

ORIGINAL PAPERS

Dent. Med. Probl. 2016, 53, 1, 66–77
DOI: 10.17219/dmp//60885

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ISSN 1644-387X

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Socioeconomic Status, Health Behaviours and Oral Health in Adult Urban Population of Krakow

Status społeczno-ekonomiczny, zachowania zdrowotne oraz zdrowie jamy ustnej u dorosłej populacji Krakowa

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Abstract

Background. Human longevity has increased throughout all developed countries in the world, including Poland. In an aging population it is important to ensure adequate oral health for future generations as prevention and treatment methods adopted so far may soon appear insufficient.

Objectives. The aim of this study was to assess whether social and behavioral factors, i.e. education, smoking, occupational activity, alcohol consumption, sports activity and perceived health influence tooth loss, functional dentition, oral hygiene, and periodontal health.

Material and Methods. The study involved 1008 Krakow residents (478 men and 530 women), between the age from 50–75 years. Information on age, education, occupational activity, alcohol consumption, perceived health, smoking status, sports activities was collected by the interview using standard questionnaire. Oral examinations were carried out according to the WHO recommendations. Two definitions of poor functional dentition (FD) were used, i.e. having less than 20 teeth and having less than 4 pairs of contacting teeth. Pocket depths (PD) were measured using Hu-Friedy periodontal probe type PCPUNC15. Oral hygiene was assessed using Plaque Index (PI) by Silness & Loe.

Results. There were 16% edentulous men and women. After adjustment for covariates, persons with low education had more than seven times higher prevalence of having poor FD in women and twice higher prevalence in men compared to persons with university education (OR = 7.05 95% CI: 2.50–19.82 and OR = 2.18 95% CI: 1.18–4.02 respectively). Smoking was strongly related to the prevalence of edentulism and to the prevalence of having no FD both in men and women. After adjustment for covariates, former male smokers and current female smokers had about twice higher prevalence of periodontal disease.

Conclusions. Low education and tobacco smoking appeared to be the factors strongly and independently associated with poor oral hygiene and health. Relations between oral health and other socioeconomic and behavioral factors were weaker and they were attenuated after adjustment to age, education and smoking (**Dent. Med. Probl.** 2016, 53, 1, 66–77).

Key words: oral health, socioeconomic status, periodontal disease, functional dentition, edentulous.

Słowa kluczowe: zdrowie jamy ustnej, status społeczno-ekonomiczny, choroba przyzębia, uzębienie o zachowanej czynności, bezzębie.

Human longevity has increased throughout all developed countries in the world, including Poland. Within the last two decades the average life expectancy in Poland has increased from 66.6 to 72.1 years for men and from 75.3 to 80.7 years for women [1]. In the aging population it is important to ensure adequate health care for future generations as prevention and treatment methods adopted so far may soon appear insufficient [2].

Loss of teeth progresses during the course of life [3, 4] due to the destruction of teeth by caries, disease and the loss of tooth supporting tissues due to periodontal disease. Gradual tooth loss causes successive reduction in chewing ability. This may result in eating less or choosing food of poorer quality, which in turn may lead to malnutrition and avitaminosis. Furthermore, choosing highly processed products can increase the risk of cardiovascular disease [5]. Indeed, having fewer than 20 teeth was found to be associated with poorer chewing ability and lower consumption of more valuable and healthy foods [6, 7]. It was found that not only the number of teeth is important but also their distribution in the oral cavity [8]. The UK National Diet and Nutrition Survey demonstrated an association between the number of posterior contacts and freedom of food choice, which affected individual's nutrients intake. Persons with fewer than 5 pairs of posterior contacting teeth were found to have limitations in food choice [9].

Periodontitis affects general health. The first epidemiological studies indicating an association between periodontal disease and cardiovascular disease, i.e. atherosclerosis and heart attack, were conducted in 1989 in Finland by Matilla et al. [10]. Results of these studies were confirmed by later reports [11]. There is also some evidence relating periodontal disease and the pathogenesis of hypertension [12].

Besides contributing to oral health and general medical problems, tooth loss reduces the quality of life, negatively affects interpersonal relationships in people sensitive to criticism, and even causes progressive social exclusion and depression [13]. Also, it was found that people with poor functional dentition (FD), i.e. having 20 or fewer teeth were less physically active and traveled less [14].

Periodontal disease and caries develop due to the lack of oral hygiene and it is postulated that they may be a consequence of poor education and related to low socioeconomic status [7, 15]. However, associations between tooth loss and such factors as social status, income, frequency of dental visits, education, and marital status were not confirmed in all studies [16].

According to the WHO report from 2003 there were 25% edentulous Poles in the age group of 65–74 years [17]. The other Polish studies car-

ried out at the same time or later indicated more than 40% of edentulous people in the corresponding age group [18]. A later international report did not include data from Poland [19]. In general, data on oral health in the general Polish population is scarce. The positive exception would be the Nationwide monitoring of oral health status and its conditioning in Polish population between the age 35–44 and 65–74 years in which authors examined oral health in the general Polish population [20]. There has been no recent Polish epidemiological study that has addressed the problem of social and behavioral determinants of oral health in Poland.

The aim of this study was to assess whether social and behavioral factors, i.e. education, smoking, occupational activity, alcohol consumption, sports activity and perceived health are related to tooth loss, functional dentition, oral hygiene, and periodontal health.

