PREVALENCE OF DENTAL CARIES AND PERIODONTAL DISEASES, AND THEIR ASSOCIATION WITH SOCIO-DEMOGRAPHIC RISK FACTORS AMONG OLDER PERSONS IN DELHI, INDIA: A COMMUNITY-BASED STUDY

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Abstract. Dental health is often neglected in the older persons, and dental conditions associated with aging are complex, adversely affecting the quality of life. The present study was undertaken to estimate the prevalence of dental caries and periodontal diseases among older persons from Delhi, India, and to study their association with selected socio-behavioral risk factors. We conducted a community-based cross sectional study among persons aged ≥60 years from Delhi during 2009-2010. A questionnaire was used to interview elderly regarding dental health. The World Health Organization (WHO) oral health assessment form was used for examining the study participants. A total of 448 participants were examined and included in the study. Of the dentate, 47.1% had active dental caries. The mean decayed, missing and filled teeth (DMFT) score for the study population was 14.4. The prevalence of gingival bleeding, periodontal pockets and loss of attachment was 96.6, 89.1, and 80.3%, respectively. The prevalence of tobacco use was 47.9%. Age, frequency of teeth cleaning, and method used for teeth cleaning were statistically associated with the DMFT score. The prevalence of dental caries and periodontal disease was high in the study population, and warrants intervention.

Keywords: decay, geriatric, periodontal diseases, India

INTRODUCTION

Health is a state of physical, mental and social well-being, and not merely the absence of disease or infirmity (WHO, 1998). Dental disease is among the most widespread diseases world wide (Petersen, 2003). Although not an important cause of mortality, dental disease may have serious consequences for the health of people with them. Poor dental health can have a significant impact on quality of life and increase the risk of other chronic deseases such as cardiovascular diseases (DeStefano *et al*, 1993; Joshipura *et al*, 1996; Mendez *et al*, 1998). Poor oral health can lead to poor nutrition; both these factors create a vicious cycle, in which the overall health of the individual deteriorates. A holistic state of health cannot be achieved without good dental health.

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The proportion of older people in the population is growing faster than any other age group world wide (UNPD, 2003). Approximately 600 million people are aged ≥60 years; this number is expected to double by 2025 (WHO, 2009). By 2050, the elderly are expected to consist of 2 billion people with 80% living in developing countries (Kalache and Gatti, 2003). The increase in the percentage of the elderly in the population is a subject of growing concern in public health and has implications for public health policies (Kinsella *et al*, 2001; World Bank, 2001; United Nations, 2002; Dave *et al*, 2003). Some believe it is the responsibility of health professionals to increase the life span, and make the later years of life more productive and enjoyable.

Dental health is often neglected in older persons, and dental diseases associated with aging are complex, adversely affecting the quality of life (Guiglia *et al*, 2010). Experiences from developed nations have shown that the burden of chronic diseases and disabilities in the geriatric population can be reduced through health promotion and appropriate non-communicable disease prevention strategies designed to improve quality of life (Puska *et al*, 2002). Assessment of the magnitude of the problem and better understanding of various epidemiological factors associated with aging and dental health are essential for planning policies to promote dental health. Few community-based studies of dental health problems among the elderly have been conducted in India. The present study was undertaken to estimate the prevalence of dental caries and periodontal diseases among older persons in an urban resettlement colony in Delhi, India, and to study their association with selected socio-behavioral risk factors.

MATERIALS AND METHODS

We conducted a community-based cross sectional study in an urban resettlement colony in Delhi, which was comprised of six blocks, with a population of 21,327. The health care in this area comes under the Urban Health Program of the Center for Community Medicine All India Institute of Medical Sciences, New Delhi; the center has been serving this area since 2002 (Centre for Community Medicine, 2010).

Study subjects were persons aged ≥60 years, living in the study area for at least six months. Those who were severely ill or unable to communicate were not included in the study. Subjects were interviewed and examined. The study was conducted from June 2009 to December 2009. Written informed consent was obtained from each subject prior to inclusion in the study.

