

# Oral Health Behaviour of Adolescents: a Comparative Study in 35 Countries

*Apolinaras Zaborskis<sup>1</sup>, Simona Milciuviene<sup>2</sup>, Egle Bendoraitiene<sup>3</sup>, Aiste Zaborskyte<sup>4</sup>*

## SUMMARY

This study is part of the Cross-National Survey on Health Behaviour in School-aged Children – World Health Organization Collaborative Study, which started in 1982. *Objectives:* The aim of this study was to describe the health behaviour patterns related to oral health (toothbrushing and dieting) in cross-national perspective and access its interrelations at the level of individuals and at the level of countries. *Materials:* The samples represent 11-15-year-old schoolchildren from 32 countries of Europe, Israel, Canada, and the USA in 2001-2002 school-year. *Methods:* The research was carried out according to the methodology of the HBSC study using the anonymous standardized questionnaire. Frequencies of toothbrushing and consumption of sweets, soft drinks, fruits and vegetables were estimated in the present study. Age standardized data in aggregated samples of 11-15-years-olds were used for the comparisons across countries. Relationships between variables were estimated both at the individual's level and at the country's level. *Results:* The toothbrushing habits apparently were best in Switzerland, Norway and Sweden, as the proportion of children who reported toothbrushing more than once a day was higher than 74% of boys and higher than 84% of girls. The lowest prevalence of recommended toothbrushing (less than 32% of boys and 52% of girls) was in Malta, Lithuania and Finland. There was also a wide range across countries in proportions of daily consumption of fruits, vegetables, sweets and soft drinks. At the individual's level, in a number of countries, toothbrushing positively correlated with the consumption of fruits and vegetables. At the country's level such relationships were negligible. Relationships between eating patterns were identified both at the level of individuals and at the level of countries. *Conclusions:* The study provides some data to suggest that different oral health behaviour profiles exist across countries. Health education should consider these cross-national differences. The risk to oral diseases based on oral health behaviour need to be assessed in future studies.

**Key words:** children; health behaviour; oral hygiene; toothbrushing; dieting; health education

Poor oral hygiene and frequent and abundant consumption of sugars have been known for many years to play a key role as behavioural risk factors for oral diseases, such as dental caries and periodontal disease (1-4). Dental caries occur because of demineralization of enamel and dentine by organic acids by bacteria in dental plaque through the metabolism of sugars derived from diet (5). There is evidence to show that good oral hygiene can offset the effects of sugar on dental health (2, 6). Regular toothbrushing, at least twice a day, is the one of the most effective methods, which is widely applied for the control and prevention of dental caries and periodontal diseases (1, 7, 8).

The consumption of "sweets" and "soft drinks", such as colas and lemonades, that contain a lot of free sugar compromise the intake of more nutritious foods among children. Moreover, it has been suggested that sugar-sweetened food, rich of empty calories, refers to the most important risk factors in the development of obesity (9, 10). "Soft drinks" may be a cause of dental erosion (11). Children are more likely than adults to use these "foods", thus they are at the greater risk of dental caries.

An abundant and regular intake of fruits and vegetables

initiated during early childhood, decreases the risk of developing degenerative chronic diseases, such as cardiovascular diseases and cancer (12). Fruits and vegetables are important sources of vitamins and minerals, which are necessary in maintaining healthy oral mucous membrane and bones. Deficiencies of vitamins D and A have been associated with enamel hypoplasia and salivary gland atrophy, which render the teeth more susceptible to decay (13). Current research is investigating the potential role of antioxidants nutrients and vitamin C in periodontal disease (14, 15). Hard vegetables, for example, gray carrots and cabbage, as well as wholegrain foods require more mastication thereby stimulating increased saliva flow. Citrus fruits are known to stimulate saliva production (16).

Nevertheless, a number of plaque pH studies have found fruit to be acidogenic (11, 17). Therefore, the carbohydrates, naturally presented in fruit, is more desirable so then "free sugars" added to foods (11, 18).

Generally, oral hygiene care and focus on a healthy diet are essential for the development of effective oral health education programmes and practice targeted at young people. Toothbrushing and other behaviours that comprise young people's lifestyles may directly or indirectly impinge on their health in the short or long term. Most of behavioural patterns became established in earlier childhood. Oral health behaviour may constitute an integral part of an individual's lifestyle. Therefore these habits should be studied more extensively and be affected in the context of broader behavioural patterns, so as to provide a better empirical basis for preventive action (19, 20).

The number of researchers worldwide has recognized the perspective of studies on child's and adolescent's health behaviour. For this purpose, a special WHO research program, the cross-national survey among school-aged children was developed, which also included oral health hab-

<sup>1</sup>Docent., Dr. hab. med., Institute for Biomedical Research, Kaunas University of Medicine, Kaunas, Lithuania

<sup>2</sup>D.D.S., PhD., Assoc. prof., Head Clinic of Preventive and Pediatric Dentistry, Faculty of Odontology, Kaunas University of Medicine, Kaunas, Lithuania

<sup>3</sup>D.D.S., Assist. at the Clinic of Preventive and Pediatric Dentistry, Faculty of Odontology, Kaunas University of Medicine, Kaunas, Lithuania

<sup>4</sup>Post graduate student at the Faculty of Public Health, Kaunas University of Medicine, Kaunas, Lithuania

Address correspondence to: Apolinaras Zaborskis, Laboratory for Social Pediatrics, Institute for Biomedical Research, Kaunas University of Medicine, Eiveniu str. 4, LT-30009, Kaunas-7, Lithuania, e-mail: [socped@kmu.lt](mailto:socped@kmu.lt)

its. The Health Behaviour in School-aged Children (HBSC) is a unique cross-national research study conducted in collaboration with the WHO Regional Office for Europe. It is a research project that aims to gain new insight into and increase understanding of health behaviour, lifestyles and their context in young people. The study also aims to inform and influence health promotion and health education policy, programmes and practice aimed at school-aged children at the national and international level (21-23).

