Oral Health
among Young Adults and the Middle-aged
in Iran

Hossein Hessari

Academic dissertation

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To my God who knows all unknowns.
   To my people who provided for me all facilities.
   To my family who dedicated to me all comforts.
ABSTRACT

HESSARI, HOSSEIN. Oral Health among Young Adults and the Middle-aged in Iran. Department of Oral Public Health, Institute of Dentistry, Faculty of Medicine, University of Helsinki, Helsinki, Finland. 2009. 69 pp. ISBN 978-952-10-5458-7 (paperback)

The aim of the present study was to assess oral health and treatment needs among adult Iranians according to socio-demographic status, smoking, and oral hygiene, and to investigate the relationships between these determinants and oral health.

Data for 4448 young adult (aged 18) and 8301 middle-aged (aged 35 to 44) Iranians were collected in 2002 as part of a national survey using the World Health Organization (WHO) criteria for sampling and clinical diagnoses, across 28 provinces by 33 calibrated examiners. Gender, age, place of residence, and level of education served as socio-demographic information, smoking as behavioural and modified plaque index (PI) as the biological risk indicator for oral hygiene. Number of teeth, decayed teeth (DT), filled teeth (FT), decayed, missing, filled teeth (DMFT), community periodontal index (CPI), and prosthodontic rehabilitation served as outcome variables of oral health.

Mean number of DMFT was 4.3 (Standard deviation (SD) = 3.7) in young adults and 11.0 (SD = 6.4) among middle-aged individuals. Among young adults the D-component (DT = 70%), and among middle-aged individuals the M-component (60%) dominated in the DMFT index.

Among young adults, visible plaque was found in nearly all subjects. Maximum (max) PI was associated with higher mean number of DT, and higher periodontal treatment needs.

A healthy periodontium was a rare condition, with 8% of young adults and 1% of middle-aged individuals having a max CPI = 0. The majority of the CPI findings among young adults consisted of calculus (48%) and deepened periodontal pockets (21%). Respective values for middle-aged individuals were 40% and 53%. Having a deep pocket (max CPI = 4) was more likely among young adults with a low level of education (Odds ratio (OR) = 2.7, 95% Confidence interval (CI) = 1.9–4.0) than it was among well-educated individuals. Among middle-aged individuals, having calculus or a periodontal pocket was more likely in men (OR = 1.8, 95% CI = 1.6–2.0) and in illiterate subjects (OR = 6.3, 95% CI = 5.1–7.8) than it was for their counterparts.

Among young adults, having 28 teeth was more (p < 0.05) prevalent among men (72% vs. 68% for women), urban residents (71% vs. 67% for rural residents), and those
with a high level of education (73% vs. 60% for those with a low level). Among middle-aged individuals, having a functional dentition was associated with younger age (OR = 2.0, 95% CI = 1.7–2.5) and higher level of education (OR = 1.8, 95% CI = 1.6–2.1).

Of middle-aged individuals, 2% of 35- to 39-year-olds and 5% of those aged 40 to 44 were edentulous. Among the dentate subjects (n = 7,925), prosthodontic rehabilitation was more prevalent (p < 0.001) among women, urban residents, and those with a high level of education than it was among their counterparts. Among those having 1 to 19 teeth, a removable denture was the most common type of prosthodontic rehabilitation. Middle-aged individuals lacking a functional dentition were more likely (OR = 6.0, 95% CI = 4.8–7.6) to have prosthodontic rehabilitation than were those having a functional dentition.

In total, 81% of all reported being non-smokers, and 32% of men and 5% of women were current smokers. Heavy smokers were the most likely to have deepened periodontal pockets (max CPI ≥ 3, OR = 2.9, 95% CI = 1.8–4.7) and to have less than 20 teeth (OR = 2.3, 95% CI = 1.5–3.6).

The findings indicate impaired oral health status in adult Iranians, particularly those of low socio-economic status and educational level. The high prevalence of dental plaque and calculus and considerable unmet treatment needs call for a preventive population strategy with special emphasis on the improvement of oral self-care and smoking cessation to tackle the underlying risk factors for oral diseases in the Iranian adult population.

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LIST OF ORIGINAL PUBLICATIONS

This present dissertation is based on the following publications, referred to in the text by their Roman numerals.


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<th>Description</th>
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<tr>
<td>CPI</td>
<td>Community periodontal index</td>
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<tr>
<td>CI</td>
<td>Confidence interval</td>
</tr>
<tr>
<td>DMFT</td>
<td>Decayed, missing, and filled permanent teeth</td>
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<tr>
<td>DT</td>
<td>Decayed permanent teeth</td>
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<tr>
<td>EMR (O)</td>
<td>Eastern Mediterranean Region (Organization)</td>
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<tr>
<td>FT</td>
<td>Filled permanent teeth</td>
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<tr>
<td>Max</td>
<td>Maximum</td>
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<tr>
<td>MT</td>
<td>Missing permanent teeth</td>
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<tr>
<td>OR</td>
<td>Odds ratio</td>
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<td>SD</td>
<td>Standard deviation</td>
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<td>SES</td>
<td>Socio-economic status</td>
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<td>WHO</td>
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ORIGINAL PUBLICATIONS
INTRODUCTION

Dental caries and periodontal diseases, as the most common oral diseases, have burdened the majority of populations with heavy treatment needs (Petersen et al. 2005). A holistic view of the components of a population’s oral health is necessary to achieve comprehensive understanding of oral health needs. To provide dental services required to match these needs, oral health need assessment surveys are necessary both locally and nationwide. Application of a comprehensive approach to oral health need assessment may also lead to more cost-effective oral health services provision (Asadi-Lari et al. 2004), and has been recommended in the Liverpool Declaration (WHO 2008a). In the evaluation of oral health programmes, in addition to disease outcomes, intermediate outcomes (which may be risk factors) and measurement of health should be considered (Petersen & Kwan 2004).

Oral health outcomes are related to the indirect socio-environmental factors and oral health services available. In a dental health care delivery system a dominant preventive approach explains part of the decrease in oral diseases (Gimmestad et al. 2003). Direct risk behaviours such as poor oral hygiene practices and dietary habits, tobacco use, and excessive consumption of alcohol are factors that may lead to biological disturbances causing oral diseases (Petersen 2005, Selwitz et al. 2007). The poor and risky health behaviours mostly characterize those of a low social level (Hobdell et al. 2003).

Risk factors for dental caries include physical, biological, environmental, behavioural, and lifestyle-related factors such as high numbers of cariogenic bacteria, inadequate salivary flow, insufficient fluoride exposure, poor oral hygiene, and poverty (Selwitz et al. 2007). An individual’s risk for tooth decay may vary over time, since many factors influencing physical and biological risks change during a lifetime.

Whereas mild and moderate forms of gingival inflammation represent a widespread periodontal condition among young adults (Albandar & Tinoco 2002), severe forms of periodontal destruction are less common and affect a minority of adult individuals in developed countries. In young people, aggressive forms of periodontitis include juvenile and rapidly progressive, and pre-pubertal periodontitis; these are very rare (Sheiham & Netuveli 2002). The generally held view is that Asians are predominantly susceptible to periodontitis, and among them poor oral hygiene and calculus are widespread (Corbet 2006). But periodontal data for some Arab countries differ; they speak for a low to moderate level of periodontal disease (Baljoon et al. 2005, WHO 2008b).

A wide range of behavioural risk factors from smoking, to brushing and flossing the teeth, or regularly attending a dental check-up have an influence upon oral health (Patrick et al. 2006). With increasing numbers of current tobacco users in the world, the smoking epidemic will not stop during the life-span of readers of the current literature
(FDI/WHO 2005). Studies on smoking uniformly address inferior periodontal conditions and a higher risk for tooth loss among tobacco smokers (Dye & Selwitz 2005, Bergström 2006, Okamoto et al. 2006). The level of accumulated exposure to smoking that causes oral disease outcomes, however, is still under study (Bergström 2003, Dietrich et al. 2007).

Oral diseases, particularly dental caries and periodontal disease, at their end stage result in tooth loss and edentulousness. Dental status is a trustworthy measure of the oral health status among adult populations (Aggeryd 1983, Ahacic et al. 1998, Bagewitz et al. 2007). Rather than health system-related factors, socio-demographic and geographical determinants, particularly social class, are associated with tooth loss and wearing a denture (McGrath & Bedi 2002).

Global data speak for a decreasing trend in edentulousness among adults. Tooth loss is considered a rare condition in western countries (Douglass et al. 2002, Mojon et al. 2004) as well as among middle-aged Chinese and Japanese (Lin et al. 2001, Hanioka et al. 2007). However, the few available data on dental status in developing countries demonstrate various patterns of tooth loss by populations (WHO 2008b).

Many studies have summarized and collected the available data on oral health of young adults and the middle-aged (Nihtilä et al. 1998, Namal et al. 2005); comparable updated information on many developing countries as well as Iran is, however, lacking.

Iran, with a population over 68 million in 2002, having literacy rates of 89% in urban areas and 75% in rural areas, and an increasing percentage (66%) of urban residents, is located in the Eastern Mediterranean Region (EMR). The oral health care system in Iran consists of two parts: public and private sectors which include the majority of dentists.

Public dental clinics deliver simple oral health services such as oral examinations, scaling, tooth extraction and dental filling. No reports evaluate the functions of the present Iran health care system on a national level.

The aim of the present study was to evaluate oral health and treatment needs among young adult and middle-aged Iranians according to socio-demographic status, smoking and oral hygiene, and to investigate relationships between these determinants and oral health.
REVIEW OF THE LITERATURE

Risk Factors for Oral Health

Causal chain of exposures leading to diseases

Health throughout life is constantly exposed to countless risks. Risk is defined as the probability of an adverse outcome, or a factor that raises this probability (Rothman 2002). The World Health Report 2002 (WHO 2002a) presented evidence of the risks to health and the burden that diseases impose on populations. According to this report, no risk arises in isolation, and generally, each disease stems from a complex chain of causes. An adverse health outcome might have indirect (distal), direct (proximal), or specific local (biological) causes or a combination (Figure 1). Indirect factors such as social gradients and socio-economic status (SES) factors, environmental, cultural and demographic risk indicators, and health system and health-system factors are risks that mostly occur at population level (Hobdell et al. 2003, Petersen 2005). A social gradient proposes that the less-healthy individuals move down the social hierarchy, and the healthy move up (Kent & Croucher 1998). SES indicators such as education, occupation, and income are some determinants of social status. These indirect factors usually help to shape direct factors like psycho-social and behavioural factors that are formulated as lifestyle, and individuals have some control over the latter (Sheiham & Watt 2000). Biological causes are specific factors operating locally within the host’s body or an environment like the oral cavity, and we assess their effects independently for each disease (Burt 2005). Recently, a new life-course approach to the study of health and illness has helped to explain the existence of wide socio-economic differentials in outcomes and sequels of chronic diseases like periodontitis. Based on this approach, exposure to harmful experiences and environments accumulates during life and adds to the risk for illness (WHO 2002a).

Systematic risk factor assessment may be influential in the planning of oral health-promotion programmes (Petersen 2005). Studying the status of disease at various ages facilitates identifying appropriate periods in life when risk for disease is highest, and will indicate when and where intervention is most required.

Theoretical approaches to oral health and its risk factors

The study models evaluating oral health and its risk factors have produced proposals of several theoretical approaches to describe determinants of oral health.

The theoretical model of the ‘Second International Collaborative Study’ -ICS II- suggests that as the intermediate output variables, predisposing and enabling characteristics shape an individual’s oral health behaviour (Chen et al. 1997).
Review of the Literature

Figure 1. Modified causal chain of exposures leading to disease and indications for interventions, adapted to web of risk factors by the WHO (WHO 2002).
The ICS II study uses a combination of models explaining oral health behaviours (Petersen & Holst 1995) and oral health status determinants, as well as general health models (Maizels et al. 1991). Based on the ICS II model, a person’s sex, education, occupation, and health beliefs “predispose” him or her to engage or not engage in specific oral health behaviour. As to enabling factors, income, having or not having access to oral health care, and place of residence represent the position that might facilitate or hinder the individual’s practice of an oral health behaviour, consequently characterizing an individual’s oral health status. The need factors reflect disease levels that require use of health services. Needs can be perceived by the individual; cultural beliefs and values (e.g., perceived health status), disease severity, and limitation of activity may have an influence on need (Chen et al. 1997).

The ‘Common Risk Factor Approach’ (Sheiham & Watt 2000) addresses the question of which oral health-promotion and prevention strategies should be adopted. A health-related behaviour is not a simple matter of freedom of choice; lifestyle is understood as an expression of the cultural and social environment in which people live and work. The major risk factors for the chronic diseases often cluster in the same population groups and individuals. People who smoke are more likely to have an unhealthy diet than are non-smokers (Fehily et al. 1984). In the Common Risk Factor Approach, smoking, diet, and hygiene are the major factors affecting dental and periodontal diseases. Controlling a small number of risk factors may have a major impact on a large number of diseases as well as on dental and periodontal diseases.