Random cluster sampling was conducted; three clusters (blocks 2, 3, and 14) were chosen out of the six blocks by lottery method. The sample size was calculated based on the prevalence of dental caries obtained from a multi-centric oral health survey conducted in 2007 (Shah *et al*, 2007). A design effect of two and a relative precision of 15% were used in the sample size calculation. Considering a refusal rate of 20%, the total sample size was calculated to be 428.

A questionnaire for interviewing elderly regarding oral health was used. It was an adaptation of the World Health Organization Geneva Oral Health Questionnaire (2004) (Parkash *et al*, 2005). The form was translated into the local language, *ie* Hindi. The World Health Organization Oral Health Assessment Form was used for examining the oral cavity of study subjects (Parkash *et al*, 2005).
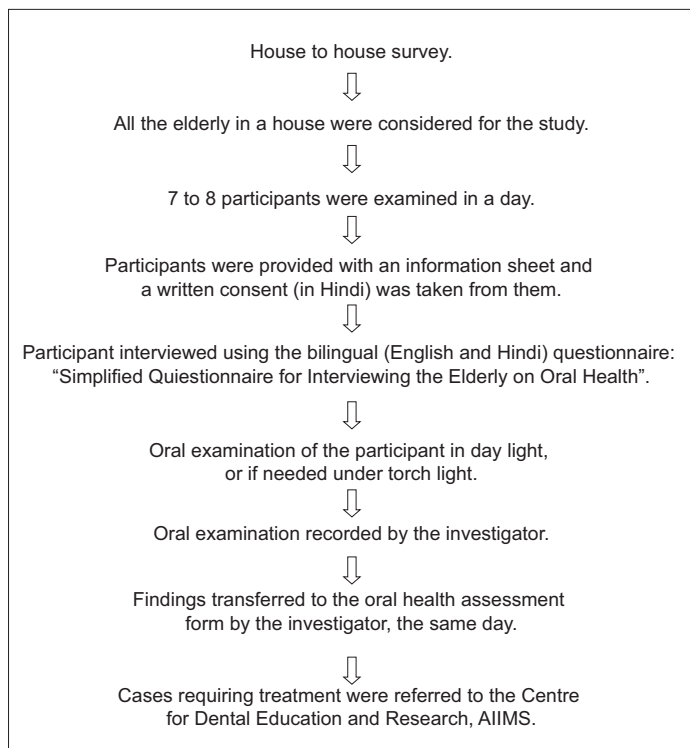
House to house survey.

⇩

All the elderly in a house were considered for the study.

⇩

7 to 8 participants were examined in a day.

⇩

Participants were provided with an information sheet and a written consent (in Hindi) was taken from them.

⇩

Participant interviewed using the bilingual (English and Hindi) questionnaire: "Simplified Quiestionnaire for Interviewing the Elderly on Oral Health".

⇩

Oral examination of the participant in day light, or if needed under torch light.

⇩

Oral examination recorded by the investigator.

⇩

Findings transferred to the oral health assessment form by the investigator, the same day.

⇩

Cases requiring treatment were referred to the Centre for Dental Education and Research, AIIMS.

Fig 1–Flow diagram showing the methodology of the study.

Total no. of houses visited: 1,460

No. of houses surveyed: 1,279 (87.6%)

Total no. of elderly: 495

← 42 refusals

No. of elderly who gave consent for the study: 453 (91.5%)

← 5 recording errors
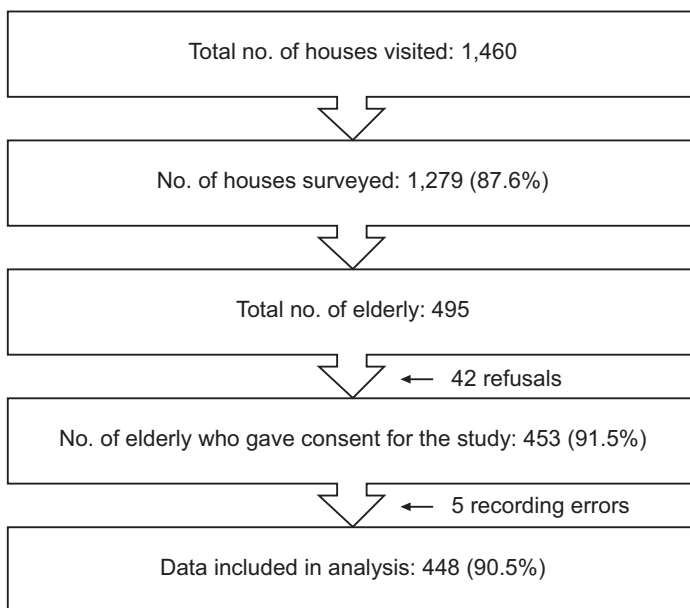
Data included in analysis: 448 (90.5%)

