Periodontal Bone Loss and Self-Reported Medical Conditions in a Dental School Patient Population

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Abstract

Purpose: This study was undertaken to determine the prevalence of periodontal bone loss and to assess the prevalence of self-reported medical conditions in patients with and without periodontal bone loss in Saudi Arabia. **Materials and methods:** A total of 2103 dental records with complete data from patients ≥ 18 years of age admitted to the King Abdulaziz University Faculty of Dentistry during the year 2005 were included. Age, gender, nationality and self reported medical history were abstracted from the dental records. Periodontal bone loss was determined by a single examiner using panoramic radiographs that were taken prior to any dental treatment. Descriptive statistics, t-test, chi-square and logistic regression models were used for data analyses. **Results:** About 20% of the study sample reported a positive history for one or more medical conditions. Diabetes was the most frequently reported condition (7.4%), followed by hypertension (5.4%) and anemia (3%). Radiographic alveolar bone loss at one or more sites was found in 71.6 % of the sample. The mean number of sites with alveolar bone loss was significantly higher among individuals with diabetes and hypertension than those without these conditions ($p < 0.05$). **Conclusion:** Prevalence of periodontal bone loss is high in the present sample, especially among those with chronic medical conditions. Collaboration between dental and medical professionals is needed for better oral and general health.

Key words: Medical history, periodontitis, periodontal bone loss, systemic diseases, Saudi Arabia

Introduction

Periodontal disease is a chronic microbial infection that leads to destruction of the periodontal structures supporting the teeth and consequently may result in premature tooth loss (Burt, 2005). It is one of the most widespread dental diseases worldwide. In the United States, for example, the prevalence of periodontitis was estimated to be 35% among adults 30 years of age or older (Albandar *et al.*, 1999). The prevalence of periodontitis is increased in developing countries (World Health Organization, 2003). In Thailand and in Iraq, respectively, about 92% and 100% suffer from periodontitis (Baelum *et al.*, 2003; Khamrco, 1999). In Saudi Arabia, little data exist on the prevalence of and risk factors for periodontal disease. In a pilot study of 282 subjects, Al-Zahrani and Kayal (2006) found that the prevalence of periodontitis was 68%.

There are several modifiable and non-modifiable factors that may predispose individuals to periodontal disease (Albandar, 2005; Burt, 2005; Page, 1998). Non-modifiable factors include increased age, male gender, black race and genetics (Albandar, 2005; Burt, 2005). Modifiable risk factors include smoking, stress, obesity, nutrition, and physical activity (Albandar, 2005; Page, 1998). Systemic diseases such as diabetes are also associated with increased risk of periodontitis. Successful control of systemic diseases by medical professionals is likely to eliminate or diminish their negative effect on the periodontium (Albandar, 2005; Burt, 2005).

For several decades, the adverse outcome of periodontal infection was thought to be localized to the gingiva and tooth supporting structures. Recent evidence, however, has implicated periodontal infection as a factor aggravating systemic inflammation (Kuo *et al.*, 2008; Seymour *et al.*, 2007). This view is reasonable

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because in individuals with generalized severe periodontitis, the total surface areas of periodontal tissues which may have direct contact with periodontal pathogens are just about the size of an adult palm hand (Mealey and Ocampo, 2007). Thus, periodontal disease has been suggested as a possible risk factor for systemic conditions such as heart disease, diabetes and delivery of preterm low birth weight infants. Individuals with periodontal disease are more likely to suffer a heart attack than periodontally healthy persons (Kuo *et al.*, 2008; Seymour *et al.*, 2007). Severe periodontitis in type 2 diabetic patients aggravates the risk of poor glycemic control (Taylor *et al.*, 1996). Moreover, pregnant women with periodontal disease are seven times more likely to deliver preterm low birth weight babies compared to pregnant women without periodontal disease (Offenbacher *et al.*, 1998). It has to be noted, however, that results of some recent studies do not support the negative impact of periodontal infection on systemic health (Michalowicz *et al.*, 2009; Offenbacher *et al.*, 2009; Janket *et al.*, 2005).

The purposes of this study were to examine prevalence of periodontal bone loss (PBL) in a sample of a dental school patient population in Saudi Arabia, and to determine the prevalence of reported medical conditions in patients with and without PBL.