Material and Methods

The study enrolled 1,008 persons (478 men and 530 women) between the age 50–75 years, a random subsample of the 10,728 participants of the Polish part of the HAPIEE Project (Health Alcohol and Psychosocial factors in Eastern Europe). Patients invited to a dental examination were randomized from the HAPIEE study population in the layers of age, gender and place of residence. Detailed information on the HAPIEE project, which involved a representative sample of residents of Krakow town, was published earlier [21]. Out of 1,008 persons invited to attend in an oral examination, 909 individuals (90.2%) agreed to participate.

The study was carried out at the University Dental Clinic in Krakow according to WHO recommendations [22]. Participants were examined by four dentists who underwent a special training in the study methods. Standard extra and intra oral examination was performed. Intra oral examination started from the first to the fourth quadrant; data about number of teeth with caries, extracted teeth, filled teeth and use of partial and full dentures was collected.

To assess oral hygiene, Plaque Index (PI) according to Silness & Løe [23] was used. Values from 0 – no plaque to 3 – a thick layer of plaque biofilm filling the interdental area were recorded for each tooth excluding third molars. For each participant the mean value for all teeth was used in the analysis. Participants who had mean PI > 2.5 were classified as having poor oral hygiene.

Pocket depth (PD) was measured for each tooth excluding third molars. Probing was performed on six surfaces of each tooth using periodontal Hu-

-Friedy probe type UNS-PCP 15. Participants who had measurements of PD \geq 6 mm in one or more sites were classified as having periodontal disease.

Two definitions of poor functional dentition (FD) were used to assess masticatory. The first definition assumed that good chewing function was maintained if a person had at least 20 natural teeth. The second definition assumed that persons with at least 4 pairs of contacting teeth (molars and premolars) had sufficient masticatory function. In our study we assume the number of functional tooth units and as a consequence only natural tooth contacts were taken into account [8].

Information on age, education, occupational activity, alcohol consumption, perceived health, smoking status, sports activities were collected by interview using standard questionnaire [20]. For the purpose of present analysis education category: no formal education, primary, vocational were combined (less than secondary). Smoking status category: occasional smokers, current smokers were combined (current smokers). Perceived health category: very good, good, average were combined into good category, poor and very poor were combined into poor category. Participants reported that had not consumed any alcohol beverage during one year prior to the examination and were defined as non-drinkers. Sports active category was assigned for those spending at least 3.5 hours on sports activities during a typical week.

Statistical analysis was performed separately for men and women. Analysis of the relation between the number of teeth and behavioral and lifestyle factors was limited to those who had at least one tooth. Mann-Whitney U test and ANOVA Kruskal-Wallis test were used to test the differences in distribution of the number of teeth by lifestyle and behavioural factors. The relation between lifestyle factors and the number of remaining teeth was assessed using multivariate linear regression. The odds of being edentulous, having poor FD, having PD \geq 6 mm, having PI \geq 2.5 (3rd quartile value) was assessed using multivariate logistic regression. Statistical significance was accepted at the level of $p < 0.05$. All calculations were performed in SPSS Software, IBM, Armonk, NY.

Results

The final study sample included 430 men and 479 women who participated in oral examination. Mean age was 63.4 years (SD = 6.3) in men and 62.8 years (SD = 6.4) in women. There were 69 (16%) edentulous men and 76 (16%) edentulous women. Older age, current and former smoking,

occupational inactivity and poor perceived health were associated with a higher proportion of edentulous persons both in men and in women. Lower education was related to edentulous status in women only (Table 1). After adjustment for covariates, low education (less than secondary) was associated with four times higher prevalence of being edentulous in women only. Compared to people who never smoked, the prevalence of edentulous status was almost seven times higher in men and five times higher in women who were current smokers. Compared to people who never smoked, the prevalence of edentulous status was almost three times higher in former male smokers and twice higher in former female smokers (Table 2).

In participants who had one tooth at least median number of teeth was 14 (IR = 15) in men and 14 (IR = 15) in women. Median number of teeth differed by socioeconomic and lifestyle factors. The exceptions were that there was no significant difference by sport activity in both sexes, by the categories of alcohol consumption in men and by the categories of smoking in women (Table 3). However, after adjustment for covariates in linear regression model, only education and smoking remained as associated significantly with the number of teeth in both sexes. Compared to women with a university education, women with secondary education had 3 teeth less and women with less than secondary education had 7 teeth less ($p < 0.001$). Men with secondary education and with less than secondary education had 2 and 3 less teeth respectively ($p < 0.001$) compared to men with a university education. Compared to current smokers, men who never smoked had 5 teeth more ($p < 0.001$) and women who never smoked had 2 teeth more ($p = 0.01$). After adjustment for covariates, no significant difference was found between former smokers and current smokers and other studied socioeconomic and lifestyle factors.