Fig 2–Flow diagram of study participants.

Dental cavities and periodontal disease (diseases of the gums) were the two main conditions screened for. To examine for periodontal disease, we examined for bleeding (bleeding of the gums on probing), pockets (distance from the surface of the gums to the attachment of the gum with the tooth) and loss of attachment (distance from the cemento-enamel junction to the attachment of the gum). We determined the mean decayed, missing and filled teeth (DMFT) score for each subject.

The methodology for data collection is shown in Fig 1. All the study subjects were examined by a single investigator and 5% of subjects were randomly chosen and re-examined by a second investigator to confirm repeatability and accuracy of the examinations. Complete agreement (kappa=1) was found between the first and second investigators. The data was entered into Microsoft Excel 2007 and analyzed with SPSS version 17 for Windows. Ethical clearance for the study was obtained from the Ethics Committee of the All India Institute of Medical Sciences.

RESULTS

A total of 448 subjects were included in the study. The division of subjects is shown in Fig 2. The ages of participants ranged from 60 to 101 years

Table 1
Demographic profile and behavioral practices of the study participants.

Variable	Male, n=216 No. (%)	Female, n=232 No. (%)	Total, n=448 No. (%)
Age group(years)			
60-64	114 (52.8)	128 (55.2)	242 (54.0)
65-69	48 (22.2)	49 (21.1)	97 (21.7)
70-74	38 (17.6)	36 (15.5)	74 (16.5)
≥75	16 (7.4)	19 (8.2)	35 (7.8)
Socio-economic status			
Upper/upper middle	26 (12.0)	11 (4.7)	37 (8.2)
Lower middle	59 (27.3)	44 (19.0)	103 (23.0)
Upper lower/lower	131 (60.6)	177 (76.3)	308 (68.8)
Smoking tobacco			
Yes	106 (49.0)	49 (21.1)	155 (34.5)
No	110 (51.0)	183 (78.9)	293 (65.5)
Chewing tobacco			
Yes	64 (29.6)	54 (23.3)	118 (26.3)
No	152 (70.4)	178 (76.7)	330 (73.7)
Use of any form of tobacco			
Yes	136 (62.9)	79 (34.0)	215 (47.9)
No	80 (37.1)	153 (66.0)	233 (52.1)
Oral pain or discomfort (during past one year[a])			
Yes	111 (51.4)	114 (49.1)	225 (50.2)
No	101 (48.6)	116 (50.9)	217 (49.8)
Self perception of oral status			
Good	48 (22.2)	47 (20.3)	95 (21.2)
Average	85 (39.4)	81 (34.9)	166 (37.0)
Poor	83 (38.4)	104 (44.8)	187 (41.7)
Frequency of teeth cleaning			
Once or more a day	187 (86.6)	193 (83.2)	380 (84.8)
Less than once a day	29 (13.4)	39 (16.8)	68 (15.2)
Method used for teeth cleaning			
Tooth brush	127 (58.8)	132 (56.9)	259 (57.9)
Other than toothbrush	89 (41.2)	100 (43.1)	189 (42.1)
Material used for teeth cleaning			
Toothpaste	128 (59.3)	129 (55.6)	257 (57.8)
Other than toothpaste	88 (40.7)	103 (44.4)	191 (42.2)

[a]Six participants did not remember whether they had any pain during past one year or not (n=442).

with a mean age of 65.2 years (SD=6.3). Demographics of the study subjects are shown in Table 1. Fifty-four percent of the participants belonged to the 60-64 year old, age group. Males (48.2%) and females (51.8%) were nearly equally distributed among all age groups. A modified Kuppuswamy scale was used to classify the participants into socio-economic status; 69% belonged to the upper lower class.

