Rs 301-600) and Social class V ( $\leq$  Rs 300). Occupational status of the study population was classified based on the occupational classification adopted during National Oral Health Survey 2002-2003 [9]. Smokers/Tobacco chewers included the current smokers/chewers. Individuals smoking at least one cigarette a day since at least the past 12-months were defined as smokers [13]. Persons chewing at least one pouch of tobacco a day since at least one year were defined as tobacco chewers [14]. Non smokers or non tobacco chewers included the never smokers/ never chewers. Those who consumed more than 25 g/day of alcohol were considered alcohol users [15].

### Statistical analysis

The recorded data was compiled and entered in a spreadsheet computer program and then exported to data editor page of SPSS version 11.5 (SPSS Inc., Chicago, Illinois, USA). The variables were assessed for normality using the Kolmogorov-Smirnov test. Descriptive statistics included computation of percentages, means and standard deviations of the number of missing teeth for the various categories of the risk indicators. Chi-Square test, Student's *t*-test and one way Analysis of Variance (ANOVA) with Bonferroni post-hoc were used to assess bivariate relationships. Multivariate analysis was used to assess the relative importance of independent variables and to identify the main variables influencing tooth loss. All the risk indicators were dichotomized and employed as independent variables in multiple logistic regression estimating values of Odds Ratio (OR) and the respective 95% Confidence Interval

(CI). Goodness of fit was assessed by means of Hosmer and Lemenshow test. Statistical significance was set at  $p \leq 0.05$ .

## Results

The study sample comprised of 1200 adults, aged 35 to 74 years with mean age of  $50.9 \pm 10.78$  years. They included 565 (47.1%) subjects from urban and 635 (52.9%) subjects from rural areas. Of these, 632 (52.7%) were males and 568 (47.3%) were females. *Table 1* show that 43% of subjects (44.2% urban adults, 41.7% rural adults) had an intact dentition, with no tooth loss. Complete (5.2%) and partial (51.8%) edentulousness was comparatively higher among the rural adults ( $p=0.05$ ) and males ( $p=0.007$ ) in particular.

The mean number of missing tooth in the study population was  $4.2 \pm 7.4$ . Significant association was found between the place of residence and tooth loss ( $3.5 \pm 6.8$  urban;  $4.7 \pm 7.8$  rural), with rural adults showing greater tooth loss compared to urban adults ( $p<0.01$ ). Tooth loss increased significantly with age, ranging from mean number of 1.2 teeth in 35-44 years old to 11.5 teeth among 65-74 years old subjects ( $p<0.001$ ). Gender showed a significant difference ( $p<0.01$ ) in tooth loss between males ( $4.7 \pm 7.7$ ) and females ( $3.6 \pm 6.9$ ). A significant association for tooth loss was also found with respect to the level of education and socio-economic status ( $p<0.001$ ). A decrease in the mean number of missing teeth with increasing education and better socio economic status was observed which was statistically significant ( $p<0.001$ ) (*Table 2*).

Subjects who used tooth brush with toothpaste or tooth powder for cleaning teeth had significantly less number of missing teeth ( $2.5 \pm 4.6$ ) ( $p<0.001$ ) as compared to individuals practicing other oral hygiene methods. In relation to frequency, though tooth loss demonstrated to be higher among the individuals who cleaned once daily than multiple times (3.2 and 2.6), the difference was not statistically significant ( $p>0.05$ ). Those who consumed a vegetarian diet, sugary snacks and/or drinks  $\geq 5$  times between meals daily showed a significant increase in the number of missing teeth than their counterparts ( $p<0.001$ ). The mean number of missing teeth was significantly higher among smokers ( $p<0.001$ ) as compared to non smokers but was not significant among tobacco chewers and non chewers ( $p=0.06$ ) (*Table 3*).

*Table 4* represents tooth loss in relation to the oral health knowledge and attitude among the study population. Individuals (62.8%) who thought that tooth loss was inevitable had higher mean number of missing teeth ( $4.8 \pm 7.9$ ). This difference was found to be statistically significant ( $p<0.001$ ). Majority adults, [57% (60.6% urban and 53.9% rural)] who had experienced tooth loss expressed desire to get their missing teeth replaced by prosthesis. Mean number of missing teeth was higher among people who had utilized dental services and this difference was statistically significant ( $p<0.001$ ).

*Table 5* illustrates the subject's responses regarding utilization of dental services. Approximately, 95% of adults in the rural area reported lack of dental treatment facilities in the vicinity. Urban population was mainly served by the dental colleges (64.8%). The greatest response for reason of dental visit was extraction of teeth (48.7%). The non utilization was because they felt they had no problem (64.5%) followed with some other priorities (12.7%) and economic constraints (12%). Nearly 68.3% of study subjects, self perceived no problem in oral health and further only 29.3% adults felt the need for dental treatment.

