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Caries experience among Romanian schoolchildren: prevalence and trends 1992-2011

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Objectives: To assess the caries experience of 6-8- and 11-13-year-olds in Romania and to compare their caries levels with those from a previous study conducted in 1992. ***Methods:*** A cross-sectional pathfinder survey was conducted in five major cities of Romania (Iasi, Timisoara, Cluj-Napoca, Tirgu Mures and the capital, Bucharest) in 2011. Cities were purposively chosen for comparability with the 1992 study. Children were clinically examined by one trained dental examiner using the International Caries Detection and Assessment System (ICDAS II). ***Results:*** Among the 548 6-8-year-olds, 84.3% had caries experience (82.7% when carious lesions at stages 1-2 were excluded) with mean d_{1-6}mft and d_{3-6}mft of 4.76 (sd 3.46) and 4.43 (sd 3.35) respectively. Among the 592 11-13-year-olds, 83.1% had caries experience (76% when carious lesions at stages 1-2 were excluded) with mean D_{1-6}MFT and D_{3-6}MFT of 4.52 (sd 4.01) and 3.39 (sd 3.35) respectively. Advanced carious lesions were the main contributors to children's caries experience. There were significant differences by cities, with the lowest caries levels seen in Bucharest. High caries levels have persisted in Romania over the last decades in spite of a small but significant decrease in d_{3-6}mft and D_{3-6}MFT values between 1992 and 2011. Variations in caries trends were found by citiy. ***Conclusion:*** These findings show that high caries levels still exist among schoolchildren in the five cities included in the study. Romania has not yet achieved the WHO target for 2000 of an average DMFT lower than 3 at 12 years of age.

Key words*: dental caries, Romania, child, prevalence, trends*

Introduction

Dental caries remains one of the most widespread diseases in the world, constituting a public health problem especially in developing countries (Marcenes *et al.*, 2013). Caries decline is a priority issue for the World Health Organization (WHO), whose global goals for oral health for the year 2000 were to have at least 50% of 5-6-year-old children free from the disease and an average DMFT index not greater than 3 at 12 years of age (FDI, 1982). Data accumulated so far show a downward trend in caries rates among Western countries; this trend is especially evident in children (Do, 2012; Kassebaum *et al.*; Marthaler, 2004; Reich, 2001). Although positive trends have also been observed in some Eastern European countries, prevalence rates among children remain at high levels for most of these countries (Beaglehole *et al.*, 2009; Kassebaum *et al.*; Petersen *et al.*, 2005).

There have been no comprehensive oral health surveys in Romania in the last two decades. A pathfinder survey conducted in 1992 and some more recent local surveys suggest that the mean DMFT for 6- and 12-year-olds was far higher than in most developed countries (Marthaler, 1990; Marthaler *et al.*, 1996; Petersen *et al.*, 1994; Petersen and Rusu, 2002). An adequate knowledge of oral health needs at population level is the foundation for planning care services and health promotion and preventive interventions. Data from oral health surveys can also be used as a means to increase community awareness about oral health, to promote community participation in preventive actions, and to make the reorientation of oral health services towards prevention and oral health promotion easier (WHO, 1997). Furthermore, WHO has recommended collecting epidemiological data routinely for oral health surveillance in both developed and developing countries (Petersen, 2009).

Most caries detection methods only take into account cavitated lesions (Ismail *et al.*, 2007). However, detection of lesions during the early non-cavitated stage is now an important step in the diagnostic process. Given the dynamic nature of dental caries, if the disease is detected early enough at the non-cavitated stage, it may be possible to enhance remineralisation or inhibit demineralisation by appropriate preventive measures (Featherstone, 2004). Therefore, the early detection, assessment and correct diagnosis of non-cavitated lesions are key objectives in the overall effort to move from operative towards non-operative preventive dentistry (Pitts, 2004b). Preventive strategies must be applied according to current diagnostic criteria that include non-cavitated lesions (Ismail *et al.*, 2007). Currently, no single standard caries detection/assessment system is universally accepted. The International Caries Detection and Assessment System (ICDAS) is a visual classification system for clinical caries diagnosis that was developed to provide clinicians, epidemiologists and researchers

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with an evidence-based system, to allow standardised data collection in different settings and to enable better comparison between studies (Pitts, 2004a). It has good validity and high reliability for caries detection in both primary and permanent teeth, and there is an increasing amount of literature supporting its applications (ICDAS Coordinating Committee, 2011; Ismail *et al.*, 2007).