Materials and methods

This study is a cross sectional evaluation of dental records of patients at King Abdulaziz University Faculty of Dentistry who were admitted during the year 2005. Records of patients 18 years of age or older who had at least 20 teeth were included. In 2005, a total of 4110 dental records were found. Of these records, 1207 (29.4%) were for patients younger than 18 years of age and 295 (7.2%) had fewer than 20 teeth. A total of 2608 records were eligible for inclusion. We excluded 143 (5.5%) because of missing or unclear panoramic radiographs and 362 (13.9%) because of missing or incomplete personal or medical data. Thus, the final sample available for the present study consisted of 2103 subjects.

Age in years, gender, nationality (Saudi or non-Saudi) and medical history were obtained from these records. Medical history was based on self-reported data and contained questions about the following conditions: hypertension, heart disease, epilepsy, systemic lupus erythematosis, stroke, renal transplantation, leukemia, asthma, anemia, blood disorder, migraine, low blood pressure, hepatitis, osteoporosis, mental retardation, thyroid problem, rheumatic fever, peptic ulcer, chemotherapy, scleroderma, tuberculosis and jaundice.

Alveolar bone loss was determined at each interproximal site by a single examiner from pre-treatment panoramic radiographs that were taken according to the manufacturer's standard protocol. Specifically, the distance from the cemento-enamel junction (CEJ) to the coronal location of the marginal alveolar bone (alveolar bone level) and the distance from the CEJ to the root apex (total root length) was measured in mm using an endodontic ruler. The coronal location of the alveolar bone was identified as the most coronal location of the marginal alveolar bone next to the tooth where periodontal ligament space was clearly visible and uniform. The most apically located point of the root was considered as the root apex. In the presence of crowns or deep restorations, the most apical extent of a restoration was considered to represent the CEJ. Subsequently, the percentage of alveolar bone loss at each site was represented as the alveolar bone level relative to the total root length. For each patient, the number of interproximal sites with ≥ 20% of bone loss and the total number of readable sites were recorded. The extent of bone loss was calculated for each subject using the following formula: (number of readable sites with ≥ 20% of bone loss/total number of readable sites) x 100. Subjects with bone loss at ≥ 30% of sites were considered to have generalized bone loss. Those with bone loss at less than 30% of the total number of readable sites were considered to have localized bone loss. Descriptive statistics, *t*-test, chi-square and logistic regression models were used for data analyses. Data entry and statistical analysis were done using SPSS version 10.

Results

The sample consisted of records of 2103 patients; of these, 41.4% were males and 58.6 % were females. The age ranged between 18 and 80 years, with a mean age of 32.69 (± 11.45) years. About 28.4% of subjects had no radiographic bone loss, whereas 53.1% and 18.5% had localized and generalized bone loss, respectively.

As shown in *Table 1*, about 80% of the sample did not mention any history of self-reported medical condition. Diabetes was the most frequently self-reported medical condition (7.4%), followed by hypertension (5.4%), anemia (3%), asthma (2.7%) and heart disease (1.8%). The prevalence of diabetes, hypertension and heart disease increased with increasing age. The reported frequency of anemia and asthma was similar for the same age groups. Diabetes was more common among males, whereas hypertension, anemia and asthma were more common among females. Diabetes and hypertension were more common among non-Saudis. No gender differences were found in other medical conditions.

The extent of PBL was higher among the elderly, males or non-Saudis compared to younger subjects, females or Saudis (*Table 2*). Individual with diabetes and hypertension had a higher extent of PBL than those without these diseases. The extent of PBL was the same in individuals with or without heart disease, anemia, asthma and hepatitis.

Table 1. Frequency and percentage of self-reported medical conditions in the sample.