Assessment of oral health and its related aspects should include the understanding of indirect and direct as well as biological factors. “Epidemiology is in conversion from a science that identifies risk factors for disease to one that analyses the interaction among risk factors in systems that engender patterns of disease” (Koopman 1996). Scientists must, however, continue to identify, measure, and reduce the risks to health caused by specific, frequently local, social, behavioural, and environmental factors (McMichael & Beaglehole 2000). It is therefore necessary that the entire causal chain be evaluated in a risk assessment. Risks act at different levels, and consequently they cannot be identified in order to be considered in isolation. Health policy-makers can generate an appropriate range of policies only if they asses a variety of risks. Study of the different levels of risks should be undertaken as complementary.

**Indirect risk factors**

Cultural, environmental, and socio-economic factors have a fundamental impact on the oral health of societies, along with behavioural and biological risk factors (McMichael & Beaglehole 2000, Sheiham & Watt 2000, Hobdell et al. 2003, Petersen 2005). Social and environmental disadvantages, even of quite a subtle kind, can lead directly to poor health behaviour and to subsequent biological disturbances. Hobdell et al. (2003), in a cross-
country study, showed a discernible association between three oral diseases (dental caries, periodontal disease, and oral cancer) and socio-economic variables. The strongest association was for chronic destructive periodontitis and the weakest for oral cancer.

**Socio-demographic risk factors**

Social context refers to the location of a person by time and place in a society. Place refers to geographical location and to group membership such as family, friends, or age-group, and according to class, ethnicity, residence, and gender that arise out of the social structure and economic arrangement of the society (Kuh et al. 2003). Education is another constituting factor of an individual’s social class that usually coincides with a higher level of income. Professionals with the highest level of education are located at the top of the social-class pyramid, and unskilled workers at the bottom of it. (Kent & Croucher 1998). Well-educated people are more likely to rate their oral health as very good, more likely to have visited a dentist recently, and less likely to visit a dentist for a problem than are less-educated ones. (Australian Research Centre for Population Oral Health 2006).

As a demographic determinant, age may have an influence on oral health for two reasons. First is the idea of socialization, which is defined as the process whereby we gradually learn the values and norms of a group or society. And the second is that older people often present with particular oral health problems (Kent & Croucher 1998).

Oral health status varies by gender. Women usually have better oral health behaviour (American Academy of Periodontology 1996, Payne & Locker 1996). They are likely to visit a dental clinic more regularly than do men (Bayat et al. 2006, Slack-Smith et al. 2007); however, some reports speak for higher levels of edentulousness among women (Harford & Spencer 2007, Slade et al. 2007).

**Direct (Behavioural) risk factors**

Behavioural risk factors for oral health can be defined as a wide range of activities affecting oral health undertaken by an individual (Patrick et al. 2006). They vary from positive behaviours like brushing and flossing the teeth, attending regularly a dental check-up, or negative behaviours such as smoking (Payne & Locker 1996). Smoking, diet, and oral hygiene, in particular, are a core set of risk factors for oral health that are causally linked to major chronic conditions affecting populations (Sheiham & Watt 2000, Petersen 2005). Alcohol consumption, stress, obesity, and physical inactivity are other risk factors in a common risk factor approach (Sanders et al. 2005).

**Smoking**

Worldwide, more than 1.2 billion people smoke, and due to tobacco use approximately 4 million of them annually die (WHO 2002b, Aquilino & Lowe 2004). Cigarette consumption, the dominant form of tobacco use, peaked in the United States in 1960s, and
the prevalence of tobacco use among adults at that time was 40% (Mackay & Eriksen 2002). With current tobacco users in the world predicted to rise to 1.6 billion by 2030, this is not an epidemic that is going to go away in the lifetime of the present reader (FDI/WHO 2005). Despite more than 40 years of policies, regulations, educational efforts, increasing information on the negative health effects of tobacco use, and the positive health benefits of tobacco cessation, tobacco use remains unacceptably high.

Cigarette consumption is rising internationally, markedly in developing countries, where more than 80% of the world’s smokers live (The World Bank 1999). Over the past three decades, smoking has seen a decrease in developed countries (WHO 2002b, Kirkland et al. 2004, CDCa 2008), while becoming more popular in developing nations among the youth, especially among girls (Global Youth Tobacco Survey Collaborative Group 2002). Tobacco first entered Iran in 1590 with the Portuguese. The water pipe has been the most popular form of tobacco consumption, which arose in the 17th century in Iran. The first cigarette company was launched in 1937 with production of 600 million cigarette tars annually. Tobacco use varies by region, education, socio-economic status, race, and ethnicity (Craig et al. 2001). Poverty, for example, is associated with higher prevalence of smoking (Datta et al. 2006). People with 16 or more years of education are less likely to smoke than are people with 9 to 11 years of education (Hopkins et al. 2001). Similarly, within the European Union, smoking is consistently related to low level of education and income (Huisman et al. 2005).

Local risk factors

Oral hygiene

In the 1960s, Löe et al. (1965) revealed the role of poor oral hygiene leading to accumulation of dental plaque as the principal etiological factor in initiation of gingival inflammation. In a 15-year follow-up study, compared to controls without adequate oral hygiene procedures, the groups with good oral hygiene showed very little change in periodontal status (Axelsson et al. 2004). The low level of oral hygiene, and consequently accumulation of dental plaque on the cervical region of the teeth is an important risk factor for gingivitis and causes the extension of periodontitis, regardless of age (Abdellatif & Burt 1987, Albandar et al. 1999). The relationship between plaque and periodontal disease has stood the test of time.

As the cause of dental caries, dental plaque is a site to retain fermentable sugars and the bacteria around the tooth (Selwitz et al. 2007). Dental caries develops where oral bio-films are allowed to grow up and stay on the teeth for extended periods. If a cavity is permitted to develop, the decayed area provides an ecological niche in which the bacteria can remain and survive at a reduced pH. A cavitated lesion protects the bio-film, and if this area is not cleansed, caries continues progressing (Fejerskov 2004).
Population Oral Health

Population studies on oral health in selected countries

International associations endeavour to direct and calibrate oral health studies for uniformity and comparability. Recently, many studies have collected national data in different countries and found interesting results (Ahacic et al. 1998, Kelly et al. 2000, Beltran-Aguilar et al. 2005, Krstrup & Petersen 2006, Micheelis & Schiffner 2006, Krstrup & Petersen 2007, Suominen-Taipale et al. 2008). Generally, studies on dental caries and periodontal diseases show a decreasing trend in oral diseases in developed countries. However, it is hard to assess the status of oral diseases in developing countries due to a lack of continuous and reliable data. Despite the WHO (1997) recommendations for oral health surveys, few studies are comparable in sampling and data collection. Available data in the WHO (2008b) Global Oral Health Data Bank are based on sparse and disparate studies from different countries. Tables 1 and 2 depict dental and periodontal data for young adults and middle-aged individuals from selected countries. Few updated data are available on oral health of 18-year-olds (Table 1). A broad range of mean DMFT values among 35- to 44-year-olds from 2.1 in China to 22 in Brazil shows the wide discrepancy among all populations’ oral health (Table 2).

Dental caries experience

Dental caries belongs to the group of non-communicable chronic diseases, and is considered as a ‘complex’ or ‘multi-factorial’ disease. There exists no simple causation pathway to tooth decay (Fejerskov 2004). Risk factors for dental caries are changeable during life, and a person’s risk for caries may vary with time. Physical and biological risk factors for enamel or root caries comprise insufficient fluoride exposure, inadequate salivary flow and composition, high numbers of cariogenic bacteria, need for special health care, and genetic factors (Anderson 2002, Fejerskov & Kidd 2003, Thomson 2004).

Dental caries is also related to an individual’s lifestyle, and socio-behavioural factors are clearly implicated. Some of these factors are poor dietary habits, poor oral hygiene, frequent consumption of refined carbohydrates, and frequent use of oral medications that contain sugar (Fejerskov & Kidd 2003, Bratthall & Hänsel Petersson 2005). Other factors related to caries risk include poverty, social status, number of years of education, and dental insurance coverage (Brown et al. 2002, Petersen 2005, Selwitz et al. 2007).

In most countries, the prevalence of dental caries experience among adults is high, as the disease has affected nearly the majority of citizens in all populations (Petersen 2005, WHO 2008b). A decline in dental caries has, however, been observed in most industrialized countries over the past 25 years or so (Chen et al. 1997, Kelly et al. 2000,
Petersen et al. 2005, Dye et al. 2007). Among UK adults, an increase has been reported in the average number of sound and untreated teeth from 13.0 in 1978 to 14.8 in 1988 and to 15.7 in 1998; no significant change emerged in the average number of decayed or unsound teeth between 1988 and 1998, although the average did decrease between 1978 and 1988, from 1.9 to 1.1 (Kelly et al. 2000). Between 1964 and 1988, adult Australians saw a startling decrease in dental caries experience, with a more steady decline from 1988 to 1996 (Hopcraft & Morgan 2003). In the United States, adults aged 18 to 45 years have enjoyed a 27% decline in the total number of decayed surfaces from NHANES I (1971-1974) to NHANES III (1988–1994) (Brown et al. 2002). This pattern has been the result of a number of public health measures, including effective use of fluorides, together with changing living conditions and lifestyles and improved self-care practices (Petersen 2005).

Most industrialized countries and some countries of Latin America show high mean DMFT values. Whereas levels of dental caries experience are low in Africa and Asia (Petersen 2005), the WHO reports speak for an increasing trend in dental caries in these two continents. However, a study in Africa shows a general decreasing trend in dental caries for children and adults (Cleaton-Jones & Fatti 1999). In the EMR, the middle-aged in most countries have a low to moderate level of dental caries experience (WHO 2008b). Reports from Syria have pointed to a 14% increase in mean DMFT values (from 9.8 to 11.2) among the middle-aged between 1988 and 1998 (Beiruti & van Palenstein Helderman 2004).

Another study, from Kuwait, shows that mean DMFT increased from 2.7 in 1982 to 3.9 in 2000 among adolescents, but no reports are available for adults (Behbehani & Scheutz 2004).

Robert and Sheiham (2002) estimated the burden of dental caries on developing nations. According to their findings, treating dental caries with the traditional method of restorative dentistry is beyond the financial capabilities of the majority of low-income nations, as most of these countries cannot even afford an essential package of health care services for children.

**Periodontal diseases**

Mild and moderate forms of gingival inflammation are common findings in young adults (Albandar & Tinoco 2002). Significant disparities have been evident in the level of periodontitis among the young population of the world. The inequalities at this early age are the starting point for further distinct differences in adults. It has been confirmed that mild gingival inflammation is common, and severe periodontal disease in Europe is rare. Severe forms of periodontal disease affect a minority of people in ‘developed’ countries, probably not more than 10% (Sheiham & Netuveli 2002). According to the comparative tables of Sheiham and Netuveli (2002), using CPITN and summarizing the available data in the WHO database, the percentage of European middle-aged individuals with CPITN = 3 ranges from 13% to 54%.
For Western Europe, the mean percentage of middle-aged individuals with CPITN = 3 is 36% and for Eastern Europe it is 45%. These figures are similar for non-European rich economies but higher than for the poorest countries in the database. The percentage of adults with deep periodontal pockets (>5.5 mm) is between 30% and 40% in some eastern European countries (Sheiham & Netuveli 2002).

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Age</th>
<th>DMFT Mean</th>
<th>Year</th>
<th>Age</th>
<th>CPI 0 %</th>
<th>CPI 1 %</th>
<th>CPI 2 %</th>
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- = not available. CPI = Community periodontal index.
Source of data: WHO oral health country/area profile (WHO 2008b).
A cross-sectional study has evaluated the periodontal status of 1,115 Danish adults (Krustrup & Petersen 2006). It confirms that periodontal health status is related to socio-economic status regardless of age, and identifies poor oral hygiene habits, tobacco use, impaired oral hygiene accompanied by a higher rate of removable partial dentures, and infrequent regular dental visits as risk indicators explaining the social gradient in periodontal status.
In Asia, available information on periodontal condition is mainly reported by means of the CPI for many countries. Among Asians, calculus and moderate pockets are pervasive (Corbet et al. 2002). In low-income countries of Asia, gender, SES, rural residence, and low level of education are risk determinants (i.e., non-modifiable risk indicators), and calculus, smoking, and systemic diseases are risk indicators (i.e., plausible correlates of disease identified in cross-sectional studies) for periodontal diseases. Moving toward the countries with a middle or high income, the risk determinants change mostly to risk indicators like smoking and systemic diseases (Corbet et al. 2002).

