

**Department of Hygiene and Preventive Medicine  
Charles University in Prague  
Faculty of Medicine in Hradec Králové**

**Brief outline of Ph. D. dissertation in Hygiene,  
Preventive Medicine and Epidemiology**

(Autoreferát disertační práce)

**SMOKING AND ORAL CAVITY DISEASE  
DENTAL CARIES**



**SAJITH VELLAPPALLY, B.D.S.**

**Hradec Králové, Czech Republic**

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This dissertation thesis has been done to obtain the Ph.D. degree at the Department of Hygiene and Preventive Medicine, Charles University in Prague, Faculty of Medicine in Hradec Králové, Czech Republic.

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### 1. INTRODUCTION

**Tobacco** represents the single most preventable cause of death in the world (20). Cigarette smoking and other forms of tobacco use imposes globally a huge and growing burden for public health. Approximately 5 million people are killed annually by tobacco use. By the year 2030, according to current trends, it is assumed that this number will increase to 10 million with 70% of deaths occurring in low and middle-income countries (10).

**Tobacco is smoked** in the form of cigarettes, cigars, bidis, hookahs, kreteks, cuttas and pipes (13, 14, 15). Tobacco smoke is highly dynamic and has a **complex matrix** consisting of a gas phase and a particulate phase with more than 3800 compounds. Among these compounds, 60 of them are well-established carcinogens in animals and 15 of them are carcinogens in humans. The carcinogens, found in tobacco smoke, include polycyclic aromatic hydrocarbons, aldehydes, arsenic, nickel and cadmium (1).

**Smoking** not only harms smokers but also harms the people around them. It is related to some **systemic diseases**, including many types of cancer, coronary heart disease, stroke and

peripheral vascular diseases (6). Smoking increases the chance of developing cancer of pancreas, renal pelvis, urinary bladder, uterine cervix, nasal cavity, pharynx, larynx, esophagus, stomach and kidney (4, 9, 24). The health effects of smoking are more serious for women than for men. In addition to the general health problems common for both genders, women face additional hazards (12). Besides women, children are very vulnerable part of population, particularly during the first year of their life. Their exposure to environmental tobacco smoke, or passive smoking, can induce serious short-term as well as long-term health effects (2).

**Smoking** is related as well to some **oral diseases** including oral cancer, oral leukoplakia, palatal leukokeratosis, smoker's melanosis, oral candidiasis, hairy tongue, discoloration of teeth, dental restorations and dentures, periodontitis, wound healing failure, dental implants failure, gingival inflammation, acute necrotizing ulcerative gingivitis and aphthous ulcers (20).

Among the major biological effect of **tobacco smoke**, which is related to **dental caries**, belongs higher concentration of thiocyanates in saliva of tobacco smokers. This effect presents caries inhibiting factor (11). On the other hand, lower buffering effect, lower pH and higher level of Lactobacilli and Streptococcus Mutans in smoker's saliva increase their susceptibility to caries (21). Immunosuppressive properties of **environmental tobacco smoke** might be a risk factor for **dental caries** development (21). Environmental tobacco smoke is suspected to play a causal role in caries formation in children. It may decrease serum vitamin C level, which may be associated with growth of cariogenic bacteria in children (21). In addition, environmental tobacco smoke may reduce the protective properties of saliva that can operate against caries (21). Almost all above mentioned important findings can contribute to increased prevalence of dental caries among smokers. However, a direct etiological relation between smoking and dental caries is still missing (21).

Due to declining of smoking in the modern world, the tobacco industry has to look for other products that can keep the old customers and attract new ones. Different forms of **smokeless tobacco** are currently massively promoted and are gaining importance (18). ST is a very broad term that refers to more than 30 different types of products around the world (e.g. plug, gutkha, khiwan, khani, iq'milk, zarda, naswar, nass, chimo, toobak, shamma, gudhaku, gul, mishri, maras, moist snus). (22). ST is normally consumed orally or nasally, and includes products that are placed in mouth, cheek or lip and sucked (dipped) or chewed (22). Cigarette smoking is pandemic, affecting large proportions of the population worldwide. In contrast, use of ST is

endemic, mainly restricted to certain geographical areas such as North America, the Scandinavian countries, India, Bangladesh, Southeast Asia and part of Africa. South Asia is the major producer and net exporter of tobacco. Over one-third of tobacco consumed regionally is ST (22).

**Smokeless tobacco** presents a **complex chemical mixture**, including not only the components of the tobacco leaf but also chemicals added during the manufacturing process (22). ST contains the addictive chemical nicotine and more than 20 cancer-causing chemical substances; nevertheless, the actual number of carcinogens found is fewer than in cigarette smoke. Most important carcinogens identified in ST are tobacco-specific N-nitrosamines: N'-nitroso-nornicotine and 4(methylnitrosamino)-1-(3-pyridyl)-1-butanone. International Agency for Research on Cancer (IARC) concluded that there is sufficient evidence that the oral use of ST is carcinogenic to humans (22).

**Smokeless tobacco** is related to some **systemic diseases**, including cardiovascular diseases and several types of cancer (stomach, rectal, prostate, bladder, pancreatic, laryngeal and esophageal cancer). It represents important risk factor for reproductive systems of men and women and risk factor for prenatal development. Smokeless tobacco can cause morphological and functional changes in nasal mucosa and a can be associated with chronic rhinitis. One of the most important systemic effects of smokeless tobacco is nicotine dependence. Smokeless tobacco contains high level of addictive nicotine (one can of snuff delivers as much nicotine as 60 cigarettes) and withdrawal symptoms such as drowsiness, nervousness, headache, irritability, and cravings have been reported (22).

**Smokeless tobacco** is related as well to some **oral diseases** like oral cancer, oral leukoplakia and snuff dipper's lesion, acute necrotizing ulcerative gingivitis, gingivitis and periodontitis, stained teeth, bad breath, mouth sores, and tooth abrasion of incisal and occlusal surface of teeth (22).

In relation to **dental carries** development, high levels of fermentable sugar and sweeteners in **smokeless tobacco** can stimulate growth of Cariogenic bacteria (19). Extracts from chewing tobacco with high sugar content increase growth of Lactobacillus Casei and extracts of smokeless tobacco may serve as a growth substrate for Streptococcus mutans, Streptococcus salivarius and Streptococcus sanguis (5). Local loss of keratinized gingiva at the side where chewing tobacco/snuff is held can present another possible contributing mechanism in the

development of mostly root-surface caries in smokeless tobacco users. This mechanism induces teeth abrasion yielding in periodontal problems reflecting the degree of gingival recession and bone loss. The exposed root surface, damaged by the loss of cementum and some dentin is at increased risk to develop caries (21).