Table 2
Prevalence of dental caries and periodontal diseases among older persons population.

Variable	Male No. (%)	Female No. (%)	Total No. (%)	Prevalence 95%CI
Active dental caries (*n*=390)				
Yes	90 (46.9)	94 (47.5)	184 (47.1)	42.2 - 52.1
No	102 (53.1)	104 (52.5)	206 (52.9)	47.9 - 57.8
Missing teeth (*n*=448)				
Yes	195 (90.2)	216 (93.1)	411 (91.7)	88.8 - 93.9
No	21 (9.8)	16 (6.9)	37 (8.2)	6.1 - 11.2
Filled teeth[a] (*n*=390)				
Yes	21 (12.2)	23 (11.6)	44 (11.2)	8.5 - 14.8
No	171 (87.8)	175 (88.4)	346 (88.7)	85.1 - 91.5
DMFT score (*n*=448)				
0	13 (6.0)	11 (4.7)	24 (5.3)	3.6 - 7.8
1-3	29 (13.4)	30 (12.9)	59 (13.2)	10.4 - 16.6
4-31	150 (69.4)	157 (67.7)	307 (68.5)	64.1 - 72.7
Edentulous	24 (11.1)	34 (14.7)	58 (12.9)	11.3 - 19.5
Bleeding (*n*=356)[b]				
No	7 (4.1)	5 (2.8)	12 (3.4)	1.9 - 5.8
Yes	165 (95.9)	179 (97.2)	344 (96.6)	94.2 - 98.1
Pockets (*n*=356)[b]				
Absent	24 (14.0)	15 (8.1)	39 (10.9)	8.1 - 14.6
4-5 mm	70 (40.9)	74 (40.0)	144 (40.5)	35.4 - 45.6
≥6 mm	77 (45.1)	96 (51.9)	173 (48.6)	43.4 - 53.7
Loss of adhesion of gums (*n*=346)[c]				
0-3 mm	40 (23.6)	28 (15.8)	68 (19.7)	15.8 - 24.2
4-5 mm	62 (36.7)	80 (45.2)	142 (41.0)	36.0 - 46.3
6-8 mm	43 (25.5)	45 (25.4)	88 (25.4)	21.3 - 30.3
9-11 mm	23 (13.6)	23 (13.0)	46 (13.3)	10.1 - 17.2
≥12 mm	1 (0.6)	1 (0.5)	2 (0.6)	0.2 - 2.1

[a]Fifty eight participants were edentulous, not included.
[b]Ninety-two participants did not have index teeth.
[c]Ninety-two participants did not have index teeth; the cemento-enamel junction could not be identified in 10 participants.

Tobacco habits

The prevalence of use of different kinds of tobacco is given in Table 1. The prevalence of tobacco smoking was 34.5%. A significant difference in tobacco smoking was seen between males and females. The prevalence of tobacco chewing was 26.3% (no significant difference between males and females). The prevalence of any kind of tobacco use was 47.9%.

Behavioral practices

Pain or discomfort in their oral cavity, during the previous 12 months was reported by 50.2% (Table 1). Of those with pain 65% consulted a dentist for their ailment; the remainder never visited to a

Table 3
DMFT score by gender.

	Male		Female		Total	
	Mean score	SD	Mean score	SD	Mean score	SD
DMFT score	13.8	10.7	14.9	11.1	14.4	10.9
Decayed teeth	1.0	1.5	0.9	1.3	0.9	1.4
Missing teeth	12.5	11.1	13.6	11.4	13.2	11.3
Filled teeth	0.2	0.6	0.2	0.4	0.1	0.5

Table 4
Association between DMFT score and socio-behavioral risk factors.