In both sexes, older age, low education, smoking, occupational inactivity and poor perceived health were associated with the larger proportion of participants having less than 20 teeth or the larger proportion of participants having less than 4 contacting pairs. No difference in proportion of functional dentition was found between categories of sport activity and alcohol consumption. After adjustment for covariates, the prevalence of poor FD was higher in persons with education lower than university. Particularly in women with less than secondary education, the chance of having no FD was more than seven times higher than in women with university education. Smoking status was also a strong correlate of FD. Particularly in men, current smokers had more than three times higher prevalence of having less than 20 teeth and

Table 1. Proportion of edentulous subjects by sex, socioeconomic and lifestyle factors

		Men		Women	
		n	%	n	%
Age	50–59	5	4,00%	10	6,10%
	60–69	37	16,40%	37	16,10%
	70–75	27	33,30%	29	34,50%
	p	< 0,001		< 0,001	
Education	less than secondary	25	20,30%	30	24,20%
	secondary	23	17,00%	35	16,20%
	higher	21	12,30%	11	8,00%
	p	NS		0,002	
Smoking	current smoker	32	25,20%	28	26,70%
	former smoker	26	17,70%	16	16,30%
	never smoker	10	6,50%	32	11,60%
	p	< 0,001		0,002	
Alcohol	non drinker	18	14,20%	30	13,40%
	drinker	38	17,00%	26	15,70%
	p	NS		NS	
Occupational activity	active	22	10,00%	21	11,50%
	inactive	47	22,40%	55	18,60%
	p	< 0,001		0,004	
Sport activity	active	38	17,50%	35	13,90%
	inactive	28	14,10%	34	17,30%
	p	NS		NS	
Perceived health	good	18	10,30%	13	9,00%
	poor	51	20,20%	62	18,70%
	p	< 0,01		< 0,01	

seven times higher prevalence of having less than 4 pairs of contacting teeth. Former smoking men had more than twice as high prevalence of having less than 20 teeth and of having less than 4 pairs of contacting teeth. After adjustment for covariates, FD was not associated significantly with alcohol consumption, occupational activity, sport activity and perceived health (Table 4).

There was no difference in the proportion of participants with periodontal disease ($PD \geq 6$) by socioeconomic and lifestyle factors. In men the highest proportion of poor oral hygiene was found in those with secondary education, current smokers, occupationally inactive and with good perceived health. A higher proportion of poor oral hygiene was found in older women.

In men, after adjustment for covariates, education lower than university and current smoking were related to more than twice higher prevalence of poor oral hygiene ($PI \geq 2.5$). The prevalence of poor oral hygiene was not associated significantly with socioeconomic and lifestyle factors in women. After adjustment for covariates, former male

smokers and current female smokers had twice higher prevalence of $PD \geq 6$ than people who never smoked (Table 5).

Discussion

Our results showed that low education and tobacco smoking are associated with poor oral health. After adjustment for age, education and other covariates, oral health was not associated significantly with alcohol consumption, occupational activity, sports activity and perceived health in a sample in which there were 16% edentulous persons.

In contrast to previous estimates of the proportion of edentulous persons, for the corresponding age group in Poland, our results did not confirm that this proportion is much higher than the European average [17]. According to the WHO report of 2003, the highest proportion of edentulous persons in Europe was found in Albania (69% at age over 65) and the lowest in Lithuania (14% in the age group 65–74). Data from the Oral Health Report by

Table 2. Relation between socioeconomic and life style factors and prevalence of edentulism for men and women

		Men		Women	
		OR ^a (95%CI)	OR (95%CI)	OR ^a (95%CI)	OR (95%CI)
Education	university	1	1	1	1
	secondary	1,45 (0,75–2,81)	1,31 (0,65–2,63) ^b	2,02 (0,97–4,21)	1,91 (0,89–4,09) ^b
	less than secondary	2,21 (1,14–4,28)	1,90 (0,94–3,85) ^b	3,59 (1,67–7,69)	4,05 (1,83–8,95)^b
Smoking	never smoker	1	1	1	1
	former smoker	2,95 (1,33–6,51)	2,92 (1,31–6,48)^c	1,81 (0,91–3,58)	2,05 (1,02–4,14)^c
	current smoker	7,55 (3,36–16,96)	7,27 (3,20–16,52)^c	4,52 (2,40–8,52)	5,03 (2,61–9,70)^c
Alcohol consumption	non drinker	1	1	1	1
	drinker	1,59 (0,84–3,02)	1,36 (0,69–2,70) ^d	1,50 (0,83–2,72)	1,84 (0,95–3,58) ^d
Occupational activity	active	1	1	1	1
	inactive	1,63 (0,90–2,95)	1,24 (0,65–2,36) ^d	0,76 (0,40–1,44)	0,47 (0,23–0,95) ^d
Sport activity	active	1	1	1	1
	inactive	0,95 (0,54–1,65)	0,84 (0,47–1,51) ^d	1,40 (0,83–2,39)	1,56 (0,89–2,74) ^d
Perceived health	good	1	1	1	1
	poor	1,86 (1,03–3,36)	1,28 (0,67–2,45) ^d	1,70 (0,92–3,40)	1,43 (0,72–2,84) ^d

^a adjusted for age; ^b adjusted for age and smoking; ^c adjusted for age and education; ^d adjusted for age, education and smoking.

