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Clinical

Periodontal health of an adult population in Hungary: findings of a national survey

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Abstract

Objectives: To estimate the levels of periodontal health conditions of Hungarian adults.

Material and Methods: Periodontal data on 4153 adults in 304 survey locations from all Hungarian regions were analysed. The Community Periodontal Index (CPI) was used to report the occurrence of probing pocket depth, calculus, and gingival inflammation.

Age, gender, socioeconomic and health status, oral hygiene and lifestyle habits, dental office attendance, level of education, and fixed partial denture (FPD) treatment were evaluated for their association with periodontal conditions. CPI score as an outcome was dichotomized using an accepted threshold as low (<3) and high (3, 4) for multiple logistic regression modelling.

Results: CPI2 was the most prevalent score in all age groups. CPI scores were also strongly associated with the independent variables. Approximately 66% of subjects visited a dentist only in the case of an emergency. Lack of periodontal aspects of restorative care was demonstrated by the result of CPI0 among 16% of non-FPD wearers compared with only 9% of individuals treated with FPD.

Conclusion: The present survey indicates that oral hygiene standards and periodontal health conditions need improvement in Hungary. Effective intervention programme for the prevention and control of periodontal disease are recommended at a national level.

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Key words: CPI method; Hungary; oral health survey; periodontal conditions; risk and determinant factors

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Periodontal diseases are a diverse group of diseases with similar aetiologies and different natural courses, prognoses, and responses to conventional therapy (Page & Beck 1997). In Europe, detailed elaborate periodontal epidemiologic studies have only been conducted in Scandinavia (Halling & Björn 1987, Papanaou et al. 1988, 1989, 1991, Papanaou & Wennström 1990, Wennström et al. 1993, Serino et al. 1994, Eliasson

Conflict of interest and sources of funding statement

This study was supported by Blend-a-med Research. The authors declare that they have no conflicts of interests. & Bergström 1997, Papanaou 1999, Skudutyte-Rysstad et al. 2007, Hugoson & Norderyd 2008, Hugoson et al. 2008) and in certain Western European countries (Schürch et al. 1988, Diamanti-Kipioti et al. 1995). However, limited epidemiologic studies and reports are available from most Eastern European countries; the Community Periodontal Index of Treatment Needs (CPITN) data can be found in the World Health Organization (WHO) Data Bank (Ainamo et al. 1982, Cutress et al. 1982). The CPITN was developed in the late 1970s. The CPITN was endorsed by the WHO for population-based surveys in the early 1980s (Ainamo et al. 1982) but was later renamed by WHO as the Community Periodontal Index (CPI)

(WHO 1997) to foster its use as an index to measure periodontal status in populations. Even though the use of CPI (CPITN) in the epidemiology of periodontal disease is controversial (Kingman & Albandar 2002, Dye & Selwitz 2005), this method was used to compare the periodontal conditions in different Eastern European countries. Epidemiologic studies using CPITN indices performed in industrialized countries have reported that in the middle-aged population, 85-95% of the subjects had a healthy periodontium or just a mild periodontal inflammation without any signs of severe clinical attachment loss (Pilot & Miyazaki 1991, Pilot 1998). In an analysis of 100 CPITN studies conducted in >50 countries, it was

found that severe periodontitis affects approximately 10–15% of most populations, irrespective of geographic, ethnic, or socioeconomic backgrounds (Miyazaki et al. 1991). Because the prevalence of severe destructive periodontitis remains unchanged despite several preventive programmes in industrialized countries, it might reflect the proportion of the high-risk, highly susceptible portion of the population (Hugoson et al. 2008).

According to CPITN studies carried out in Eastern Europe, there is a considerable variation in the percentage of subjects having one or several deep pockets (i.e., a probing pocket depth >6 mm). The percentage of subjects in the 35-44-year-old age group displaying at least one pocket >6 mm varied between 2% and 40% in this region (Pilot & Miyazaki 1991, Mengel et al. 1993, Pilot 1996, 1998). In Hungary, the first national baseline examinations were carried out in 1985, followed by data collections in 1991 according to the WHO standards using the pathfinder methodology (Czukor 1994). There was a general tendency towards a slight improvement in the periodontal health of the analysed population during the 6-year period. A subsequent Hungarian national epidemiologic examination (Pathfinder Survey) carried out in the year 2000 has indicated poor periodontal conditions in the 35-44-year-old age group (Szőke & Petersen 2004). The findings of this survey pointed to the enormous need for periodontal treatment of the population. Since that time, no comprehensive epidemiologic Pathfinder Survey has been conducted in Hungary aiming to assess the periodontal condition of the Hungarian adult population.