Out of 930 million global tobacco consumers, 1.1 billion smokers live in developing countries; India alone has 182 million smokers (16). In **India**, different forms of tobacco are consumed. Cigarettes and “bidis” are the two most common forms of tobacco smoked in India. Data reported by the Cancer Patients Aid Association of India in 2004 reveal that smoking of cigarettes (prevalence of 20%) and “bidis” (prevalence of 40%), followed by the use of smokeless tobacco in various forms (prevalence of 40 %) is widespread among both, men and women. Documented data of Indian population suggested that 65% of all men and 33% of all women use some form of tobacco (3). However, demographic variation and distribution of forms of tobacco consumption in India are not uniform.

**The Czech Republic** is among the ten countries with the highest rate of cigarette consumption worldwide. Recent data of WHO indicates that in the Czech Republic, 31.1 % of males and 20.1 % of females smokes (17). According to annual estimation, approximately 22,000 people die from diseases caused by smoking (i.e. 60 deaths daily). Most of these deaths are in middle age (15,000). Other forms of tobacco products, like smokeless tobacco (snuff, chewing tobacco), are banned in EU (the Czech Republic) since 1992, with the exception of Sweden (23).

In conclusion, the known facts can lead to assumption that tobacco use have certain influence on dental caries incidence, nevertheless, further studies, clinical trials and experiments are needed to elucidate the independent effect of tobacco use as an inducer of dental caries. Generally, an association between tobacco using and some types of oral diseases (such as oral cancer) has been well documented but the role of tobacco using in dental caries development, however, has not been widely investigated in the India and in the Czech Republic. In this study, the DMFT index was used to evaluate the influence of tobacco use on dental caries development in Indian and Czech respondents. The confounding factors were evaluated on the basis of different population character.



## **2. AIM OF WORK**

The primary aim of the presented cross sectional study was to investigate the influence of tobacco use and other factors on dental caries in the groups of Indian and Czech respondents. The secondary aim was to compare the results found in the Indian group with those obtained in the Czech group; taking into consideration the differences in culture and race, socioeconomic status, food and drink habits, oral hygiene practices, and the use of tobacco in different forms.

## **3. MATERIALS AND METHODS**

The study was approved by the Ethics Committees of Charles University of Prague, Faculty of Medicine in Hradec Králové. The Indian subjects were randomly selected from patients who visited dental clinics in two South Indian cities (Cochin and Chennai) from July 2005 to February 2007. The Czech part of the research was conducted simultaneously at the Department of Hygiene and Preventive Medicine and Department of Dentistry in Charles University Medical Faculty in Hradec Králové in cooperation with private dentists from July 2005 to February 2007.

### **3.1. Studied population**

Several studies used a representative sample (8), whereas most studies used a convenience sample such as volunteers or patients attending dental clinics (7) for collecting data. The respondents who participated in this study were patients of dentists cooperating with the study. The principle criterion was age. Edentulous patients were excluded from the study. The participants were informed about the purpose of the study, an informed consent was taken and at the end of clinical examination, each participant was given instructions regarding dental treatment needs.

### **3.2. Questionnaires**

Two different sets of questionnaires were prepared; one for the Czech respondents (in Czech language) and the other, with minor variations, for the Indian respondents (in English). All participants in our study were requested to answer the questionnaire which included questions concerning their personal history, economic status, level of education, profession, general health status, food habits, frequency of dental visits, brushing habits, dental aids used and detailed tobacco consumption history. Information collected on use of tobacco included current tobacco

consumption status, duration and amount of tobacco use and form of tobacco use in case of Indian respondents.

We found six forms of tobacco consumption in the group of Indian respondents: tobacco with betel nuts and leaves, tobacco alone, bidi/chutta, cigarettes without filters, cigarettes with filters, and pipes and other forms. The respondents were classified into 5 groups: 1) regular smokers, 2) occasional smokers, 3) ex-smokers, 4) tobacco chewers (tobacco alone or tobacco with beetle nuts and leaves), and 5) tobacco non-users. Regular smokers were defined as individuals who, at the time of examination, smoked at least one cigarette a day. Occasional smokers were individuals who smoked less than one cigarette per day. Former or ex-smokers were defined as individuals who smoked at least 1 cigarette per day for 6 consecutive months and didn't smoke at least for the past 6 months from the time of the study. Since the use of smokeless tobacco, mostly in the form of chewing tobacco is prevalent in India, we further classified the Indian respondents into 'tobacco chewers' and 'tobacco non-users'. 'Tobacco chewers does not smoke but only chew tobacco (alone or tobacco with betel nuts and leaves) and tobacco non-users never used any form of tobacco (smoking or smokeless tobacco). 'Tobacco non-users' consisted of subjects who never used tobacco (at the time of study or in the past) in any form.

In case of Czech respondents, the most prevalent mode of tobacco consumption was smoking in various forms like cigarettes, pipes and cigars. In addition, tobacco status of Czech patients was classified into four groups: regular smoker, occasional smoker, ex-smoker and non-smoker.

### **3.3. Clinical examination**

Oral health examinations were performed (according to WHO oral examination procedure) after the self-administered questionnaire session and before dental treatment. The examiners in India and the Czech Republic used standard examination environment, standard equipment and followed detailed instructions. For caries score were utilized the following: decayed teeth (reflecting recent untreated disease experience); missing teeth and filled teeth (reflecting caries treatment experience). Decayed, missing, and filled teeth (DMF-T) altogether provide an estimation of accumulated caries experience score. Each clinician carried out all clinical examination using artificial light; a flat surface mouth mirror, gauze, and sponge dry air.

### 3.4. Data analysis

Statistical analysis of the data included the classification of data and calculation of frequencies and was performed by NCSS 2004 program. Mann-Whitney test or Kolmogorov-Smirnov test was used for comparison of the two groups (tobacco users and tobacco non-users or smokers and non-smokers) according to quantitative data (e.g., age), and Kruskal-Wallis analysis of variance with multiple comparison tests was used for the five groups (regular smokers, occasional smokers, ex-smokers, tobacco chewers and tobacco non-users) according to the way of tobacco use. Chi-square test of independence in contingency tables or Fisher's exact test was used for qualitative data (e.g., DMFT, income, education, preventive dental visits, brushing habits, food and drinking habits, tobacco habits). The level of significance was  $\alpha = 0.05$  in all calculations.