We estimated the odds ratio and their 95% confidence intervals for variables affecting tooth loss in our study population (*Table 6*). Here we shall describe exclusively the odds ratio that had statistical significance. The odds of tooth loss in adults aged over 55 years were nearly 1.2 times higher than those for adults aged less than 55 years. Married adults showed about 87% odds than unmarried subjects. The odds were 1.1 times higher in illiterates than literates. In persons with monthly income of less than Rs. 10,000 the odds were nearly twice higher than the higher income group. The odds among frequent snackers between meals showed 80% higher chances of tooth loss. Similarly, 94% odds were observed in smokers than non smokers. Those who cleaned their teeth more than twice daily showed nearly 90% less odds for tooth loss. Variance in the number of missing teeth was also ascertained among the adults utilizing dental care services (OR=0.959). Finally, the odds for tooth loss among those who expressed their desire for replacement of missing teeth were 1.4 times lower than their counterparts.

**Table 1.** Tooth Loss according to Place of Residence and Sex among the Study Population.

Variables	Sex	No tooth loss n (%)	Completely edentulous n (%)	Partially edentulous n (%)	$\chi$ value p value
Urban (n=565)	Males	119 (40.8)	15 (5.1)	158 (54.1)	$\chi = 20.794$ $p=0.05^*$
	Females	131 (48)	12 (4.4)	130 (47.6)	
	Total	250 (44.2)	27 (4.8)	288 (51)	
$\chi = 10.774$ and $p=0.224$					
Rural (n=635)	Male	126 (37.1)	23 (6.8)	191 (56.2)	
	Females	139 (47.1)	13 (4.4)	143 (48.5)	
	Total	265 (41.7)	36 (5.7)	334 (52.6)	
$\chi = 19.556$ and $p=0.028^*$					
Overall (n=1200)	Males	245 (38.8)	38 (6.0)	349 (55.2)	
	Females	270 (47.5)	25 (4.4)	273 (48.1)	
	Total	515 (43)	63 (5.2)	622 (51.8)	
$\chi = 25.476$ and $p=0.007^*$					

Test applied: Chi square test

\* $p \leq 0.05$  is Statistically significant

**Table 2.** Prevalence of tooth loss in relation to Socio-demographic characteristics among the study population.

	Urban (n = 565)			Rural (n = 635)			Overall (N = 1200)		
	n (%)	Mean (SD)	p-value	n (%)	Mean (SD)	p-value	n (%)	Mean (SD)	p-value
<b>Residence</b>	565 (47.1)	3.5 (6.8)	-	635 (52.9)	4.7 (7.8)	-	1200 (100)	4.2 (7.4)	t=2.80 <0.01*
<b>Age (in years)</b>									
35-44	187 (33.1)	1.0 (2.0) <sup>a</sup>	F =42.5 <0.01*	177 (27.9)	1.4 (3.1) <sup>a</sup>	F =66.9 <0.001*	364 (30.3)	1.2 (2.6) <sup>a</sup>	F =114.0 <0.001*
45-54	187 (33.1)	2.6 (5.1) <sup>a</sup>		189 (29.8)	2.6 (5.0) <sup>a</sup>		376 (31.3)	2.6 (5.0) <sup>b</sup>	
55-64	130 (23.0)	5.2 (7.9) <sup>b</sup>		148 (23.3)	5.6 (7.9) <sup>b</sup>		278 (23.2)	5.4 (7.9) <sup>c</sup>	
65-74	61 (10.8)	10.7 (11.3) <sup>c</sup>		121 (19)	12.0 (10.8) <sup>c</sup>		182 (15.2)	11.5 (10.9) <sup>d</sup>	
<b>Sex</b>									
Males	292 (51.7)	3.9 (7.0)	t=1.12	340 (53.5)	5.5 (8.2)	t=2.48	632 (52.7)	4.7 (7.7)	t=2.67
Females	273 (48.3)	3.2 (6.5)	0.26	295 (46.5)	3.9 (7.2)	<0.05*	568 (47.3)	3.6 (6.9)	<0.01*
<b>Marital Status</b>									
Married	516 (91.3)	3.3 (6.4) <sup>a</sup>	F = 8.45 <0.001*	586 (92.3)	4.2 (7.3) <sup>a</sup>	F = 28.3 <0.001*	1102 (91.8)	3.8 (6.9) <sup>a</sup>	F = 36.3 <0.001*
Unmarried	23 (4.1)	3.7 (8.3) <sup>a</sup>		12 (1.9)	1.9 (2.6) <sup>a</sup>		35 (2.9)	3.1 (6.9) <sup>a</sup>	
Widow/ Widower	26 (4.6)	8.8 (10.1) <sup>b</sup>		37 (5.8)	13.6 (10.4) <sup>b</sup>		63 (5.3)	11.7 (10.5) <sup>b</sup>	
<b>Education Level</b>									
No education	61 (10.8)	5.5 (8.9) <sup>ab</sup>	F = 11.3 <0.001*	242 (38.1)	5.0 (8.2) <sup>a</sup>	F = 3.76 <0.05*	303 (25.2)	5.1 (8.3) <sup>a</sup>	F = 15.3 <0.001*
Primary	119 (21.1)	5.9 (8.6) <sup>a</sup>		206 (32.4)	5.8 (8.5) <sup>a</sup>		325 (27.1)	5.8 (8.5) <sup>a</sup>	
Secondary	180 (31.9)	3.2 (6.4) <sup>bc</sup>		143 (22.6)	3.0 (6.1) <sup>bc</sup>		323 (26.9)	3.1 (6.3) <sup>b</sup>	
Graduation and above	205 (36.2)	1.9 (4.2) <sup>c</sup>		44 (6.9)	4.1 (6.5) <sup>ac</sup>		249 (20.8)	2.3 (4.8) <sup>b</sup>	
<b>Socio-Economic Status</b>									
I	229 (40.5)	2.5 (5.4) <sup>a</sup>	F = 2.95 <0.05*	33 (5.2)	1.8 (2.7) <sup>a</sup>	F = 2.55 <0.05*	262 (21.8)	2.4 (5.2) <sup>a</sup>	F = 7.13 <0.001*
II	128 (22.7)	4.4 (7.9) <sup>b</sup>		73 (11.5)	4.1 (8.0) <sup>b</sup>		201 (16.8)	4.3 (7.9) <sup>b</sup>	
III	107 (18.9)	4.0 (7.2) <sup>bc</sup>		91 (14.3)	3.9 (6.6) <sup>b</sup>		198 (16.5)	3.9 (6.9) <sup>b</sup>	
IV	60 (10.6)	3.6 (6.1) <sup>c</sup>		163 (25.7)	4.6 (7.4) <sup>b</sup>		223 (18.6)	4.3 (7.1) <sup>b</sup>	
V	41 (7.3)	5.5 (8.5) <sup>d</sup>		275 (43.3)	5.7 (8.6) <sup>c</sup>		316 (26.3)	5.6 (8.6) <sup>c</sup>	