Profile and practices	Groups	Mean DMFT score	Simple regression		Multiple regression	
			β coefficient	p-value	β coefficient	p-value
Gender						
	Male	13.8	1.2 (-0.9 to 3.2)	0.28	1.2 (-0.6 to 3.1)	0.18
	Female	14.9				
Age		14.4	0.6 (0.5 to 0.6)	<0.01	0.4 (.2 to 0.5)	<0.01
Socio-economic status						
	Upper/upper middle	9.8	2.1 (0.5 to 3.7)	0.01	0.4 (-0.9 to 1.8)	0.56
	Lower middle	14.2				
	Upper lower/lower	15.1				
Tobacco use of any kind						
	No	13.7	1.45 (-0.6 to 3.5)	0.16	1.2 (0.6 to 3.0)	0.20
	Yes	15.2				
Frequency of cleaning						
	≥ Once a day	12.7	11.5 (8.9 to 14. 2)	<0.01	6.7 (4.0 to 9.3)	<0.01
	Less than once a day	24.2				
Material used for cleaning						
	Tooth paste	10.7	8.6 (6.7 to 10.5)	<0.01	1.3 (-1.4 to 4.0)	0.35
	Others	19.4				
Method used for cleaning						
	Tooth brush	10.3	9.8 (7.9 to 11.6)	<0.01	5.3 (2.6 to 8.1)	<0.01
	Others	20.1				

dentist. Of the 448 study subjects, 21% believed their teeth were in good condition, 37% believed their teeth were in average condition and the remaining 42% believed their teeth were in poor condition. Most subjects (85%) cleaned their teeth at least once a day. Twenty-nine subjects (8.7%) did not clean their teeth at all. Fifty-eight percent of subjects reported using a toothbrush to clean their teeth and 30% reported using their finger. Fifty-eight percent of subjects used tooth paste to clean

their teeth while 30% used tooth powder.

Dental caries

Of the 448 subjects, 58 (12.9% with 95%CI 11.3 - 19.5) were edentulous. Of the 390 dentate participants, 47.1% (95%CI 42.2 - 52.1), had active dental caries in at least one tooth (Table 2). Eight point two percent of participants (95%CI 6.1 - 11.2) had intact dentition, and the rest had at least one tooth missing. Of the 390 dentate subjects, 11.2% (95%CI 8.5 - 14.8) had fillings.

Five point three percent of subjects (95%CI 3.6 - 7.8) had completely healthy teeth (DMFT=0) (Table 2). Thirteen point two percent of subjects (95%CI 10.4 - 16.6) had a DMFT score between 1 and 3 and 68.5% (95%CI 64.1 - 72.7) had a DMFT score between 4 and 31. The mean DMFT score for the study subjects was 14.4 (SD = 10.9). The gender-wise distribution of the DMFT scores is shown in Table 3. The DMFT scores were similar between males (13.8) and females (14.9). The mean missing tooth score was 13.2 (SD = 11.3). The mean decay score was 0.9 (SD = 1.4) and the mean filled score was 0.1 (SD = 0.5).

Periodontal disease

Of the 356 subjects who had their index teeth intact, gingival bleeding was present in 96.6% (95%CI 94.2 - 98.1) (Table 2). The prevalence of periodontal pockets was 89.1% (95%CI 85.4 - 91.9). Shallow pockets (4 to 5 mm) were present in 40.5% and deep pockets (≥6 mm) were present in 48.6%. The prevalence of loss of attachment (LoA) was 80.3%.