A specific objective of this study was to collect data on oral hygiene habits and related variables from various countries in the European region and North America, to compare its trends over time and between countries. Oral health behaviours are being investigated together with other health habits (19, 24).

This paper aims to describe the health behaviour patterns related to oral health (toothbrushing and dieting) in cross-national perspective and access its interrelations at the level of individuals and at the level of countries. The samples obtained for this study represent 11 – 15-year-old schoolchildren from 32 countries of Europe, Israel, Canada, and the United States of America in 2001-2002 school-year.

## MATERIALS AND METHODS

### Subjects

This study is a part of the cross-national study on Health Behaviour in School-aged Children (HBSC) conducted in collaboration with the WHO Regional Office for Europe. The research protocol for the study complies with the strict ethical standards that the WHO requires of its collaborative research. The surveys of schoolchildren are also being carried out according to the ethical procedures required by each individual participating country or region. Presentation of this paper agrees with the rules of Terms of Reference developed for the HBSC study. The philosophy and aims of the project have been described in more detail elsewhere (21, 22).

The HBSC school-based surveys used a common research protocol to standardize sampling methods, data collection, and measurements (23). The guidelines for the survey state that children of both genders of three age groups – 11, 13 and 15 years – should be targeted for each country. In each country, a cluster sample design of classrooms within schools was used to obtain recommended sample size, approximately 1500 children in each of three age groups, although very small countries or regions may have required fewer respondents. The samples are considered to be representative for pupils in each age group over the whole of each country.

This report is based on cross-sectional 2001-2002 school-year surveys of 11, 13 and 15-year-old children from 32 countries (or regions) of Europe, Israel, Canada, and the USA. Table 1 presents information on the countries or regions participated in that survey.

### Instruments and measures

The survey instrument was an anonymous standardized questionnaire which included structured questions followed by alternative answers. Questionnaire items were devised through cooperative research among members of the HBSC research network and finally approved by the Protocols. Then they were translated forward and backward from the English-language standard version to the national languages.

This analysis uses data from questions about oral health behaviour. Pupils were asked to indicate how often they brush their teeth. The following response categories were used: *more than once a day, once a day, at least once a week but not daily, less than once a week, never*. In the analyses, the answers were recoded into two categories: “regular brushing” = *more than once a day*, and “irregular

brushing” = the remaining answers.

The items on food habits related to oral health sought information on frequency of eating of fruits, vegetables, sweets (candy or chocolate) and drinking soft drinks (coke or others). Children indicated how often they consume each listed food item by choosing one of the following seven responses: *never, less than once a week, once a week, 2-4 days a week, 5-6 days a week, once a day, more than once a day*. To interpret the findings the following classification of the answer categories was used: “daily use” = *once a day or more than once a day*, and “less than daily use” = the remaining answers.

The relevance and the validity of all the studied questions has been studied during the pilot surveys (23).

The questions for this analysis were included into the list of core items that have been used by all participating countries. The rate of missing answers to any of questions was less than 0.6%.

### Data collection and file preparation

Questionnaires were administrated in schools between October 2001 and June 2002. The survey was conducted in school classes with a teacher or investigator overseeing the

**Table 1.** Countries and regions of HBSC survey in 2001-2002: number of respondents, by country and gender.

Country or region	Gender		Total
	Boys	Girls	
Austria	2241	2231	4472
Belgium-Flem <sup>1</sup>	2996	3293	6289
Belgium-Fren <sup>2</sup>	2069	2254	4323
Canada	1996	2365	4361
Croatia	2180	2217	4397
Czech Republic	2412	2600	5012
Denmark	2259	2413	4672
England	2943	3138	6081
Estonia	1983	1996	3979
Finland	2713	2675	5388
France <sup>3</sup>	4054	4131	8185
Germany <sup>4</sup>	2786	2864	5650
Greece	1870	1937	3807
Greenland	386	505	891
Hungary	1848	2316	4164
Ireland	1302	1573	2875
Israel	2625	3036	5661
Italy	2125	2261	4386
Latvia	1633	1848	3481
Lithuania	2887	2758	5645
Macedonia	2053	2108	4161
Malta	905	1075	1980
Netherlands	2120	2148	4268
Norway	2554	2469	5023
Poland	3204	3179	6383
Portugal	1419	1521	2940
Russia <sup>5</sup>	3752	4285	8037
Scotland	2246	2158	4404
Slovenia	1996	1960	3956
Spain	2873	2954	5827
Sweden	1978	1948	3926
Switzerland	2309	2370	4679
Ukraine	1893	2197	4090
USA	2322	2703	5025
Wales	2004	1883	3887
TOTAL	78936	83369	162305

<sup>1</sup> Flemish-speaking part.