Student's *t*-test and One way ANOVA with Bonferroni post-hoc test. (Values with same letter superscripted do not vary significantly)

\*p ≤ 0.05 is statistically significant

## Discussion

Loss of teeth reflects a major public health problem in many countries. The prevalence of tooth loss among the adults of Davangere taluk, India was 57%. Mean number of missing teeth (4.2) was higher in comparison with Haitian immigrants (2.64) of New York City [16]. Complete edentulousness was more prevalent among rural adults which is in conformity with few other studies [10,17,18]. Several other studies have shown no association between tooth loss and the place of residence [19,20].

The difference in tooth loss between rural and urban adults might be explained by the fact that meeting dental care needs is more challenging to the people living in the rural areas compared to their urban counterparts. Availability, accessibility, acceptability and affordability of dental services might be the potential barriers for the rural people to seek timely advice and treatment. In India there is gross disparity in oral health care provision between urban and rural areas [10]. Also, the attitude of the rural people is generally such that they elect to have their symptomatic teeth extracted rather than conserving those [18].

A directly proportional relationship was observed between age and tooth loss, which was lower than that found in National Oral Health Survey of India [9] and also among Saudi Arabian adults [19]. Greater tooth loss among the older age groups may be due to the cumulative effect of

dental diseases and lack of oral health care measures. It may also reflect many things that the older people might have experienced in their past, like high prevalence and intensity of oral diseases, unavailability of care, past economic and social conditions and the nature and philosophy of dental care provided in earlier days. It has also been reported that age alone is not responsible for deterioration of oral health [2,3]. There may be several other factors such as multiple chronic diseases, side effects of medications and psychological factors as depression and isolation (because of loss of spouse, friends and feeling of being unwanted by family) leading to neglect of personal and oral hygiene resulting in higher tooth loss among the older aged people [10].

In the present study, females had fewer missing teeth than males. Though similar observation was found in other studies [17,21], few studies have shown female predominance [10,19,22] and also no difference in tooth loss [16,23,24]. Females are generally more concerned about their oral health and are more likely to choose preservation of their teeth over extraction. Self consciousness to look beautiful, fear psychosis that losing teeth is a sign of ageing, the negative impact of bleeding gums and halitosis - that might affect their personality and socialization encourages the women to maintain good oral hygiene. Females are also found to brush their teeth more regularly and utilize dental services more

**Table 3.** Tooth loss in relation to oral hygiene practices, dietary habits, sugar consumption and adverse oral habits among the study population.