The aim of the present study was to assess the oral health in a sample with age and gender groups similar to those of the general Hungarian population. The survey covered the deprived regions of the country as well, where the population does not visit to a dentist on their own accord. We generated thorough health statistics that will help the government improve the health care system.

Material and Methods

A 2-year nationwide comprehensive oral epidemiologic Pathfinder Survey following the WHO criteria (World Health Organization 1997) was performed by calibrated examiners of the Semmelweis University in Budapest. Ethical approval was also obtained from the Semmelweis University Regional and Institutional Committee of Science and Research Ethics (permission number TUKEB: 206/2003). In this paper, only the periodontal health data of this survey are presented.

The targeted total sample size was determined through precision-based calculations. Upper/lower bound ratios (UB/LB) of the 95% exact binomial confidence intervals for prevalence values such as 5%, 1%, and 0.5% were computed as functions of sample size. For the purposes of the study, a sample size was considered sufficient for an adequately precise estimation of a prevalence value if the associated UB/LB ratio was <2. Because 4000 subjects set this ratio at 1.9 for the estimation of a 1% prevalence, this figure was considered to be a sensible compromise between the requirements for precision and sensibility of resource use.

In the national Pathfinder Survey, no subjects over the age of 18 were excluded; those who volunteered and provided written statements were examined. A total of 6397 subjects were offered the chance to volunteer for participation; the rate of non-respondents was 28% (n = 1791) due mostly to being in a hurry and having no time for a dental examination. Of the 4606 participants, only edentulous adults (n = 453; 10.1%) were excluded from the present periodontal study due to the impossibility of evaluating the periodontal conditions in this population.

A total of 4153 persons (n = 2585 females and n = 1568 males) with at least one sextant available for evaluation were included as participants in this study.

For convenience and practicability, we decided to approach members of the population on occasion of their participation in community chest X-ray examinations. There has for long been an established system of chest X-ray TB screening in Hungary (tuberculosis is also referred to as Morbus Hungaricus), and for decades, chest X-ray was compulsory by law. Nowadays, in spite of the survey not being compulsory, Hungarians still feel that it is their duty to comply with screening calls, and all Hungarian adults over the age of 18 receive mail invitations every 5 years. From the complete list of locations where compulsory chest X-ray stations operated, we randomly selected

304 (about the maximum we could reasonably expect to cover, given staff and time constraints), by ensuring representation of all place categories (capital; cities of county rank: other cities: and sub-city places in the surroundings of each of the former three) in each of Hungary's 16 practicality-based (same health authority) contiguous geographic areas. We used the Hungarian Central Statistical Office gender and age group proportions pertinent to place category at each station to calculate stationspecific targeted sample compositions. Station-specific target sample sizes were calculated by dividing place categoryspecific total target sample sizes between stations within the same place category as evenly as possible. A factor of 1.15 was used to allow for volunteers unavailable for evaluation. Subjects were invariably approached upon finishing the X-ray test unless they were apparently in a demographic stratum already saturated to target at that station. Socioeconomic characteristics were not used in the sample selection but were taken into account through the proxy variable of geographical region because they correlate in Hungary.

The periodontal condition was assessed using the CPI probe with a 0.5-mm ball tip and a coloured band between 3.5 and 5.5 mm. Gingival bleeding, calculus, and periodontal pocket depth were investigated in the dentition divided into sextants. Only the highest of the component CPI scores for each sextant was recorded. We followed the directive that a sextant should only be examined if there are two or more teeth present and not indicated for extraction. Wisdom teeth were only taken into account if they had assumed the function of the first or the second molars. Patients were recorded in the dataset but were excluded from analysis if these criteria left no sextant available for evaluation. The CPI was recorded according to WHO criteria (World Health Organization 1997).

Clinical examinations were carried out in a portable dental X-ray chair with a head-rest, in a sufficient artificial spotlight with a dental probe, a dental mirror, dental forceps, and a WHO probe.

The survey was conducted at 304 different survey places by the same dentists. A 12-member survey group (seven surveyors and five data recorders) of the Department of Prosthodon-tics travelled around Hungary so that all surveys were conducted by the same calibrated group of dentists.

The survey group had undergone theoretic and practical training and calibration held by a senior member of the Department of Periodontology of Semmelweis University.