Table 3. Median number of teeth for men and women by socioeconomic and lifestyle factors in dentate individuals

		Men				Woman			
		n	Me	IQR	p	n	Me	IQR	P
Age	50–59	119	20	11	< 0,0001**	155	20	11	< 0,0001**
	60–69	188	15	11		193	14	10	
	70–75	54	11	10		55	11	12	
Education	less than secondary	98	15	12	0,0003**	94	9	11	< 0,0001**
	secondary	112	15	12		181	15	11	
	higher	150	18	10		127	19	10	
Smoking	current smoker	95	14	10	< 0,0001**	77	14	11	NS**
	former smoker	121	15	11		82	15	12	
	never smoker	144	19	10		243	16	13	
Alcohol	drinker	183	16	11	NS*	140	17	10	0,01*
	non drinker	109	16	11		194	14	13	
Occupational activity	active	198	18	10	< 0,0001*	162	18	11	< 0,0001*
	inactive	163	13	12		241	13	12	
Sport activity	active	179	16	12	NS*	216	15	13	NS*
	inactive	170	16	9		162	15	13	
Perceived health	good	157	18	9	< 0,0001*	132	18	11	< 0,0001*
	poor	201	15	11		270	14	12	

* Mann-Whitney U test; ** ANOVA Kruskal-Wallis test; IQR – interquartile range.

the European Commission from 2010 showed that 18% of Europeans over 55 years of age were edentulous. Results of the Polish study of 2010 reported 44% of edentulous people in a population between the age 65–74 years [18]. The proportion is substantially lower in residents of Krakow, suggesting that their oral health over the life course is better. How-

ever, residents of Krakow cannot be regarded as representative for Poland. Compared to many other parts of Poland, Krakow residents are characterized by better health in general in example they have lower mortality rates and one of the longest life expectancy [1]. Still, the proportion of edentulous persons in Krakow is far higher than in the top

Table 4. Relation between functional dentition (FD) and socioeconomic and life style factors by sex

	Men						Women					
	< 4 pairs			< 20 teeth			< 4 pairs			< 20 teeth		
	OR ^a (95%CI)	OR (95%CI)	OR ^a (95%CI)	OR (95%CI)	OR (95%CI)	OR ^a (95%CI)	OR (95%CI)	OR ^a (95%CI)	OR (95%CI)	OR ^a (95%CI)	OR (95%CI)	
Education	university	1	1	1	1	1	1	1	1	1	1	
	secondary	2,35 (1,35-4,09)	1,87 (1,04-3,35) ^b	3,41 (1,60-7,28)	2,89 (1,33-6,25) ^b	2,45 (1,48-4,04)	2,37 (1,41-3,96) ^b	2,41 (1,32-4,40)	2,38 (1,30-4,38) ^b			
	less than secondary	2,80 (1,57-4,97)	2,18 (1,18-4,02) ^b	1,80 (0,92-3,52)	1,56 (0,78-3,14) ^b	8,49 (4,11-17,52)	8,50 (4,08-17,71) ^b	6,36 (2,41-16,76)	7,05 (2,50-19,82) ^b			
Smoking	never smoker	1	1	1	1	1	1	1	1	1	1	
	former smoker	2,781 (1,61-4,92)	2,76 (1,57-4,86) ^c	4,16 (1,90-9,10)	2,23 (1,15-4,51) ^c	2,24 (1,22-4,09)	2,41 (1,29-4,50) ^c	2,01 (0,95-4,25)	1,93 (0,90-4,14) ^c			
	current smoker	8,38 (4,31-16,32)	7,09 (3,61-13,93) ^c	2,35 (1,20-4,61)	3,47 (1,56-7,73) ^c	2,81 (1,55-5,09)	2,79 (1,50-5,22) ^c	1,87 (0,91-3,84)	1,62 (0,76-3,50) ^c			
Alcohol consumption	non drinker	1	1	1	1	1	1	1	1	1	1	
	drinker	1,62 (0,95-2,77)	1,17 (0,65-2,10) ^d	1,92 (1,00-3,70)	1,48 (0,74-2,96) ^d	1,1 (0,68-1,8)	1,36 (0,77-2,40) ^d	1,92 (1,00-3,70)	1,47 (0,74-2,91) ^d			
Occupational activity	active	1	1	1	1	1	1	1	1	1	1	
	inactive	1,70 (1,04-2,75)	1,03 (0,59-1,80) ^d	2,06 (1,05-4,02)	1,62 (0,78-3,39) ^d	1,46 (0,90-2,38)	0,96 (0,55-1,65) ^d	1,37 (0,75-2,52)	0,91 (0,46-1,81) ^d			
Sport activity	active	1	1	1	1	1	1	1	1	1	1	
	inactive	1,19 (0,75-1,90)	1,05 (0,63-1,73) ^d	0,76 (0,43-1,35)	0,59 (0,32-1,10) ^d	1,07 (0,68-1,69)	1,09 (0,67-1,78) ^d	1,10 (0,62-1,94)	1,16 (0,63-2,11) ^d			
Perceived health	good	1	1	1	1	1	1	1	1	1	1	
	poor	1,89 (1,19-2,99)	1,37 (0,83-2,27) ^d	1,26 (0,72-2,21)	1,06 (0,58-1,95) ^d	1,86 (1,18-2,93)	1,34 (0,81-2,21) ^d	2,18 (1,25-3,80)	1,75 (0,97-3,17) ^d			

^a adjusted for age; ^b adjusted for age and smoking; ^c adjusted for age and education; ^d adjusted for age, education and smoking.