	Urban (n = 565)			Rural (n = 635)			Overall (N = 1200)		
	n (%)	Mean (SD)	p-value	n (%)	Mean (SD)	p-value	n (%)	Mean (SD)	p-value
<b>Oral Hygiene Practices</b>									
<i>Materials Used</i>									
Tooth brush with paste/ powder	501(92.6)	2.3(4.1) <sup>a</sup>	F=203.87 <0.001*	369(61.0)	2.8(5.2) <sup>a</sup>	F=80.03 <0.001*	870(75.7)	2.5(4.6) <sup>a</sup>	F=211.96 <0.001*
Tooth brush with other materials	0 (0)	0 (0)		9(1.5)	2.6(2.9) <sup>a</sup>		9(0.8)	2.6(2.9) <sup>a</sup>	
Finger with paste/powder	29(5.4)	5.2(1.9) <sup>b</sup>		123(20.2)	5.2(7.0) <sup>b</sup>		152(13.2)	5.3(7.1) <sup>b</sup>	
Finger with other materials	10(1.8)	10.7(11.3) <sup>c</sup>		104(16.3)	5.5(8.2) <sup>b</sup>		114(10)	5.2(8.1) <sup>b</sup>	
Others	1(0.2)	0 (0)		3(0.5)	9.0(10.1) <sup>c</sup>		4(0.3)	6.8(9.4) <sup>c</sup>	
<i>Frequency of cleaning</i>									
Once	423(78)	2.8(4.9)	t=2.87	552(90.8)	3.6(6.1)	t=1.85	975(84.9)	3.2(5.6)	t=1.29
Twice/more	118(22)	1.4(2.6)	<0.01*	56(9.2)	5.2(7.5)	0.07	174(15.1)	2.6(5.1)	0.20
<b>Dietary Habits</b>									
Vegetarians	367(65)	4.2(7.3)	t=2.88	431(67.9)	5.4(8.3)	t=3.22	798(66.5)	4.8(7.9)	t=4.39
Mixed	198(35)	2.4(5.5)	<0.01*	204(32.1)	3.3(6.5)	<0.01*	402(33.5)	2.9(6.1)	<0.001*
<b>Frequency of consumption of sugary snacks/drinks between meals</b>									
No	110(19.5)	4.3(7.9) <sup>a</sup>	F=4.39 <0.05*	72(11.3)	5.7(9.0) <sup>a</sup>	F=13.9 <0.001*	182(15.2)	4.9(8.4) <sup>a</sup>	F=14.1 <0.001*
≤ 4	342(60.5)	2.9(5.9) <sup>b</sup>		475(74.8)	3.9(6.9) <sup>b</sup>		817(68.1)	3.5(6.5) <sup>b</sup>	
≥ 5	113(20.0)	4.8(7.9) <sup>a</sup>		88(13.9)	8.5(10.1) <sup>c</sup>		201(16.7)	6.4(9.1) <sup>c</sup>	
<b>Adverse Habits</b>									
<i>Smoking</i>									
Yes	112(19.8)	4.9(7.8)	t=2.35	552(90.8)	3.6(6.1)	t=1.85	975(84.9)	3.2(5.6)	t=1.29
No	453(80.2)	3.2(6.5)	<0.05*	56(9.2)	5.2(7.5)	0.07	174(15.1)	2.6(5.1)	0.20
<i>Tobacco chewing</i>									
Yes	59(10.4)	2.8(4.9)	t=0.85 0.40	143(22.5)	6.0(8.7)	t=2.14	202(16.8)	5.1(7.9)	t=1.85 0.06
No	506(89.6)	3.6(7.0)		492(77.5)	4.4(7.5)	<0.05*	998(83.2)	4.0(7.2)	
<i>Alcohol</i>									
Yes	84(14.9)	3.1(5.3)	t=0.60	61(9.6)	3.5(6.2)	t=1.32	145(12.1)	3.3(5.7)	t=1.56
No	481(85.1)	3.6(7.0)	0.55	574(90.4)	4.9(8.0)	0.19	1055(87.9)	4.3(7.6)	0.12

Student's *t*-test and One way ANOVA with Bonferroni post-hoc test. (Values with same letter superscripted do not vary significantly)

\*p ≤ 0.05 is statistically significant.