## 4. RESULTS

### 4.1. Indian respondents

The Indian group of respondents comprised 805 adult patients (580 men and 295 women). For extended description, tobacco users were divided into four sub-groups: regular smokers, occasional smokers, ex-smokers and tobacco chewers. Detailed analyses over economic status, level of education, profession, health status, food habits, frequency of dental visits, brushing habits, dental aids use and tobacco consumption history were undertaken. Table 1 presents an example of analysis of nutritional habits of respondents in relation with their tobacco status.

**Table 1. Consumption of chosen food, drinks and tobacco status of Indian respondents (%)**

1 – Regular smokers, 2 – Occasional smokers, 3 – Ex-smokers, 4 – Tobacco chewers, 5 – Tobacco non-users, \* several times

	Type of tobacco use					Total
	1	2	3	4	5	
<b>Sweets</b>	<i>p &lt; 0.001; <math>\chi^2</math> test, ***</i>					
<b>Never</b>	2.0	0.0	0.0	5.0	2.1	2.4
<b>Less frequently</b>	47.1	45.7	51.3	59.6	54.9	50.8
<b>Per month*</b>	16.7	22.9	38.5	19.9	27.5	20.5
<b>Per week*</b>	21.1	31.4	5.1	8.5	12.7	17.4
<b>daily</b>	12.4	0.0	5.1	7.1	2.8	8.9

Sweet drinks <i>p &lt; 0.001; <math>\chi^2</math> test; ***</i>							
Never	1.1	5.7	5.1	11.3	6.3	4.3	
Less frequently	29.9	37.1	46.2	42.6	38.0	34.7	
Per month*	40.5	28.6	28.2	29.8	44.4	38.2	
Per week*	24.7	28.6	20.5	12.8	10.6	20.0	
daily	3.8	0.0	0.0	3.5	0.7	2.9	
Fruits and vegetables <i>p &lt; 0.001; <math>\chi^2</math> test; ***</i>							
Never	0.0	0.0	0.0	3.5	0.7	0.8	
Less frequently	15.4	20.0	15.4	17.7	31.7	18.9	
Per month*	26.9	17.1	25.6	27.0	32.4	27.4	
Per week*	19.7	31.4	33.3	17.0	12.7	19.1	
daily	38.0	31.4	25.6	34.8	22.5	33.8	
Alcoholic drinks <i>p &lt; 0.001; <math>\chi^2</math> test; ***</i>							
Never	10.2	40.0	59.0	70.9	81.0	37.2	
Less frequently	50.9	48.6	25.6	19.1	13.4	37.3	
Per month*	19.9	5.7	10.3	2.1	4.2	12.9	
Per week*	15.2	2.9	2.6	5.0	0.7	9.6	
daily	3.8	2.9	2.6	2.8	0.7	3.0	

The most important results concerning the influence of tobacco use and other influencing factors on dental carries in the group of Indian respondents are summarized in table 2.

**Table 2. Effect of selected factors on DMF-T statute in the Indian respondents**

Factor		DMF-D		DMF-M		DMF-F	
		Mean ± SD	p- value	Mean ± SD	p-value	Mean ± SD	p-value
Age	Younger	5.72 ± 3.90	0.015 (* )	1.53 ± 1.88	0.0017 (** )	2.91 ± 3.12	0.00639 (** )
	Older	6.80 ± 4.36		2.12 ± 2.19		3.50 ± 3.31	

Sex	Males	6.07 ± 4.01	0.709 (NS)	1.82 ± 2.12	0.786 (NS)	3.08 ± 3.16	0.497 (NS)
	Females	6.25 ± 4.36		1.59 ± 1.75		3.25 ± 3.32	
Education	No education	5.07 ± 3.63	0.0103 (* )	2 ± 1.64	<0.001 (***)	0.83 ± 1.31	<0.001 (***)
	Basic – Till 5 <sup>th</sup> . std.	5.48 ± 4.03		2.45 ± 2.2		2.22 ± 3.14	
	High school	6.07 ± 4.20		1.88 ± 1.99		2.78 ± 2.87	
	University graduation	6.46 ± 4.11		1.46 ± 1.98		3.88 ± 3.34	
Preventive check-ups	Twice a year	6.59 ± 4.06	<0.001 (***)	1.42 ± 2.14	<0.001 (***)	4.18 ± 3.51	<0.001 (***)
	Once a year	6.89 ± 4.58		1.62 ± 2.06		4.33 ± 3.56	
	Having problem	5.94 ± 3.99		1.93 ± 1.99		2.75 ± 2.92	
	Never before	4.09 ± 3.26		0.67 ± 1.31		0.39 ± 1.12	
Brushing frequency	Once a day	6.29 ± 4.10	0.0179 (* )	1.86 ± 2.04	<0.001 (***)	3.05 ± 3.19	0.110 (NS)
	Twice daily	5.43 ± 4.08		1.20 ± 1.84		3.62 ± 3.31	
	3 times a day	4.56 ± 3.92		1.69 ± 1.89		2.63 ± 2.60	
Smoking	Regular smokers	6.29 ± 3.95	<0.001 (***)	1.9 ± 2.14	0.529 (NS)	3.29 ± 3.19	<0.001 (***)
	Occasional smokers	3.6 ± 2.68		1.57 ± 2.02		1.97 ± 2.20	
	Ex-smokers	5.5 ± 3.75		1.62 ± 1.84		3.23 ± 3.09	
	Tobacco chewers	6.96 ± 4.43		1.62 ± 2.01		3.67 ± 3.61	
	Tobacco non-users	5.1 ± 4.24		1.53 ± 1.65		2.33 ± 2.86	

(Kruskal-Wallis test; Kolmogorov- Smirnov test; Mann-Whitney test)

#### 4.2. Czech respondents

The Czech group of respondents comprised 679 adult patients (339 men 340 women). For extended description, tobacco users were divided into four sub-groups: regular smokers, occasional smokers and ex-smokers. Detailed analyses over economic status, level of education, profession, health status, food habits, frequency of dental visits, brushing habits, dental aids use and tobacco consumption history were undertaken. Table 3 presents an example of analyze of nutritional habits of respondents in relation with their tobacco status.