This study aimed to assess the prevalence of dental caries, diagnosed using the ICDAS II, among 6-8- and 11-13-year-old schoolchildren in Romania and to compare caries levels with those from a previous study conducted in 1992. This allowed exploring the long-term trends in caries experience among Romanian schoolchildren between 1992 and 2011.

Methods

A cross-sectional oral health survey of schoolchildren was conducted in five major cities of Romania (Iasi, Timisoara, Cluj-Napoca, Tirgu Mures, and the capital Bucharest) in 2011. Children were selected using a stratified cluster sampling, following the pathfinder survey methodology (WHO, 1997). Cities were purposively chosen for comparability with findings from the previous national pathfinder survey conducted in the same five cities (Petersen *et al.*, 1994). In each city, two state schools were selected for having on their premises an available dental chair for the clinical examinations. All 592 6-8-year-olds and 618 11-13-year-olds in the selected schools were invited to participate in the survey (with 92.6% and 95.8% response rates, respectively). A minimum sample size of 37 participants per city had an 80% power to detect a difference in the dmft/DMFT score of 1 unit or greater between any two cities at 5% significance level, and assuming a common standard deviation of 1.5 units.

The Research Ethics Committee of the "Grigore T. Popa" University of Medicine and Pharmacy Iasi approved the survey protocol. Parents were fully informed about the study and given the opportunity to opt out. Children were only examined if written parental consent was provided.

All examinations were performed by one trained and calibrated dentist (DB), during normal school hours, in the schools' dental office, where a dental unit with functioning operation light and pressurised air was available. Clinical examinations were conducted using plane mouth mirrors and CPI probes, following the ICDAS recommended protocol (2009). Dental caries was recorded according to the ICDAS II diagnostic criteria (ICDAS Coordinating Committee, 2009; Ismail *et al.*, 2007), which uses a two-digit coding method. The first digit (0 to 8) refers to the presence of restorations and/or sealants and the second digit (0 to 6) refers to the actual stage of the carious lesion. Another four special codes are used to record missing tooth surfaces and those excluded from examination. No radiographs were taken. Caries experience was described using the sum of decayed, missing and filled teeth (dmf/DMF index). The ICDAS II caries codes were classified in two groups of severity: non-cavitated enamel carious lesions at d/D_{1-2} level (codes 1 and 2); and cavitated carious lesions at d/D_{3-6} level (codes 3 to 6). The f/F component included surfaces with fillings associated or not with early lesions (codes 1 and 2) on the same tooth surface. Fillings diagnosed in conjunction with cavitated carious lesions (codes 3 to 6) were added to the d/D component for calculation of dmf/DMF index. Occlusal surfaces with full or partial sealants were considered as healthy (code 0) (ICDAS Coordinating Committee, 2009). Intra-examiner reliability in caries diagnosis was determined by re-examining 92 children from the age groups (a total of 9,901 tooth surfaces) after a week. Kappa value was 0.95 at surface level.

Children's caries experience was compared by gender using the Mann-Whitney test and by cities using the Kruskal-Wallis test, as dmft/DMFT scores had a skewed distribution. If the latter test was significant, the Mann-Whitney test was then used for the post-hoc comparisons. Caries prevalence was calculated both including all caries codes (codes 1 to 6) and only cavitated lesions (codes 3 to 6).