**Table 4.** Tooth loss in relation to oral health knowledge and attitude among the study population.

	Urban			Rural			Overall		
	n (%)	Mean (SD)	p-value	n (%)	Mean (SD)	p-value	n (%)	Mean (SD)	p-value
<b>Belief that Losing teeth is normal with increasing age (n=565) (n=635) (N=1200)</b>									
Yes	333 (59)	3.8 (7.0) <sup>a</sup>	F**=3.44 <0.05	420 (66.1)	5.5 (8.4) <sup>a</sup>	F**=6.46 <0.01	753 (62.8)	4.8 (7.9) <sup>a</sup>	F**=8.72 <0.001
No	79 (14)	1.7 (4.1) <sup>b</sup>		99 (15.6)	2.7 (5.4) <sup>b</sup>		178 (14.8)	2.3 (4.9) <sup>b</sup>	
2.3 (4.9) <sup>b</sup>	153 (27)	3.9 (7.2) <sup>a</sup>		116 (18.3)	3.7 (6.9) <sup>c</sup>		269 (22.4)	3.8 (7.1) <sup>c</sup>	
<b>Desire for replacement of missing teeth (n=315) (n=371) (N=686)</b>									
Yes	191 (60.6)	7.5 (9.2)	t*=3.23	200 (53.9)	8.5 (9.3)	t*=0.98	391 (57)	8.0 (9.2)	t*=2.58
No	124 (39.4)	4.6 (5.5)	<0.01	171 (46.1)	7.6 (8.1)	0.33	295 (43)	6.4 (7.3)	<0.05
<b>Utilization of Dental services (n=565) (n=635) (N=1200)</b>									
Yes	355 (62.8)	4.6 (7.6)	t*=4.84	247 (38.9)	6.5 (8.8)	t*=4.63	602 (50.2)	5.4 (8.2)	t*=5.73
No	210 (37.2)	1.8 (4.7)	<0.001	388 (61.1)	3.6 (6.9)	<0.001	598 (49.8)	3.0 (6.3)	<0.001

Student's *t*-test and One way ANOVA with Bonferroni post-hoc test. (Values with same letter superscripted do not vary significantly)

\*p ≤ 0.05 is statistically significant.

frequently than men, which might have resulted in less tooth loss among them [25,26].

People who were married and living together with their

spouse had fewer missing teeth. Marital status may be an independent factor for better oral health and better care seeking behavior and consequently less tooth loss, because

*Table 5. Distribution of subjects' responses regarding utilization of dental services.*

	Urban		Rural		Overall	
	N	%	N	%	n	%
<b>Dental facilities available nearby</b>						
None	11	1.9	602	94.8	613	51.1
Govt. Hospital	12	2.1	21	3.4	33	2.7
Private Clinic	56	9.9	6	0.9	62	5.2
Dental College	366	64.8	6	0.9	372	31
>1 dental treatment facility available	120	21.3	-	-	120	10
Total	<b>565</b>	<b>100</b>	<b>635</b>	<b>100</b>	<b>1200</b>	<b>100</b>
<b>Reason for Utilization of services</b>						
Consultation	16	4.5	28	11.4	44	7.3
Filling	39	11	5	2	44	7.3
Extraction	149	42	144	58.3	293	48.7
Gum problem	9	2.5	3	1.2	12	2
Cleaning	37	10.4	24	9.7	61	10.1
Replacement of teeth	40	11.3	26	10.5	66	11
Combination of above reasons	65	18.3	17	6.9	82	13.6
Total	<b>355</b>	<b>100</b>	<b>247</b>	<b>100</b>	<b>602</b>	<b>100</b>
<b>Reasons for non-utilization of services</b>						
No dentist nearby	2	1	11	2.8	13	2.2
Fear of pain	15	7.1	18	4.6	33	5.5
Economic problem	17	8.1	55	14.2	72	12
Transportation problem	1	0.5	13	3.4	14	2.4
Other priorities	9	4.3	67	17.3	76	12.7
Feeling that they had no problem	162	77.1	224	57.7	386	64.5
Combination of above reasons	4	1.9	-	-	4	0.7
Total	<b>210</b>	<b>100</b>	<b>388</b>	<b>100</b>	<b>598</b>	<b>100</b>
<b>Self-perceived oral health</b>						
No problem	407	72.0	412	64.9	819	68.3
Tooth decay and pain	84	14.9	111	17.5	195	16.3
Gum disease	41	7.3	70	11	111	9.2
Others	33	5.8	42	6.6	75	6.2
Total	<b>565</b>	<b>100</b>	<b>635</b>	<b>100</b>	<b>1200</b>	<b>100</b>
<b>Self-Perceived need of treatment</b>						
Treatment needed	156	27.6	195	30.7	351	29.3
Treatment not needed	409	72.4	440	69.3	849	70.7
Total	<b>565</b>	<b>100</b>	<b>635</b>	<b>100</b>	<b>1200</b>	<b>100</b>

marital relation by its very nature acts as an incentive for seeking oral health care out of partner's encouragement. Loneliness and depression due to loss of spouse may lead to neglect of personal and oral hygiene [10].

The level of education was found to be associated with tooth loss. In this study, people with higher levels of education had experienced less tooth loss. This result extends the finding of previous researches documenting that lower literacy level is associated with higher number of missing teeth [10,21,23,24]. Well educated people are more knowledgeable, understand the importance of maintaining a healthy oral cavity; can be motivated easily and generally comply with the instructions given to them by the dentist in order to maintain good oral hygiene. They are also likely to visit the dentist regularly for check-ups and utilize more of preventive services.