**Tab 3. Consumption of chosen food, drinks and tobacco status of the Czech respondents (%)**

	Regular smokers	Occasional smokers	Ex-smokers	Non-smokers	Total
<b>Sweets</b> $p = 0.08; \chi^2 \text{ test}; *$					
Daily	15.0	20.5	12.1	15.3	15.1
Per week*	32.7	41.0	22.0	36.4	33.8
Per month*	24.5	23.1	29.7	26.8	26.4
Less frequently	24.5	15.4	34.1	17.9	21.5
Never	3.4	0.0	2.2	3.6	3.2
<b>Sweet drinks</b> $p = 0.0012; \chi^2 \text{ test}; **$					
Daily	31,0	32,5	13,5	18,0	21,2
Per week*	19,3	40,0	20,2	27,5	25,5
Per month*	17,9	10,0	23,6	15,9	17,0
Less frequently	18,6	10,0	27,0	26,7	23,9
Never	13,1	7,5	15,7	11,9	12,4
<b>Fruits and vegetables</b> $p = 0.006; \chi^2 \text{ test}; **$					
Daily	37,5	59,0	54,9	61,2	55,0
Per week*	52,8	33,3	36,3	32,3	37,4
Per month*	5,6	5,1	3,3	3,9	4,3
Less frequently	4,2	2,6	4,4	2,1	2,9
Never	0,0	0,0	1,1	0,5	0,5

Beer and vine		$p = 0.028; \chi^2$ test; *				
Daily	8,9	7,7	9,6	5,5	6,9	
Per week*	33,6	33,3	31,9	26,6	29,3	
Per month*	29,5	30,8	35,1	25,3	27,9	
Less frequently	18,5	25,6	19,1	30,8	26,1	
Never	9,6	2,6	4,3	11,7	9,7	
Beverages		$p < 0.001; \chi^2$ test; ***				
Daily	2,8	0,0	2,2	0,3	1,1	
Per week*	7,6	2,6	3,3	1,9	3,4	
Per month*	20,0	35,9	22,2	10,9	16,0	
Less frequently	44,8	56,4	47,8	56,5	52,7	
Never	24,8	5,1	24,4	30,5	26,9	

\* Several times

The most important results concerning the influence of tobacco use and other factors on dental carries in the group of the Czech respondents are summarized in table 4.

Table 4. Effect of selected factors on DMF-T statute in the Czech respondents

		DMF-D		DMF-M		DMF-F	
		Mean ± SD	p-value	Mean ± SD	p-value	Mean ± SD	p-value
Age	Younger	0.843 ± 1.932	0.092 NS	2.843 ± 4.347	<0.001	10.009 ± 5.017	0.083 NS
	Older	1.005 ± 1.737		8.298 ± 8.217		10.195 ± 5.776	
Sex	Males	1.051 ± 2.021	0.373 NS	4.901 ± 6.856	0.647 NS	9.459 ± 5.178	0.0028 (**)
	Females	0.737 ± 1.694		4.723 ± 4.723		10.673 ± 5.282	

<b>Education</b>	<b>Basic</b>	1.16 ± 2.52	0.0061 (**)	6.263 ± 7.46	<0.001 (***)	9.44 ± 5.81	0.0919 NS
	<b>Skilled</b>	1.38 ± 2.35		3.9 ± 5.64		9.5 ± 4.02	
	<b>High school</b>	0.664 ± 1.39		4.812 ± 6.82		10.627 ± 5.29	
	<b>University graduation</b>	0.792 ± 1.23		3.427 ± 4.89		9.947 ± 4.83	
<b>Preventive check-ups</b>	<b>Twice a year</b>	0.656 ± 1.27	0.002 (**)	4.381 ± 5.72	0.091 NS	10.657 ± 5.13	<0.001 (***)
	<b>Once a year</b>	0.964 ± 1.7		4.551 ± 6.49		10.109 ± 5.13	
	<b>Once in 2 years</b>	1.435 ± 1.93		6.913 ± 9.18		6.783 ± 4.11	
	<b>Less frequently</b>	1.029 ± 1.5		7.571 ± 9.59		8.286 ± 5.25	
	<b>Never</b>	3.533 ± 5.32		7.633 ± 9.35		5.433 ± 4.72	
<b>Brushing frequency</b>	<b>3 times daily / more</b>	0.618 ± 1.60	0.0181 (*)	6.058 ± 8.43	0.0189	9.309 ± 5.53	0.0485 (*)
	<b>2 times daily</b>	0.808 ± 1.58		4.333 ± 5.82		10.381 ± 5.12	
	<b>Once a day</b>	1.308 ± 2.24		6.667 ± 8.66		9.372 ± 5.55	
	<b>Less frequently</b>	2.933 ± 5.52		5.933 ± 3.77		7.267 ± 5.71	
<b>Smoking</b>	<b>Regular smokers</b>	1.257 ± 2.408	0.034 (*)	5.859 ± 7.063	<0.001	9.149 ± 5.353	0.0213 (*)
	<b>Occasional smokers</b>	1.39 ± 2.246		2.561 ± 4.615		9.122 ± 4.723	
	<b>Ex-smokers</b>	0.947 ± 1.6		5.979 ± 6.995		10.213 ± 5.586	
	<b>Non-smokers</b>	0.69 ± 1.59		4.363 ± 6.263		10.487 ± 5.162	

NS = non significant



### 4.3. Comparative analysis of DMF-T score of the Czech and the Indian respondents

Figure 1 shows higher number of decayed teeth in Indian tobacco users (tobacco chewers, regular smokers, occasional smokers and ex-smokers; DMF-D =  $6.35 \pm 4.05$ ), when compared with Czech tobacco users (regular smokers, occasional smokers, ex-smokers; DMF-D =  $1.17 \pm 2.16$ ). Both mentioned groups show more decayed teeth when compared with adequate groups – the Indian tobacco non-users (DMF-D =  $5.09 \pm 4.24$ ) and the Czech tobacco non-users (DMF-D =  $0.69 \pm 1.59$ ).