Association between dental caries and periodontal disease

On simple regression analysis, age, socio-economic status, frequency of teeth cleaning, material use for teeth cleaning and method of teeth cleaning were significantly associated with the DMFT score, while gender and tobacco use of any kind were not associated with the DMFT score (Table 4). On correlation analysis, all independent variables, except for gender (p=0.28) and tobacco use of any kind (p=0.16), were found to be statistically significant with Pearson correlation coefficient ranging from 0.35 (age) to 0.44 (method used for teeth cleaning). On multiple regression analysis, age, frequency of teeth cleaning and method used for teeth cleaning remained statistically significant. The R^2 for the multiple regression model was 0.30 (p<0.01) for regression as a whole. With each one year increase in age, the DMFT score increased by 0.4, and the difference between the DMFT scores between those who cleaned their teeth less than once a day or not at all and those who cleaned their teeth once or more times per day, was significant; the difference in the mean DMFT scores between the two group was 6.7 (Table 4). Of those who reported not using a toothbrush for cleaning their teeth, their mean DMFT score was higher by 5.3 than the mean DMFT score of those who did use a toothbrush. The DMFT score among females was 1.1 higher than males, but the difference was not significant. Periodontal status was not significantly associated with age, socio-economic status, tobacco use or behavioral practices on univariate and logistic regression analysis.

DISCUSSION

In the present study, nearly half (47%) of dentate subjects had active dental caries. Similar findings have been seen in other studies: in a study among those aged 65-74 years, a Dental Council of India survey (2003) reported the prevalence of caries was 70% had a multi-centric oral

health survey (Shah *et al*, 2007) reported the prevalence of carries to be 51-95%, and in Delhi it was 55.2%. A National Oral Health Survey Program from China reported 65% had carious teeth (Laun, 2000), similar to our study. Differences between studies may be due to local differences in eating habits, oral cleaning habits, fluoride content of water, study settings and year when the study was conducted.

In the present study, the mean DMFT score was high at 14.4. A major contributor of the high DMFT score was the high score for missing teeth (13.2). The present study was conducted in an urban resettlement colony in which the population belonged predominantly to a low socio-economic status. Restorative and preventive services available in urban slums or resettlement colonies are minimal. The only treatment available for dental caries is tooth extraction. A high percentage of periodontal disease also contributes to such a high rate for missing teeth. Similar to the present study, the Oral Health Survey conducted during 2002 - 2003 by the Dental Council for India reported a mean DMFT score of 17.9, with a mean missing tooth score of 16.9. Another study conducted in Delhi (Goel *et al*, 2006) reported a lower mean DMFT score (9.56); a reason why they had a lower DMFT is the study population was people who had retired from their jobs and had a better economic status than our study population. They also had a better knowledge regarding their oral health status. The filled teeth score was the lowest in our study (0.1). Goel *et al* (2006) found no filled teeth in their study as Thomas *et al* (1994). The low filling score indicates an unmet need in the treatment of dental caries. Those requiring dental care for caries were treated by extraction instead of restoration. These findings are similar to those of Lo and Schwartz (1994) in a study conducted among older persons in Honk Kong. They reported the mean decayed score was 1.4, but the missing teeth score was 17.0, and the filled teeth score was 0.5. Christein (1977) surveyed the oral health status of elderly people in Denmark and found the mean DMFT score was 30 with an average of 28 missing teeth. These studies were conducted more than a decade ago.

Most of the subjects in the present study had periodontal disease (gingival bleeding in 96%, periodontal pockets in 89%, and loss of attachment in 80%). This high rate of periodontal morbidity is also reflected by the high percentage of missing teeth. The third national epidemiological investigation of oral diseases(Wang *et al*, 2002; Qi, 2008) conducted in 2005 in China, revealed gingival bleeding and calculi occur in most older persons (68.0%, and 88.7%, respectively), while periodontal pocket prevalence was 52.3%. A multi-centric study from India (Shah *et al*, 2007) reported a prevalence of gingival bleeding from different parts of the country (12.3 - 99.8%) but overall lower thant that reported in our study (56.2%).

In the present study, the DMFT score was significantly associated with socio-economic status and behavioral practices (frequency of teeth cleaning, material used for cleaning, and method used for cleaning) on simple regression analysis, while on multiple regression analysis, age, frequency of teeth cleaning and method used for teeth cleaning remained statistically significant. A positive association was found between the DMFT score and the independent variables included in the model. The physical and economical dependency of the individual increases as the age increases and poor oral care is a result; this is the likely cause for the significant positive association between

age and DMFT score. A similar association was also reported by Thomas *et al* (1994) although another study from India (Rao *et al*, 1999) and a study from Norway (Henriksen *et al*, 2004) found no significant association between age and DMFT score Shah and Sundaram (2004) reported a significant association between socio-economic status and dental caries, but in the present study we found no significant association. The two extremes in socio-economic status have risk factors for dental caries. A reason for this could be the low socio-economic population has poor oral hygiene, while the higher socio-economic group tends to consume more carbohydrates.