<sup>2</sup> French-speaking part.

<sup>3</sup> Nancy and Toulouse regions only.

<sup>4</sup> Nordrhein-Westfalen region only.

<sup>5</sup> St. Petersburg and district of the Russian Federation only.

process. All personnel involved in the field work were fully trained and followed agreed guidelines. Anonymity of the answers was ensured in each country.

National data files were prepared and exported to the HBSC international databank at the University of Bergen (Norway). The data were checked and cleaned according to strict criteria, e.g. 90 percents of the respondents should fall within one-half a year of the mean age and the remaining 10 percents no more than one-half a year beyond this point. Schoolchildren outside the targeted age ranges were removed.

The final population of the cleaned data consisted of more than 160 thousands of young people (Table 1). The study population was well balanced by gender and age groups for all countries (data not presented).

**Statistical analyses**

Statistical analyses were carried out by Statistical Package for the Social Sciences (SPSS), version 11.5. Two steps of analysis were accomplished.

The first step was aimed to calculate statistical estimations of variables studied in combined 11-15-year-old population for each country. An univariate analyse of the distributions of the variables were completed by cross-tabulations according to gender and age groups. Then, in order to prevent not balanced age distribution in several countries, the age-adjusted distribution of variables in 11-15-year-old population was constructed using direct adjustment with equal age-specific rates (25). Finally, proportions of children who met required criteria were calculated for every country. These proportions represents country-specific indicators of oral health behaviour.

The second step included inter-country comparisons and analyses of country-specific data. For that reason a working data set was prepared. It consisted of 35 records identified by the name of the country or region. All 35 countries or regions were equally represented in the data set. Thus, the HBSC average values of health behaviour indicators were calculated as means of country-specific data without implication of different numbers of observations from each country. In addition, countries were ranked in ascending or descending order by values of selected indicator separately for boys and girls. The consistency between two country rankings, as well as the relationships between behavioural items within country, were estimated by Spearman's rank correlation coefficient, Rho (26). The associations between country-specific indicators were demonstrated using scatter diagrams and the linear regression technique. The level of statistical significance was 0.05.

**RESULTS**

**Toothbrushing**

In every country girls reported higher frequency of toothbrushing than boys and the proportion of children who brushed more than once a day was on the average about 15% greater for the girls than for the boys.

Fig. 1 presents proportions of regu-

lar toothbrushing, estimated for the HBSC countries or regions (units are sorted by descending order of that indicator, separately for boys and girls). For both genders, regular toothbrushing frequency was highest in Switzerland, Sweden, Norway and Denmark. In nominated countries regular toothbrushing was reported for more than 73% of boys and for more than 83% of girls.

Extraordinary low regular toothbrushing frequency was in Malta (16,4% of boys and 25,1% of girls). Going up, small proportions of toothbrushing more than once a day were identified also in Finnish, Lithuanian and Ukrainian populations of 11-15-year-old children, both for boys and girls.

The presented data show a wide range across countries in the proportion of children who brushed regularly their teeth – from 16.4% to 79.8% for boys and 25.1% to 88.7% for girls. Therefore, ranks of sorted countries among boys and among girls were highly correlated (Spearman's rank correlation coefficient Rho = 0.977).

With the exception of several countries, among girls regular toothbrushing seemed to become more frequent with increasing age (on average 7% between 11 and 15-year-olds), while among boys there was a wide range in age trends of this pattern.

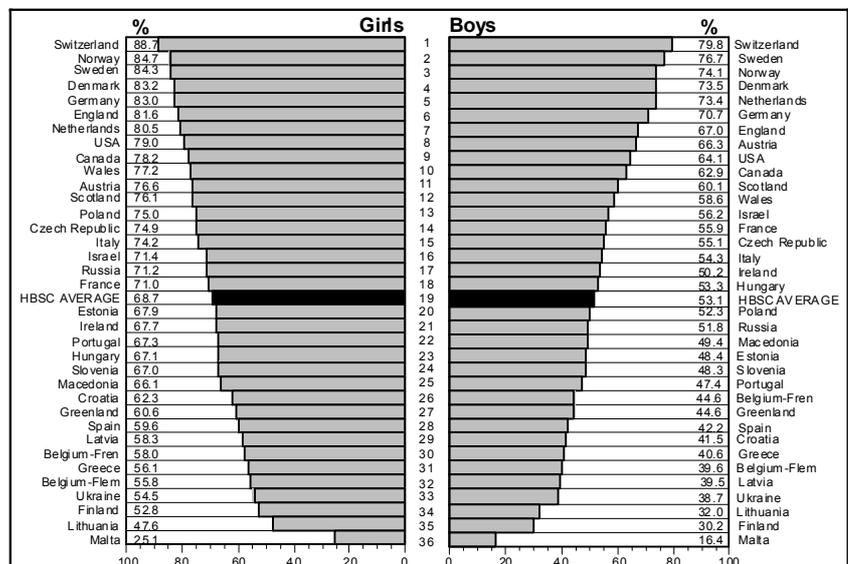


Figure 1. Proportions of toothbrushing more than once a day, 11-15-year-olds, in 35 countries or regions. Data are from the 2001-2002 HBSC survey.