Higher social class people showed less prevalence of tooth loss which was similarly reported in other studies also [16,17,27]. People of lower social classes tend to place very little value for health in general and oral health in particular.

They give little or no importance for preservation of their teeth for the entire life time and prefer extraction over restoration [17].

The positive effect of cleaning the teeth with tooth brush twice daily resulting in greater tooth retention is consistent with the results of other studies [27-29]. Less tooth loss among tooth brush users may be due to superior plaque control among them, as the bristles of the tooth brush can reach the interproximal areas as well as pits and fissures of the teeth more efficiently than finger or other indigenous materials, thus resulting in better oral hygiene.

In this study, it was seen that tooth loss was higher among vegetarians compared to people with mixed diet. Very few studies have evaluated the role of diet on tooth loss [30,31]. A recent Indian study has also shown similar result, with the explanation that higher protein content of the mixed diet provides essential amino acids for the health of the supporting structures of the teeth and repair of wear and tear of the

**Table 6.** Estimates of multiple logistic regressions for variables affecting tooth loss.

Variables	Category	Odds Ratio	95% Confidence Interval
Place of residence	Urban	0.831	0.426-1.619
	Rural		
Age in years	≤ 55	1.186*	0.913-1.541
	>55		
Sex	Male	1.123	0.854-1.475
	Female		
Marital Status	Married	0.876*	0.56-1.368
	Unmarried		
Education	Illiterate	1.065*	0.781-1.453
	Literate		
Socio-Economic Status(Monthly income in Rupees)	≤ 10,000	1.855*	1.334-2.581
	>10,000		
Diet	Vegeterian	1.012	0.782-1.311
	Mixed		
Frequency of consumption of sugary snacks/ drinks between meals	≤ 4	0.802*	0.615-1.046
	>4		
Smoking	Yes	0.938*	0.67-1.315
	No		
Frequency of cleaning the teeth	<2	0.886*	0.624-1.259
	≥ 2		
Utilization of dental services	Yes	0.959*	0.493-1.866
	No		
Desire for replacement of missing teeth	Yes	1.319	1.008-1.726
	No		

\* Indicates statistical significance at  $p < 0.05$

supporting tissues, or it may be related to the lifestyle factors of vegetarian and mixed diet individuals [10].

Individuals who consumed sugary snacks/drinks  $\geq 5$  times between meals, had higher tooth loss compared to individuals with no or  $\geq 4$  such exposures. A study conducted in Finland, also showed that number of missing teeth was associated with age, tooth brushing and greater frequency of daily sugar exposure [32], supporting the fact that frequent consumption of sugary snacks and/or drinks between meals is associated with greater tooth loss.

Smoking was found to be associated with tooth loss. Higher mean number of missing teeth was seen among smokers than non-smokers. This observation is in agreement with results of some other studies [17,32-34]. On comparing the urban and rural adults, tooth loss was found to be significantly higher among smokers of rural area. This might be due to the fact that people in urban area smoke cigarettes with filters, which are relatively less harmful compared to beedis usually smoked by the rural people.

The misconception that tooth loss was an inevitable part of ageing process was widely accepted in this study population as observed among adults in Hong Kong, United Kingdom and China [35,36]. A possible explanation might be that the peoples' health beliefs are influenced by a range of factors like primary and secondary socialization which usually guides the human behaviors and values. Most importantly, education plays a significant role in influencing knowledge and hence implying their health beliefs [37].

Among the people who had experienced tooth loss, 57.1% and in particular urban adults expressed a desire to get their

missing teeth replaced. Education, socio-economic status and availability of dental services might be some of the factors responsible for the positive attitude among the urban adults. Non replacement in the remaining population may be related to the feeling that dentures are made of natural teeth extracted from another person's mouth. Some people felt that tooth replacement was uneconomical and that they would rather invest that money for the education and better future of their children. Still others, being aware of their limited life expectancy, appeared to accept the limitation of a disabled mouth rather than embark upon a potentially unsettling course of treatment for tooth replacement [37,38].

Around half of the study population (50.2%) claimed that they had utilized dental services in the past and the most frequently reported reason for the dental visit was tooth extraction. Consequently mean number of missing teeth among dental services users was higher than non-users which only confirm that most dental therapies aim to alleviate the consequences of dental diseases, rather than prevent the onset or course of the disease itself. This finding is in agreement with results obtained in previous research [37], but at variance with other studies which have confirmed that non-users of dental services had greater number of missing teeth [27,28].