In the present study, nearly half the population used tobacco of some kind. Smoking was predominantly practiced by males while chewing tobacco was used equally by both genders. Tobacco use had a slightly increased risk for dental caries but this association was not significant. More studies are needed to determine the link between tobacco use and dental caries (Weintraub and Burt, 1987). Campus *et al* (2011) reported a high risk for dental caries was associated with smoking tobacco. Offenbacher and Weathers (1985) reported no increase in dental caries among smokeless tobacco users.

Tooth brushing, toothpaste use and frequency of teeth cleaning are hallmarks of dental hygiene. The present study findings support the above statement, as did two other studies from India (Thomas *et al*, 1994; Doifode *et al*, 2000); however, a study by Shah and Sundaram (2004) did not support the belief that these behaviors prevent oral disease. Multiple factors contribute to the etiology of dental caries, including environmental and host factors, which could explain the variable results by different study.

In conclusion, the prevalences of dental caries and periodontal disease were high in the study population. Dental health problems have multiple etiologies. Maintaining and promoting dental health among older people requires modification of social and behavioral practices. Increasing awareness of oral health care among the population is important irrespective of the age of the persons. This study suggests that restorative and preventive services need to be more accessible for the study population.

REFERENCES

Campus G, Cagetti MG, Senna A, *et al*. Does smoking increase risk for caries? A cross-sectional study in an Italian military academy. *Caries Res* 2011; 45: 40-6.

Center for Community Medicine. Annual departmental census – 2009, urban health programme. New Delhi: Center for Community Medicine, All India Institute of Medical Sciences, 2010.

Christein J. Oral health status of 65 to 75 year old Danes: A preliminary report of the replication of WHO's international collaborative study in Denmark. *J Dent Res* 1977; 65: C149-153.

Dave SA, Palacious R, Bhardwaj G. Rethinking pension provision for India. Chapter 1. New Delhi: Tata McGraw Hill, 2003. [Cited 2011 Mar 3]. Available from: URL: http://www.iief.com/downloads.htm#re

Dental Council of India. National oral health survey and fluoride mapping. New Delhi: Dental Council of India in collaboration with Ministry of Health and Family Welfare, Government of India, 2002-2003.

DeStefano F, Anda RF, Kahn HS, Williamson DF, Russell CM. Dental disease and risk of coronary heart disease and mortality. *BMJ* 1993; 306: 688-91.

Doifode VV, Ambadekar NN, Lanewar AG. Assessment of oral health status and its association with some epidemiological factors in population of Nagpur, India. *Indian J Med Sci* 2000; 54: 261-9.

Goel P, Singh K, Kaur A, Verma M. Oral health-care for elderly: identifying the needs and feasible strategies for service provision. *Indian J Dent Res* 2006; 17: 11-21.

Guiglia R, Musciotto A, Compilato D, *et al*. Aging and oral health: effects in hard and soft tissues. *Curr Pharm Des* 2010; 16: 619-30.

Henriksen BM, Ambjørnsen E, Axéll T. Dental caries among the elderly in Norway. *Acta Odontol Scand* 2004; 62: 75-81.

Joshipura KJ, Rimm EB, Douglass CW, Trichopoulos D, Ascherio A, Willett WC. Poor oral health and coronary heart disease. *J Dent Res* 1996; 75: 1631-6.

Kalache A, Gatti A. Active ageing: a policy framework. *Adv Gerontol* 2003; 11: 7-18.

Kinsella K, Velkoff VA, Victoria A. An ageing world: 2001 - international population reports. Washington, DC: US Department of Health and Human Service and US Department of Commerce, 2001; 1: 95-101.

Laun WM. A summary of geriatric oral health in China. *Int Dent J* 2000; 51: 207-11.