Figure 1. DMF-D differences in tobacco users and tobacco non-users in India and in the Czech Republic

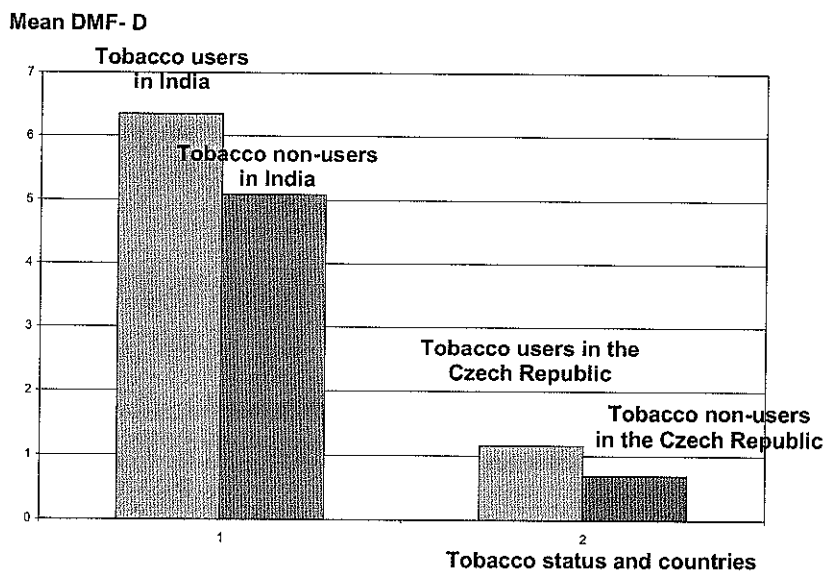


Figure 2 shows higher number of missing teeth in the Czech tobacco users (regular smokers, occasional smokers and ex-smokers; DMF-M =  $5.42 \pm 6.82$ ) when compared with the Indian tobacco users (regular smokers, occasional smokers, ex-smokers, tobacco chewers; DMF-M = 1.8

$\pm 2.09$ ). Both mentioned groups shows more missing teeth when compared with adequate groups – the Czech tobacco non-users (DMF-M =  $4.4 \pm 6.25$ ) and the Indian tobacco non-users (DMF-M =  $1.5 \pm 1.65$ ).

**Figure 2. DMF-M differences in tobacco users and tobacco non-users in India and in the Czech Republic**

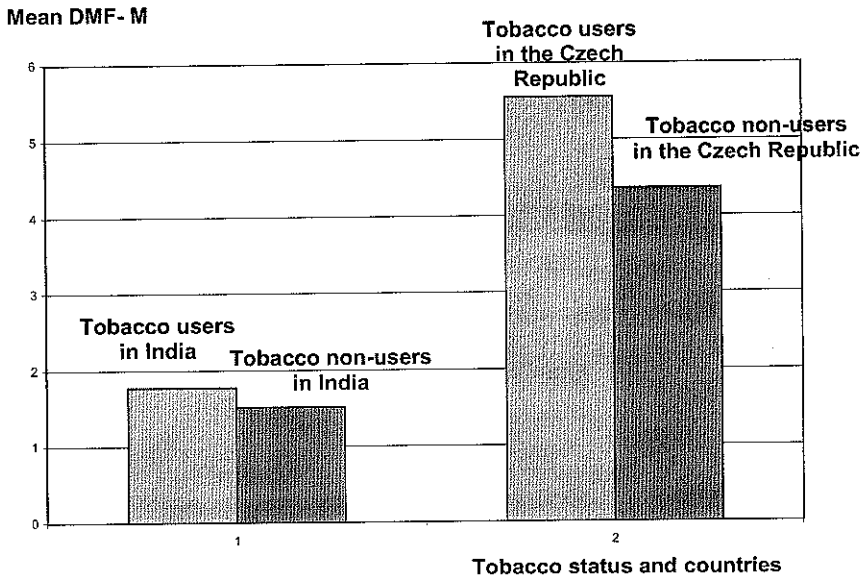
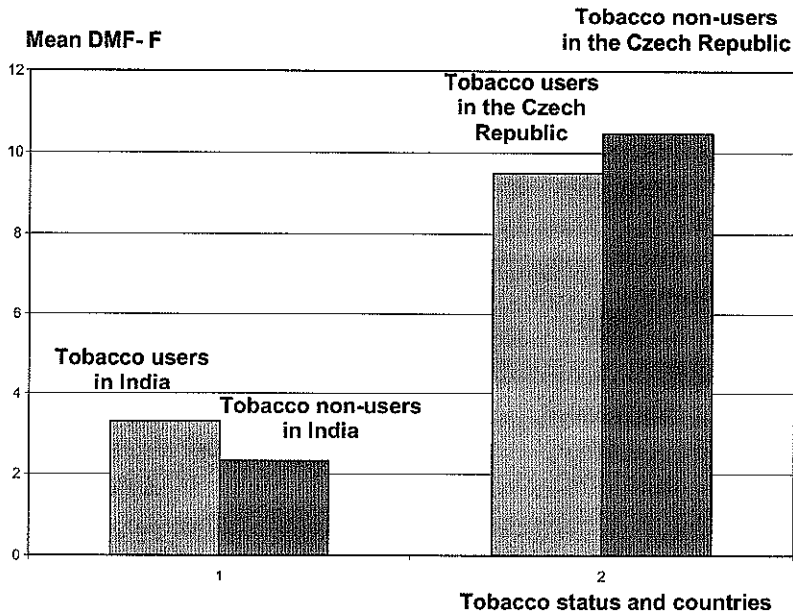


Figure 3 shows higher number of filled teeth in the Czech tobacco users (regular smokers, occasional smokers and ex-smokers; DMF-F =  $9.5 \pm 5.35$ ) when compared with the Indian tobacco users (regular smoker, occasional smoker, ex-smokers, tobacco chewers; DMF-F =  $3.3 \pm 3.25$ ). The Indian tobacco users shows higher number of filled teeth (DMF-F =  $3.3 \pm 3.25$ ) when compared with the Indian tobacco non-users (DMF-F =  $2.3 \pm 2.86$ ) whereas the Czech tobacco users (DMF-F =  $9.5 \pm 5.35$ ) shows lower number of filled when compared with the Czech tobacco non-users (DMF-F =  $10.5 \pm 5.16$ ).

**Figure 3. DMF-F differences in tobacco users and tobacco non-users in India and in the Czech Republic**



## **5. DISCUSSION AND CONCLUSIONS**

Certain **limitations** should be taken into consideration during the interpretation of the results presented in this work. At first, the validity of self-reported smoking is often discussed because of the widespread belief that smokers prone to underestimating of the amount of smoked products or to deny smoking altogether. At second, although general information about tobacco statues was obtained, other information about tobacco usage, including age of tobacco initiation and duration of tobacco usage, was not taken. At third, we were not able to generalize our findings to Indian and Czech population. Our examined groups were convenient samples and were not randomized.

At fourth, an exact comparison of our data with recent studies was not always possible to carry out because of the differences in methodologies.