Medical condition*	Total n = 2103	Nationality		Gender		Age (years)			
		Non-Saudi n = 1068	Saudi n = 1031	Female n = 1232	Male n = 871	> 45 n = 309	36-45 n = 453	26-35 n = 584	18-25 n = 750
None	1681(79.9)	833(78)	844 (81.9)	945 (76.7)	736 (84.5)	158 (51.1)	336 (74.2)	502 (86)	678 (90.4)
Diabetes	156 (7.4)	91 (8.5)	65 (6.3)	83(6.7)	73(8.4)	85 (27.5)	47 (10.4)	22 (3.8)	2 (0.3)
Hyper-tension	113 (5.4)	66 (6.2)	47 (4.6)	78 (6.3)	35 (4)	67 (21.7)	32 (7.1)	10 (1.7)	4 (0.5)
Heart disease	38 (1.8)	23 (2.1)	15 (1.5)	27 (2.2)	11(1.3)	17 (5.5)	8 (1.8)	6 (1.0)	7 (0.9)
Asthma	57 (2.7)	23 (2.1)	34 (3.3)	44 (3.6)	13(1.5)	8 (2.6)	13 (2.9)	18 (3.1)	18 (2.4)
Anemia	64 (3)	36 (3.4)	28 (2.7)	60 (4.9)	4 (0.5)	1 (0.3)	19 (4.2)	17 (2.9)	27 (3.6)
Other blood disorders	8 (0.4)	4 (0.4)	4 (0.4)	7 (0.6)	1 (0.1)	2 (0.6)	3 (0.7)	2 (0.3)	1 (0.1)
Jaundice	2 (0.1)	2(0.2)	0	1 (0.1)	1 (0.1)	0	0	1 (0.2)	1 (0.1)
Hepatitis	7 (0.3)	3 (0.3)	4 (0.4)	3 (0.2)	4 (0.5)	2 (0.6)	2 (0.4)	2 (0.3)	1 (0.1)
Others+	69 (3.3)	39 (3.7)	30 (2.9)	50 (4.1)	19 (2.2)	20 (6.5)	18 (4.0)	17 (2.9)	14 (1.9)

*Self-reported medical condition is not exclusive; some patients have more than one condition. Numbers in parentheses are column percentage. Nationality data were missing from four records and age data were missing from seven records of those with no reported medical conditions.

+Others include epilepsy, systemic lupus erythematosis, brain stroke, renal transplantation, leukemia, migraine, low blood pressure, osteoporosis, mental retardation, thyroid problem, rheumatic fever, peptic ulcer, chemotherapy, scleroderma and tuberculosis.

As shown in *Table 3*, more than 22% of patients with generalized PBL suffered from diabetes, whereas only 4.1% of patients with localized or no bone loss had diabetes. Hypertension was also more frequent among individuals with generalized PBL (11.9%) than those without (3.9%). Heart disease, asthma and hepatitis were more frequent among subjects with generalized PBL, while anemia was more frequent among patients with localized or no PBL. However, the differences were not statistically significant.

Discussion

In the present study, records of 2103 dental patients were reviewed. About 20% of these patients had a positive finding in their medical history for one or more systemic conditions. This figure is less than that reported (35%-53%) in other studies (Lagervall *et al.*, 2003; Egg-leston, 1997; Peacock and Carson, 1995). The lower prevalence of reported medical conditions in the present sample could be due to possibly undiagnosed medical conditions. For example, in a recent study among female dental patients, high blood pressure (≥ 140 systolic or ≥ 90 diastolic) was recorded on 12% of the sample who did not have a prior history of hypertension (Al-Zahrani, 2009). It is also possible that some dental patients select not to disclose some of their medical history to dental professionals.

Diabetes and hypertension were the most common medical conditions in the present study. This is in line with the results of other studies in Saudi Arabia (Al-Zahrani and Kayal, 2006; Almas and Awartani, 2003). In the present study, a history of diabetes was reported by 7.4% of the sample. The prevalence of diabetes in the Saudi Arabian population ranged from 2.6 to 9.7% (Karim *et al.*, 2000; Warsy and el-Hazmi, 1999; Fatani *et al.*, 1987). A history of hypertension was reported by 5.4% of the present sample. In the general population in Saudi Arabia, the prevalence of hypertension ranged from 2.2 to 8.9% (Warsy and el-Hazmi, 1999; Al-Nozha *et al.,* 1998; Wahid Saeed *et al.*, 1996).

Our findings showed a higher prevalence of systemic conditions among individuals with generalized periodontal bone loss, which is consistent with previous studies that reported an association between radiographic alveolar bone loss and systemic conditions such as cardiovascular disease (Engebretson *et al.*, 2005; Molloy *et al.*, 2004). In addition, the mean percentage of sites with alveolar bone loss was higher among patients with diabetes and hypertension than those without these conditions. These findings support the reported relationship between periodontal disease and overall health. The presence of risk factors that are shared by periodontal and systemic diseases could be one explanation for this relationship. Another possible explanation is that periodontal infection could in fact contribute to a poorer overall health. In periodontitis

Table 2. Characteristics of the study population and periodontal bone loss (PBL)