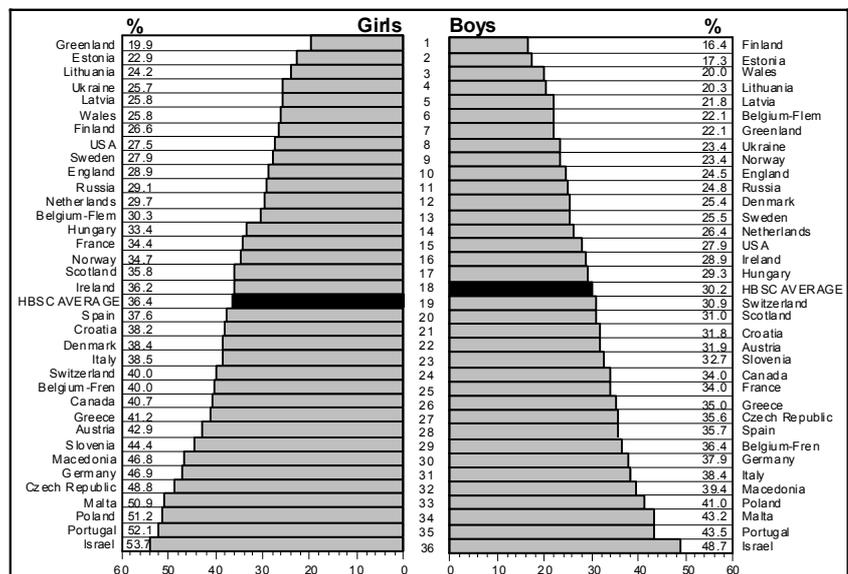


Figure 2. Proportions of eating fruits every day, 11-15-year-olds, in 35 countries or regions. Data are from the 2001-2002 HBSC survey.

Eating of fruits and vegetables

Figure 2 shows the proportion of boys and girls in the survey who reported eating fruits at least daily. There is a wide disparity in the proportions of daily consumption of fruits between countries – from 16.4% to 48.7% for boys and from 19.9% to 53.7% for girls. The consistency across gender groups of the country rankings in terms of that indicator was quite high (Rho=0.899).

A relatively small proportion (about one fifth) of boys in Finland, Estonia, Wales, Lithuania and Latvia reported that they ate fruits once or more than once a day. The pattern was quite similar for girls in this group of countries – girls from Estonia, Lithuania and Latvia were consistently among the smallest proportions of eating fruits daily (less than one fourth).

At the other end of the scale, over 40% of boys and over 50% of girls from Israel, Portugal, Malta and Poland indicated on daily eating of fruits.

In most countries (with exception of Greenland and the USA) it was marked that girls reported higher frequency of daily eating fruits than boys. Average gender difference was 6,2%. For both genders, in all many countries except Italy,

fewer 15-year-olds than 11-year-olds said they ate fruits at least once every day.

Fig.3 presents country-specific proportions of eating vegetables every day sorted in ascending order. The results suggests a wide variation of this indicator, ranging from a low of 10.3% of boys and of 11.3% of girls in Spain to a high of 46.9% of boys and of 57.8% of girls in Flemish-speaking Belgium part. The consistency across gender groups of the country rankings by proportion of children who reported eating vegetables daily was especially high (Rho=0.957).

Generally, fewer than half of the students and slightly more (on average about 5%) girls than boys ate vegetables daily. Comparison of the three age groups shows a decreasing trend of vegetable consumption by age (on average 5% between 11 and 15-year-old boys or girls).

Consumption of sweets and soft drinks

Both for boys and girls, the lowest proportions (less than 15%) of children who used sweets daily were in Finland, Denmark, Sweden, Greece and Norway, the highest proportions (more than 45%) of those children were in Malta and Ireland (Fig.4). The difference between the highest and the lowest proportions was approximately fivefold.

In average, there was no significant gender difference regarding consumption of sweets in most of the countries. The ranks of countries sorted by ascending proportion of daily eating sweets were highly correlated (Rho=0,948). The differences in frequencies of daily consumption of sweets between age groups were generally small too.

Figure 5 shows the proportion of boys and girls who drank soft drinks such as colas or lemonades at least once a day. The countries with the lowest proportion of children drinking soft drinks at least daily were essentially the same as those for sweets, mainly Finland, Denmark and Sweden but Lithuania and Estonia appeared consistently among these countries. Therefore, the highest proportions of students drinking daily soft drinks were identified in other countries – in Israel and Scotland. Going up by the scale, soft drinks are most drunk by boys in Netherlands, Belgium (Flemish-speaking part) and USA, or by girls in USA, Netherlands and Malta.

Overall, girls were less likely than boys to report daily consumption of soft drinks (on average about 7%). The range of responses between countries was also greater for girls (from 5.2% in Finland to 51.0% in Israel) than for boys (from 10.1 in Finland to 56.1% in Israel), nevertheless ranks of sorted countries among boys and among girls were highly correlated (Rho = 0.957).

Age seems to play an important role in determining patterns of consumption of soft drinks among boys. In most of the countries, the proportion of 15-year-old boys who consume soft drinks at least once a week was higher on average 7% than of their 11-year-old counterparts. For the girls, less marked an increasing trend of soft drinks consumption by age was identified.