Lo ECM, Schwartz E. Tooth and root condition in middle aged and elderly in Hong Kong, *Community Dent Oral Epidemiol* 1994; 22: 381-85.

Mendez MV, Scott T, LaMorte W, Vokonas P, Menzoian JO, Garcia R. An association between periodontal disease and peripheral vascular disease. *Am J Surg* 1998; 176: 153-7.

Offenbacher S, Weathers DR. Effect of smokeless tobacco on periodontal, mucosal and caries status of adolescent males. *J Oral Pathol* 1985; 14: 169-81.

Parkash H, Duggal R, Mathur VP, Petersen PE. Manual for multi-centric oral health survey. New Delhi: Directorate General of Health Services, Ministry of Health and Family Welfare and World Health organization. Government of India and WHO India Biennium 2004-2005.

Petersen PE. The world oral health report 2003. Continuous improvement of oral health in the 21st century - the approach of the WHO Global Oral Health Programme. Geneva: WHO, 2003. [Cited 2011 Mar 3]. Available from: URL: http://www.who.int/oral_health/media/en/orh_report03_en.pdf

Puska P, Pietenen P, Uusitalo U. Influencing public nutrition for non-communicable disease prevention: from community intervention to national programme – experiences from Finland. *Public Health Nutr* 2002; 5: 245-51.

Qi XQ. Report of the third national oral health survey. Beijing: People's Medical Publishing House, 2008: 11-12.

Rao A, Sequeira P, Peter S, Rajeev A. Oral health status of the institutionalized elderly in Mangalore, India. *Indian J Dent Res* 1999; 10: 55-61.

Shah N, Pandey RM, Duggal R, Mathur VP, Parkash H, Sundaram KR. Oral health in India. A report of multi-centric study. New Delhi: Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India and WHO collaborative programme, December 2007. [Cited 2011 Mar 3]. Available from: URL: http://www.whoindia.org/en/ Section20/Section30_1525.htm

Shah N, Sundaram KR. Impact of socio-demographic variables, oral hygiene practices, oral habits and diet on dental caries experience of Indian elderly: a community-based study. *Gerodontology* 2004; 21: 43-50.

Thomas S, Raja RV, Kutty R, Strayer MS. Pattern of caries experience among an elderly population in south India. *Int Dent J* 1994; 44: 617-22.

United Nations (UN). World population ageing, 1950-2050. New York: Department of Economic and Social Affairs, Population Division, United Nations (UN), 2002. [Cited 2011 Mar 3]. Available from: URL: http://

www.un.org/esa/population/publications/worldageing19502050/index.htm

United Nations Population Division (UNPD). World population prospects: the 2002 revision. New York: UNPD, 2003. [Cited 2011 Mar 3]. Available from: URL: http://www.un.org/esa/population/publications/wpp2002/WPP2002-HIGHLIGHTSrev1.PDF

Wang HY, Petersen PE, Bian JY, Zhang BX. The second national survey of oral health status of children and adults in China. *Int Dent J* 2002; 52: 283-90.

Weintraub JA, Burt BA. Periodonatl effects of dental caries associated with smoke-less tobacco use. *Public Health Rep* 1987; 102: 30-5.

World Bank. India: The challenge of old age income security. Finance and private sector development: South Asia Region. New York: World Bank, 2001; Report No. 22034–IN. [Cited 2011 Mar 3]. Available from: URL: http://www.silverinnings.com/docs/Finance/Pension/India%20%20Challenge%20of%20Old%20age%20Security.pdf

World Health Organization (WHO). Preamble to the Constitution of the World Health Organization as adopted by the Inter-national Health Conference, New York, 19-22 June, 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organiza-tion, no. 2, p 100) and entered into force on 7 April 1948. Geneva: WHO, 1998. [Cited 2011 Mar 3]. Available from: URL: http://www.who.int/about/definition/en/print.htm

World Health Organization (WHO). 1 October: International day of older persons: older people – a new power for development. Geneva: WHO, 2009. [Cited 2013 Apr 12]. Available from: URL: http://www.who.int/ageing/events/idop_rationale/en/