The calibration training focused on the sensing method, the use of the WHO probe as a "sensing" instrument to determine pocket depth, and to detect subgingival calculus and bleeding responses. The sensing force used was no more than 20 g. When the probe was inserted, the ball tip followed the anatomic configuration of the surface of the tooth root. The probe tip had to be inserted gently into the gingival sulcus or pocket and the total extent of the sulcus or pocket was explored. The following CPI coding system was used to record periodontal status: 0, healthy periodontium; 1, bleeding observed after probing; 2, calculus detected during probing, but the black band on the probe was visible; 3, pocket 4-5 mm (the black band on the probe is within the gingival margin); 4, pocket $\ge 6 \text{ mm}$ (black band on the probe not visible): x. excluded sextant (<2 teeth present); and 9, not recorded. Each examiner's rating performance was evaluated by calculating the inter-rater agreement κ statistic between them and the established expert. The average over all examiners was 0.85.

During the screening, each proband was questioned on their level of education (categorical: elementary - medium level - university level), systemic health (binary indicators for each of the following conditions: healthy, presence of diabetes, epilepsy, heart disease, hypertension, disease of the digestive system, of the kidneys, lung disease, and any other disease), oral hygiene habits (binary indicators for regular use of toothdental floss, brush, mouthwash, toothpick; categories of yes - no cannot tell for use of fluoride toothpaste), frequency of routine and other

dental visits (binary indicator for regular checkups at least annually versus visit only if prompted by pain or other problems: categories of more than 2 years ago - 1-2 years ago - <1 year ago for the last dental appointment); and smoking (categories of current regular smoker - current occasional smoker non-smoker - former smoker who quit at least 6 months earlier). Variables recorded also included gender, age in years, geographic area (integers 1-7 to identify region of residence within Hungary), and presence and type of denture (categories of none - fixed - removable partial - fixed and removable partial complete removable).

Data were collected by a questionnaire. Most questions were of a multiple choice type.

Statistical analysis

A single overall CPI score calculated as the maximum score found over all sextants was assigned to each subject. Unadjusted associations between factors included in the survey and periodontal conditions were tabulated and assessed using χ^2 tests. CPI score as an outcome was dichotomized using an accepted threshold (Angeli et al. 2003) as low (<3) and high (3, 4) for multiple logistic regression modelling. The sample was analysed as usual for data obtained through simple random sampling. The starting set of explanatory variables included demographic variables, oral hygiene, oral and other health status, lifestyle, and education-related factors. Model building was based on elimination of weak explanatory variables from a full model unless they were considered important a priori. Plausible interactions were assessed. Model fit was checked using the Hosmer-Lemeshow test. The statistical package Stata version 10.1 was used for analysis.

Results

Prevalence data measured by CPI

The overall prevalence of periodontitis in the Hungarian adult population is shown in Table 1. Healthy periodontal conditions (CPI0) were found in only 12% of the examined population. Gingival bleeding (CPI1) was observed in 8% of the population. Gingival bleeding and calculus were present (CPI2) in 49% of the individuals examined. In 23% of the participants, shallow periodontal pockets (4–5 mm) were recorded (CPI3) in at least one sextant. A deep pocket (CPI4) existed in at least one sextant in 7% of the subjects.

Association between periodontal condition and demographic determinants

Gender, age, and geographic location

Thirty-four percent of males *versus* 28% of females had a high (>2) CPI score, and males were over-represented in all high (3, 4) and under-represented in all low (0–2) score categories (p < 0.001; Table 1).

The distribution of the Hungarian adult population by maximum CPI scores in relation to age is shown in Table 2. It clearly demonstrates that a CPI score of 2 was the most prevalent (gingival bleeding and calculus) in all age groups and this prevalence first increased, and later decreased with age; overall, a significant tendency towards deterioration of periodontal status with age was observable (p < 0.001).

The regional breakdown of the prevalence estimates of periodontitis showed similar distributions in the examined populations living in different geographic locations outside middle Hungary, with an indication of regional differences on the whole (p < 0.001) and a contrast between the central region and the rest of the country. CPI2 was the most prevalent

Table 1. Periodontal condition in relation to gender, FPD treatment, dental office attendance, education, and smoking

	Ν					Percentage of	f persons w	ho have as hig	ghest score			
		female	male	no FPD	FPD	in case of pain	regularly	elementary	mid-level	university	non-smoker	smoker
Healthy	512	13.2	10.8	15.6	9.4	10.4	16.1	7.9	13.7	16.8	13.8	9.9
Bleeding	341	8.7	7.4	6.3	9.9	7.7	9.2	7.9	8.4	8.2	9.4	6.3
Calculus	2034	49.8	47.7	52.6	45.7	49.6	47.7	50.0	50.3	43.7	47.7	51.1
Pd 4–5 mm	959	22.5	24.0	18.4	27.4	23.9	21.5	24.7	22.5	21.6	23.2	23.1
Pd 6+ mm	307	5.8	10.0	7.1	7.6	8.4	5.5	9.5	5.1	9.8	6.1	9.6

Distribution of the Hungarian adult population by maximum CPI scores in relation to gender (p < 0.001), FPD treatment (p < 0.001), dental office attendance (p < 0.001), levels of education (p < 0.001), and smoking (current smokers+former smokers who quit within 6 months+occasional smokers *versus* non-smokers) (p < 0.001).