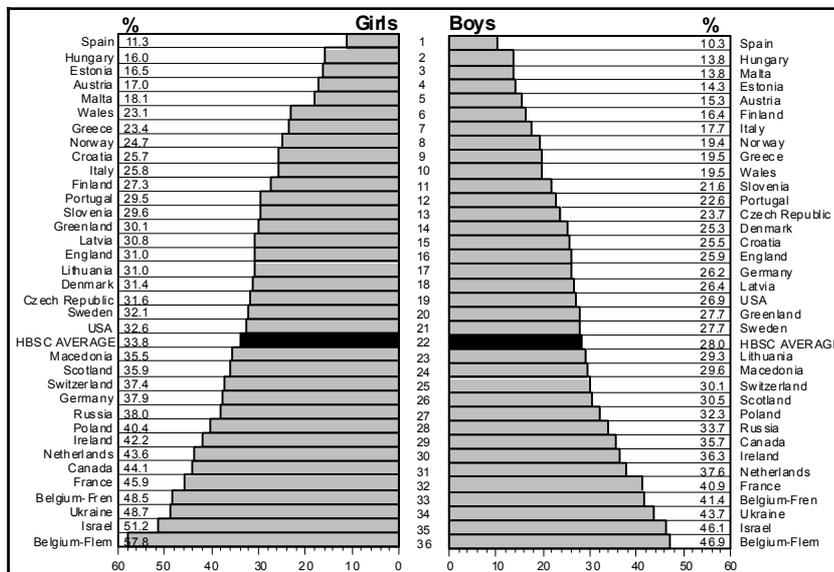


Figure 3. Proportions of eating vegetables every day, 11-15-year-olds, in 35 countries or regions. Data are from the 2001-2002 HBSC survey.

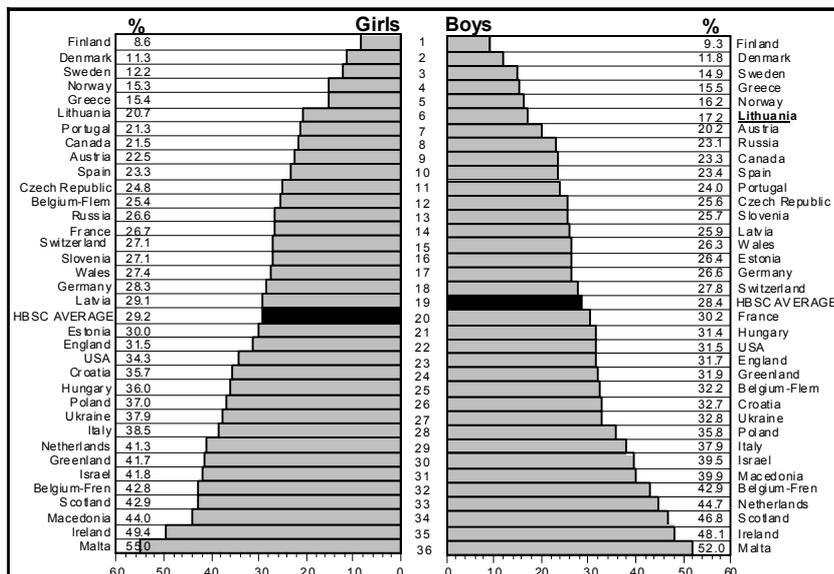


Figure 4. Proportions of eating sweets every day, 11-15-year-olds, in 35 countries or regions. Data are from the 2001-2002 HBSC survey.

**Correlation of oral health behaviours**

To learn associations of oral health behaviour items at the level of individuals Spearman's correlation coefficients (Rho) between studied items were calculated by the gender and countries. In a number of countries, toothbrushing frequency was positively correlated with the frequency of fruits and vegetables consumption (Table 2). Only in few countries, there was statistically significant, therefore in verse relationship between toothbrushing frequency and consumption of sweets and soft drinks. An exception was one country, Ukraine, in which toothbrushing frequency was positively linked to drinking of soft drinks.

In a number of countries, significant correlations were also detected between eating of fruits and vegetables as well as between eating of sweets and drinking soft drinks. Using data from all countries in aggregated form it was found that the coefficient of correlation between eating of fruits and vegetables was 0.377 for the boys and 0.375 for the girls. Correspondingly, the coefficient of correlation between eating of sweets and drinking soft drinks was 0.402 for the boys and 0.373 for the girls.

These results indicate that among young people consumption of healthy foods (fruits and vegetables) is part of an oral health-enhancing lifestyle including good oral hygiene, while consumption of unhealthy foods (sweets and soft drinks) is linked to poorer oral hygiene.

**Interrelationships between country-specific oral health behaviour indicators**

Table 3 shows correlations (Spearman's Rho) between five country-specific oral health behaviour indicators, both for the boys and for the girls. According to the findings presented in the table, the proportion of children who brushed their teeth regularly did not correlated significantly with country-specific eating items. Therefore, both for the boys and the girls, there was a strong correlation between scales of countries ranked by daily eating of sweets and daily drinking of soft drinks. In countries or regions in which the proportions of daily eating sweets were the lowest (for example, in Finland, Denmark, Sweden) the proportions of daily drinking soft drinks was also low. At the end, in countries in which the proportions of daily eating of sweets were the highest (for example, in Malta and Ireland) the proportions of daily drinking soft drinks likely seem to be high.