Summary data at tooth-level from all previous surveys (Marthaler, 1990; Marthaler *et al.*, 1996; Petersen *et al.*, 1994; Petersen and Rusu, 2002) were used to plot caries trends. The 1992 survey was the main focus for comparison as it was collected on the same five cities and used comparable diagnostic criteria for dental caries. Briefly, caries was diagnosed if there was evidence of broken enamel on smooth surfaces or probe sticks with or without staining in fissures or pits (Petersen *et al.*, 1994), which is equivalent to code 3 on ICDAS II (ICDAS Coordinating Committee, 2009). Caries experience was reported as the deft/DMFT index (Petersen *et al.*, 1994). The deft index referred to the sum of decayed, extracted due to caries and filled teeth, which is therefore equivalent to d_{3-6}mft. For the full sample and each city, mean d_{3-6}mft and D_{3-6}MFT scores were compared over time (between 1992 and 2011) using the one-sample Wilcoxon signed rank test.

Results

The sample comprised 548 6-8-year-olds (282 boys, 266 girls; mean age 7.4 years, sd 0.6) and 592 11-13-year-olds (269 boys, 323 girls; mean age 12.3 years, sd 0.7).

In 6-8-year-olds, the prevalence of dental caries including enamel and dentine carious lesions (d_{1-6}mft>0) was 84.3% and the prevalence of established dental caries (d_{3-6}mft>0) was 82.7%. The mean d_{1-6}mft and d_{1-6}mfs were 4.79 (sd 3.46) and 9.89 (sd 9.34) whereas the d_{3-6}mft and d_{3-6}mfs were 4.43 (sd 3.35) and 9.28 (sd 9.09), respectively. Carious lesions at stage 6 were the largest contributors to dmft/s values. No differences in caries experience or its components were found by gender (all $p>0.05$). However, there were significant differences by city, except for the number of missing teeth and the number of missing and filled tooth surfaces (Table 1). The highest d_{3-6}mft/s scores were observed in Cluj-Napoca (5.28 and 10.87 respectively) and Iasi (4.94 and 10.78) while the lowest values were observed in Bucharest (3.33 and 6.76) and Tirgu Mures (3.45 and 7.16).

Table 1. Caries experience in 6-8-year-old Romanian children in 2011 (n=548), overall and by city

	Over all 5 cities	*Bucharest (n=111)*	*Iasi (n=155)*	*Cluj-Napoca (n=108)*	*Timisoara (n=99)*	*Tirgu Mures (n=75)*	*p*
	Mean (sd)	*Mean (sd)*	*Mean (sd)*	*Mean (sd)*	*Mean (sd)*	*Mean (sd)*	
$d_{1-2}t$	0.33 (0.86)	0.37 (1.14)^{a}	0.18 (0.43)^{b,c}	0.44 (0.81)^{b,d}	0.18 (0.52)^{d,e}	0.65 (1.25)^{a,c,e}	**0.001**
$d_{3-6}t$	3.76 (3.23)	2.60 (2.97)^{a,b,c}	4.41 (3.06)^{a,d}	4.64 (3.55)^{b,e}	3.89 (3.17)^{c,f}	2.72 (2.85)^{d,e,f}	**<0.001**
mt	0.18 (0.57)	0.14 (0.44)	0.26 (0.76)^{a}	0.08 (0.28)^{a}	0.22 (0.60)	0.17 (0.53)	0.256
ft	0.48 (0.99)	0.59 (1.07)^{a}	0.28 (0.73)^{a,b,c}	0.56 (1.08)^{b}	0.55 (1.05)^{c}	0.56 (1.09)	**0.027**
d_{3-6}mft	4.43 (3.35)	3.33 (3.45)^{a,b,c}	4.94 (3.12)^{a,d}	5.28 (3.42)^{b,e}	4.66 (3.36)^{c,f}	3.45 (2.98)^{d,e,f}	**<0.001**
$d_{1-2}s$	0.61 (1.33)	0.75 (1.69)^{a}	0.41 (0.87)^{b,c,d}	0.81 (1.44)^{b,e}	0.23 (0.64)^{a,c,e,f}	0.99 (1.80)^{d,f}	**<0.001**
$d_{3-6}s$	7.51 (8.41)	4.94 (7.10)^{a,b,c}	8.98 (8.22)^{a,d}	9.52 (9.99)^{b,e}	7.63 (0.80)^{c,f}	5.20 (7.25)^{d,e,f}	**<0.001**
ms	0.85 (2.63)	0.59 (1.85)	1.22 (3.55)^{a}	0.41 (1.36)^{a}	1.07 (2.84)	0.80 (2.39)	0.250
fs	0.93 (1.93)	1.23 (2.22)^{a}	0.58 (1.30)^{a}	0.94 (2.00)	0.96 (2.08)	1.16 (2.19)	0.115
d_{3-6}mfs	9.28 (9.09)	6.76 (8.34)^{a,b,c}	10.78 (8.96)^{a,d}	10.87 (9.90)^{b,e}	9.66 (9.14)^{c,f}	7.16 (8.04)^{d,e,f}	**<0.001**