CPI, Community Periodontal Index; FPD, fixed partial denture.

	Ν	Percentage of persons who have as highest score						
		healthy	bleeding	calculus	Pd 4–5 mm	Pd 6+ mm		
<20	151	36.4	18.5	35.1	9.9	0.0		
20-34	982	22.2	10.2	51.1	15.3	1.2		
35-44	743	10.6	5.3	56.7	21.9	5.5		
45-64	1753	6.9	6.9	47.2	27.7	11.3		
65–74	408	6.9	10.1	45.8	26.2	11.0		
> = 75	116	10.3	10.3	37.1	32.8	9.5		

Table 2. Periodontal conditions by age

Distribution of the Hungarian adult population by maximum CPI scores in relation to age (p < 0.001).

CPI, Community Periodontal Index.



Fig. 1. Periodontal conditions measured by Community Periodontal Index (CPI) in relation to region. Percentages of maximal CPI scores in the Hungarian adult population by region (p < 0.001).

score in all locations. Probands in middle Hungary (MH-Budapest and surrounding areas) had the highest prevalence of healthy periodontium (CPI0 = 16%), while only 5% and 8% of probands in middle Transdanubium (MT) and southern Transdanubium (ST) had a healthy periodontium (CPI0), respectively. The prevalence of deep periodontal pockets of these two regions (MT and ST) was higher than the prevalence of a healthy periodontium (MT: CPI4 = 7% versus CPI0 = 5%; ST: CPI4 = 9%versus CPI0 = 8%; Fig. 1).

Fixed partial denture (FPD) treatment and periodontal health

Of 4153 patients examined, 2175 (52%) individuals had FPD treatment and 1978 persons (48%) had no bridges or crowns. The prevalence of CPI maximal scores of FPD-wearers and non-wearers is shown in Table 1. In FPD-wearers, the prevalence of a high CPI score was 35% while only 25% of non-wearers had CPI>2 (p<0.001). The difference was

most accentuated in the category of shallow periodontal pockets.

Oral hygiene habits, dental office attendance, level of education, and smoking behaviour

Evaluation of the questionnaire assessing oral hygiene habits indicated that brushing with a toothbrush was the most commonly used method, with a moderate proportion (2.8%) of subjects admitting to not using a toothbrush at all. The frequency of self-reported brushing of teeth, and especially of dental floss use, was dependent on the level of education. Subjects with a medium level or higher education brushed their teeth significantly more often and had better oral hygiene than those with the lowest levels of education (p < 0.001). Of the individuals interviewed, 4.6% of those who had only completed elementary school did not brush their teeth at all. The percentage of non-brushers in the groups with a medium and a high level of education was 1.8%. Flossing on a daily basis was even much lower in all

Table 3. The use of toothbrush and dental floss by education

Education level	Ν	Percentag persons wi	ge of ho use	
		toothbrush	dental floss	
Elementary	1393	95.4	2.8	
Medium	1955	98.4	9.0	
University	779	97.8	13.2	

Use of toothbrush and dental floss in relation to education level (p < 0.001).

education groups than brushing teeth. The self-reported regular use of dental floss was only 3%, 9%, and 13% among those with an elementary, high school, and a college or university education, respectively (p < 0.001; Table 3).

Dental office attendance rates revealed that 66% of subjects visited a dentist only in the case of an emergency and only 1/3 of the population had annual dental visits. With respect to regular dental office attendance, 37% of females and 30% of males reported visiting a dentist once per year (p < 0.001). CPI score distribution stratified by dental office attendance showed that a significantly higher percentage of regular dental office attendants had a healthier periodontium (CPI0) than of those who saw a dentist only in the case of pain (16% versus 10%, respectively); a similar but less accentuated difference existed for CPI1 scores (9% versus 8%, respectively). With respect to the CPI2, CPI3, and CPI4 categories, the pattern was reversed, as a higher percentage of those who did not visit dentists regularly were in the categories of gingival bleeding, calculus, and shallow or deep periodontal pockets (overall *p* < 0.001; Table 1).

With increasing levels of education, a significantly higher (p < 0.001) percentage of subjects visited the dental office regularly: 18% of the elementary school group, 39% of the mid-level education group, and 49% of university graduates and the others went to the dentist only in case of an emergency.