### **5.1. Discussion and conclusions to the first aim of the presented work: Investigation of influence of tobacco use and other factors on dental caries in the group of Indian respondents.**

The age, level of education, regular dental check-ups, brushing frequency and the form of tobacco use proved significant influence on the number of decayed teeth in the Indian respondents. Older respondents and respondents with higher level of education, higher frequency of regular dental check-ups, lower brushing frequency, regular smokers and tobacco chewers had higher number of decayed teeth when compared with younger respondents and respondents with lower level of education, lower frequency of regular dental check-ups, higher brushing frequency, occasional smokers, tobacco non-users and ex-smokers.

The age, level of education, regular dental check-ups, brushing frequency and the form of tobacco use proved significant influence on the number of missing teeth in the Indian respondents. Older respondents and respondents with lower level of education, lower frequency of regular dental check-ups, lower brushing frequency, regular smokers, tobacco chewers and ex-smokers had higher number of missing teeth when compared with younger respondents and respondents with higher education, higher frequency of regular dental check-ups, higher brushing frequency, occasional smokers and tobacco non-users.

The age, level of education, regular dental check-ups and the form of tobacco use proved significant influence on the number of filled teeth in the Indian respondents. Older respondents and respondents with higher level of education, higher frequency of regular dental check-ups, regular smokers, tobacco chewers and ex-smokers had higher number of filled teeth when compared with younger respondents and respondents with lower level of education, lower frequency of regular dental check-ups, occasional smokers and tobacco non-users.

Selected factors (variables) which can play the role of “confounding factors” influenced dental health of the Indian respondents quite differently. Statistical analysis disclosed that older respondents had higher number of decayed, missing and filled teeth. Respondents with higher level of education proved higher number of decayed and filled teeth but lower frequency of missing teeth. Regular participation on preventive dental check ups influenced the number of decayed teeth

and filled teeth (higher number). Higher brushing frequency decreased the number of decayed, missing and filled teeth. The respondents with low frequency of brushing proved worse results of DMF-T index and higher treatment need.

**Tobacco use influenced negatively all components of DMF-T index in Indian respondents. Smokers and tobacco chewers had higher average number of decayed, missing and filled teeth. In addition, higher number of missing and filled teeth was found even in ex-smokers.**

## **5.2. Discussion and conclusions to the first aim of the presented work: Investigation of influence of tobacco use and other factors on dental caries in the group of Czech respondents.**

The age, level of education and smoking proved to have the highest influence on the number of missing teeth in the Czech respondents. Elderly respondents, respondents with lower education and regular smokers (resp. ex-smokers) had higher average number of missing teeth when compared with younger respondents, respondents with higher education and occasional smokers (resp. non-smokers).

The level of education and attending regular dental check ups proved to have the highest influence on the number of decayed teeth in Czech respondents. The participants with higher education and participants who visited dentists regularly had lower number of decayed teeth, when compared to lower educated respondents and to respondents who ignored regular dental check ups.

Sex in connection to attending regular dental check ups proved the highest influence on the number of filled teeth in the Czech respondents. Women had higher number of filled teeth, probably also due to more frequent attending regular dental check ups.

Selected factors (variables) which can play the role of “confounding factors” influenced quite differently dental health of the Czech respondents. Statistical analysis disclosed high influence of age to the number of missing teeth (the number increased according to the age) while sex influenced mostly the number of filled teeth, (women had higher number of filled teeth when compared with men). The level of education influenced particularly the number of missing teeth and decayed teeth (the respondents with lower level of education had more missing and decayed teeth when compared with participants with higher level of education). Regular attending preventive dental check ups influenced the number of decayed teeth (lower number) and the number of filled teeth (higher number). Brushing frequency influenced the number of decayed

teeth, the number of missing teeth and the number of filled teeth. The participants with low frequency of brushing proved worse results of DMF-T index and higher treatment need.

**Smoking influenced negatively all components of DMF-T index in Czech respondents. Smokers had higher average number of decayed and missing teeth and lower number of filled teeth.**

**5.3. Discussion and conclusions to the second aim of the presented work: Comparison of the results found in the Indian group with those obtained in the Czech group; taking into consideration the differences in culture and race, socioeconomic status, food and drink habits, oral hygiene practices, and the use of tobacco in different forms.**

The Indian tobacco users-chewers and smokers (regular smokers and ex-smokers) had more decayed teeth than tobacco non-users. The Czech smokers (regular smokers and ex-smokers) had more decayed teeth than non-smokers. The Czech smokers (regular smokers, ex-smokers) had more missing teeth than the Czech non-smokers. In Indian group no significant association between tobacco use and the number of missing teeth was found. Higher number of filled teeth was found in the Indian tobacco users. Main responsibility for this fact could be ascribed to high smokeless tobacco consumption (mainly to chewing). In the Czech group, higher prevalence of filled teeth was found in tobacco non-users. This fact could be explained by fractional consumption of smokeless tobacco by tobacco users and by high interest of non-smokers to preventive dental check-ups. The Indian regular smokers and tobacco chewers demonstrated a higher percentage of oral mucosal changes or lesions. Smoking in the case of the Czech respondents had no significant influence on oral mucosa. **It can be concluded that in both groups of respondents the tobacco use was associated with higher prevalence of dental caries.**

**It can be concluded that in both groups of respondents, the tobacco non-users had higher education compared to tobacco users.**

The Indian regular tobacco users (chewers) had lower income when compared to other Indian groups. The Czech group with the highest income showed high prevalence of current smokers (regular and occasional smokers). **Thus, different effect of income on tobacco status in both groups of respondents can be stated.**

Tobacco use was associated with alcohol consumption in both examined groups of respondents. Smokers from both groups reported more frequent intake of sugar rich soft drinks. The Czech

regular smokers consumed fewer vegetables and fruits than the tobacco non-users (non-smokers). The Indian tobacco users consumed more vegetables and fruits than the tobacco non-users. These facts could be explained on the basis of prices of meat, vegetables and fruits in India and in the Czech Republic and on the basis of different level of income of tobacco users and tobacco non-users in each country. **It can be concluded that except the intake of vegetables, the tobacco non-users in both groups of respondents had better dietary habits.**

**Finally, we can conclude that our results confirmed the negative influence of tobacco consumption on dental carries in both groups of respondents.**