Variable	Sample size	Prevalence of PBL* n (%)	Extent+ of PBL mean ± (SD)		p-value
Age					
18-25	750	359 (47.9)	4.7	(8.40)	< 0.01
26-35	584	443 (75.9)	12.2	(14.53)	
36-45	453	407 (89.9)	26.5	(25.82)	
> 45	309	297 (96.1)	40.0	(30.28)	
Gender					
Male	871	635 (72.9)	20.2	(26.40)	< 0.01
Female	1232	871 (70.7)	14.4	(19.65)	
Nationality					
Saudi	1031	656 (63.6)	13.5	(21.19)	< 0.01
Non-Saudi	1068	850 (79.6)	19.9	(23.91)	
Diabetes					
Yes	156	146 (93.59)	42.5	(34.13)	< 0.01
No	1947	1359 (69.8)	14.71	(20.35)	
Hypertension					
Yes	113	99 (87.61)	31.4	(29.15)	< 0.01
No	1990	1407 (70.7)	16.0	(22.18)	
Heart disease					
Yes	38	30 (88.0)	23.6	(25.02)	0.52
No	2065	1476 (71.8)	16.7	(22.81)	
Anemia					
Yes	64	45 (70.3)	13.3	(19.29)	0.10
No	2039	1461 (71.7)	16.9	(22.96)	
Asthma					
Yes	57	39 (68.4)	16.9	(22.28)	0.87
No	2046	1467 (71.7)	16.8	(22.88)	
Hepatitis/jaundice					
Yes	9	9 (100)	18.5	(17.55)	0.79
No	2094	1498 (71.5)	16.8	(22.88)	
Total sample					
-	2103	1507 (71.7)	23.4	(23.93)	-

*Defined as presence of ≥ one site with ≥ 20% of alveolar bone loss as measured on panoramic radiographs; +(number of readable sites with bone loss/total number of readable sites) x 100

Table 3. Prevalence of self-reported medical conditions in patients with and without generalized periodontal bone loss (GP)

Medical conditions	n (%) in the total sample	Frequency and % of medical conditions in patients		OR (95% CI)
		without GP n = 1716	with GP n = 387	
Diabetes	156 (7.4)	71 (4.1)	85 (22)	6.6 (4.7-9.2)*
Hypertension	113 (5.4)	67 (3.9)	46 (11.9)	3.3 (2.2-4.9)*
Heart disease	38 (1.8)	27 (1.6)	11 (2.8)	1.8 (0.9-3.7)
Anemia	64 (3)	57 (3.3)	7 (1.8)	0.5 (0.2-1.2)
Asthma	57 (2.7)	44 (2.6)	13 (3.4)	1.3 (0.7-2.5)
Hepatitis/jaundice	9 (0.4)	7 (0.4)	2 (0.5)	1.5 (0.3-7.4)

* $p < 0.05$

patients, a variety of Gram-negative bacteria and their endotoxins can easily enter into the blood stream during various dental procedures, everyday oral hygiene practice, and even gentle mastication. Thus, bacterial infection, antigens, endotoxins, and proinflammatory cytokines may aggravate the systemic inflammation and negatively impact overall health.

In the present study, about 72% of the sample had ≥ 20% of bone loss at one or more sites. This confirms the high prevalence findings of Al-Zahrani and Kayal (2006) in their study of 282 dental school patients in Saudi Arabia. Despite this high prevalence, it is possible that this study had underestimated the prevalence of periodontal bone loss because only records of patients with ≥ 20 teeth were included. Thus, effective strategies to prevent and control periodontal disease in Saudi Arabia are warranted. Recent evidence of a possible effect of periodontal infection on the overall health underscore the importance of prevention and managing periodontal infection for improving both oral and general health.

Periodontal bone loss in the present study was measured on panoramic radiographs (also known as orthopantomographs, or OPGs). The use of OPGs in diagnosing periodontal bone loss has been criticized (Kantor *et al.*, 1989; Barrett *et al.*, 1984). Recent studies, however, support the use of OPGs as a radiographic method in diagnosing periodontal bone loss (Persson *et al.*, 2003; Tugnait *et al.*, 2001; Molander *et al.*, 1991; Akesson *et al.*, 1989). In fact recently, Persson *et al.* (2003) concluded that OPGs could substitute for full-mouth periapical radiographic evaluation in most cases. In addition, several recent epidemiological studies use OPGs for assessment of alveolar bone loss (Kasaj *et al.*, 2008; Tezal *et al.*, 2007; Jansson *et al.*, 2006).