When the prevalence of CPI scores was assessed by educational level, significant differences were found between groups (p < 0.001). Higher prevalences of a CPI score of 0 were found with increasing levels of education. CPI score 2 (gingival bleeding and calculus), which primarily reflects poor oral hygiene, had the lowest prevalence in the group with the highest level of education. The prevalence of a CPI score of 4 was approxi-

Table 4. Periodontal condition by age among smokers and non-smokers

	Ν	Percentage of persons who have as highest score						
		< 20	20-34	35–44	45-64	65-74	> = 75	
Smokers								
Healthy	156	29.2	17.7	5.8	4.7	7.1	6.9	
Bleeding	99	20.8	6.3	2.1	6.6	4.8	13.8	
Calculus	806	37.5	59.1	59.6	45.6	38.1	20.7	
Pd 4–5 mm	364	12.5	15.7	24.2	27.4	33.3	31.0	
Pd 6+ mm	152	0.0	1.3	8.3	15.7	16.7	27.6	
Non-smokers								
Healthy	352	43.0	26.0	14.3	7.9	6.9	11.6	
Bleeding	240	16.5	13.6	7.8	7.1	11.2	8.1	
Calculus	1220	32.9	44.3	54.1	48.1	48.0	43.0	
Pd 4–5 mm	593	7.6	14.9	20.4	28.0	24.3	33.7	
Pd 6+ mm	155	0.0	1.1	3.4	8.9	9.7	3.5	

Distribution of the Hungarian adult smoker and non-smoker population by maximum CPI scores in relation to age (p < 0.001).

CPI, Community Periodontal Index.

mately the same in the highest and the lowest education level groups (9% and 10%, respectively; Table 1).

The questionnaire on smoking habits revealed that 984 individuals (24%) were smokers, 2560 subjects (62%) had never smoked or had quit more than 6 months before, 9% reported they had quit smoking within the previous 6 months, and 5% claimed to be occasional smokers. We pooled recent quitters with regular and occasional smokers (1577 persons, 38%). The prevalence of a CPI score of 0 was higher in non-smokers compared with smokers (14% versus 9%, respectively); the prevalence of a CPI score of 1 was also higher in the non-smoker group (9% versus 6%; overall p < 0.001, Table 1). Forty-eight percent of non-smokers and 52% of smokers had calculus. The prevalence of deep periodontal pockets in smokers was 1.6 times as high as in nonsmokers (10% versus 6%, respectively). Especially in the age group of 75 years and older, there was a significant difference in the prevalence of deep periodontal pockets between smokers and non-smokers (28% versus 3%, respectively). In contrast, a healthy periodontium existed in a higher percentage in almost all age groups of non-smokers than smokers. (Table 4).

Adjusted assessment of factors associated with a high CPI score

Logistic regression results are shown in Table 5. Of the 4153 subjects, 3965 (95.5%) had data available in all variables taken into account in the models. Because gender appeared to be in significant interaction with a number of other factors (p < 0.0001), models were separately fitted in males and females. For the sake of between-gender com parability of estimates, variables with significant odds ratios (OR) in at least one gender were retained in both models. Variables describing oral hygiene practices were considered important on an a priori basis and were never removed.

In males, increasingly older age and living in other than the country's most affluent central region significantly predicted poor periodontal conditions. Smoking was estimated to represent a significant extra 41% odds relative to non-smokers (p = 0.004). No oral hygiene factors except toothpick use seemed to play a definitive role; an indication of a detrimental effect of picking teeth was apparent (OR = 1.45, p = 0.020). Taking as a reference the subject's last dental office visit occurring <1 year before the survey time, a visit less recent than that indicated better outcomes, while the opposite was true of visits even further in the past, although none of these differences was significant. Of the two diseases found to be associated with high CPI scores in at least one gender, hypertension significantly predicted poor periodontal outcomes in males (OR = 1.64, p = 0.001). An interaction between education and regular dental office attendance was found. Being educated above the primary level meant that odds decreased by around 40% for moderate to severe periodontitis only in those seeking dental services exclusively in the case of pain. On the other hand, regular attendance was found to indicate a significant protective effect in low-educated subjects only (OR = 0.45, p = 0.003).

The model with the same explanatory variable and interaction structure fitted in the female stratum revealed a considerably different set of relationships. The effect of older age, although still significant, was much less accentuated than in males, especially in the nonelderly age groups. The areas in the country were not characterized by generally poorer periodontal conditions of females relative to the most developed Central region. However, female subjects with FPD faced about 32% greater odds of high CPI scores than those without bridges (p = 0.011). The detrimental effect of smoking was suggested by the estimate but did not quite reach significance. Dental appointment between 1 and 2 years before the survey time versus one within the last year indicated better periodontal conditions (OR = 0.68, p = 0.003). Women with pulmonary disease or hypertension showed better periodontal conditions than those without these diseases. Quite the opposite of the findings in males, education predicted better periodontal health in regular, but not in emergency-only, dental office-attending females. The significant beneficial effect of regular visits to the dentist was restricted to women with a mid-level education (OR = 0.65, p = 0.004).