Among the boys, it was found out a relatively strong correlation between country-specific proportions of daily consumption of nutritious foods (fruits and vegetables) and of non-nutritious foods (sweets and soft drinks). Two of these four correlations were statistically significant. It is important to notify that there was a positive correlation between the variables; as one increases so does the other. Analogous relationships at the individual's level

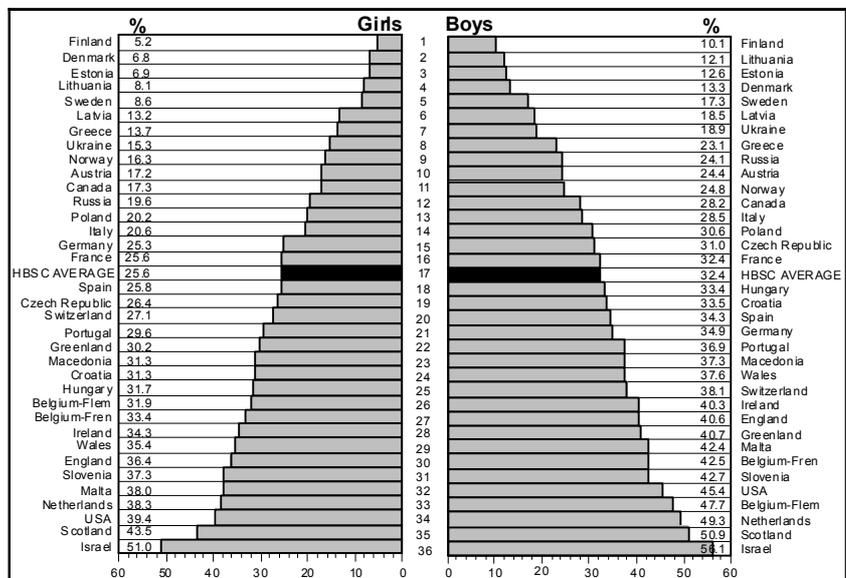


Figure 5. Proportions of drinking soft drinks every day, 11-15-year-olds, in 35 countries or regions. Data are from the 2001-2002 HBSC survey.

Table 2. Correlation (Spearman's Rho\*) of toothbrushing with consumption of fruits, vegetables, sweets and soft drinks, by gender of children and countries, 11-15-year-olds, HBSC survey in 2001-2002

Country or region	Boys				Girls			
	Fruits	Vegetables	Sweets	Soft drinks	Fruits	Vegetables	Sweets	Soft drinks
Austria					.131	.103		
Belgium-Flem	.187	.107			.157	.147		
Belgium-Fren	.129							
Canada	.153	.128			.130			
Croatia	.168				.152			
Czech Republic	.110			-.124	.113	.113		
Denmark	.102	.147			.132	.148		
England	.159	.154			.169	.120		
Estonia	.134				.128			
Finland	.153	.161			.126	.163		
France	.126				.109			
Germany	.146	.119						
Greece	.171	.132		-.106	.176	.138		
Greenland	.161	.232		-.148	.210			
Hungary	.141	.120			.133	.117		
Ireland	.154	.116		-.113	.178	.109		
Israel								
Italy	.166	.168			.100			
Latvia	.130				.203			
Lithuania	.167				.163	.110		
Macedonia	.168	.127			.123			
Malta	.202	.125				.145	-.166	-.150
Netherlands								
Norway	.139	.191						
Poland	.163	.154			.193	.144		
Portugal	.137					.100		
Russia	.153				.117			
Scotland	.192	.157		-.103	.163	.123		-.134
Slovenia	.133	.109			.155			
Spain	.177	.151			.167	.163	-.103	
Sweden		.100						
Switzerland		.103						
Ukraine	.183			.164	.146			.142
USA	.190	.111			.141			
Wales	.165	.145			.141	.142		
<b>TOTAL</b>	<b>.140</b>	<b>.111</b>			<b>.133</b>	<b>.100</b>		

\* Printed only values ≥ .100; all presented correlations are significant at the 0.01 level (2-tailed).

in a number of countries were negligible or, in few countries, were positive or inverse.

## DISCUSSION

Cross national comparison of health behaviours is important for evaluation of health programs especially in those countries where there is no history of monitoring practice. Possible behavioural differences between countries should be also considered if the health education programs are correctly targeted.

Several attempts have been made from the previous HBSC surveys to compare toothbrushing habits and eating patterns in various European countries (19, 21, 22, 24, 27). This study enables reliable comparisons of the oral health behaviours thus far at most number of participating countries using standardized methods for procedures of sampling and data collection. Moreover, the age standardized estimations, which represented aggregated samples of three selected age groups, were applied for the cross national comparison of data. This approach allows us to reduce the number of variates in analyses.

The following question might arise: how reliable is information gathered by the questions used in this study. The comparison of the present study results with earlier studies leads to the conclusion on high reliability of information because of consistent patterns in all studies. Strong similarities in the interrelationships between variables in different countries are also good evidence that there is validity in comparing the data from these different countries.