Periodontal diseases are potential risk factors for some systemic diseases. A number of case-control and longitudinal studies indicate a potential role for sub-gingival periodontal pathogenic infection as a risk indicator for cardiovascular diseases. In vitro and animal studies support a moderate association - but not a causal relationship - between periodontal disease and heart disease. (Arbes et al. 1999, Genco et al. 2002). A longitudinal prospective study has monitored the effect of periodontal disease on overall and cardiovascular disease mortality in patients with type 2 diabetes and concluded that periodontal disease is a strong risk marker for mortality from ischemic heart disease and diabetic nephropathy in these patients (Saremi et al. 2005).

**Dental status**

Loss of permanent teeth among adult populations is a trustworthy measure of their oral health status and an important explanatory factor for oral health-related quality of life (Aggeryd 1983, Ahacic et al. 1998, Bagewitz et al. 2007). The assessment of tooth loss patterns within populations and over subsequent time periods could make available valuable information on the impact of oral disease and the outcome of oral health care systems (Burt et al. 1990, Haugejorden & Klock 2002, Copeland et al. 2004).

Tooth loss may be associated with an increased risk for systemic diseases and a higher mortality rate. A 15-year cohort study on 29,584 individuals among the Chinese population (Abnet et al. 2005) points out tooth loss as one risk marker for total death and death from upper gastrointestinal cancer, heart disease, and stroke. In another follow-up study involving 41,380 individuals (Joshipura et al. 2003), men with fewer than 25 teeth were at higher risk for stroke than were those with 25 teeth or more (Hazard Ratio = 1.6, CI=1.2–2.0).

Reduced number of teeth may lead in adults to impairment of or disability in the masticatory system and a poor-quality diet (Daly et al. 2003, Carr et al. 2005). In Part I of the ‘National Status Study’ in the United States (Papas et al. 1998), a significant correlation appeared between the quality of nutrient intake and the degree of edentulousness among the elderly. Number of teeth could also provide an indication of the prospects of tooth retention (Kelly et al. 2000).

In the developed countries, adults tend to maintain higher numbers of teeth (Hescot et al. 1997, Kelly et al. 2000, Dye et al. 2007), and prevalence of partial or complete
edentulousness is on the decline (Mojon et al. 2004, Suominen-Taipale et al. 2008). In Sweden (Ahacic et al. 1998), edentulousness and partial edentulousness decreased from 38% in 1968 to 13% in 1991; and in fact edentulousness was pushed 20 years forward in age from 50- to 54- to 70- to 74-year-olds. In the United States, a 10% decline in edentulousness has been reported with each decade for the past 30 years (Douglass et al. 2002). In Finland, the prevalence of edentulousness in 2000 was about half the level recorded in 1980. The change was particularly noticeable among people of working age, and in the age-group 30 to 44 in 2000 edentulousness had disappeared altogether (Suominen-Taipale et al. 2008). According to a 10-year follow-up study from Finland, the 10-year incidence of edentulousness was 8% for women and 7% for men aged 40 years and over (Hiidenkari et al. 1997).

Despite the decreasing trend in edentulousness, one-fourth of elderly people in the United States are still edentulous (Beltran-Aguilar et al. 2005); 16% of dentate adults in the UK (Kelly et al. 2000) and about 20% of individuals from 18 to 74 years of age in the US wear dentures (Redford et al. 1996). The proportion of persons having teeth with many fillings, crowns or bridges increased in Sweden from 1968 to 1991 (Ahacic et al. 1998). However, younger populations in industrialized countries nowadays enjoy a complete set of permanent teeth (Hescot et al. 1997, Kelly et al. 2000, Beltran-Aguilar et al. 2005, Suominen-Taipale et al. 2008).

Data from other countries, such as China and Japan, speak also for a general trend toward a decrease in loss of teeth, and tooth loss is considered a rare condition among middle-aged Chinese and Japanese (Lin et al. 2001, Hanioka et al. 2007). Many adults in developed countries expect definitely or possibly to retain 20 or more teeth for life (Haugejorden & Klock 2002). Among EMR countries, the limited available data on prevalence of edentulousness among the middle-aged present a range of 0% for Saudi Arabia to 3.2% for Lebanon (Doughan et al. 2000). The mean number of missing teeth for those aged 35 to 44 reported in the WHO data bank is from 2.9 for Pakistan as the fewest to 8.3 in Jordan as the highest (WHO 2008b).

The tooth-loss phenomenon is a complicated subject related to all three sets of risk indicators for oral health (indirect, direct, and local risk factors) depending on level of disease. Even in industrialized countries with well-developed oral health care systems, social gradient has been the risk indicator for edentulousness. Results of a US study indicate as determinants of edentulousness among adults: a lower self-rated level of general health, being poor, older, and white (Dolan et al. 2001). A longitudinal study from Finland shows that the importance of some socio-demographic determinants of edentulousness such as gender, urbanization, and marital status has disappeared during recent decades, while geographical area and education are persistently related to edentulousness, suggesting that socio-economic determinants become more important than demographic variables (Suominen-Taipale et al. 1999). A study on Saudi Arabian children and adults, however, indicates tooth loss as varying by age, gender, and socio-economic status, but not by city or rural lifestyle (Al-Shammery et al. 1998).
Apart from indirect and direct factors such as orientation of the oral health system, socio-economic and demographic characteristics, and behavioural factors (smoking), dental caries and periodontal disease are the major reasons for tooth extraction or tooth loss (Holm 1994, Nuttall & Nugent 1997, Al-Shammari et al. 2006, Da'ameh 2006). A historical cohort study to examine the tooth-loss pattern over a 28-year period has shown that loss of periodontal attachment of 4 mm and more, early loss of the first permanent molar and educational attainment are significant risk factors for tooth loss in regression analyses (Burt et al. 1990). That study indicates that partial tooth loss tends to be more disease-related, while edentulousness seems to be a social-behavioural as much as disease-related concern. Findings of another study from the United States (Copeland et al. 2004) illustrate the limits of generalizing tooth loss findings to other societies; they conclude that patterns of tooth loss vary by population.

Oral functionality is interpreted as the maintenance of efficient mastication and preservation of the health of oral life tissues (Armellini & von Fraunhofer 2004). The traditional approach in dentistry has been that for a healthy masticatory system and for satisfactory oral function, a prerequisite is a full complement of teeth. It appears, however, that the potential capacity of the masticatory system to adjust to loss of teeth is great. Shortened dental arches comprising anterior and premolar teeth, in general, fulfil the requirements of a functional dentition (Kayser 1981). In practice this means a cut-off point of functional dentition for wearing removable partial dentures.

A study on chewing ability in subjects with different levels of shortened dental arches (Sarita et al. 2003) concludes that shortened dental arches comprising all anterior teeth and premolars and at least one occluding pair of molar teeth provide sufficient chewing ability. Shortened dental arches with a long side result in insufficient chewing ability, and having shortened dental arches with 0 to 2 occluding premolars implies severely impaired chewing ability.

According to a WHO technical report of 1992, “the retention, throughout life, of a functional, aesthetic, natural dentition of not less than 20 teeth and not requiring recourse to prostheses should be the treatment goal for oral health” (WHO 1992). National surveys in the UK, Finland, and Australia have used the presence of 21 or more teeth as the indicator of a functional dentition (Kelly et al. 2000, Slade et al. 2007, Suominen-Taipale et al. 2008).

**Prosthodontic rehabilitation**

Predisposing, enabling, and need characteristics are explanatory factors for having one or more prosthetic crowns, as findings from the ‘Florida Dental Care Study’ of 5,254 subjects indicate (Dolan et al. 2001). That study shows that, once difference in income, clinical factors, behavioural, and attitudinal factors are taken into account, place of residence is not relevant to wearing a fixed prosthetic crown (Dolan et al. 2001).
Rather than service-related factors, socio-demographic and geographical determinants (particularly social class) are associated with having dentures (McGrath & Bedi 2002). In Britain, about one in 20 adults aged 16 and over has experienced considerable tooth loss, but lacks the resources to obtain dentures (McGrath & Bedi 2002). Results of stepwise logistic regression analyses in a study among Swedish adults (Palmqvist et al. 1992) confirm that age, education, and income are the strongest predictors in relation to the presence of removable dentures and complete edentulousness; but gender and place of residence are less important. The social or geographical differences in having dentures may also be related to differences in attitudes towards oral health (Kelly et al. 2000).

Despite trends towards an increase in tooth retention, dependence on removable prosthodontic appliances is still a reality of life for many (Redford et al. 1996). The increase in number of teeth in the adult population in industrialized countries will offset decreasing rates of edentulousness, and dental practitioners will find an ample minority of their patients being in need of complete dentures (Douglass et al. 2002). NHANES III findings have reported a figure of 21% of denture users among adult Americans in the 1990s (Redford et al. 1996). This was 16% in the United Kingdom in 1998 (Kelly et al. 2000). A removable partial upper denture with no lower denture is the most frequent type of denture among those with dentures in combination with natural teeth (Kelly et al. 2000). Of Finnish adults aged 30 to 44 in 2000, only 3% had removable dentures, while more than half of those aged 55 and over had removable dentures (Suominen-Taipale et al. 2008). According to the “Third German Oral Health Study” (WHO 2008b), the proportion of missing teeth replaced by dentures in adults aged 35 to 44 is 57%, and removable dentures (31%) are more frequent than bridges (26%). A study of 1000 Swedish individuals has compared the results of four sets of cross-sectional data (Hugoson et al. 2005). In the age-groups between 20 and 50, a decreasing number of teeth fitted with crowns or bridges was recorded during the 30-year period from 1973 to 2003. In 1973, the 50-year-olds had a mean of 25% of their teeth crowned, and in 2003 this had fallen to 7%.

A study in northern Saudi Arabia based on a sample of adult patients attending a dental centre reports that only 10% of patients wore dentures, with higher figures for men than for women (Al-Ghannam et al. 2002). Data on prosthodontic rehabilitation based on socio-demographic information are sparse in the EMR countries.

**Oral health and smoking**

The association between tobacco consumption and periodontal health has been studied over the years (Solomon et al. 1968, Sheiham 1971). In 1982, Feldman et al. (1983) and Bergström & Floderus-Myrhed (1983) verified simultaneously the hypothesis of a positive association between smoking and impaired periodontal status. Over the past two decades, the dentistry literature has accepted smoking as an important risk factor for periodontal diseases (Albandar et al. 2000, Susin et al. 2005a, Torrungruang et al. 2005).
Smokers have greater odds for more severe bone loss than do non-smokers, ranging from 3.3 for light and 7.3 for heavy smokers (Grossi et al. 1995). The NHANES III, in separate studies, has indicated a higher range of odds ratios for current smokers to have periodontal disease, depending on the criteria for measurement of periodontal status and the severity of the disease, from 1.5 to 10.5 (Tomar & Asma 2000, Hyman & Reid 2003, Dye & Selwitz 2005). Smoking, even among young adults with rather few (6) years of smoking experience, was in one study a major factor for periodontal destruction (Al-Wahadni & Linden 2003). Periodontal disease progression among smokers is approximately 3 to 9 years faster than that of non-smokers (Torrungruang et al. 2005). Smoking is the most potent factor for periodontal diseases; quitting smoking reduces the odds of having periodontitis (Nishida et al. 2005, Yamamoto et al. 2005).

Impacts of water pipe and cigarette smoking on periodontal bone height reduction are of equal magnitude (Natto et al. 2005). An earlier study on the association between smoking different tobacco products and one’s periodontal condition, however, had already demonstrated a significantly greater alveolar bone loss in cigarette smokers than it did in non-smokers and pipe/cigar smokers (Feldman et al. 1983).

Increasing exposure to smoking is correlated with a greater risk for periodontal pocketing among current smokers (Bergström 2003). The association between level of exposure to smoking and loss of attachment has displayed a monotonic dose-response pattern among both former and current smokers (Bergström et al. 2000, Hyman & Reid 2003). Severity of periodontal diseases is also directly associated with serum cotinine concentration level in a quantitative relationship (González et al. 1996, Yamamoto et al. 2005).

A 10-year follow-up study has demonstrated that the relative risk (4.6) for loss of teeth is greater ($p < 0.001$) for the 30- to 50-year-old age-group smoking more than 15 cigarettes a day, than is the risk for those who do not smoke (Holm 1994). Recently, a 4-year longitudinal study (Okamoto et al. 2006) also has indicated cigarette smoking as an independent risk factor for periodontal disease and tooth loss with a linear trend, and suggests there may be a causal path from smoking to tooth loss other than via periodontal disease. The ongoing longitudinal ‘Health Professionals’ Follow-Up Study (HPFS)’ provides data on 51,529 male health professionals and evaluates the association between smoking and tooth loss (Dietrich et al. 2007). This study’s results demonstrate a strong, dose-dependent association between cigarette smoking and risk for tooth loss in men. The risk declines soon after cessation of cigarette smoking, but remains elevated for more than 10 years compared with risk in never-smokers.