In a complementary model to evaluate the adjusted effect of gender and containing the explanatory variables as above, males were found to have 1.44 times greater odds for moderate to severe periodontitis than females (p < 0.001).

Auxiliary logistic regression-based exploration confirmed that educated subjects, non-smokers, people who regularly attend dentists and had their last appointment within 2 years in the past have significantly greater odds to be toothbrush users, and female gender, living in affluent areas, maintaining other recommended oral hygiene practices, visiting dentists regularly and recently, and being educated were significant predictors of dental floss use. The effect of education on regular dental office attendance was also corroborated when controlling for potential confounders in a multiple logistic regression model.

All models showed a sufficiently good fit in Hosmer–Lemeshow tests.

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Table 5. Multiple logistic regression estimates of the effect of various factors on the odd	lds of a high $(> = 3)$ CPI score
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Factor	Reference category	Index category	Men			Women		
			odds ratio	р	95% CI	odds ratio	р	95% CI
Age group	<20	20-34	1.87	0.104	0.88; 3.98	1.54	0.342	0.63; 3.76
		35-44	3.70	0.001	1.72; 7.95	2.68	0.030	1.10; 6.55
		46-64	6.68	0.000	3.18; 14.06	4.48	0.001	1.85; 10.84
		65-74	4.68	0.000	2.07; 10.60	5.24	0.000	2.08; 13.15
		> = 75	6.82	0.000	2.62; 17.75	6.13	0.001	2.18; 17.20
Geographic area	Middle-Hungary	Rest of Hungary	1.77	0.000	1.34; 2.34	1.12	0.286	0.91; 1.37
Fixed partial denture	No	Yes	1.07	0.589	0.83; 1.38	1.32	0.011	1.06; 1.63
Smoking	Non-smoker	Smoker or quit within 6 months	1.41	0.004	1.11; 1.79	1.19	0.082	0.98; 1.45
Toothbrush use	No	Yes	0.70	0.284	0.36: 1.35	0.67	0.198	0.37: 1.23
Dental floss use	No	Yes	0.71	0.262	0.39: 1.29	0.72	0.074	0.51: 1.03
Toothpick use	No	Yes	1.45	0.020	1.06; 1.99	1.12	0.438	0.84; 1.51
Mouthwash use	No	Yes	1.23	0.308	0.83; 1.81	1.64	0.000	1.29; 2.10
Fluoride toothpaste use	No or cannot tell	Yes	1.88	0.000	1.39; 2.53	1.27	0.064	0.99; 1.65
Last dental office visit	<1 year ago	1-2 years ago	0.77	0.124	0.54; 1.08	0.68	0.003	0.53; 0.88
	, ,	>2 years ago	1.22	0.199	0.90; 1.66	1.02	0.903	0.78; 1.32
Pulmonary disease	Absent	Present	1.13	0.737	0.56; 2.26	0.41	0.003	0.22; 0.74
Hypertension	Absent	Present	1.64	0.001	1.22; 2.21	0.75	0.009	0.60; 0.93
Education in pain-only	Elementary	Middle	0.55	0.000	0.41; 0.76	1.00	0.985	0.77; 1.28
attenders of dental services	•	University	0.70	0.089	0.47; 1.06	1.00	0.995	0.70; 1.44
Education in regular	Elementary	Middle	1.31	0.357	0.74; 2.30	0.59	0.012	0.39; 0.89
attenders of dental services		University	1.42	0.262	0.77; 2.64	0.63	0.049	0.39; 1.00
Dental office attendance	Pain-only	Regular	0.45	0.003	0.26; 0.76	1.10	0.647	0.73; 1.66
in the elementary educated	•	e						
Dental office attendance	Pain-only	Regular	1.06	0.794	0.70; 1.59	0.65	0.004	0.49; 0.87
in the mid-level educated	•	e						
Dental office attendance in the university educated	Pain-only	Regular	0.91	0.737	0.53; 1.57	0.69	0.090	0.45; 1.06

Test against gender-stratified model being no better fit than gender-adjusted model: p < 0.0001. Interaction between education and dental office attendance in men: p = 0.028; in women: p = 0.086.

CI, confidence interval; CPI, Community Periodontal Index.