## **6. SUMMARY**

The primary aim of presented cross sectional study was to investigate the influence of tobacco products usage on dental caries in the groups of Indian and Czech respondents. The secondary aim was to compare the results found in the Indian group with those obtained in the Czech group; taking into consideration the differences in culture, race, socioeconomic status, food and drink habits, oral hygiene practices, and the use of tobacco in different forms. Participants in this study were patients of dentists cooperating with authors of the study. Age was principal criterion for their participation (30 – 69 years). Two different sets of questionnaires were prepared; one for the Czech participants, and the another, with minor variations, for the Indian participants. All participants were requested to complete the questionnaire which included questions concerning their personal history, economic status, educational qualification, profession, health status, food habits, frequency of dental visits, brushing habits, dental aids used and a detailed tobacco consumption history. Information concerning the use of tobacco included determination of current tobacco consumption status and form of tobacco use. We found six forms of tobacco consumption in the group of Indian respondents: tobacco with betel nuts and leaves, tobacco alone, bidi/chutta, cigarettes without filters, cigarettes with filters, pipes and other minority forms. Subsequently, the Indian respondents were classified into 5 groups: 1) regular smokers, 2) occasional smokers, 3) ex-smokers, 4) tobacco chewers (tobacco alone or tobacco with betel nuts and leaves), and 5) tobacco non-users. The respondents in the group 1, 3 and 4 are next specified as tobacco users. In the group of Czech respondents, unambiguously most prevalent form of tobacco consumption was smoking in different forms like cigarettes, pipes and cigars. Thus, the Czech respondents were classified only into 4 groups: 1) regular smokers, 2) occasional smokers, 3) ex-smokers, and 4) non-smokers.

In both groups of respondents, intra-oral clinical examination (DMFT index) was used for detailed evaluation of dental health status. The whole Indian group of respondents comprised 580 men and 225 women. The group of Indian regular smokers was formed mostly of men (98%) while the group of Indian tobacco non-users (73%) and the group of tobacco chewers (75%) was formed mostly of women. The whole Czech group of respondents comprised 339 men and 340 women. The group of Czech regular smokers was formed mostly of men (60%) while the group of Czech non-smokers was formed mostly of women (59%). In both groups of respondents the tobacco non-users had higher education when compared to tobacco users. In both groups the tobacco use was associated with higher intake of alcohol. Smokers from both groups reported frequent intake of sugar rich soft drinks. The group of Czech regular smokers consumed fewer vegetables and fruits than Czech non-smokers while the group of Indian tobacco-users (smokers, chewers) consumed more vegetables and fruits when compared with the Indian group of tobacco non-users. In both groups of respondents tobacco non-users or non-smokers showed better oral health status than tobacco users. The Indian regular smokers and tobacco chewers demonstrated a higher percentage of oral mucosal changes or lesions. The Indian group of tobacco users-chewers and smokers (regular smokers and ex-smokers) showed more decayed teeth than Indian tobacco non-users and the group of Czech smokers (regular smokers and ex-smokers) showed more decayed teeth than Czech non-smokers. The group of Czech smokers (regular smokers, ex-smokers) had more missing teeth than Czech non-smokers. In the Indian group of respondents we found no significant association between the tobacco use and the number of missing teeth. Higher number of filled teeth was found in the group of Indian tobacco users when compared with Indian tobacco non-users. We found higher number of filled teeth in the group of Czech tobacco non-smokers when compared with Czech tobacco users (regular smokers and ex-smokers). Selected factors (variables) which can play the role of "confounding factors" influenced dental health of respondents quite differently in both groups of participants. In the Indian group of respondents, older participants had higher number of decayed, missing and filled teeth. Participants with higher education showed higher frequency of decayed and filled teeth but lower frequency of missing teeth. Surprisingly, attendance of preventive dental check ups increased the number of decayed and filled teeth. Higher brushing frequency decreased the number of decayed, missing and filled teeth. In the Czech group of respondents the age influenced the number of missing teeth (the number increased according to the age) while sex mostly influenced the number of filling teeth (women had a higher number of



filled teeth when compared to men). The level of education particularly influenced the number of missing teeth and decayed teeth (the respondents with lower education had more missing and decayed teeth). Regular attendance of preventive dental check ups reduced the number of decayed teeth and the number of filled teeth (higher number). Brushing frequency influenced the number of decayed teeth, the number of missing teeth and the number of filling teeth. The respondents with low frequency of brushing showed worse results of DMF index and higher treatment need. It can be concluded that tobacco using (in all studied forms) influenced negatively all components of DMF-T index in Indian respondents. Smokers and tobacco chewers had higher average number of decayed, missing and filled teeth. In addition, higher number of missing and filled teeth was found even in ex-smokers. Likewise, smoking influenced negatively all components of DMF-T index in Czech respondents. Smokers had higher average number of decayed and missing teeth and lower number of filled teeth. In both groups of respondents, the tobacco non-users had higher education compared to tobacco users. Different effect of income on tobacco status in both groups of respondents can be stated. Except the intake of vegetables, the tobacco non-users in both groups of respondents had better dietary habits. Finally, we can conclude that our results confirmed the negative influence of tobacco consumption on dental carries in both groups of respondents.

## **7. SOUHRN**

Prvním cílem prezentované průřezové studie bylo sledování dopadu užívání tabákových výrobků na tvorbu zubního kazu u skupiny indických a skupiny českých respondentů. Druhým cílem bylo porovnání výsledků nalezených u indických respondentů s výsledky získanými u respondentů českých. Bylo přitom přihlédnuto k rozdílům v oblasti kultury, rasy, sociálně-ekonomického statutu, dietárních zvyklostí, ústní hygieny a k formám užívání tabáku. Účastníci prezentované studie byli pacienti spolupracujících zubních lékařů. Hlavním kritériem pro jejich účast ve studii byl věk (30 - 69 let). Byly vypracovány dvě verze dotazníků, jeden pro české participanty, a druhý, s malými modifikacemi, pro participanty indické. Všichni participanti byli požádáni o vyplnění dotazníku, který zahrnoval otázky týkající se jejich osobních dat, ekonomického postavení, vzdělání, profese, zdravotního stavu, stravovacích návyků, četnosti návštěv zubního lékaře, frekvence čištění zubů, používaných pomůcek pro čištění zubů a podrobné historie užívání tabákových výrobků. Dotazy týkající se užívání tabákových výrobků zahrnovaly popis aktuálního stavu a formy jejich spotřeby. Ve skupině indických respondentů jsme našli