Majority (68.3%) did not feel they had any problem in their oral cavity. The self perceived oral health status and need for treatment are important factors that influence utilization of dental services. The low level of utilization of dental services suggest that people tend to overestimate their dental health and underestimate their need for care and those who underestimate their own dental care needs utilize the services

less frequently. Tooth loss may be considered as the ultimate barometer of failure or success of dentistry and dental health programs. The risk indicators included in this study reflect aspects of a complex process whose outcome is the loss of one or more teeth i.e. they document the characteristics of the individual losing teeth, rather than the characteristics of the teeth that are lost.

### Conclusion

The findings of this study provide an insight into the prevalence of tooth loss which was observed to be higher among rural than urban adults in Davangere taluk. The associated socio-demographic risk indicators responsible for increased tooth loss included age, males, illiterates and low socio-economic status groups. Allied behavioral risk indicators comprised of smokers and frequent snackers. This epidemiological data confirms the need for community based oral health promotion and disease prevention programs designed to reduce the risk for tooth loss in this and similar populations.

### Authors' Contribution

BFJ contributed with the study design, acquisition, analysis and interpretation of data and took part in drafting of the manuscript. RN, AKM and GR contributed with the design, analysis and interpretation of data and took part in drafting of the manuscript. All authors listed on the title page have read the manuscript, attest to the validity and legitimacy of the data and its interpretation, and agree to its submission.

### Acknowledgements

The authors would like to thank the study participants for their participation and kind cooperation throughout the study.

### Conflict of Interest

None declared

### Sources of Funding

Nil

### References

- Hobdell M, Petersen PE, Clarkson J, Johnson N. Global goals for oral health 2020. *International Dental Journal*. 2003; **53**: 285-288.
- Warren JJ, Watkins CA, Cowen HJ, Hand JS, Levy SM, Kuthy RA. Tooth loss in the very old: 13-15 year incidence among elderly Iowans. *Community Dentistry and Oral Epidemiology*. 2002; **30**: 29-37.
- Presson SM, Niendorf WJ, Martin RF. Tooth loss and need for extractions in American Indians and Alaska Native Dental Patients. *Journal of Public Health Dentistry*. 2000; **60**: 267-272.
- Batista MJ, Rihs LB, Sousa Mda L. Risk indicators for tooth loss in adultworkers. *Brazilian Oral Research*. 2012; **26**: 390-396.
- Susin C, Oppermann RV, Haugejorden O, Albandar JM. Tooth loss and associated risk indicators in an adult urban population from south Brazil. *Acta Odontologica Scandinavica*. 2005; **63**: 85-93.
- Gaio EJ, Haas AN, Carrard VC, Oppermann RV, Albandar J, Susin C. Oral health status in elders from South Brazil: a population-based study. *Gerodontology*. 2012; **29**: 214-223.
- Ekanayake L, Perera I. The association between clinical oral

health status and oral impacts experienced by older individuals in Sri Lanka. *Journal of Oral Rehabilitation*. 2004; **31**: 831-836.

- Mundt T, Polzer I, Samietz S, Grabe HJ, Do`ren M, Schwarz S, et al. Gender-dependent associations between socioeconomic status and tooth loss in working age people in the Study of Health in Pomerania (SHIP), Germany. *Community Dentistry and Oral Epidemiology*. 2011; **39**: 398-408.

- Oral Health Status. *National Oral Health Survey and Fluoride Mapping*, 2002-2003. India: Dental Council of India, New Delhi; 2004.

- Shah N, Prakash H, Sundaram KR. Edentulousness, denture wear and denture needs of Indian elderly – a community based study. *Journal of Oral Rehabilitation*. 2004; **31**: 467-476.

- Government of India, Ministry of Home Affairs. Census of India 2011. Our Census, our Future. Accessed (2011 September 24) at: <http://censusindia.gov.in/>

- Kumar P. Social Classification-need for constant updating. *Indian Journal of Community Medicine*. 1993; **18**: 60-61.

- Javed F, Näsström K, Benchimol D, Altamash M, Klinge B, Engström PE. Comparison of periodontal and socioeconomic status between subjects with type 2 diabetes mellitus and non-diabetic controls. *Journal of Periodontology*. 2007; **78**: 2112-2119.

- Javed F, Tenenbaum HC, Nogueira-Filho G, Nooh N, O'Bello Correa F, Warnakulasuriya S, et al. Periodontal inflammatory conditions among gutka-chewers and non-chewers with and without prediabetes. *Journal of Periodontology*. 2013; **84**: 1158-1164.

- Albuquerque R, López-López J, Mari-Roig A, Jané-Salas E, Roselló-Llabrés X, Santos JR. Oral tongue squamous cell carcinoma (OTSCC): alcohol and tobacco consumption versus non-consumption. A study in a Portuguese population. *Brazilian Dental Journal*. 2011; **22**: 517-521.