Table 5. Relation between socioeconomic and life style factors and the prevalence of pocket depth (PD) ≥ 6 , and plaque index (PI) $\geq 2,5$ by sex

	Men						Women					
	PD ≥ 6			PI $\geq 2,5$			PD ≥ 6			PI $\geq 2,5$		
	OR ^a (95%CI)	OR (95%CI)	OR ^a (95%CI)	OR (95%CI)	OR ^a (95%CI)	OR (95%CI)	OR ^a (95%CI)	OR (95%CI)	OR ^a (95%CI)	OR (95%CI)	OR ^a (95%CI)	OR (95%CI)
Education	university	1	1	1	1	1	1	1	1	1	1	1
	secondary	1,46 (0,8–2,45)	1,49 (0,81–2,74) ^b	2,27 (1,53–4,99)	2,51 (1,38–4,56) ^b	1,28 (0,66–2,47)	1,14 (0,59–2,23) ^b	1,31 (0,72–2,36)	1,35 (0,74–2,47) ^b			
	less than secondary	0,8 (0,41–2,45)	0,83 (0,41–1,65) ^c	2,38 (1,29–4,40)	2,18 (1,17–4,05) ^b	1,18 (0,51–2,69)	0,98 (0,41–2,31) ^b	1,61 (0,79–3,31)	1,53 (0,74–3,17) ^b			
Smoking	never smoker	1	1	1	1	1	1	1	1	1	1	1
	former smoker	1,96 (1,06–3,61)	1,94 (1,05–3,58) ^c	1,55 (0,86–2,78)	1,52 (0,84–2,75) ^c	0,85 (0,38–1,89)	0,86 (0,38–1,92) ^c	1,46 (0,78–2,72)	1,48 (0,79–2,76) ^c			
	current smoker	1,35 (0,68–2,69)	1,31 (0,65–2,63) ^c	2,47 (1,34–4,54)	2,12 (1,14–3,94) ^c	2,15 (1,07–4,32)	2,17 (1,07–4,38) ^c	1,04 (0,51–2,13)	1,01 (0,5–2,08) ^c			
Alcohol consumption	non drinker	1	1	1	1	1	1	1	1	1	1	1
	drinker	1,32 (0,69–2,49)	1,32 (0,68–2,54) ^d	0,81 (0,46–1,41)	0,70 (0,39–1,26) ^d	1,55 (0,81–2,98)	1,73 (0,86–3,49) ^d	0,86 (0,48–1,56)	0,74 (0,39–1,40) ^d			
	active	1	1	1	1	1	1	1	1	1	1	1
Occupational activity	inactive	0,72 (0,4–1,30)	0,70 (0,37–1,33) ^d	2,00 (1,17–3,42)	1,50 (0,84–2,66) ^d	0,75 (0,38–1,46)	0,63 (0,31–1,28) ^d	1,32 (0,72–2,43)	1,12 (0,59–2,11) ^d			
	active	1	1	1	1	1	1	1	1	1	1	1
	inactive	0,98 (0,58–1,7)	0,90 (0,52–1,55) ^d	1,07 (0,66–1,74)	0,95 (0,57–1,59) ^d	1,45 (0,8–2,63)	1,52 (0,82–2,79) ^d	0,93 (0,54–1,59)	0,89 (0,51–1,56) ^d			
Sport activity	good	1	1	1	1	1	1	1	1	1	1	1
	poor	1,33 (0,78–2,28)	1,37 (0,78–2,39) ^d	1,81 (1,09–3,00)	1,60 (0,94–2,72) ^d	0,99 (0,64–1,55)	0,97 (0,51–1,85) ^d	0,89 (0,51–1,54)	0,79 (0,45–1,41) ^d			

^a adjusted for age; ^b adjusted for age and smoking; ^c adjusted for age and education; ^d adjusted for age, education and smoking.

countries in Europe like Sweden (only 1,1%), Lithuania (10,7%) or Switzerland (11,4%) [19].

According to Nationwide monitoring of oral health status and its conditioning in Polish population between the age 35–44 and 65–74 years Krakow’s population represents similar average number of teeth in men and in woman in corresponding age group compared to four large Polish cities altogether [20].

The association between the level of education and the number of remaining teeth and functional dentition is consistent with results of the large studies from Thailand and Norway [24, 25]. Smoking was a very strong correlate of the number of teeth and having poor functional dentition in our study. Men who were current smokers were 7 times more likely to have fewer than 20 teeth and about 3.5 times more likely to have fewer than 4 pairs contacting teeth compared to men who never smoked. However, the association between smoking and periodontal disease was weaker and significant only in women who were current smokers and in men former smokers. Our findings on the association between smoking and the number of teeth are in accordance with findings in earlier study [26] but are not fully consistent with some other studies in which smoking was strongly associated with periodontal disease [27]. Weaker relation between smoking and periodontal disease in our study could be explained partially by more extensive tooth loss due to caries at younger age in Poland.

The differences in number of teeth and proportions of participants with poor oral health by occupational activity are consistent with other findings [28]. Further, the association of occupational activity with number of teeth is in accordance with suggestions that good dental health is important for appearance and free contacts with other people and that poor dental health is associated with social isolation [29]. It is also in accordance with the report on better FD in people with higher income [25] and with the results of NHANES III in which in white population, the poorest people had fewer teeth [30]. It is likely that those who have higher income are also better educated and have better access to health care. However, in our study the relation between occupational activity and oral hygiene, functional dentition and periodontal health was attenuated after adjustment to education and smoking suggesting that the relation was not strong and stable.