Bacterial plaque is the major risk factor for gingival inflammation (Löe et al. 1965). In current smokers, however, evidence shows that gingival inflammatory responses to dental plaque are suppressed, as measured by bleeding on probing (Bergström & Fjodorus-Myrked 1983, Axelsson et al. 1998, Scott & Singer 2004). The suppressive effects of smoking are stronger at sites having calculus, deepened periodontal pockets or both (Dietrich et al. 2004).
AIMS OF THE STUDY

General Aim

The general aim was to assess oral health and treatment needs among adult Iranians according to socio-demographic status, smoking, and oral hygiene, and to investigate relationships between these determinants and oral health.

Specific Aims

Specific aims of the present study were as follows:

- To assess dental caries experience, oral hygiene, periodontal treatment needs, and their determinants among 18-year-old Iranians (I)
- To assess dental caries experience, periodontal treatment needs, and their determinants among 35- to 44-year-old Iranians (II)
- To assess tooth loss, prosthodontic rehabilitation, and their determinants among 35- to 44-year-old Iranians (III)
- To assess smoking, and its relations to periodontal treatment needs and dental status among 35- to 44-year-old Iranians (IV)

Working Hypotheses

Working hypotheses were as follows: a) among Iranian adults, oral health and treatment needs, and prosthodontic rehabilitation are related to socio-demographic status; b) greater exposure to smoking is related to greater periodontal treatment needs and poorer dental status.
SUBJECTS AND METHODS

The present data were part of a national survey conducted in Iran in 2002 under the supervision of the Oral Health Bureau, Ministry of Health and Medical Education and the Iran Centre for Dental Research. The Ethics Committee in the School of Dentistry, Shaheed Beheshti Medical University, and the Oral Health Bureau, Ministry of Health and Medical Education approved the present study. The author designed the proposal of the study and sampling, conducted the calibration workshops for the examiners, supervised all the stages of the data collection procedure, and performed the statistical analyses. This study is part of a joint programme between the University of Helsinki, Finland, and Shaheed Beheshti Medical University, Iran, initiated by the WHO (EMRO) in 2002.

Socio-demography of the Iranian Population

The population of Iran in 2002 exceeded 68 million, with 66% living in urban areas. Iran at the time of the study had 28 provinces, but Tehran province alone has a population that exceeds 15% of the total population. During the past 50 years, the population of Iran has grown 3-fold, and the population of cities has shown a 6-fold growth (from 6 million to 36 million). The population growth rate has shown some variation, declining from 3.2% in 1986 to 1.5% in 1998. The tendency to emigrate from rural areas to big cities is high, as the percentage of urban residents has increased from 61% in 1996 to 67% in 2005. More than half the population is within the age-group 15 to 64, and about 40% are under 14 years of age. Thus, the population of Iran is one of the youngest in the world. (Statistical Centre of Iran 2008).

Of all Iranians aged 6 years or more, 84% are literate. Literacy rates are 89% in urban areas, 75% in rural areas, 89% for men, and 80% for women. The well-educated population of adult Iranians comprises about 7 million university graduates or students. (Statistical Centre of Iran 2008).

Oral Health System in Iran

Currently, health care services in Iran are delivered at three levels: health houses (in villages) and health posts (in cities), rural and urban health centres, and district hospitals. In rural areas, basic health care is provided in over 16,000 health houses that are staffed by more than 35,000 auxiliary health workers (or Behvarzes), and cover most of Iran’s 65,000 villages. In urban areas, health posts, which are staffed by about 50,000 female volunteers, provide primary health care (including education, family planning, child growth follow-ups, child immunization, and environmental health) for urban populations. Health centres in rural (more than 2,500) and urban areas (more than 2,300), are each staffed by a
medically qualified general physician and a team of up to 10 to 15 health workers to provide health services to about 7,500 to 10,000 people. In the district hospitals, advanced treatments are offered by specialists. (Asadi-Lari et al. 2004).

After the establishment of a comprehensive primary health care system throughout Iran in 1983 (Nasseri et al. 1991), oral health has been considered an important aspect of general health by the Ministry of Health and Medical Education. In 1997, oral health services were integrated into the primary health care system (Pakshir 2004).

In Iran, the oral health care system comprises both the governmental sector and the private sector; charity dental clinics are considered to be part of the private sector. The majority (80-85%) of dentists work in the private sector.

The Ministry of Health and Medical Education, responsible for the governmental sector, is in charge of primary oral health care services in villages and cities. Behvarzes and health volunteers offer oral health care including oral health education, periodic examination of the teeth, and referrals to the higher levels (rural or urban health centres).

Oral therapists in rural and dentists in urban public dental clinics deliver simple oral health services such as oral examinations, scaling, tooth extraction, and dental filling. For children under 12 and pregnant women these services are subsidized.

In the private sector, more than 20,000 dentists provide general and specialized dental services in cities. Although a dentist:population ratio of 1:5,500 has been reported for the whole country (Bayat et al. 2006), given the lack of any dentist in rural areas, the real dentist:population ratio for urban areas is 1:2,800, and most rural residents must travel to the nearest city to have access to dentists.

A national oral health-promotion programme was initiated in 1997 for children aged 6 to 12 years. The components of this programme are a) oral health education for the children in the schools, b) preventive activities including supervised tooth-brushing, and weekly use of 0.2% sodium fluoride mouth-rinse, and c) provision of low-cost facilities for basic curative and preventive treatments (Pakshir 2004).

**Sampling and Data Collection**

Stratified cluster random sampling in the present study followed WHO guidelines (1997). In the original national study, within each of the 28 provinces and separately in the capital city, Tehran, 15 clusters of 15- to 19-year-olds and 15 clusters of 35- to 44-year-olds were defined and divided according to the provincial urban:rural ratio by a provincial health worker who was expert in biostatistics. In each cluster, 23 individuals were invited to equally represent that cluster’s population, but no more than 20 were examined. Within the clusters, more than 95% participated. For rural households, subjects were selected from existing lists in governmental health centres (that cover more than 95% of the rural
Subjects and Methods

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population of Iran) and for urban households from lists prepared following a national polio vaccination programme conducted in 1996.

With support of the Oral Health Bureau, relevant authorities at the survey sites had been contacted and informed before field activities began. Information also came through the mass media about the implementation of the national oral health survey in order to achieve better cooperation. Meetings were held to explain the aims of the study and its detailed plan to those in charge. The leading health authorities of the province sent letters inviting subjects to their nearest dental health centre. Participation was voluntary, and as an incentive subjects received a toothbrush and toothpaste. Altering the examination appointments provided subjects with an extra chance to benefit from a better-adjusted selection. In case of the absence of the invited subject at the required time, the examiner had to go to the subject’s house. Any subject requiring emergency service was referred to a dentist. In some rural clusters, due to an insufficient number of invited subjects, the nearest neighbouring village served as the source of the remaining subjects.

Prior to the clinical examination, a brief interview ascertained subjects’ socio-demographic and smoking information. Clinical examinations were conducted to record number of teeth present, number of decayed teeth (DT), filled teeth (FT), DMFT, oral hygiene by Plaque Index (PI) (Silness & Löe 1964), community periodontal index (CPI), and prosthodontic rehabilitation status (WHO 1997).

The instruments, examination procedures, and diagnostic criteria followed the WHO recommendations (WHO 1997). A flat mouth mirror, a disclosing tablet, and a WHO probe by Dentsply™ were used to examine the subjects. Examinations were carried out in the nearest public dental centre, and under a dental light to reduce the probability of diagnostic bias. Dental status was diagnosed for all teeth except for wisdom teeth and roots with no clinical crown.

Examiners and Calibration

Examiners were in their last year of studies in dentistry, each having had 10 years of experience as an oral therapist. The examiners received four days of training and calibration, including a workshop on theory, a package with written information and instructions, coloured pictures, schematic dental casts of various clinical findings, and a pre-practical and practical phase, with 10 to 15 subjects examined by each examiner. Final agreement for the 33 examiners, evaluated with Kappa values for number of teeth, DT, FT, DMFT, PI, and CPI, ranged between 0.6 and 0.9. In each province the chief oral health officers supervised the practical arrangements, and dental faculties checked the procedures of clinical examinations randomly in the field.
Subjects and Methods

Study Framework

Subjects

Among the recommended reference age-groups by the WHO (Aggeryd 1983), target populations for the present study included all 18-year-old and 35- to 44-year-old Iranians living in Iran. The inclusion criteria for each study are illustrated in Figure 2.

Socio-demographic characteristics of the study population

The present sample of young adults and middle-aged individuals represented about 1,020,000 18-year-old and 7,552,000 35- to 44-year-old Iranians. The socio-demographic characteristics of the present study population are shown in Table 3. Among middle-aged individuals, the percentage of illiteracy was higher (p < 0.01) among women.

Framework

Based on the causal chain of exposures leading to diseases and indications for interventions, adapted to the web of risk factors by the WHO (Figure 1), Figure 3 demonstrates the present study framework and interrelationships between variables.

Figure 2. Schematic view of study subjects in studies I to IV.
Figure 3. Study models for oral health of (a) young adult, and (b) middle-aged Iranians: chain of risk indicators for adverse oral health outcomes and the following sequences.
Variables and Definitions

Socio-demography

Gender, age, place of residence, and level of education served as socio-demographic variables. Those aged 17 to 19 were defined as 18-year-olds (young adults). For the 35- to 44-year-old age-group (middle-aged individuals), age was further categorized and reported as two age-groups (35–39 and 40–44). Place of residence was recorded as urban or rural. Level of education for young adults was recorded in five categories, which were later combined into three levels: low (illiterate, though few were illiterate, and primary school), medium (secondary and high school), and high (high school diploma and any university education). Level of education for middle-aged individuals was recorded as six categories, later combined into four levels: illiterate, low (primary, secondary, and incomplete high school), medium (high school diploma), and high (any university education) to minimize reporting bias by the subjects.

Smoking

Due to the insufficient incubation time to evaluate impacts of smoking on oral health in young adults (Bergström et al. 2000), smoking was reported only among the middle-aged. The subjects reported their smoking status in three categories: non-smoker (never smoked), former smoker (has quit smoking) and current smoker. Duration of smoking was recorded as years of smoking. Daily smoking (as number of cigarettes smoked per day) was recorded only for the current smokers. Duration of smoking was reported as years of smoking for former and current smokers, further categorized into three: 10 and fewer years, 11 to 20, and 21 or more years. For current smokers, the age they started smoking was also determined. Daily smoking was expressed as number of cigarettes smoked per day only for the current smokers and further categorized into two: 1 to 10 cigarettes/day, and 11 or more cigarettes/day (Bergström et al. 2000).

Lifelong exposure to smoking was reported for the current smokers only. Based on previous studies (Grossi et al. 1995, Bergström 2003, Susin et al. 2005a), the lifelong exposure to smoking was calculated as accumulated exposure over time by multiplying the

| Table 3. Distribution (%) of adult Iranian study populations based on socio-demographic characteristics |
|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| Number of subjects                            | 18-year-olds                                  | 35- to 39-year-olds                           | 40- to 44-year-olds                           |
|                                               | Men, 2,021                                    | Women, 2,427                                  | Men, 1,994                                    | Women, 2,640                                  | Men, 1,631                                    | Women, 2,036                                  |
| Place of residence                            |                                               |                                               |                                               |                                               |                                               |                                               |
| Urban                                        | 59                                            | 57                                            | 55                                            | 59                                            | 60                                            |
| Rural                                        | 41                                            | 43                                            | 45                                            | 41                                            | 41                                            | 40                                            |
| Level of education                            |                                               |                                               |                                               |                                               |                                               |                                               |
| Illiterate                                   | --                                            | --                                            | 14                                            | 34                                            | 22                                            | 44                                            |
| Low                                          | 10                                            | 17                                            | 60                                            | 52                                            | 51                                            | 44                                            |
| Medium                                       | 50                                            | 41                                            | 16                                            | 10                                            | 17                                            | 9                                             |
| High                                         | 40                                            | 42                                            | 10                                            | 4                                             | 10                                            | 3                                             |

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daily number of cigarettes consumed, years of exposure to smoking and 365 days in a year, divided by 20 cigarettes per pack; accordingly the current smokers were categorized into three groups: light smoker = 1 to 2,000, moderate smoker = 2,001 to 7,000, and heavy smoker = more than 7,000 packs of cigarettes smoked lifelong.