Kruskal-Wallis test was used for the omnibus comparison and Mann Whitney tests were used for the comparisons by pairs. For each row, cities with similar letters in superscripts indicate that the caries indicator was significantly different between them.

Table 2. Caries experience in 11-13-year-old Romanian children in 2011 (n=592), overall and by city

	Over all 5 cities	*Bucharest (n=226)*	*Iasi (n=139)*	*Cluj-Napoca (n=105)*	*Timisoara (n=66)*	*Tirgu Mures (n=56)*	*p*
	Mean (sd)	*Mean (sd)*	*Mean (sd)*	*Mean (sd)*	*Mean (sd)*	*Mean (sd)*	
$D_{1-2}T$	1.13 (1.56)	0.63 (1.23)^{a,b,c,d}	1.23 (1.69)^{a,e}	1.91 (1.73)^{b,e,f}	1.03 (1.41)^{c,f}	1.52 (1.53)^{d}	**<0.001**
$D_{3-6}T$	2.72 (3.05)	1.07 (1.63)^{a,b,c,d}	3.45 (2.79)^{a}	3.94 (3.37)^{b}	4.53 (3.59)^{c,e}	3.20 (3.64)^{d,e}	**<0.001**
MT	0.04 (0.25)	0.01 (0.94)^{a,b}	0.02 (0.15)^{c}	0.10 (0.39)^{a,c}	0.11 (0.40)^{b}	0.05 (0.30)	**0.006**
FT	0.62 (1.21)	0.38 (0.98)^{a,b}	0.57 (1.16)^{c,d}	1.05 (1.42)^{a,c,e}	0.97 (1.49)^{b,d}	0.52 (1.13)^{e}	**<0.001**
D_{3-6}MFT	3.39 (3.36)	1.46 (1.85)^{a,b,c,d}	4.04 (2.88)^{a,e,f}	5.10 (3.42)^{b,e,g}	5.61 (3.96)^{c,f,h}	3.77 (4.20)^{d,g,h}	**<0.001**
$D_{1-2}S$	1.71 (2.10)	0.86 (1.48)^{a,b,c,d}	2.19 (2.32)^{a,e}	2.50 (2.16)^{b,f}	1.55 (1.94)^{c,e,f,g}	2.66 (2.46)^{d,g}	**<0.001**
$D_{3-6}S$	3.89 (5.27)	1.38 (2.42)^{a,b,c,d}	5.00 (5.61)^{a}	5.90 (6.28)^{b,e}	6.50 (5.96)^{c,f}	4.36 (5.84)^{d,e,f}	**<0.001**
MS	0.22 (1.25)	0.04 (0.47)^{a,b}	0.11 (0.73)^{c}	0.52 (1.95)^{a,c}	0.53 (1.99)^{b}	0.27 (1.48)	**0.006**
FS	0.96 (1.94)	0.50 (1.25)^{a,b}	0.85 (1.84)^{c,d}	1.64 (2.17)^{a,c,e}	1.67 (2.75)^{b,d}	1.04 (2.26)^{e}	**<0.001**
D_{3-6}MFS	5.07 (6.30)	1.93 (2.75)^{a,b,c,d}	5.96 (6.28)^{a,e,f}	8.06 (6.97)^{b,e,g}	8.70 (7.60)^{c,f,h}	5.66 (7.84)^{d,g,h}	**<0.001**

Kruskal-Wallis test was used for the omnibus comparison and Mann Whitney tests were used for the comparisons by pairs. For each row, cities with similar letters in superscripts indicate that the caries indicator was significantly different between them.