In an earlier study periodontal disease was related to education, occupational activity and perceived health [31]. In our study these relations, as well as the relation with sports activity, were not significant after adjustment for covariates. There is evidence on the association between oral hy-

Table 6. Difference in the number of teeth by sex and socioeconomic and life style factors

Education	Secondary	Men			Women				
		b ^a (95%CI)	p	b (95%CI)	b ^a (95%CI)	p	b (95%CI)	p	
(reference group: university education)	less than secondary	-3 (-4,5; -1,4)	< 0,001	-2 (-3,9; -0,9) ^b	0,02	-3 (-4,5; -1,6)	< 0,001	-3 (-4,4; -1,5) ^b	< 0,001
Smoking	never smoker	-3 (-4,9; -1,7)	< 0,001	-3 (-4,2; -1,1) ^b	0,001	-7 (-8,8; -5,4)	< 0,001	-7 (-8,7; -5,3) ^b	< 0,001
(reference group: current smokers)	former smoker	5 (3,5; 6,8)	< 0,001	5 (2,9; 6,2) ^c	< 0,001	2 (0,7; 4,2)	< 0,01	2 (0,5; 3,8) ^c	0,01
Alcohol consumption (reference group: non drinkers)	drinker	2 (0,5; 3,9)	0,01	2 (-0,04; 3,3) ^c	NS	1 (-0,8; 3,5)	NS	1 (-1,1; 2,9) ^c	NS
Occupational activity (reference group: inactive)	active	-1 (-2,8; 0,3)	NS	-1 (-2,04; 0,9) ^d	NS	1 (-0,5; 2,5)	NS	0 (-1,5; 1,5) ^d	NS
Sport activity (reference group: inactive)	active	2 (0,9; 3,9)	0,002	1 (-0,4; 2,6) ^d	NS	2 (0,4; 3,5)	0,02	0 (-1,2; 1,8) ^d	NS
Perceived health (reference group: poor)	good	-1 (-2,1; 0,7)	NS	-1 (-2,4; 0,2) ^d	NS	0 (-1; 1,8)	NS	0 (-0,9; 1,7) ^d	NS
		2 (0,9; 3,9)	0,02	1 (-0,7; 2,0) ^d	NS	2 (0,6; 3,4)	< 0,01	1 (-0,5; 2,2) ^d	NS

^a adjusted for age; ^b adjusted for age and smoking; ^c adjusted for age and education; ^d adjusted for age, education, smoking.

Table 7. Proportion of subjects having less than 4 pairs of contacting teeth and subjects having less than 20 teeth by sex and socioeconomic and lifestyle factors

		Men				Woman			
		< 4 pairs		< 20 teeth		< 4 pairs		< 20 teeth	
		n	%	n	%	n	%	n	%
Age	50–59	83	66,90	58	46,80	107	64,80	80	48,50
	60–69	199	88,40	175	77,80	212	92,20	194	84,30
	70–75	78	96,30	73	90,10	82	97,60	75	89,30
	p	< 0,001		< 0,001		< 0,001		< 0,001	
Education	less than secondary	105	85,40	95	77,20	118	95,20	112	90,30
	secondary	124	91,90	105	77,80	186	86,10	161	74,50
	higher	130	76,00	105	61,40	96	69,60	75	54,30
	p	< 0,001		< 0,001		< 0,001		< 0,001	
Smoking	current smoker	116	91,30	108	85,00	90	85,70	82	78,10
	former smoker	129	87,80	111	75,50	86	87,80	77	78,60
	never smoker	113	73,40	85	55,20	225	81,80	189	68,70
	p	< 0,001		< 0,001		0,003		NS	
Alcohol	non drinker	102	80,30	88	69,30	189	84,40	167	74,60
	drinker	191	85,30	163	72,80	136	81,90	118	71,10
	p	NS		NS		NS		NS	
Occupational activity	active	165	75,00	134	60,90	133	72,70	107	58,50
	inactive	195	92,90	172	81,90	268	90,50	242	81,80
	p	< 0,001		< 0,001		< 0,001		< 0,001	
Sport activity	active	189	87,10	156	71,90	210	83,70	183	72,90
	inactive	161	81,30	142	71,70	164	83,70	142	72,40
	p	NS		NS		NS		NS	
Perceived health	good	137	78,30	106	60,60	104	71,70	87	60,00
	poor	220	87,30	197	78,20	295	88,90	260	78,30
	p	< 0,001		< 0,001		< 0,001		< 0,001	

giene, health behaviors and socioeconomic characteristics [32]. According to Nationwide monitoring of oral health status and its conditioning in Polish population between the age of 35–44 and 65–74 years, Krakow's population represents better periodontal condition in women in the corresponding age group. The proportion of men with deep pockets is similar comparing with those from biggest Polish cities, which were Białystok, Szczecin, Warszawa and Wrocław [20]. In our study poor oral hygiene was associated with education and smoking in men only. These findings are consistent with earlier reports where associations between socioeconomic characteristics and oral hygiene were stronger in men but such associations were also found in women.

Weak and unstable relations between oral health and socioeconomic characteristics other than education are not consistent with some of the previous studies, which were mostly done in the US and Western Europe. However, they are in

accordance with the WHO report on poverty and non-communicable diseases in Central and Eastern Europe, in which among several characteristics, education was recognized as the best indicator of socioeconomic status at an individual level. In the studies carried out in Central and East Europe, education was showing strong and consistent associations with different indicators of health status, despite of the fact that before political and economic transition in 1980/1990s, high education was not necessary related to high economic position in the society [33].