The frequency of medical conditions in our study was obtained from a self-reported health questionnaire. This method has been shown to be reliable and cost-effective, especially for researching purposes (Ho *et al.*, 1997). However, no information on the time of the initial diagnosis or the duration of systemic diseases was available.

In conclusion, the prevalence of periodontal bone loss is high among the present study sample, especially among those with chronic medical conditions such as diabetes and hypertension. Joint effort of dental and medical professionals is needed for better oral and general health.

References

Akesson, L., Rohlin, M. and Håkansson, J. Marginal bone in periodontal disease: an evaluation of image quality in panoramic and intra-oral radiography. *Dentomaxillofacial Radiology* 1989; **18**:105–112.

Albandar, J.M. Epidemiology and risk factors of periodontal diseases. *Dental Clinics of North America* 2005; **49**:517-532

Albandar, J.M., Brunelle, J.A. and Kingman, A. Destructive periodontal disease in adults 30 years of age and older in the United States, 1988-1994. *Journal of Periodontology* 1999; **70**:13-29.

Almas, K. and Awartani, F.A. Prevalence of medically compromised patients referred for periodontal treatment to a teaching hospital in Central Saudi Arabia. *Saudi Medical Journal* 2003; **24**:1242-1245.

Al-Nozha, M.M. and Osman, A.K. The prevalence of hypertension in different geographical regions of Saudi Arabia. *Annals of Saudi Medicine* 1998; **18**:401-407.

Al-Zahrani, M.S. Prehypertension and undiagnosed hypertension in a sample of dental school female patients. *International Journal of Dental Hygiene* **2009** (in press).

Al-Zahrani, M.S. Increased intake of dairy products is related to lower periodontitis prevalence. *Journal of Periodontology* 2006; **77**:289-294.

Al-Zahrani, M.S. and Kayal, R.A. Alveolar bone loss and reported medical status among a sample of patients at a Saudi dental school. *Oral Health and Preventive Dentistry* 2006; **4**:113-118.

Baelum, V., Pisuithanakan, S., Teanpaisan, R., *et al.* Periodontal conditions among adults in Southern Thailand. *Journal of Periodontal Research* 2003; **38**:156-163.

Barrett, A.P., Waters, B.E. and Griffiths, C.J. A critical evaluation of panoramic radiography as a screening procedure in dental practice. *Oral Surgery, Oral Medicine, & Oral Pathology* 1984; **57**:673–677.

Burt, B. Position paper: Epidemiology of periodontal diseases. *Journal of Periodontology* 2005; **76**:1406-1419.

Eggleston, D.J. The value of a simple medical questionnaire in dentistry. *Australian Dental Journal* 1977; **22**:160-164.

Engebretson, S.P., Lamster, I.B., Elkind, M.S., *et al.* Radiographic measures of chronic periodontitis and carotid artery plaque. *Stroke* 2005; **36**:561-566.

Fatani, H.H., Mira, S.A. and el-Zubier, A.G. Prevalence of diabetes mellitus in rural Saudi Arabia. *Diabetes Care* 1987; **10**:180-183.

Ho, A.W., Grossi, S.G., Dunford, R.G. and Genco, R.J. Reliability of a self-reported health questionnaire in a periodontal diseases study. *Journal of Periodontal Research* 1997; **32**:646-650.

Janket, S.J., Wightman, A., Baird, A.E., *et al.* Does periodontal treatment improve glycemic control in diabetic patients? A meta-analysis of intervention studies. *Journal of Dental Research* 2005; **84**:1154-1159.

Jansson, H., Lindholm, E., Lindh, C., Groop, L. and Bratthall, G. Type 2 diabetes and risk for periodontal disease: a role for dental health awareness. *Journal of Clinical Periodontology* 2006; **33**:408-414.

Kantor, M.L. and Slome, B.A. Efficacy of panoramic radiography in dental diagnosis and treatment planning. *Journal of Dental Research* 1989; **68**:810–812.

Karim, A., Ogbeide, D.O., Siddiqui, S. and Al-Khalifa, I.M. Prevalence of diabetes mellitus in a Saudi community. *Saudi Medical Journal* 2000; **21**:438-442.