- Cruz GD, Galvis DL, Kim M, Le-Geros RZ, Barrow SY, Tavares M, et al. Self-perceived oral health among three subgroups of Asian-Americans in New York City: a preliminary study. *Community Dentistry and Oral Epidemiology*. 2001; **29**: 99-106.

- Hamasha AA, Sasa I, Al-Qudah M. Risk indicators associated with tooth loss in Jordanian adults. *Community Dentistry and Oral Epidemiology*. 2000; **28**: 67-72.

- Vargas CM, Dye BA, Hayes KL. Oral health status of rural adults in the United States. *Journal of American Dental Association*. 2002; **133**: 1672-1681.

- Al Shammery A, El Backly M, Guile EE. Permanent tooth loss among adults and children in Saudi Arabia. *Community Dental Health*. 1998; **15**: 277-280.

- Dolan TA, Gilbert GH, Duncan RP, Foerster U. Risk indicators of edentulism, partial tooth loss and prosthetic status among black and white middle-aged and older adults. *Community Dentistry and Oral Epidemiology*. 2001; **29**: 329-340.

- Suominen-Taipale AL, Alanen P, Helenius H, Nordblad A, Uutela A. Edentulism among Finnish adults of working age, 1978-1997. *Community Dentistry and Oral Epidemiology*. 1999; **27**: 353-365.

- Luan WM, Baelum V, Chen X, Fejerskov O. Tooth mortality and prosthetic treatment patterns in urban and rural Chinese aged 20-80 years. *Community Dentistry and Oral Epidemiology*. 1989; **17**: 221-226.

- Heft MW, Gilbert GH. Toothloss and caries prevalence in older Floridians attending senior activity centres. *Community Dentistry and Oral Epidemiology*. 1991; **19**: 228-232.

- Klein BE, Klein R, Knudtson MD. Lifestyle correlates to tooth loss in an adult Mid-Western population. *Journal of Public Health Dentistry*. 2004; **64**: 145-150.

- Al-Zaidi WH, Ahmed MAA. Tooth loss among Iraqi adolescent. *Journal of College of Dentistry of University of Baghdad*. 2005; **17**: 85-89.

- Tin-Oo MM, Saddki N, Hassan N. Factors influencing patient satisfaction with dental appearance and treatments they desire to improve aesthetics. *BMC Oral Health*. 2011; **11**: 6.

- Gilbert GH, Duncan RP, Crandall LA, Heft MW, Ringelberg

ML. Attitudinal and behavioral characteristics of older Floridians with tooth loss. *Community Dentistry and Oral Epidemiology*. 1993; **21**: 384-389.

28. Fukuda H, Shinsho F, Nakajima K, Takahashi S, Tatara K. Oral health habits and the number of teeth present in Japanese aged 50-80 years. *Community Dental Health*. 1997; **14**: 248-252.

29. Kressin NR, Boehmer U, Nunn ME, Spiro A 3rd. Increased preventive practices lead to greater tooth retention. *Journal of Dental Research*. 2003; **82**: 223-227.

30. De Marchi RJ, Hugo FN, Hilgert JB, Padilha DM. Association between oral health status and nutritional status in south Brazilian independent-living older people. *Nutrition*. 2008; **24**: 546-553.

31. Adegboye AR, Fiehn NE, Twetman S, Christensen LB, Heitmann BL. Low calcium intake is related to increased risk of tooth loss in men. *Journal of Nutrition*. 2010; **140**: 1864-1868.

32. Telivuo M, Kallio P, Berg MA, Korhonen HJ, Murtomaa H. Smoking and oral health. a population survey in Finland. *Journal of Public Health Dentistry*. 1995; **55**: 133-138.

33. Ragnarsson E, Eliasson ST, Olafsson SH. Tobacco smoking, a factor in tooth loss in Reykjavik, Iceland. *Scandinavian Journal of Dental Research*. 1992; **100**: 322-326.

34. Axelsson P, Paulander J, Lindhe J. Relationship between smoking and dental status in 35-, 50-, 65-, and 75-year-old individuals. *Journal of Clinical Periodontology*. 1998; **25**: 297-305.

35. Kwan SY, Williams SA. Dental beliefs, knowledge and behaviour of Chinese people in the United Kingdom. *Community Dental Health*. 1999; **16**: 33-39.

36. Lin HC, Wong MC, Wang ZJ, Lo EC. Oral health knowledge, attitudes and practices of Chinese adults. *Journal of Dental Research*. 2001; **80**: 1466-1470.

37. Lin HC, Corbet EF, Lo EC, Zhang HG. Tooth loss, occluding pairs and prosthetic status of Chinese adults. *Journal of Dental Research*. 2001; **80**: 1491-1495.

38. MacEntee MI, Dowell TB, Scully C. Oral health concerns of an elderly population in England. *Community Dentistry and Oral Epidemiology*. 1988; **16**: 72-74.