To our knowledge, ours is the first study addressing the social and behavioral determinants of oral health in Poland in a larger sample. However, there are several limitations in the interpretation of our results. The main limitation is that cross-sectional design does not allow us to address the problem of causality. Also, our results cannot be regarded as representative for general population of Poland. As mentioned earlier it is possible

Table 8. Proportion of subjects having plaque index (PI) $\geq 2,5$, pocket depth (PD) ≥ 6 by socioeconomic and lifestyle factors among subjects with at least 6 teeth

		men				women			
		PI $\geq 2,5$		PD ≥ 6		PI $\geq 2,5$		PD ≥ 6	
		n	%	n	%	n	%	n	%
Age	50–59	34	29,6	27	23,5	20	13,8	19	13,2
	60–69	48	29,4	38	23,3	46	28,2	31	19
	70–75	14	34,1	10	24,4	11	28,2	6	15,4
	p	NS		NS		0,006		NS	
Education	Less than secondary	31	36,5	16	18,9	18	26,9	11	16,4
	Secondary	38	40	28	29,5	37	22,3	28	17,6
	Higher	27	19,4	31	22,3	22	18,3	17	14,3
	p	0,0001		NS		NS		NS	
Smoking	Current smoker	34	41,5	19	23,2	13	19,9	17	25
	Former smoker	32	31,1	31	30,1	20	27,1	9	12,2
	Never smoker	30	22,6	24	18,1	43	21,1	29	14,3
	p	0,01		NS		NS		NS	
Alcohol consumption	Drinker	46	28,2	39	23,9	24	19,4	23	18,6
	Non drinker	31	33	18	19,2	38	23,5	22	13,6
	p	NS		NS		NS		NS	
Occupational activity	Active	47	25,1	48	25,7	26	17,5	26	17,6
	Inactive	49	37,1	27	20,5	51	25,8	30	15,2
	p	0,02		NS		NS		NS	
Sport activity	Active	45	29,8	36	23,9	42	22,6	26	14,1
	Inactive	49	31,2	37	23,6	29	20,6	27	19,2
	p	NS		NS		NS		NS	
Perceived health	Good	61	35,3	30	20,1	50	22	19	16,1
	Poor	34	23,4	44	25,4	26	31,8	37	16,3
	P	0,02		NS		NS		NS	

that oral health in the study group was better than the national average because the study enrolled only residents from one of the largest Polish cities which is also one of the largest academic centers in Poland with high proportion of university education. Nevertheless, it seems to be plausible that the found associations are not unique for Krakow.

Low education and tobacco smoking appeared to be the factors strongly and independently associated with poor oral hygiene and health. Relations between oral health and other socioeconomic and behavioral factors were weaker and they were attenuated after adjustment to age, education and smoking.

References

- [1] Central Statistical Office. The Demographic Yearbook of Poland 2013. Warsaw, Statistical Publishing Establishment, 2013.
- [2] PETERSEN P.E., KANDELMAN D., ARPIN S., OGAWA H.: Global oral health of older people – Call for public health action. *Community Dent Health*, 2010, 27, 257–267.
- [3] DE MARCHI R.J., HILGERT J.B., HUGO F.N., SANTOS C.M., MARTINS A.B., PADILHA D.M.: Four-year incidence and predictors of tooth loss among older adults in a southern Brazilian city. *Community Dent Oral Epidemiol.* 2012, 40, 396–405.
- [4] RENVERT S., PERSSON R.E., PERSSON G.R.: Tooth loss and periodontitis in older individuals: results from the Swedish National Study on Aging and Care. *J. Periodontol.* 2013, 84, 1134–1144.
- [5] HUNG H.C., COLDITZ G., JOSHIPURA K.J.: The association between tooth loss and the self-reported intake of selected CVD related nutrients and foods among US women. *Community Dent. Oral Epidemiol.* 2005, 33, 167–173.