In 11-13-year-olds, the prevalence of dental caries including enamel and dentine carious lesions (D_{1-6}MFT>0) was 83.1% and the prevalence of established dental caries (D_{3-6}MFT>0) was 76.0%. The mean D_{1-6}MFT and D_{1-6}MFS were 4.52 (sd 4.02) and 6.78 (sd 7.25) whereas the mean D_{3-6}MFT and D_{3-6}MFS were 3.39 (sd 3.36) and 5.07 (sd 6.30), respectively. Carious lesions at stage 6 were the largest contributors to DMFT/S values. There were no differences in caries experience or its components by gender (all p>0.05). However, there were significant differences in all measures by city (Table 2). The highest D_{3-6}MFT/S values were observed in Timisoara (5.61 and 8.70 respectively) and Cluj-Napoca (5.10 and 8.06) while the lowest values were observed in Bucharest (1.46 and 1.93).

Figure 1 shows trends in mean d_{3-6}mft/D_{3-6}MFT values between 1986 and 2011. Levels of caries experience have remained constant over the last 25 years in both primary and permanent dentition, with a peak in the early nineties. There was a significant decrease in both the d_{3-6}mft and D_{3-6}MFT values between 1992 and 2011 (p<0.001 in both cases). Table 3 presents the comparison by cities over time. Among 6-8-year-olds, there were no significant changes in the mean d_{3-6}mft in Iasi or Timisoara. However, there were significant decreases in the mean d_{3-6}mft in Bucharest, Cluj-Napoca and Tirgu Mures, with the largest decrease seen in Bucharest and the smallest decrease seen in Iasi. Among 11-13-year-olds there were significant changes in the mean D_{3-6}MFT in all cities. However, significant decreases were found in Bucharest, Cluj-Napoca and Tirgu Mures whereas significant increases were found in Iasi and Timisoara. Again, the largest decrease was found in the capital city, Bucharest (Table 3).

Table 3. Changes over time (1992-2011) in caries experience among 6-8- and 11-13-year-old children by city

City	*6-8-year-olds ($d_{3-6}mft$)*			*11-13-yearolds ($D_{3-6}MFT$)*		
	1992	*2011*	*p value*	*1992*	*2011*	*p value*
	Mean (SE)	*Mean (SE)*		*Mean (SE)*	*Mean (SE)*	
Bucharest	5.2 (0.5)	3.3 (0.3)	**<0.001**	4.8 (0.3)	1.5 (0.1)	**<0.001**
Iasi	5.1 (0.6)	4.9 (0.3)	0.221	3.0 (0.2)	4.0 (0.2)	**<0.001**
Cluj-Napoca	6.6 (0.4)	5.3 (0.3)	**<0.001**	5.9 (0.4)	5.1 (0.3)	**0.013**
Timisoara	5.2 (0.3)	4.7 (0.3)	0.081	3.3 (0.2)	5.6 (0.5)	**<0.001**
Tirgu Mures	4.9 (0.3)	3.5 (0.3)	**<0.001**	4.6 (0.3)	3.8 (0.6)	**0.011**

One-sample Wilcoxon signed rank test was used for comparisons.