Kasaj, A., Vasiliu, Ch., and Willershausen, B. Assessment of alveolar bone loss and angular bony defects on panoramic radiographs. *European Journal of Medical Research* 2008; **13**:26-30.

Khamrco, T.Y. Assessment of periodontal disease using the CPITN index in a rural population in Ninevah, Iraq. *Eastern Mediterranean Health Journal* 1999; **5**:549-555.

Kuo, L.C., Polson, A.M. and Kang, T. Associations between periodontal diseases and systemic diseases: a review of the interrelationships and interactions with diabetes, respiratory diseases, cardiovascular diseases and osteoporosis. *Public Health* 2008; **122**:417-433.

Lagervall, M., Jansson, L. and Bergstrom, J. Systemic disorders in patients with periodontal disease. *Journal of Clinical Periodontology* 2003; **30**:293-299.

Michalowicz, B.S., Hodges, J.S., Novak, M.J., *et al.* Change in periodontitis during pregnancy and the risk of pre-term birth and low birthweight. *Journal of Clinical Periodontology* 2009; **36**:308-314.

Molander, B., Ahlqwist, M., Gröndahl, H-G., Hollender, L. Agreement between panoramic and intra-oral radiography in the assessment of marginal bone height. *Dentomaxillofacial Radiology* 1991; **20**:155–160.

Molloy, J., Wolff, L.F., Lopez-Guzman, A. and Hodges, J.S. The association of periodontal disease parameters with systemic medical conditions and tobacco use. *Journal of Clinical Periodontology* 2004; **31**:625-632.

Offenbacher, S., Beck, J.D., Moss, K., *et al.* Results from the Periodontitis and Vascular Events (PAVE) Study: a pilot multicentered, randomized, controlled trial to study effects of periodontal therapy in a secondary prevention model of cardiovascular disease. *Journal of Periodontology* 2009; **80**:190-201.

Offenbacher, S., Jared, H.L., O'Reilly, P.G., *et al.* Potential pathogenic mechanisms of periodontitis associated pregnancy complications. *Annals of Periodontology* 1998; **3**:233-250.

Page, R.C. The pathobiology of periodontal diseases may affect systemic diseases: inversion of a paradigm, *Annals of Periodontology* 1998; **3**:108-120.

Peacock, M.E. and Carson, R.E. Frequency of self-reported medical conditions in periodontal patients. *Journal of Periodontology* 1995; **66**:1004-1007.

Persson, R.E., Tzannetou, S., Feloutzis, A.G., Brägger, U., Persson, G.R. and Lang, N.P. Comparison between panoramic and intra-oral radiographs for the assessment of alveolar bone levels in a periodontal maintenance population. *Journal of Clinical Periodontology* 2003; **30**:833-839.

Seymour, G.J., Ford, P.J., Cullinan, M.P., Leishman, S. and Yamazaki, K. Relationship between periodontal infections and systemic disease. *Clinical Microbiology and Infection* 2007; **13**:3-10.

Taylor, G.W., Burt, B.A., Becker, M.P., *et al.* Severe periodontitis and risk for poor glycemic control in patients with non-insulin-dependent diabetes mellitus. *Journal of Periodontology* 1996; **67**:1085-1093.

Tezal, M., Sullivan, M.A., Reid, M.E., *et al.* Chronic periodontitis and the risk of tongue cancer. *Archives of Otolaryngology--Head & Neck Surgery* 2007; **133**:450-454.

Tugnait, A., Clerehugh, D.V. and Hirschmann, P.N. A survey of radiographic practices for periodontal disease in UK and Irish dental teaching hospitals. *Dentomaxillofacial Radiology* 2001; **29**:376–381.

Wahid Saeed, A.A., al Shammary, F.J., Khoja, T.A., Hashim, T.J., Anokute, C.C. and Khan, S.B. Prevalence of hypertension and sociodemographic characteristics of adult hypertensives in Riyadh City, Saudi Arabia. *Journal of Human Hypertension* 1996; **10**:583-587.

Warsy, A.S. and el-Hazmi, M.A. Diabetes mellitus, hypertension and obesity -common multifactorial disorders in Saudis. *Eastern Mediterranean Health Journal* 1999; **5**:1236-1242.

World Health Organization. The world health report. Continuous improvement of oral health in the 21st century- the approach of the WHO global oral health program. Geneva: World Health Organization; 2003.