- [6] MUSACCHIO E., PERISSINOTTO E., BINOTTO P., SARTORI L., SILVA-NETTO F., ZAMBON S., MANZATO E., CORTI M.C., BAGGIO G., CREPALDI G.: Tooth loss in the elderly and its association with nutritional status, socio-economic and lifestyle factors. *Acta Odontol. Scand.* 2007, 65, 78–86.
- [7] ERVIN R.B., DYE B.A.: Number of natural and prosthetic teeth impact nutrient intakes of older adults in the United States. *Gerodontology*. 2012, 29, e693–702.
- [8] GOTTFREDSSEN K., WALLS A.W.: What dentition assures oral function? *Clin. Oral Implants Res.* 2007, 18, 34–45.
- [9] STEELE J.G., SHEIHAM A., MARCENES W., WALLS A.W.G.: National diet and nutrition survey: people aged 65 years and over. Volume 2: Report of the oral health survey. The Stationery Office, London 1998.
- [10] MATILLA K.J., NIEMINEN M.S., VALTONEN V.V., RASI V.P., KESANIEMI Y.A., SYRJALA S.L., JUNGELL P.S., ISOLUOMA M., HIETANIEMI K., JOKINEN M.J., HUTTUNEN J.K.: Association between dental health and acute myocardial infarction. *Br. Med. J.* 1989, 298, 779–782.
- [11] JUNG Y.S., SHIN M.H., KIM I.S., KWEON S.S., LEE Y.H., KIM O.J., KIM Y.J., CHUNG H.J., KIM O.S.: Relationship between periodontal disease and subclinical atherosclerosis: The Dong-gu study. *J. Clin. Periodontol.* 2014, 41, 262–268.
- [12] DESVARIEUX M., DEMMER R.T., JACOBS D.R. JR, RUNDEK T., BODEN-ALBALA B., SACCO R.L., PAPAPANOU P.N.: Periodontal bacteria and hypertension: the oral infections and vascular disease epidemiology study (INVEST). *J. Hypertens.* 2010, 28, 1413–1421.
- [13] VISSCHER C.M., LOBBEZOO F., SCHULLER A.A.: Dental status and oral health-related quality of life. A population-based study. *J. Oral Rehabil.* 2014, 41, 416–422.
- [14] TADA A., WATANABE T., YOKOE H., HANADA N., TANZAWA H.: Relationship between the number of remaining teeth and physical activity in community-dwelling elderly. *Arch. Gerontol. Geriatr.* 2003, 37, 109–117.
- [15] DENTINO A., LEE S., MAILHOT J., HEFTY A.F.: Principles of periodontology. *Periodontol.* 2000, 2013, 61, 16–53.
- [16] DE MARCHI R.J., HILGERT J.B., HUGO F.N., SANTOS C.M., MARTINS A.B., PADILHA D.M.: Four-year incidence and predictors of tooth loss among older adults in a southern Brazilian city. *Community Dent. Oral Epidemiol.* 2012, 40, 396–405.
- [17] World Health Organization. The World Oral Health Report 2003. World Health Organization, Geneva, Switzerland, 2003.
- [18] JODKOWSKA E.: The condition of dentition status of adults polish citizens in years 1998–2009. *Przegl. Epidemiol.* 2010, 64, 571–576 [in Polish].
- [19] KÖNIG J., HOLTFRETER B., KOCHER T.: Periodontal health in Europe: future trends based on treatment needs and the provision of periodontal services – position paper 1. *Eur. J. Dent. Educ.* 2010, 14, 4–24.
- [20] <http://www.mz.gov.pl/zdrowie-i-profilaktyka/programy-zdrowotne/wykaz-programow/monitorowanie-stanu-zdrowia-jamy-ustnej-populacji-polskiej-w-latach-2013-2015>, entered: 10.08.2015
- [21] PEASEY A., BOBAK M., KUBINOVA R., MALYUTINA S., PAJAK A., TAMOSIUNAS A.: Determinants of cardiovascular disease and other non-communicable diseases in Central and Eastern Europe: rationale and design of the HAPIEE study. *BMC Public Health*, 2006, 6, 255.
- [22] World Health Organization. Oral Health Surveys Basic Methods. World Health Organization, Geneva, Switzerland, 1997.
- [23] SILNESS J., LOE H.: Periodontal disease in pregnancy. *Acta Odont. Scand.* 1966, 24, 747–759.
- [24] VASOONTARA Y., TEWARIT S., MATTHEW K., SAMANG S., ADRIAN C.S.: Factors associated with self-reported number of teeth in a large national cohort of Thai adults. *BMC Oral Health*, 2011, 11, 31.
- [25] HAUGEJORDEN O., KLOCK K.S., ASTRØM A.N., SKARET E., TROVIK T.A.: Socio-economic inequality in the self-reported number of natural teeth among Norwegian adults – an analytical study. *Community Dent. Oral Epidemiol.* 2008, 36, 269–278.
- [26] ARORA M., SCHWARZ E., SIVANESWARAN S., BANKS E.: Cigarette smoking and tooth loss in a cohort of older Australians: the 45 and up study. *J. Am. Dent. Assoc.* 2010, 141, 1242–1249.
- [27] CÉSAR NETO J.B., ROSA E.F., PANNUTI C.M., RÔMITO G.A.: Smoking and periodontal tissues: a review. *Braz. Oral Res.* 2012, 26, 25–31.
- [28] WENNSTRÖM A., AHLQWIST M., STENMAN U., BJÖRKELUND C., HAKEBERG M.: Trends in tooth loss in relation to socio-economic status among Swedish women, aged 38 and 50 years: repeated cross-sectional surveys 1968–2004. *BMC Oral Health* 2013, 13, 63.
- [29] PAPADAKI E., ANASTASSIADOU V.: Elderly complete denture wearers: a social approach to tooth loss. *Gerodontology*. 2012, 29, e721–727.
- [30] JIMENEZ M., DIETRICH T., SHIH M.-C., LI Y., JOSHIPURA K.J.: Racial/ethnic variations in associations between socioeconomic factors and tooth loss. *Community Dent. Oral Epidemiol.* 2009, 37, 267–275.
- [31] HAAS A.N., WAGNER M.C., OPPERMAN R.V., RÖSING C.K., ALBANDAR J.M., SUSIN C.: Risk factors for the progression of periodontal attachment loss: a 5-year population-based study in South Brazil. *J. Clin. Periodontol.* 2014, 41, 215–223.
- [32] ARMPFIELD J.M., MEJÍA G.C., JAMIESON L.M.: Socioeconomic and psychosocial correlates of oral health. *Int. Dent. J.* 2013, 63, 202–209.
- [33] BOBAK M., POWLES J.: Poverty and non-communicable diseases in Central and Eastern Europe and the Former Soviet Union with implications for surveillance: A report for the Non-Communicable Diseases and Mental Health Cluster, World Health Organization, Geneva, London, University College London, 2001.

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Conflict of Interest: None declared

Received: 25.06.2015

Revised: 22.11.2015

Accepted: 5.12.2015