celkem šest forem užívání tabákových výrobků: tabák s betelovými ořechy a listy, samotný tabák, bidi / chutta, cigarety bez filtru, cigarety s filtrem, dýmky a skupinu minoritních forem užívání. Indičtí respondenti byli rozděleni do 5 skupin: 1) pravidelní kuřáci, 2) příležitostní kuřáci, 3) ex-kuřáci, 4) žvýkači tabáku (tabáku samotného nebo tabáku s betelovými ořechy a listy) a 5) ne-konzumenti tabáku. Respondenti ve skupinách 1, 3, 4 jsou dále označeni jako konzumenti tabáku. Ve skupině českých respondentů bylo jednoznačně nejčastější formou užívání tabákových výrobků kouření: cigarety, dýmky a doutníky. Čeští respondenti byli proto zařazeni pouze do 4 skupin: 1) pravidelní kuřáci, 2) příležitostní kuřáci, 3) ex-kuřáci a 4) nekuřáci. V obou skupinách respondentů byl při klinickém vyšetření stavu chrupu použit jako kvantifikátor stavu index DMF-T (Decayed, Missed, Filled – Teeth). Skupinu indických respondentů tvořilo celkově 580 mužů a 225 žen. Skupinu indických pravidelných kuřáků tvořili převážně muži (98%), zatímco skupinu indických ne-konzumentů tabáku (73%) a skupinu žvýkačů tabáku (75%) tvořily převážně ženy. Českou skupinu respondentů tvořilo celkově 339 mužů a 340 žen. Skupinu českých pravidelných kuřáků tvořili převážně muži (60%), zatímco skupinu českých nekuřáků tvořily převážně ženy (59%). V obou skupinách respondentů měli ne-konzumenti tabáku (nekuřáci) vyšší vzdělání ve srovnání s konzumenty tabáku (kuřáky). V obou skupinách bylo užívání tabáku spojováno s vyšší spotřebou alkoholu a kuřáci v obou skupinách respondentů vykazovali častou konzumaci nealkoholických nápojů s vysokým obsahem cukru. Skupina českých pravidelných kuřáků konzumovala méně zeleniny a ovoce ve srovnání se skupinou českých nekuřáků, zatímco skupina indických konzumentů tabáku konzumovala více zeleniny a ovoce ve srovnání s indickou skupinou ne-konzumentů tabáku. V obou skupinách respondentů ne-konzumenti tabáku (nekuřáci) vykazovali lepší zdravotní stav dutiny ústní než konzumenti tabáku (kuřáci). U indických pravidelných kuřáků a žvýkačů tabáku jsme našli vyšší procento změn sliznice dutiny ústní. Indiické skupiny žvýkačů tabáku a kuřáků (pravidelných kuřáků a ex-kuřáků) vykazovaly, v porovnání se skupinou indických ne-konzumentů, větší počty zkažených zubů. Obdobně, skupina českých kuřáků (pravidelných kuřáků a ex-kuřáků) vykazovala, v porovnání s českou skupinou nekuřáků, větší počty zkažených zubů. Skupina českých kuřáků (pravidelných kuřáků a ex-kuřáků) vykazovala, v porovnání s českou skupinou nekuřáků, větší počty chybějících zubů. V indiické skupině respondentů jsme nezjistili významný vztah mezi užíváním tabáku a počtem chybějících zubů. Ve skupině indických konzumentů tabáku byly nalezeny vyšší počty zubů s výplní, v porovnání se skupinou ne-konzumentů. Vyšší počty zubů s výplní byl nalezen ve skupině českých nekuřáků, v porovnání se

skupinou českých konzumentů tabáku (pravidelní kuřáci a ex-kuřáci). Vybrané faktory (proměnné), které mohou mít úlohu "matoucích faktorů" (confounding factors), měly v obou skupinách odlišný dopad na stav dentice respondentů. V indické skupině vykázali starší respondenti vyšší počty zkažených a chybějících zubů i zubů s výplní. Respondenti s vyšším vzděláním vykázali vyšší počty zkažených zubů a zubů s výplní, ale nižší počty chybějících zubů. Participace indických respondentů na preventivních stomatologických prohlídkách překvapivě zvýšila počty zkažených zubů a zubů s výplní. Vyšší frekvence čištění zubů snižovala počty zkažených a chybějících zubů i zubů s výplní. V české skupině respondentů věk ovlivňoval počty chybějících zubů (počty se zvyšoval s věkem), zatímco pohlaví většinou ovlivňovalo počty zubů s výplní (ženy vykázaly, v porovnání s muži, vyšší počty zubů s výplní). Úroveň vzdělání ovlivňovala počty chybějících zubů a zkažených zubů (participanti s nižším vzděláním vykázali více chybějících a zkažených zubů). Pravidelná účast na preventivních stomatologických prohlídkách snižovala u účastníků počty zkažených zubů, ale zvyšovala počty zubů s výplní. Frekvence čištění zubů ovlivňovala počty zkažených zubů, počty chybějících zubů i počty zubů s výplní. Respondenti s nízkou frekvencí čištění vykázali vyšší hodnoty DMF-T a vyšší potřebu léčebného zákroku. Souhrnně lze říci, že konzumace tabáku (ve sledovaných formách) negativně ovlivňovala všechny složky DMF-T indexu indických respondentů. Kuřáci a žvýkači tabáku měli vyšší průměrné počty zkažených a chybějících zubů i zubů s výplní. Vyšší počty chybějících zubů a zubů s výplní byly nalezeny dokonce i u ex-kuřáků. Podobně kouření negativně ovlivňovalo i všechny složky DMF-T indexu českých respondentů. Kuřáci vykázali vyšší počty zkažených a chybějících zubů a nižší počty zubů s výplní. V obou skupinách respondentů měli ne-konzumenti tabákových výrobků obecně vyšší vzdělání než konzumenti. Byl zjištěn odlišný vliv finančních příjmů na úroveň konzumace tabáku v obou skupinách respondentů. Kromě diferencí v příjmu zeleniny, měli ne-konzumenti tabáku v obou skupinách respondentů lepší stravovací návyky. Závěrem lze konstatovat, že naše výsledky potvrdily negativní vliv konzumace tabáku na tvorbu zubního kazu u obou skupin respondentů.

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### **Reviews**

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1. **Vellappally S.**, Influence of smoking on dental caries (**oral presentation**). Scientific seminar of Dept. of Hygiene and preventive medicine, Hradec Králové, 31<sup>th</sup> May 2005.
2. **Vellappally S.**: Tobacco and dental caries (**oral presentation**). Seminar of postgraduate students of Medical Faculty and Teaching Hospital, Hradec Králové, November 20, 2006.
3. **Vellappally S.**, Jacob V.: Effects of various forms of tobacco consumption on dental and periodontal health in Indian population (**poster**). Liškutínovy dny 2007, Charles University Medical Faculty Hradec Králové, June 12-13, 2007.
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