**Dental plaque**

Dental plaque was recorded by use of the Plaque Index (PI) (Silness & Løe 1964) for buccal or lingual surfaces of the index tooth for each sextant. The highest reading score for each index tooth in a sextant was recorded. The codes (sextant score) were:

0 = no plaque
1 = plaque visible on to one-third of the buccal surface from the gingival margin
2 = plaque visible on to two-third of the buccal surface from the gingival margin
3 = plaque visible on the incisal margin of the buccal surface from the gingival margin
X = missing sextant (less than two teeth present)

The dentition was divided into six sextants: one anterior and two posterior regions in the arch, defined by tooth numbers 17-14, 13-23, 24-27, 37-34, 33-43, and 44-47. A sextant was examined only if two or more teeth were present, and these were not indicated for extraction. When only one tooth remained in a sextant, the sextant was considered missing, and the tooth was included in the adjacent sextant. PI was further reported individually according to the highest score among all sextants and totally as max PI scores and mean numbers of sextants with each index score.

**Dental caries experience**

Caries experience refers to the level of dental decay and was determined by use of the Decayed, Missing, and Filled Teeth index on all erupted teeth according to criteria defined by the WHO (1997). Separately for anterior and posterior teeth, numbers of decayed (DT), and filled teeth (FT) were recorded. If in doubt, no caries was recorded. The presence of dental caries was recorded if caries was observed at the cavitation level (detected softened floor, undermined enamel or softened wall). This level of diagnosis ensured standardization of the diagnosis and allowed comparison with other epidemiological studies using this standard. A tooth was considered filled with decay, when it had one or more permanent restorations and one or more areas that were decayed. A tooth was considered filled without decay when one or more restorations were present and no caries appeared anywhere on the crown.

**Periodontal treatment needs**

The Community Periodontal Index (CPI) was selected for assessment of periodontal treatment needs (WHO 1997). Three indicators of periodontal status served for the assessment: 1) presence or absence of gingival bleeding, 2) supra- and sub-gingival calculus, 3) periodontal pocket, subdivided into 4-5 mm and ≥ 6 mm (Ainamo et al. 1987,
Subjects and Methods

WHO 1997). The dentition was categorized into six sextants according to that applied for dental plaque. For 18-year-olds, only six index teeth – 16, 11, 26, 36, 31 and 46 – were examined. This modification was made to avoid scoring the deepened sulci associated with eruption as periodontal pockets.

The index tooth, or all remaining teeth in a sextant without any index tooth, was to be probed and the highest scores recorded. The codes (sextant score) were:
0 = healthy
1 = bleeding after probing
2 = calculus (detected during probing)
3 = pocket 4-5 mm
4 = pocket 6 mm or more
X = missing sextant (fewer than two functional teeth present)

CPI was further reported individually according to the highest score among all sextants and totally as max CPI scores and mean numbers of sextants with each index score. Since only the highest score was recorded, the CPI is based on an assumed hierarchical relationship between these indicators.

Tooth loss, functional dentition and edentulousness

The number of teeth present was counted and recorded excluding the third molars and roots with no clinical crown. Functional dentition, as defined by the WHO (1992), was assigned to subjects with 20 or more teeth. Edentulousness was defined as the subject’s having no teeth present in his/her mouth.

Prosthodontic rehabilitation

Prosthodontic rehabilitation status was recorded as six conditions (WHO 1997) by jaw: 1 = no denture, 2 = one bridge, 3 = more than one bridge, 4 = removable partial denture, 5 = combination of fixed and removable partial denture and 6 = complete denture.

Prosthodontic rehabilitation was categorized further by jaw as follows: no denture, fixed, removable partial, and complete denture.

Statistical Evaluation

Data were entered in the Epi Info 6 (CDCb 2008) format with check points and by double entry of 10% of the cases. Because the same number of subjects was sampled for each province, estimates of oral health were adjusted according to the proportion in provincial populations of the corresponding age-group.

Differences between subgroups were evaluated by ANOVA for mean values and by the Chi-square test for frequencies. Logistic regression models were fitted to the data to evaluate the strength of the relationships between socio-demographic factors and oral health indices. The corresponding results were expressed as odds ratios (OR) with their 95% confidence intervals (95% CI).
RESULTS

Oral Hygiene among Young Adult Iranians (I)

Visible dental plaque on index teeth existed in nearly all subjects. The majority (81%) had at least one index tooth fully covered by plaque (max PI = 3), 14% having max PI = 2, 4% with max PI = 1, and 1% with no plaque. On average, the mean PI was 2.8 (SD = 0.6). Higher amounts of dental plaque on index teeth were more prevalent (p < 0.01) among men, rural residents, and those with lower levels of education than among their counterparts.

Oral hygiene and dental diseases: Those with higher amounts of dental plaque on index teeth had higher (p < 0.01) mean numbers of decayed teeth (DT). Mean DT was 1.3 (SD = 1.7) for those having no dental plaque (max PI = 0), 2.3 (SD = 2.5) for those having max PI = 1, 2.4 (SD = 2.6) for those having max PI = 2, and 3.2 (SD = 3.1) for those with max PI = 3. Having dental plaque was also associated (p < 0.01) with higher periodontal treatment needs.

Dental Caries Experience (I & II)

Mean number of DMFT was 4.3 (SD = 3.7) in young adults and 11.0 (SD = 6.4) among middle-aged individuals. Figure 4 presents the mean numbers of sound teeth and DMFT components according to socio-demographic characteristics.

Among young adults, intact dentition (DMFT = 0) was found in 18%, 22% had one to two DMF teeth, and 60% had three or more. Intact dentition was more likely to be found among men than it was among women (OR = 1.5, 95% CI = 1.3–1.6), and among rural residents than it was among their counterparts (OR = 1.2, 95% CI = 1.1–1.3). Overall, 74% had one or more DT, and the D-component dominated (DT = 70%) in the DMFT index (MT = 14%, FT = 16%). In total, 19% had one or more FT. The higher mean numbers of FT were associated (p < 0.001) with female gender, urban residence, and higher levels of education. Overall, the majority (81%) had no FT, and 74% were in need of dental restorations.

Among middle-aged individuals, intact dentition (DMFT = 0) occurred in 2%, 8% had one to three DMF teeth, 42% four to ten DMF teeth, and 48% had ten or more. Results of logistic regression analysis showed that women (OR = 1.5, 95% CI = 1.3–1.8), urban residents (OR = 3.0, 95% CI = 2.5–3.7), and those with a high level of education (OR = 2.9, 95% CI = 2.6–3.3) were more likely to have one or more FT than were their counterparts. The M-component (60%) dominated in the DMFT index (DT = 24%, FT = 16%).
Periodontal Treatment Needs (I & II)

Healthy periodontium was a rare condition: only 8% of young adults and 1% of middle-aged individuals had a healthy gingiva (max CPI = 0). Figure 5 presents the max CPI scores according to socio-demographic variables.

Among young adults, periodontal treatment needs comprised mainly calculus (CPI = 2, 48%) and deepened periodontal pockets (CPI ≥ 3, 21%). Calculus (CPI = 2) was more likely among rural residents (OR = 1.2, 95% CI = 1.2–1.3) than among their urban counterparts.

Subjects with a low level of education were more likely to have calculus (CPI = 2, OR = 1.5, 95% CI = 1.4–1.7) and deep periodontal pockets (CPI = 4, OR = 2.7, 95% CI = 1.9–4.0) than were those with higher levels of education. Of the young adults, 30% had at least three healthy sextants or more, and 44% had no healthy sextant.

Among middle-aged individuals, the vast majority had calculus (CPI = 2, 40%) and deepened periodontal pockets (CPI ≥ 3, 53%). Male gender, greater age, and lower levels of education were associated (p < 0.05) with greater periodontal treatment needs. Calculus
or periodontal pocket were more likely to be found in men than in women (OR = 1.8, 95% CI = 1.6–2.0) and in illiterate subjects than in their counterparts (OR = 6.3, 95% CI = 5.1–7.8).

Tooth Loss, Functional Dentition, and Edentulousness (I & II & III)

Tooth loss was an occasional finding (30%) among young adults (Table 4), whereas the majority (90%) of middle-aged individuals had one or more lost teeth.

Young adults had an average of 27.4 (SD = 1.3) teeth, and all of them had a functional dentition. Having 28 teeth was more (p < 0.05) frequent among men (72% vs. 68% for women), urban residents (71% vs. 67% for rural residents), and those with a high level of education (73% vs. 60% for those with a low level of education).
Results

Table 4. Distribution (%) of tooth loss and edentulousness among young adults (n = 4,448) and middle-aged (n = 8,301) Iranians

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of teeth lost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
</tr>
<tr>
<td>18-year-olds</td>
<td>4,448</td>
</tr>
<tr>
<td>35- to 39-year-olds</td>
<td>4,634</td>
</tr>
<tr>
<td>40- to 44-year-olds</td>
<td>3,667</td>
</tr>
</tbody>
</table>

All estimates adjusted by provincial population percentages of the respective age-group.

Middle-aged individuals had an average of 21.5 (SD = 6.2) teeth. Of 35- to 39-year-olds, 2%, and of those aged 40 to 44, 5% had no teeth (Table 4). Percentages of edentulousness were higher (p < 0.01) among women (4% vs. 2% among men), and illiterate and less-educated people (4% vs. 0.3% among medium- and well-educated people). Of dentate middle-aged individuals, 76% enjoyed a functional dentition. Having 28 or more teeth was more frequent (p < 0.001) among younger subjects, urban residents, and those with a medium or high level of education than it was among their counterparts. Results of a logistic regression analysis controlling for gender and place of residence indicated that having a functional dentition was associated with younger age-group (OR = 2.0, 95% CI = 1.7–2.5) and higher levels of education (OR = 1.8, 95% CI = 1.6–2.1).

Prosthodontic Rehabilitation among Middle-aged Individuals (III)

Of edentulous middle-aged individuals (3%, n = 315), 86% had complete dentures in their upper and lower jaws, 2% in one jaw, and 12% had no denture. Among dentate middle-aged individuals (n = 7,925), prosthodontic rehabilitation was associated (p < 0.001) with female gender, older age-group, urban residence, and medium and high level of education.

Percentages of prosthodontic rehabilitation among dentate middle-aged individuals according to the number of teeth appear in Table 5. Of dentate subjects (n = 7,925), 86% had no prosthodontic rehabilitation, and 14% had a fixed or removable denture. Those with medium and high levels of education had the highest (p < 0.001) percentages of prosthodontic rehabilitation. Among those having 1 to 19 teeth, a removable denture was the most common type of prosthodontic rehabilitation. Among dentate subjects with prosthodontic rehabilitation (n = 909), having a removable partial denture in the upper jaw only (23%), and a fixed partial denture in the upper jaw only (20%) were the most frequent conditions.
Results

Table 6 shows the results of a binary logistic regression model controlling for socio-demographic variables and functional dentition. Middle-aged individuals lacking a functional dentition were more likely (OR = 6.0, 95% CI = 4.8–7.6) to have prosthodontic rehabilitation than were those having a functional dentition.

Table 6. Logistic regression model for having prosthodontic rehabilitation among middle-aged Iranians (n = 8,240)

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>SE</th>
<th>p</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (1 = Men, 2 = Women)</td>
<td>0.73</td>
<td>0.12</td>
<td>&lt; 0.001</td>
<td>2.1</td>
<td>1.7–2.6</td>
</tr>
<tr>
<td>Age (35,…, 44)</td>
<td>0.04</td>
<td>0.02</td>
<td>&lt; 0.001</td>
<td>1.0</td>
<td>1.0–1.1</td>
</tr>
<tr>
<td>Place of residence (1 = Rural, 2 = Urban)</td>
<td>0.73</td>
<td>0.14</td>
<td>&lt; 0.001</td>
<td>2.1</td>
<td>1.6–2.7</td>
</tr>
<tr>
<td>Level of education (1 = Illiterate, ....4 = high)</td>
<td>0.40</td>
<td>0.07</td>
<td>&lt; 0.001</td>
<td>1.5</td>
<td>1.3–1.7</td>
</tr>
<tr>
<td>Functional dentition (1 = Yes, 2 = No)</td>
<td>1.80</td>
<td>0.12</td>
<td>&lt; 0.001</td>
<td>6.0</td>
<td>4.8–7.6</td>
</tr>
<tr>
<td>Constant</td>
<td>-7.17</td>
<td>0.81</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Goodness-of-fit: Hosmer-Lemeshow test = 0.850. All estimates were adjusted by provincial population percentages of the 35- to 44-year-old age-group.
Smoking among Middle-aged Individuals (IV)

In total, 81% reported being non-smokers, 3% were former smokers and 16% current smokers. Of them all, 37% of men and 6% of women were current smokers. Table 7 shows the smoking indicators among middle-aged smokers. Current smokers were more likely to be found among men than they were among women (OR = 11.5, 95% CI = 8.9–15.5) and among the illiterate than they were among those with higher levels of education (OR = 1.4, 95% CI = 1.2–1.6). Of all current smokers, 38% were light smokers and 25% were heavy smokers.