Discussion

Using the highest CPI score is recommended by the WHO (1997); however, the CPI index has some limitations. It is important to differentiate between the objectives of aetiological studies and surveys. In the former, a more detailed examination is mandatory. On the other hand, in a survey context, a cost-benefit evaluation needs to be taken into account (Cascaes et al. 2008). In the present survey, the occurrences of various probing pocket depths, calculus, gingival inflammation, or healthy periodontal conditions were assessed using the highest CPI score.

A lower prevalence of severe periodontitis (CPI score 4, 7%) was found in Hungary than by Pilot & Miyazaki (1991) where CPI score 4 varied from 10% to 15%, but our findings were similar to those of Skudutyte-Rysstad et al. (2007) (CPI score 4, 8%). Gender differences in the Hungarian population exhibit the same distribution as in the US population (Oliver et al. 1998, Albander & Kingman 1999), where males generally exhibit poorer oral conditions and periodontal conditions compared with females.

The present findings have indicated that the prevalences of periodontal disease and severity tend to be higher in older age groups when compared with younger age groups, which in turn corroborates age-related epidemiologic data available from the WHO data bank and results from previous studies (Petersen 2003, WHO 2003). When analysing at the age groups from younger to older, the prevalence of CPI0 was gradually reduced. There was a shift in this trend in the 75+-year-old age group. The higher percentage of healthy periodontal conditions observed in this age group could be related to the higher levels of oral hygiene. Individuals surviving to this advanced age probably lived healthier than typical lives, including maintenance of higher levels of oral hygiene, thereby retaining teeth with a healthier periodontium.

The regional differences in the prevalence of periodontal disease are considerable; remarkably, Hungarian males seem to be much more susceptible to the effects of underlying socioeconomic dif-

ferences than females. Socio-environmental factors are highly responsible for distinct profiles of periodontal disease observed in populations living in certain geographic regions or locations (Page & Beck 1997). In most epidemiologic studies carried out globally, significant relationships between socioeconomic status and periodontal disease have been observed. According to Drury et al. (1999), there was a 10-20% difference in periodontal disease prevalence and severity between people of higher and lower socioeconomic status in the US population. In agreement with these findings, the economically most developed middle Hungary region (Budapest with its surroundings) showed the highest prevalence of a CPI score of 0 (16%) and a CPI score of 1 (9%), and the lowest percentage of the population affected by severe periodontal disease (CPI4, 6%). It should be pointed out that no similar tendency among the other six Hungarian regions was identified.

The quality of restorations has a substantial influence on periodontal health and disease (Gera 2004), which might explain the relationship found between FPD treatment and high CPI scores. Dentists should consider dental restorations to be local risk factors for periodontal attachment loss (Broadbent et al. 2006). While findings of studies among the Scandinavian and US populations demonstrated 2/3 of restorations with excellent or good quality (Grosso et al. 1979, 1985), a study in 1984 reported worse conditions in Hungary than many had believed (Keszthelyi & Szabó 1984). The preparation technique widely used in Hungary does not allow for an adequate marginal fit. Consistent with prosthodontic treatment imperfections, the present survey showed a 7% higher prevalence of CPI0 among persons without FPD treatment compared with FPD wearers. The prevalence of gingivitis was 4% higher when treated with an FPD. The prevalence of more severe periodontal diseases (CPI3 and CPI4) of the two groups investigated (FPD treatment versus no FPD treatment) showed lower differences.

Oral hygiene behaviour has a relevant influence on periodontal health. Most forms of gingivitis are related to host defence against dental plaque (Lindhe et al. 1983, Gera 2005). Dental plaque is an essential aetiologic factor for caries and gingivitis (Löe et al. 1965, Fehr et al. 1970). The higher the CPI score, the lower the probability of acceptable oral hygiene.

Toothbrushing is the most widespread mechanical means of personal plaque control in the world (Axelsson 1998) and is considered to be an important factor in the long-term maintenance of periodontal health (Axelsson 1993).

A comparison of the frequency of tooth brushing and flossing among schoolchildren revealed considerable differences between European countries (Kuusela et al. 1997). Behaviour and attitude shows a similar pattern in adult populations as well; lower sales of dental care products in new countries joining the European Union clearly reflect this unfortunate situation (Baehni & Bourgeois 1998).

It was interesting to note that 4.6% of the investigated population with the lower level education (elementary school) self-reported no use of toothbrush and toothpaste. Most astonishing is that 2.2% of the higher education level (university) probands said they did not brush their teeth, self-admitting their negligence. Dental floss was almost unknown for those with an elementary education level, while a slightly better rate of flossing was found among those with a medium or a university level of education (91% and 87%, respectively). The findings of the present survey are in agreement with recent studies reporting oral hygiene standards in Central and Eastern Europe to be inferior to the Western European levels (Miyazaki et al. 1991).