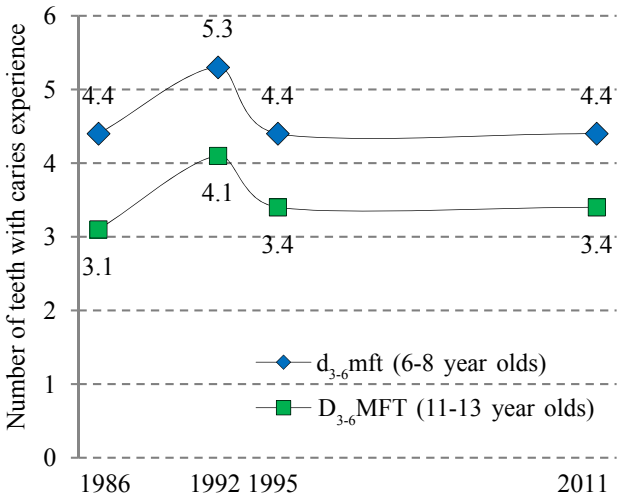

Figure 1. *Caries trends among 6-8- and 11-13-year-olds in Romania. The $d_{3-6}mft$ and $D_{3-6}MFT$ values for the 1986 and 1995 survey correspond to 6- and 12-year-olds only.*

Discussion

This study found high levels of dental caries in children of both age groups, suggesting that this oral disease remains a problem in Romania. At national level, our findings confirm the divide between Western and Eastern Europe as they are similar to those seen in other Eastern European countries but higher than those observed in Western European countries (Petersen *et al.*, 2005; WHO, 2013). Advanced stages of disease were the main contributors of caries experience, indicating a high normative need for restorative dental care among these children. At the local level, we found differences in caries experience by cities with lower caries levels in primary and permanent teeth among children in the capital Bucharest and Tirgu Mures. These two cities are more economically developed than the rest of the country and there are some cultural differences between different regions of Romania due to the influence of the neighbouring countries.

Findings from our trend analysis showed that caries levels in Romanian children have remained stable since the eighties; with a slight decrease observed between the largest two surveys conducted in 1992 and 2011. Our finding agrees with what is known about the epidemiology of dental caries in Europe, with major improvements in caries levels observed among children in Western countries but only minor improvements in Eastern countries in the last 30 years (Kassebaum *et al.*; Marthaler, 1990; 2004). Although caries levels have declined globally in the last three decades, Romania has not yet met the WHO targets for dental caries for the year 2000, namely most 5-6-year-olds are caries-free and DMFT for 12-year-olds should be ≤3.0 (FDI, 1982).

In addition, analyses based on national estimates may mask inequalities that exist within countries. In this regard, we found caries declines in primary and permanent teeth in Bucharest (the greatest declines), Cluj-Napoca and Tirgu Mures while no changes in primary teeth and caries increments in permanent teeth in Iasi and Timisoara. These changes over time by cities may be attributed to the political and economic changes that Romania has experienced in the last two decades but which have affected each part of the country differently. There is no water fluoridation in Romania (Baez *et al.*, 2007). However, children in the capital are more likely to be exposed to topical fluoride from school preventive programmes or during dental visits. Further research should explore why the caries decline is more pronounced in the capital. Therefore, there is a pressing and urgent need for strengthening of public health programmes through implementation of effective oral disease prevention measures and oral health promotion at both population and individual level. The revitalisation of the school dental services would meet the need for preventive and curative care in children, and schools also provide an appropriate setting for oral health promotion.

This study has some limitations which need to be addressed. First, although this study was based on a relatively large sample with good participation rate, children were drawn by non-probabilistic sampling, and therefore, they may not represent the general child population of 6-8- and 11-13-year-olds in Romania. However, the pathfinder survey methodology is widely advocated by the WHO (1997) and provides a satisfactory degree of precision on the oral health status of a population for planning purposes when compared to random national samples (Bourgeois *et al.*, 1992). Second, our analysis of caries trends was limited by the fact that we did not have access to the full data of the 1992 study. This issue forced us to use summary estimates reported in previous publications instead (Petersen *et al.*, 1994), which narrowed the scope and depth of our analysis. However, even with these restrictions we were able to perform meaningful comparisons at country and city levels.

In conclusion, there were high levels of dental caries in both children and adolescents. Advanced carious lesions were the main contributors to children's caries experience, indicating an increased need for preventive and restorative treatment in both age groups. Lower levels of caries experience were found in 2011 than in 1992. However, improvements were not observed across all of the five cities evaluated; the capital Bucharest showed the greatest improvement whereas Iasi and Timisoara showed some deterioration of children dental status, particularly among 11-13-year-olds.

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