The mean starting age for the current smokers was reported as 22 (SD = 7) years, with a delayed start for women (26 years, SD = 8). The current smokers consumed on average 13 (SD = 10) cigarettes/day, and that was higher (p < 0.01) for men than for women (15 cigarettes/day, SD = 10 vs. 5 cigarettes/day, SD = 6).

Table 7. Distribution (%) of current smokers and duration of smoking exposure (years) among middle-aged Iranian smokers based on gender, place of residence and level of education

<table>
<thead>
<tr>
<th></th>
<th>Distribution of current smokers based on lifelong exposure to smoking (%)</th>
<th>Duration (years) of smoking exposure Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Light smoker (n = 483)</td>
<td>Moderate smoker (n = 460)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>29</td>
<td>43</td>
</tr>
<tr>
<td>Women</td>
<td>85</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.01</td>
<td>p = 0.2</td>
</tr>
<tr>
<td>Place of residence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>39</td>
<td>38</td>
</tr>
<tr>
<td>Rural</td>
<td>39</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>p = 0.5</td>
<td>p = 0.9</td>
</tr>
<tr>
<td>Level of education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate &amp; low</td>
<td>44</td>
<td>26</td>
</tr>
<tr>
<td>Medium &amp; high</td>
<td>43</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.05</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>All</td>
<td>38</td>
<td>37</td>
</tr>
</tbody>
</table>

Lifelong exposure to smoking: Light smoker = 1 to 2,000, Moderate smoker = 2,001 to 7,000, and Heavy smoker = more than 7,000 packs of cigarettes smoked over a lifelong. Statistical evaluation: Chi-square test for frequencies and t-test for mean values. All estimates were adjusted by provincial population percentages of middle-aged Iranians.
Oral Health and Smoking among Middle-aged Individuals (IV)

Table 8 depicts periodontal treatment needs and mean number of teeth according to smoking indicators among dentate middle-aged Iranians. Periodontal treatment needs among the current smokers were significantly (p < 0.01) related to all three smoking indicators: duration of smoking (years), daily smoking (cigarettes/day) and lifelong exposure to smoking.

Results of logistic regression analyses, controlling for gender, age, place of residence, level of education, and lifelong exposure to smoking, showed that smoking is the best determinant for periodontal treatment needs; max CPI ≥ 3 (OR = 2.9, 95% CI = 1.8-4.7) and max CPI = 4 (OR = 2.4, 95% CI = 1.4-4.1) were the most likely to be seen in the current heavy smokers. Number of teeth was lower (p < 0.01) for those with higher levels of exposure to smoking measured by any of the smoking indicators compared to those with lower levels of exposure or non-smokers (Table 8). Percentage of edentulousness in non-smokers was 3.9% and in former smokers was 1.6%. Among current smokers, edentulousness was significantly higher (p < 0.01) in heavy smokers (7.3%) than it was in moderate (3.1%) or light smokers (2.1%). Lifelong exposure to smoking was negatively related (p < 0.001) to having a functional dentition. Current heavy smokers were the most likely to have less than 20 teeth (OR = 2.3, 95% CI = 1.5-3.6).
### Table 8. Distribution of subjects by their periodontal treatment needs according to smoking indicators among dentate middle-aged Iranians (n = 7,961); for each subgroup mean number of teeth also shown

<table>
<thead>
<tr>
<th>Smoking indicators</th>
<th>CPI ≤ 1 (%)</th>
<th>CPI = 2 (%)</th>
<th>CPI = 3 (%)</th>
<th>CPI = 4 (%)</th>
<th>No. of teeth Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-smoker</td>
<td>7</td>
<td>43</td>
<td>42</td>
<td>8</td>
<td>22.5 (4.8)</td>
</tr>
<tr>
<td>Former smoker</td>
<td>2</td>
<td>37</td>
<td>42</td>
<td>19</td>
<td>21.9 (4.8)</td>
</tr>
<tr>
<td>Current smoker</td>
<td>2</td>
<td>28</td>
<td>53</td>
<td>17</td>
<td>21.2 (5.4)</td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.01</td>
<td>p &lt; 0.01</td>
<td>p &lt; 0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of smoking (years) for former smokers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 years or less</td>
<td>3</td>
<td>44</td>
<td>39</td>
<td>14</td>
<td>21.6 (5.2)</td>
</tr>
<tr>
<td>11–20 years</td>
<td>1</td>
<td>50</td>
<td>37</td>
<td>12</td>
<td>20.7 (5.4)</td>
</tr>
<tr>
<td></td>
<td>p = 0.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of smoking (years) for current smokers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 years or less</td>
<td>3</td>
<td>34</td>
<td>47</td>
<td>16</td>
<td>21.3 (6.0)</td>
</tr>
<tr>
<td>11–20 years</td>
<td>2</td>
<td>29</td>
<td>51</td>
<td>18</td>
<td>20.2 (6.6)</td>
</tr>
<tr>
<td>21 years or more</td>
<td>1</td>
<td>25</td>
<td>54</td>
<td>20</td>
<td>18.5 (8.0)</td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily smoking for current smokers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1–10 cigarettes/day</td>
<td>3</td>
<td>34</td>
<td>47</td>
<td>16</td>
<td>21.1 (4.8)</td>
</tr>
<tr>
<td>&gt;10 cigarettes/day</td>
<td>1</td>
<td>25</td>
<td>54</td>
<td>20</td>
<td>19.1 (6.0)</td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifelong exposure to smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light smoker</td>
<td>4</td>
<td>33</td>
<td>47</td>
<td>16</td>
<td>22.3 (4.9)</td>
</tr>
<tr>
<td>Moderate smoker</td>
<td>2</td>
<td>25</td>
<td>57</td>
<td>16</td>
<td>21.0 (5.3)</td>
</tr>
<tr>
<td>Heavy smoker</td>
<td>≤ 1</td>
<td>23</td>
<td>57</td>
<td>20</td>
<td>19.7 (6.1)</td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.01</td>
<td></td>
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</tr>
</tbody>
</table>

Differences between subgroups were evaluated by Chi-square test for frequencies and by ANOVA for mean values. Lifelong exposure to smoking: Light smoker = 1 to 2,000, Moderate smoker = 2,001 to 7,000, and Heavy smoker = more than 7,000 packs of cigarettes smoked over a lifelong. All estimates were adjusted by provincial population percentages of 35- to 44-year-old age-group.
DISCUSSION

National surveys are vital in evaluating any nation’s disease patterns and treatment needs. Such information can prove useful for the planning and evaluation of health care programmes. The present study evaluated oral health and treatment needs among young adult and middle-aged Iranians, according to socio-demographic background, smoking, and oral hygiene, and demonstrated the relationships between these determinants and oral health in a national sample.

Main Findings

The majority of young adults retained all their teeth at the age of 18. Their DMFT values were dominated by DT. Three-fourths of young adults were in need of restorative treatments. Their poor oral hygiene was pervasive, and a healthy periodontium was a condition rarely met.

Middle-aged individuals had a moderate level of the mean DMFT, and it mainly comprised MT. Filled teeth were more prevalent among women, urban residents, and those with a high level of education than they were among their counterparts. Calculus and deepened pockets characterized periodontal treatment needs. The majority of middle-aged individuals had a functional dentition. Prosthodontic rehabilitation was an occasional condition related to high social status. Lacking a functional dentition was a determinant for having received prosthodontic rehabilitation, in particular a removable denture.

For the first time, the present study evaluated the relationship between oral health and smoking among Iranians, on a national level. One in five middle-aged Iranians of both genders reported being a current smoker. Typically, the current smokers in the present study were men and the illiterate. Among these current smokers, great periodontal treatment needs and high number of missing teeth were positively associated with lifelong exposure to smoking, with a dose-response relationship.

Results of the Study

Oral hygiene

The high prevalence of dental plaque among the present young adults results from their poor oral hygiene practices. According to one study (Samadzadeh & Hessari 1999), 27% of this age cohort, who were aged about 12 in 1997, had reported no brushing, and only half of them reported brushing their teeth once daily or more. Similarly, a high prevalence
of dental plaque and calculus has been highlighted in other Asian countries (Corbet et al. 2002).

Dental plaque is a well-known risk factor for dental caries (Selwitz et al. 2007) and gingivitis (Nunn 2003). The high prevalence of this risk factor has been reflected in the high prevalence of dental diseases presently among adult Iranians. Among future adults, as recent studies on 9-year-old (Saied-Moallemi et al. 2006) and 15-year-old Iranians (Yazdani et al. 2008) have shown, poor oral hygiene continues to be a significant oral health challenge. This poor oral hygiene stems from inadequate personal self-care. The situation will hardly be improved in Iran, without the decisive action of health policy-making in terms of oral health education programmes for adults. Intermediate dental manpower, such as oral hygienists or other health personnel could have an important role in developing the oral health-promotion programmes.

Dental plaque is essential in the production of the gingival inflammation (Löe et al. 1965) which is a probable risk marker for periodontal disease (Page & Beck 1997). However, most cases of gingival inflammation do not bring about periodontitis (Albandar 2002, Sheiham & Netuveli 2002). The latter researchers (Sheiham & Netuveli 2002) suggest that “achievement of a compatible level of plaque with an acceptable rate of periodontal destruction, which will retain teeth for a lifetime and does not cause handicaps”, is a reasonable goal for periodontal disease control. The high frequency of having visible dental plaque among the present young adults, and the common finding of calculus in both age cohorts, however, indicate that achieving an acceptable level of oral hygiene in Iran will take a very long time.

Dental caries experience

According to the available worldwide data on 18-year-olds in 12 countries (Namal et al. 2005), the mean value of 4.3 DMF teeth for young adult Iranians occupies the position of medium to high level dental caries experience. The mean DMFT of the present young adult cohort has undergone a doubling from 2 in 1997 (Samadzadeh & Hessari 1999) to 4.3 in 2002. The level of the mean DMFT in the present study is comparable to that of a recent study from Sweden, in which the mean DMFT for 19-year-olds was 3.9, and with 81% having DMFT ≥1 (Julihn et al. 2006). However, similar to findings on oral health in the EMR countries (WHO 2008b), the DMFT in young adult Iranians is dominated by DT, while in developed countries, FT is the main DMFT component; The proportion of FT was 58% in 17- to 20-year-olds in Australia (Hopcraft & Morgan 2003), and was 80% in 16- to 19-year-old Americans (Beltran-Aguilar et al. 2005). The high prevalence of decayed teeth among the young adults in Iran speaks for shortcomings of existing school-based oral health promotion-programmes in controlling dental caries, thus demanding their revision.

According to a worldwide map of oral health of 35- to 44-year-olds provided by the WHO (Petersen 2005), the mean DMFT of middle-aged individuals was at a moderate level as to dental caries experience, which comprises values between 9.0 and 13.9. The
mean figure for MT in the present study is similar to the recent figures from Morocco (MT = 7.0) (WHO 2008b) and Lebanon (MT = 6.4) (Doughan et al. 2000), but lower than earlier figures for MT in other EMR countries (WHO 2008b). The mean DMFT values of the middle-aged in industrialized countries are similar to those of Iran’s present middle-aged individuals. The notable difference is the dominant percentage of MT (60%) for these Iranians compared to high proportions of FT in industrialized countries such as France (71%) (Hescot et al. 1997), the UK (63%) (Kelly et al. 2000), and Finland (70%) (Suominen-Taipale et al. 2008). According to the present findings, the oral health system in Iran has not provided an appropriate response to these enormous dental treatment needs of young adults, and for the middle-aged, extraction of teeth has been the most frequent treatment procedure received.

**Periodontal treatment needs**

The frequency of healthy sextants among the present adults was very low. Studies in Syria also show a low level of healthy gingiva among their adolescents and adults (Beiruti et al. 2001), while reports from Saudi Arabia, Pakistan, and Lebanon (WHO 2008b) indicate less need for periodontal treatments compared to that of the present findings. The prevalence of shallow and deep periodontal pockets presently among Iranian adults is high, although not outside the reported range of worldwide data for adults (Albandar & Tinoco 2002, Corbet et al. 2002, Bourgeois & Llodra 2004, Corbet 2006). The high figures for calculus and deepened periodontal pockets reflect, in Iran, the inadequacy of both preventive programmes and specialised professional services. To handle the existing bulk of periodontal treatment needs, one of the key issues is that dental insurance companies should place emphasis upon preventive services such as dental prophylaxis and scaling. In order to accentuate the prevention aspect of the dental care system in Iran, the health insurance scheme should include obligatory regular dental check-ups, which still are lacking (Bayat et al. 2008).