In this study, the toothbrushing figures for those countries, where previous HBSC surveys existed, corresponded quite well with the earlier studies in 1993-1994 and in 1997-1998 (19, 21, 22, 24, 27). In all surveys, among countries, where the highest proportion of children brushed their teeth according to the recommendations, were countries from Northern Europe: Sweden, Norway and Denmark. Since the last HBSC survey, Switzerland from the third place get in the top of ranked countries scale due to small decrease in the prevalence of regular brushing in Sweden and Denmark.

In contrast, the lowest proportion of those children for many years was in Lithuania and Finland, in two countries with the quite different social-economic background and oral health care service system. Less than half of children brush their teeth regularly, as it has been already found in previous surveys, in Flemish-speaking Belgium and Greece. Extraordinary low regular toothbrushing frequency was in Malta, which joined to the HBSC study recently. Maltese children reported also the highest proportion of daily eating sweets, as well as quite high proportion of daily drinking of soft drinks.

It is difficult to explain the main differences in oral hygiene habits across the countries studied on the basis of characteristics of the national economy or the health care system. Therefore, several epidemiological surveys have shown the importance of socio-economic background for determining children's toothbrushing behaviour (7, 20). The improvement of welfare and school health education would evidently also improve toothbrushing frequency (24). Also, intervention efforts should consider the existing cross national differences.

Besides children's dental hygiene habits, an attention was paid to their eating patterns related with the oral health. Our findings indicate that there are also substantial differences in food habits across countries. A number of factors play a role in these differences. In addition to personal and social factors, food availability and culture definitely play

**Table 3.** Correlation (Spearman's Rho) between country-specific oral health behaviour indicators, 11-15-year-old boys and girls, HBSC survey in 2001-2002.

	Tooth-brushing <sup>1</sup>	Fruits <sup>2</sup>	Vegetables <sup>3</sup>	Sweets <sup>4</sup>	Soft drinks <sup>5</sup>
	Girls				
Tooth-brushing <sup>1</sup>	1	0.118	0.124	-0.166	0.057
Fruits <sup>2</sup>	0.067	1	0.087	0.094	0.250
Vegetables <sup>3</sup>	0.087	0.011	1	0.237	0.203
Sweets <sup>4</sup>	-0.107	0.329	0.409*	1	0.660**
Soft drinks <sup>5</sup>	0.137	0.348*	0.324	0.696**	1
	Boys				

\* Correlation is significant at the 0.05 level (2-tailed).

\*\* Correlation is significant at the 0.01 level (2-tailed).

<sup>1</sup> Proportion of toothbrushing twice a day.

<sup>2</sup> Proportion of eating fruits every day.

<sup>3</sup> Proportion of eating vegetables every day.

<sup>4</sup> Proportion of eating sweets every day.

<sup>5</sup> Proportion of drinking soft drinks every day.

an important part (12, 28).

Regardless wide variation in food consumption patterns, the ranking of countries done in this study correspond well to those found in earlier surveys (21, 22). The highest proportions of daily consumption of sweets remain in Scotland, Ireland, and the highest proportions of daily consumption of soft drinks remain in the USA, Scotland, and Israel.

Another interesting finding in this study was obtained from the analysis of interrelationships of oral health behaviour items. At the individual's level, in a number of countries, toothbrushing positively correlated with the consumption of fruits and vegetables. In several countries, it correlated also with the consumption of sweets and soft drinks, but the inverse correlation was notified. The results indicate that consumption of healthy foods is part of a health-enhancing lifestyle, such as perfect dental hygiene habits. On the other hand, consumption of unhealthy foods is related to health-risk behaviours, such as poor dental hygiene habits. Thus, the food items in this survey may be better perceived as indicators of oral health-related lifestyles rather than comprehensive measures of healthy or unhealthy diets. The corresponding conclusion was drawn on the basis of analyses of relationships between dieting patterns and health-risk behaviour such as alcohol abuse and smoking (21).

Therefore, according to data of our study, at the country's level the relationships between toothbrushing and eating country-specific indicators were negligible. Therefore, relationships between eating patterns were identified both at the level of individuals and at the level of countries.

The later findings encourage as to the ecological research. As a good example of ecological research could be presented studies aimed to access relationship between the total sugar consumption and caries prevalence across countries (29). The results of our study also will give a possibility to test the hypothesis about relationship between oral health behaviour patterns and prevalence of oral diseases in studied countries if the latter data are gathered from existing data basis. However, if the hypothetical relationship exists only in the level of individual's, such research could end in failure.

In conclusion, the study provides some data to suggest that different oral health behaviour profiles exist across European countries, Israel, Canada, and the USA. Health education should consider these cross-national differences. The risk to oral diseases based on oral health behaviour need to be assessed in future studies.

## ACKNOWLEDGEMENTS

The *Health Behaviour in School-Aged Children (HBSC)* is a WHO/European Regional Office collaborative study. The international coordinator of the 2001-2002 survey was Candace Currie, University of Edinburgh, Scotland; the data bank manager was Oddrun Samdal, University of Bergen, Norway. A complete list of the participating researchers can be found on the HBSC-website <http://www.hbsc.org/>.