Brush use was estimated to decrease the odds of a high CPI score by about 30%, but it was not found to be a significant factor when adjusted for other variables. This is probably because of a collinearity between toothbrush use and other variables (education, smoking, regular dentist attendance, last appointment <2 years in the past) that are good predictors of high CPI. Another reason why the estimate of the protective effect of toothbrush use fails to achieve significance is the unbalanced way in which it is represented in the sample: more than 97% brush their teeth, which works against effect estimate precision. This is also true for dental floss use, especially in males.

Dental office attendance rates provide a clear view of the quality and efficiency of a nation's oral health promotion and oral health care systems. Frequent dental visits and high utilization of dental services is a protective factor of periodontal disease (Brown & Garcia 1994). Most insurance companies take this fact into serious consideration and reward regular dental checks. In a Swedish study, 75% of the subjects visited their dentist at least once a year (Söder et al. 1994), in contrast to Hungary, where 5% had never attended a dental office in their life and 49% of the subjects visited a dentist exclusively in case of dental emergencies (Dombi et al. 1996). The findings of the present study indicating that women have a higher level of oral health awareness are consistent with the results obtained in industrialized countries (Oliver et al. 1998, Albander & Kingman 1999, Tada & Hanada 2004, Kallestal et al. 2006). It has been shown that in Hungary a higher proportion of females visit their dentist more regularly than males, while the regular dental office attendants have better periodontal conditions; these findings are parallel to those of a Swedish survey (Söder et al. 1994). The level of education seems to significantly influence the frequency of dental office attendance, which is indicated by a regular dental office attendance rate of 47% in the university group. These two factors were in interaction in terms of predicting CPI scores in multiple regression. In males, regular dental office attendance seems to neutralize the detrimental effects generally

associated with low education, and education reveals the active role of associated protective factors when those are allowed to work in the absence of regular checkups. In females, however, education seems to represent only protective factors in those who also regularly visit dentists, while the advantages of the latter practice are countered in females with a lack of decent education. The complexity of this set of phenomena may have much to do with between-gender differences in behavioural reactions to life situations and circumstances.

Tobacco smoking has been implicated in a large number of diseases, and so smokers also have a high risk of periodontal disease and lesions of the oral mucosa. The age-matched smoker population shows a significantly higher average periodontal index score than non-smokers (Salvi et al. 1997, Gelskey 1999). The use of tobacco is a highly predictive risk factor for periodontal disease, especially severe periodontitis. Our findings are in agreement with the findings of Gelskey (1999) and Salvi et al. (1997), emphasizing that cigarette smoking is consistently associated with an increased prevalence/severity of periodontitis.

Conclusion

This national survey was helpful in assessing oral health in a sample semirepresentative of the entire population. It had the advantage of a dental team examining even those individuals who would not attend a dental office on their own volition. Our survey revealed that poor oral hygiene habits, negligence of dental office attendance, inferior quality of restorative care, and smoking habits could be responsible for poor periodontal conditions of Hungarian adults. A further advantage of our present investigation is that it provides a point of reference for longitudinal analysis of oral health. For effective prevention and treatment of periodontal diseases, it is important to have actual data on a population's periodontal conditions, treatment needs, and risk factors. Survey results and accurate health statistics serve as base findings for the government to make choices on how to improve the healthcare system. There is a strong need in Hungary for improvement of the population's selfawareness of oral hygiene and better oral health education: we need to focus more on periodontal aspects of dental care, and effective prevention programmes and better control of periodontal disease are required.

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Clinical Relevance

Scientific rationale for the study: For effective prevention and treatment of periodontal diseases, it is important to have actual data on a population's periodontal conditions and risk factors. The results of a national survey are helpful in monitoring oral health. Evaluation of risk factors can indicate effective actions of oral health programs where most needed. among 35-year-olds in Oslo, 1973–2003. Journal of Clinical Periodontology 34, 867–872.

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Principal findings: Poor oral hygiene habits, negligence of dental office attendance, and inferior quality of restorative care are associated with worse periodontal conditions of Hungarian adults.

Practical implication: The present investigation provides a point of reference for the longitudinal analysis of oral health. The survey results and accurate health statistics serve as

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the basis upon which the government makes choices on how to improve the health-care system. Screening a section of the population also has the advantage of dentists approaching the patients and examining those individuals who would not attend a dental office on their own volition. This document is a scanned copy of a printed document. No warranty is given about the accuracy of the copy. Users should refer to the original published version of the material.