The high frequency of periodontal disease worldwide is associated with lower social class (Craig et al. 2001, Sheiham & Netuveli 2002). This was also the case in the present study. Poor oral hygiene (Nunn 2003) and smoking (Bergström 2006), as the well-known risk factors for periodontal health, were higher among present Iranians having a lower level of education and among those dwelling in rural areas. Geographical factors, place of residence, low level of income and education, according to the only available previous study on the prevalence of periodontal diseases in Iran (Ramfjord et al. 1968), have been relevant regarding severe periodontal disease. A recent study from Denmark (Krstrup & Petersen 2006) reports a weak association between periodontal health and income, but a strong one between higher periodontal treatment needs and lower levels of education. Disadvantaged groups should be the priority in oral health-promotion programmes in Iran, and local oral health administrators should facilitate the development of the oral health care network in rural areas and suburbs.
Comparison of the present findings with the suggested goal for “acceptable” periodontal health, based on at least three healthy sextants for 90% of those aged 18 (Ainamo et al. 1987), indicates that much remains to be done both individually and professionally to achieve this goal.

**Tooth loss, functional dentition, and edentulousness**

The FDI and WHO have suggested that 85% of any population should have maintained all of their teeth by the age of 18 years (Aggeryd 1983) by the year 2000. The present estimate for Iranians who may retain all their teeth at age 18 (70%) is far from that goal.

Edentulousness and tooth loss are common among those of the lower social class (Palmqvist et al. 1992, Kelly et al. 2000, Dolan et al. 2001). In the present study, lack of a functional dentition was associated with a lower level of education. During the past three decades, the literacy rate in Iran has increased from 47% to 85%, the literacy rate at ages 35 to 44 being 83%, and at 6 to 19, 98% (Statistical Centre of Iran 2008). This societal improvement may result in future a greater benefit from a functional dentition for young adults.

Another suggested goal by the FDI and WHO in the year 1983 was a 50% reduction worldwide in the level of edentulousness at the age of 35 to 44 years by the year 2000. Compared to findings during 1988 to 1990 on the same age cohort of Iranians (Ministry of Health and Medical Education 1993), the present level of edentulousness has tripled (from 1% to 3%) with the mean number of teeth being about three teeth fewer (21.5 vs. 24.2 in 1988–90). These are serious findings, since tooth loss and edentulousness reduce chewing ability and are associated with a poor diet (Daly et al. 2003), an increased risk for systemic diseases (Joshipura et al. 2003), and a higher mortality rate (Abnet et al. 2005). This trend toward increasing tooth loss among middle-aged Iranians appears alarming for health policy-makers. They must allocate more financial resources to the dentistry field, as an integrated part of general health care, to improve the oral health system and to expand existing preventive services.

The WHO goal for the year 2010 suggests that 90% of the middle-aged should have a minimum of 20 functional teeth, and the percentage of edentulousness should not exceed 2% (WHO 2003). Although the existing figure of 3% edentulousness among the middle-aged in Iran is near the recommended goal for the year 2010, the percentage of those who have maintained a functional dentition (76%) is rather far from the suggested goal. Comparing Iran to other EMR countries, its present figures for edentulousness and tooth loss stand at a high level (Doughan et al. 2000, WHO 2008b). Developed countries have practically no edentulous individuals among their adults aged 35 to 44, and the majority of this age cohort have more than 20 natural teeth (Hescot et al. 1997, Ahacic et al. 1998, Kelly et al. 2000, Beltran-Aguilar et al. 2005, Suominen-Taipale et al. 2008).
**Prosthodontic rehabilitation**

Prosthodontic rehabilitation was currently rare among middle-aged Iranians, in spite of the substantial number of missing teeth; this indicates the generally low level of access to or delivery of prosthodontic services, or both. The need for prosthetic replacement of lost teeth, similar to findings of a study from Saudi Arabia (Al-Ghannam et al. 2002), will continue to be a major dental treatment demand also in Iran.

Results of studies from the US (Redford et al. 1996), France (Hescot et al. 1997), and Finland (Suominen-Taipale et al. 2008) corroborate the present finding as to gender differences in prosthodontic rehabilitation. The higher frequency of prosthodontic rehabilitation among women may reflect their greater appreciation of the resultant aesthetic aspects.

Currently, urban residents and well-educated middle-aged individuals, compared to their rural and less-educated counterparts, had lower proportions with tooth loss; they had benefitted, however, from more prosthodontic rehabilitation, signifying inequality in access to and availability of existing dental services in Iran. In the UK, conversely, higher proportions of denture use appear among those of a lower social class (Kelly et al. 2000). The dimensions of and determinants for disparities in prosthodontic rehabilitation among adult Iranians remain unclear. Evaluating dental manpower, locating those areas without access to dental care, and facilitating the establishment of dental clinics in disadvantaged areas will be enormously helpful in improving access to oral health care.

**Oral health and socio-demographic characteristics**

Similar to findings in some developing countries (Al-Shammery et al. 1998, Doughan et al. 2000, Wang et al. 2002, Susin et al. 2005b), women in the present study exhibited a worse dental condition than did the men: the frequency of having 28 teeth was lower among women, they had fewer sound teeth, and their percentages of edentulousness were twice that for men. Gender differences in developed countries do not exist among adults (Kelly et al. 2000) or are the reverse (Hescot et al. 1997, Suominen-Taipale et al. 2008). The reason for the present findings among Iranian women is neither poor oral hygiene, given that women showed lower scores of max PI, nor is less access to dental services, since FT and prosthodontic rehabilitation were higher among women; it probably stems from other factors such as style of nutrition or sugar consumption.

In line with the present findings for the men, who had more sextants with deepened periodontal pockets than did women, other epidemiological studies have consistently confirmed that periodontal diseases are more prevalent in men (Gamonal et al. 1998, Albandar 2002, Krstrup & Petersen 2006). A high frequency of periodontal disease among men has been attributed to poorer oral hygiene and dental visit behaviours, rather than to any genetic factor in some US studies (American Academy of Periodontology 1996). In the present study, poor oral hygiene may also be the reason for higher
periodontal treatment needs among men, because their oral hygiene was found to be poorer than that of women.

Higher dental caries experience and periodontal treatment needs among middle-aged individuals compared to young adults, and for older subjects among the middle-aged individuals in the present study, reflect the natural accumulative trend of impacts of dental diseases throughout life. Over their life-course, individuals acquire increasingly more fillings, then crowns and bridges, and then become edentulous often in old age. In a one-year period, one-tenth of Canadians experienced tooth loss (Miller & Locker 1994), and there, the only significant determinant was age. On the other hand, according to a survey in Sweden, dental health in similar age cohorts improved from 1968 to 1991 (Ahacic et al. 1998), an improvement associated with the number of those who annually made a dental visit. Increased numbers of dentists in Iran should provide more dental services, a prerequisite for good oral health on a national level. It can be expected that the present young adult cohort, compared with middle-aged individuals, will have more favourable dental health in adulthood; this is, however, not guaranteed.

Place of residence and level of education are determinants of social class (Ellwood & O’Mullane 1996, Kent & Croucher 1998). Several studies have demonstrated that members of societies from the lower social class exhibit poor dental health (Locker & Ford 1994, Ellwood & O’Mullane 1996, Benigeri et al. 1998, Thomson & Mackay 2004, Peres et al. 2005). The skewed distribution of filled teeth and prosthodontic rehabilitation for present urban residents of Iran and well-educated individuals, points to behavioural and physical, as well as economic and system-related barriers to access to dental treatment, and to disparities among available dental services. The role of education was reflected in periodontal treatment needs and in tooth loss among both young adults and middle-aged individuals. The present findings are consistent with earlier reports indicating that well-educated individuals maintain a more favourable oral health status than do less-educated individuals (Miura et al. 1997, Petersen 2005). Illiteracy in Iran is rapidly diminishing, and the new generation is much more capable of receiving the written information on health and of applying it well.

**Oral health and smoking**

**Smoking**

The present findings as to the frequency of self-reported current smoking are in line with WHO statistics. One-third of adult men smoked, globally according to the WHO report of 2002 (2002b). In Tehran city, among 35- to 44-year-olds in 2002, 38% of men and 4% of women had reported smoking cigarettes (Azizi et al. 2002); the percentage of smoking, in both genders, was associated with age and was at its highest by age 44 among Tehranians (Azizi et al. 2002). Similar percentages have been reported for Saudi Arabian adults (Natto et al. 2005), but were higher (55%) for Japanese men (Ojima et al. 2006).
The lower percentage of those smoking among the well-educated Iranian subjects is in line with findings of a recent study on dental educators in Iran (Khami et al. 2006). Few or no women have reported being smokers, among medical students (Ahmadi et al. 2001a) or dental educators (Khami et al. 2006). The percentage of current smokers among women, 5% in the present study, was much lower than figures reported for Canadian, 26% (Kirkland et al. 2004) and US middle-aged women, 27% (CDCa 2008). The grounds for gender differences in smoking maybe rooted in Iranian culture, which downgrades women socially if they smoke; smoking is much more permissible for men (Ahmadi et al. 2001b). A recent report on Iranian adolescents showed, however, an alarming rise in adolescents’ smoking, especially among girls, with a tendency toward water pipes for enjoyment (Kelishadi et al. 2006). Accordingly, an increasing trend toward smoking is predicted in the near future in Iran in particular among the young and women. This trend indicates the lack of a prohibitive environment for adult smokers. Smoking-cessation campaigns for adults should start from adolescence, as a part of school-based health programmes (Yazdani et al. 2008), to prevent or delay tobacco-use initiation (Aquilino & Lowe 2004).

Smoking is a multi-dimensional phenomenon, including intensity, duration, and time since cessation (Dietrich & Hoffmann 2004). To avoid the side-effects of smoking, total smoking cessation is the best solution. However, in cases of failure of total cessation among heavy or moderate smokers, temporary interruptions, or reducing the number of cigarettes will then categorize them as light smokers receiving a reduced amount of exposure. This strategy is accompanied by a lower level of oral health-related smoking side-effects (Bergström 2003).

Smoking cessation activities should be prioritized in oral health-promotion programmes for adults. Training of oral health professionals as well as carrying out interventions in dental settings on abstinence from smoking may increase the rate of tobacco cessation by patients, especially when reinforced by follow-up prompts and reminders (Lancaster et al. 2000, Carr & Ebbert 2006). In addition, according to the international guidelines on “the care pathways for tobacco-use cessation”, oral health care professionals in Iran should play a key role in supporting and assisting their patients to stop smoking (Ramseier et al. 2006).

The effects of exposure to smoking accumulate throughout the years. According to findings of a study in adults up to age 39, only a minor variation in effects appears from exposure to smoking among current smokers, whereas in individuals aged 40 and over, the oral health-related effects are strong (Bergström et al. 2000). The impacts of smoking on health could be clinically detected within a 30-year incubation time (Peto et al. 1996). In the present study, the impact of the duration of smoking on oral health was well detectable after an average of two decades of smoking.

**Periodontal and dental diseases and smoking**

During the past 30 years, smoking has been recognized as an important risk factor for general health as well as oral health (Feldman et al. 1983, Grossi et al. 1995, Tomar &
Asma 2000). As reviewed by Bergström (2006), smoking is associated with higher periodontal treatment needs; this was evident also in the present findings.

Both intensity and duration of smoking among the Iranian current smokers were associated with higher need for periodontal treatment, a finding apparent in other recent studies (Bergström 2003, Susin et al. 2005a, Torrungruang et al. 2005). Based on the present findings, deepened periodontal pockets were more frequent among heavy smokers than among the moderate and light smokers, speaking for the dose-response relationship also revealed earlier (Grossi et al. 1995, Hyman & Reid 2003, Torrungruang et al. 2005). Further analysis of the present data supports the likelihood of more periodontal treatment need among those with greater lifelong exposure to smoking.

The hazardous impacts of smoking on periodontal treatment needs are more dominant than for other known risk factors. For example, educational attainment (Dye & Selwitz 2005) or female gender (American Academy of Periodontology 1996) each has been introduced as a strong predictor of periodontal health, as present findings also indicated. However, with smoking included in the logistic regression model, the role of socio-demographic determinants disappeared.

The present findings showed that lifelong exposure to smoking was negatively associated with number of teeth and having a functional dentition. Smoking is a predictor of tooth loss due to progressive periodontitis and interferes with achievement of a stable periodontal condition even following treatment (Fardal et al. 2004). In addition to periodontitis, duration of smoking may be associated with current tooth decay as a reason for tooth loss (Jette et al. 1993). A significant linear trend toward tooth loss is convincing, based on lifetime number of cigarettes smoked (Ylöstalo et al. 2004, Okamoto et al. 2006). Findings from longitudinal data drawn from 43,112 male health professionals in the USA (Dietrich et al. 2007) confirm both dose- and time-dependent effects of smoking on tooth-loss incidence, in line with the present findings on the associations between duration of smoking and daily smoking and number of teeth.