## REFERENCES

1. Axelsson P. Diagnosis and risk prediction of dental caries. Quintessence Publishing Co, Inc.; 2000;2.
2. Scully CS. ABC of oral health. BMJ Books. 2001.
3. Fejerskov O, Kidd EAM. Dental caries. The disease and its clinical management. Copenhagen: Blackwell Munksgaard. 2003.
4. Touger-Decker R, van Loveren C. Sugars and dental caries. Review. *Am J Clin Nutr* 2003;78(4):881S-892S.
5. Thylstrup A, Fejerskov O. Textbook of clinical cariology. Copenhagen: Blackwell Munksgaard. 1986.
6. Konig KG, Navia JM. Nutritional role of sugars in oral health. Review. *Am J Clin Nutr* 1995;62(Suppl1):275S-282S; discussion 282S-283S.
7. Addy M, Dummer PM, Hunter ML, Kingdon A, Shaw WC. The effect of toothbrushing frequency, toothbrushing hand, sex and social class on the incidence of plaque, gingivitis and pocketing in adolescents: a longitudinal cohort study. *Community Dent Health* 1990;7(3):237-47.
8. McDonald ME, Avery DR. Dentistry for the child and adolescent. Mosby. 2000.
9. Ludwig DS, Peterson KE, Gortmaker SL. Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet* 2001;357(9255):505-8.
10. Gillis LJ, Bar-Or O. Food away from home, sugar-sweetened drink consumption and juvenile obesity. *J Am Coll Nutr* 2003;22(6):539-45.
11. Rugg-Gunn AJ. Nutrition, diet and oral health. *J R Coll Surg Edinb* 2001;46(6):320-8.
12. World Health Organization. Diet, nutrition and the prevention of chronic diseases. Report of a Joint WHO/FAO Expert Consultation. World Health Organization Technical Report Series 916. Geneva: World Health Organization, 2003.
13. Rugg-Gunn AJ. Nutrition and dental health. Oxford: Oxford Medical Publications; 1993.
14. Enwonwu CO. Interface of malnutrition and periodontal diseases. Review. *Am J Clin Nutr* 1995;61(2):430S-436S.
15. Nishida M, Grossi SG, Dunford RG, Ho AW, Trevisan M, Genco RJ. Dietary vitamin C and the risk for periodontal disease. *J Periodontol* 2000;71(8):1215-23.
16. DePaola DP, Faine MP, Palmer CA. Nutrition in relation to dental medicine. In: Shils ME, Olson JA, Shike M, Ross AC, editors. Modern nutrition in health and disease, 9<sup>th</sup> ed. Baltimore, Md: Williams & Wilkens; 1999.
17. Hussein I, Pollard MA, Curzon ME. A comparison of the effects of some extrinsic and intrinsic sugars on dental plaque pH. *Int J Paediatr Dent* 1996;6(2):81-6.
18. Murphy SP, Johnson RK. The scientific basis of recent US guidance on sugars intake. Review. *Am J Clin Nutr* 2003;78(4):827S-833S.
19. Honkala E, Kannas L, Rise J. Oral health habits of schoolchildren in 11 European countries. *Int Dent J* 1990 Aug;40(4):211-7.
20. Koivusilta L, Honkala S, Honkala E, Rimpela A. Toothbrushing as part of the adolescent lifestyle predicts education level. *J Dent Res* 2003;82(5):361-6.
21. King A, Wold B, Tudor-Smith C, Harel Y. The health of youth. A cross-national survey. A report of the 1993-94 survey results of the Health Behaviour in School-Aged Children: A WHO Cross-National Study. WHO Regional Publications, European Series No. 69, Copenhagen: World Health Organization Regional Office for Europe, 1996.
22. Currie C, Hurrelmann K, Settertobulte W, Smith R, Todd J, Editors. Health and health behaviour among young people. Health Behaviour in School-aged Children: A WHO Cross-National Study (HBSC). International report. Copenhagen: World Health Organization Regional Office for Europe, 2000.
23. World Health Organization. Health Behaviour in School-Aged Children: A World Health Organization Cross-National Study. Research protocol for the 2001/02 survey. Edinburgh: the University of Edinburgh, 2002.
24. Kuusela S, Honkala E, Kannas L, Tynjala J, Wold B. Oral hygiene habits of 11-year-old schoolchildren in 22 European countries and Canada in 1993/1994. *J Dent Res* 1997;76(9):1602-9.
25. Kahn HA, Sempos CT. Statistical methods in epidemiology. Monographs in Epidemiology and Biostatistics. Vol. 12. New York, Oxford: Oxford University Press, 1989. p. 85-136.
26. Bland M. An introduction to medical statistics. 3<sup>rd</sup> ed. New York, Oxford: Oxford University Press, 2000. p. 220-2.
27. Honkala E, Kannas L, Rimpela M, Wold B, Aaro LE, Gilles P. Dental health habits in Austria, England, Finland and Norway. *Int Dent J* 1988;38(2):131-8.
28. Schneider D. International trends in adolescent nutrition. Review. *Soc Sci Med*. 2000;51(6):955-67.
29. Honkala E, Tala H. Total sugar consumption and dental caries in Europe-an overview. Review. *Int Dent J* 1987;37(3):185-91.

Received: 02 05 2004

Accepted for publishing: 20 05 2004