**Methodological Aspects**

**Limitations of the study**

National surveys usually confront practical problems or geographical barriers in collecting subjects in big cities and in gaining access to remote areas. As part of its responsibilities, the Ministry of Health and Medical Education in Iran monitors diseases via a data registry system or national surveys that help to reduce the usual barriers in this regard. Completion of the present survey was facilitated through the widespread Primary Health Care network that covers more than 95% of rural areas and 50% of urban areas (Asadi-Lari et al. 2004). Involvement of local health authorities in providing suitable transportation made it possible to reach subjects’ homes to invite them to participate in the study and even to transfer them to the nearest health centre if needed.
Representativeness of the study sample

In order to generalize the results of the present study to a national level, several strategies were necessary. To cover all subgroups of the population under investigation required sufficient sample sizes and adequate numbers of clusters, and on the basis of a valid registry list, random cluster sampling was applied. All stages of the present study, from sampling to data collection, including procedures for training and calibrating examiners, followed WHO criteria (WHO 1997). Announcements through TV or radio during the data collection were essential to inform and encourage individuals as to the importance of this national survey. Data were adjusted by gender and provincial population percentages of related age-groups; however, adjusting the data resulted in only minor changes in the estimates. All of these activities facilitated achievement of successful sample selection, high participation rates within the clusters, and finally a sound data set allowing for broad generalization of these results.

Clinical examinations

The quality of findings in any study relies on the reliability and validity of the data collected. In the present study, careful training of the examiners enhanced data reliability. Calibration of examiners aimed at ensuring uniform interpretation, understanding, and application of the codes and the criteria for various conditions by all examiners, and at ensuring that each examiner could perform examination consistently. The kappa values of 0.6 to 0.9 for inter-examiner reliability of the 33 examiners reveal the resultant acceptable level of reliability.

The DMFT and CPI have been applied in a number of studies (WHO 2008b) and are still recommended by the WHO (1997) to enhance international uniformity of epidemiological studies of dental caries experience and periodontal treatment needs. The validity of these indices has, however, met with criticism.

The DMFT index reflects the ongoing caries experience within populations. The most relevant doubts in any caries diagnosis arise in regards to initial potential enamel caries (Assaf et al. 2006). Therefore, initial caries lesions within the present study have been considered sound, as the WHO has suggested (1997). The DMFT index combines the disease signs with treatments received and allots an equal burden to missing, untreated decay, or well-restored teeth. For calculation of the M component, participants must recall the reason for extraction. The transition of a “filled” tooth or surface to “filled and decayed” is usually considered in longitudinal studies as an increment of dental caries, whereas in cross-sectional surveys their values are identical. Despite some advantages, none of the suggested solutions to offset these DMFT shortcomings is as yet satisfactory (Benigeri et al. 1998, Broadbent & Thomson 2005).

The CPITN, first introduced by Ainamo J. et al. (1982), is a composite index that combines features of gingivitis and periodontitis. As a screening procedure, the CPITN
assesses the presence or absence of gingival bleeding, calculus, and periodontal pockets (Cutress et al. 1987). However, standard recordings do not include direct measures of periodontal destruction (Baelum & Papapanou 1996), and the hierarchical principle underlying use of the CPITN is no longer valid (Holmgren & Corbet 1990, Baelum et al. 1993). The WHO, however, after minor modifications, still recommends using the CPI, as an epidemiologic tool in periodontology (WHO 1997).

The data on smoking exposure were self-reported. Because smoking is considered unfavourable social behaviour, socially acceptable answering (Sjöström & Holst 2002) may have occurred. Thus, underestimation bias in smoking data should be kept in mind, in particular among women. For better monitoring of smoking status, cotinine plasma half-life served as a biochemical marker of tobacco use. Measuring one’s cotinine level assesses the systemic effect of smoking, and may not be comparable with the number of cigarettes smoked, even for the smokers who provide accurate self-reporting (González et al. 1996). Needleman et al. (2006) indicate the lack of any gold standard as reasons for measuring tobacco use both by self-report and by biochemical measures. Self-reporting, however, still has scientific value, and many studies present the association between self-reported tobacco use and systemic diseases as well as oral diseases (Bergström 2006, Lubin & Caporaso 2006, Dietrich et al. 2007).
CONCLUSIONS

Generally, adult Iranians have poor oral hygiene that engenders oral diseases. Healthy periodontium and intact dentition are rare conditions; poor oral hygiene can expose the oral health of the majority of adult Iranians to risk for further dental and periodontal diseases for the rest of their lives.

Most risks to oral health accumulate in individuals with a low socio-economic status, and education is a strong determinant for most oral health indicators.

Unmet dental and periodontal treatment needs are high in Iran, indicating the existence of barriers to accessible dental care, especially among those of lower socio-economic status. The low prevalence of filled teeth and high prevalence of missing teeth indicate that extraction is the most common response among dentists to existing treatment needs. In Iran, the limited restorative treatments and prosthodontic rehabilitation works are unevenly distributed.

Smoking is a risk indicator for oral health that accumulates in men and in those with a low level of education. The risk is higher with the greater number of cigarettes per day, the longer duration of smoking, and the heavier lifelong exposure. Among the current smokers, great periodontal treatment needs and a high number of missing teeth are positively associated with lifelong exposure to smoking, with a dose-response relationship.

The higher need for periodontal treatments among men may be attributed in Iran to their poorer oral hygiene and their higher prevalence of smoking.
RECOMMENDATIONS

For citizens
- Oral self-care should be acknowledged from childhood, to become an established habit in adulthood.
- Adults should regard healthy dentition as an integral part of good general health and healthy ageing.
- Smokers should be supported to stop smoking to prevent further oral health deterioration caused by tobacco.

For dental professionals
- Dental professionals should put an emphasis on oral self-care instructions during each patient’s visit and treatment, especially among those with a low socio-economic status.
- Preventive approaches should be highlighted in continuing education and during dental curriculum revision.
- Education and training in tobacco use prevention and in cessation skills should be integrated into dental curricula, and into dental continuing education.
- Tobacco-use prevention and cessation activities should be integrated into the treatment procedures of patients according to international guidelines.

For policy-makers
- National oral health prevention programmes for adults should be introduced, with priority given to those who are underprivileged.
- Oral health care should be integrated with other health care promotion programmes, employing the common risk factor approach.
- Tobacco use-cessation programmes should be reinforced at all levels of health policymaking.
- The strategic plan for a comprehensive oral health care system in Iran should be revised to diminish inequalities in oral health. The composition and distribution of dental manpower, coverage of dental insurance, and school-based oral health-promotion programmes are subjects that need evaluation and development in this strategic plan.
SUMMARY

The present study aimed to assess the oral health and treatment needs of young adult and middle-aged Iranians according to socio-demographic status, smoking, and oral hygiene. Data for young adults and middle-aged Iranians were collected as part of a national survey using the WHO criteria for sampling and clinical diagnoses, across 28 provinces. Data were ascertained for socio-demographic information, smoking indicators, plaque index (PI), number of teeth, decayed teeth (DT), filled teeth (FT), community periodontal index (CPI), and prosthodontic rehabilitation.

Dental plaque was pervasive and was more prevalent among men, rural residents, and those with a low level of education than it was among their counterparts. Dental plaque was associated with higher dental caries experience and greater periodontal treatment needs.

Dental caries experience was higher among women. DT dominated in DMFT among young adults and MT among the middle-aged. FT was related to gender, place of residence and level of education. Intact dentition was higher among adult men. Tooth loss was a common finding among both age-groups. Tooth loss was higher among women, rural residents, and the illiterate.

Healthy periodontium was a rare finding. High periodontal treatment needs were associated with male gender, older age, and a high level of education. The majority of max CPI scores consisted of calculus and deepened periodontal pockets. Having deep pockets was more likely among those with a low level of education than it was among well-educated individuals.

Prosthodontic rehabilitation was associated with older age, female gender, urban residence, and low level of education. Lacking a functional dentition was associated with having prosthodontic rehabilitation. Removable partial dentures were more common than were other types of dental prostheses.

Smoking was more prevalent among illiterates and men than it was among their counterparts. Among men, heavy smoking was more common than among women. Lifelong exposure to smoking was associated with higher periodontal treatment needs, fewer teeth and higher percentage of edentulousness.

Decayed and missing teeth characterise the dental status, and calculus and periodontal pockets are the major typifying figures regarding the periodontium among adults in Iran. To overcome their substantial unmet treatment needs will require a national oral health-promotion programme emphasising the prevention of risk factors for oral health such as poor oral hygiene and smoking.
ACKNOWLEDGMENTS

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In other words, community oral health in Iran is indebted to the efforts of Professor Heikki Murtomaa, as the innovator of a new era for inter-country joint-activities in dental research. His name and the names of his co-workers will be registered in the history of dentistry in Iran.

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Helsinki
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REFERENCES


Bratthall D, Hänsel Petersson G. Cariogram - a multifactorial risk assessment model for a


References


Thomson WM. Dental caries experience in older people over time: what can the larger cohort studies tell us? Br Dent J 2004;196:89–92.


World Health Organization (WHO). The Liverpool Declaration: Promoting oral health in the 21st
References


خلاصه

هدف این مطالعه ارتباطی وضعیت سلامت دهان و نیازهای درمانی در بین جوانان و میانسالان ایرانی بر اساس شرایط زمینه‌ای، مصرف سیگار و رعایت بهداشت دهان، بررسی ارتباط بین این شاخص‌ها و سلامت دهان می‌باشد.

در روش این مطالعه، داده‌هایی از 4484 جوان 18 ساله و 8301 فرد میانسال 35 تا 44 ساله ایرانی توسط 33 مراجع گر آموزش دیده و بر اساس اصول ارائه شده توسط سازمان جهانی بهداشت در 28 استان کشور جمع‌آوری شد. جنس، سن، محل سکونت، و سطح سود به عنوان عوامل زمینه‌ای، مصرف سیگار به عنوان عامل رفتاری، و شاخص پلک به عنوان عامل بیولوژیک در نظر گرفته شدند. تعداد دانش‌آموزان، دانش‌آموزان پیوسته، دانش‌آموزان پرده‌دار.

و وضعیت پروتزیه عنوان شاخص‌های وضعیت سلامت دهان انتخاب شدند.

نتایج این مطالعه حاکی از این است که تقسیم جویان پلاک دندانی دیده شد. شاخص پلک با تعدد با الکترونی و نیاز DT بیشتر به درمان‌های پروتزیات در جوانان در ارتباط بود. میانگین در جوانان 4.3 (SD = 3.7) و در میانسالان 11.0 (SD = 6.4) بود. در بین جوانان (70%) و در بین میانسالان (60%) البته کسانی با تعداد بالاتر OR = 6.3, 95% CI = 5.1–8.7 و در افراد سالم در جوانان (28%) در افراد سالم بهترین نشان دهنده S.D = 0.4 (OR = 2.3, 95% CI = 1.5–3.6) بود.

وجود لثه سالم در بین مردان ایرانی بسیار نادر بود، 8% جوانان و 1% میانسالان دارای لثه سالم بودند. غالب دندان داشتن 28 دندان در مردان (72%) در پی این در جوانان 68% در زنان، در شهر نشینان (71%) در پی این در جوانان 68% در زنان، در افراد با سکته (73%) در پی این در جوانان 68% در زنان.

در بین جوانان داشتن 19 دندان در مردان (72%) در پی این در جوانان 68% در زنان، در افراد با سکته (73%) در پی این در جوانان 68% در زنان (OR = 2.0, 95% CI = 1.7–2.5) و سواد بالاتر همراه بود (OR = 1.8, 95% CI = 1.6–2.1).

برای روش‌های دندانپزشکی فرد (22%) و در افراد سالم در جوانان (73%) و در افراد سالم بهترین نشان دهنده S.D = 0.4 (OR = 2.3, 95% CI = 1.5–3.6) بود.

در کل، 18% اظهر داشتن سیگار نمی‌کشند. در افراد بالاتر از 50 سال و 32% مردان و 5% زنان سیگاری بودند. سیگاری های شدید بیش از همه دندان داشتند (OR = 2.9, 95% CI = 1.8–4.7) و کمتر از همه دندان داشتند (max CPI ≥ 3, OR = 2.9, 95% CI = 1.8–4.7) و کمتر از همه دندان داشتند (max CPI ≥ 3, OR = 2.9, 95% CI = 1.8–4.7).

نتیجه‌گیری‌های این مطالعه حکایت از وضعیت ناپایدار سلامت دهان و دندان بزرگسالان ایرانی به خصوص در بین طبقات پایین جامعه پدیده شد. شیوع بالای پلاک دندانی و جرم و نیازهای درمانی بروز داده‌های نشان دهنده همگی نیاز به یک استراتژی پیشگیری جامعه نگر را با تاکید بر بهبود بهداشت شخصی و تکنیک سیگاری از پیش مشخص می‌نماید.
موضوع:
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