Prevalence of Dental Caries in Child School from two Libya's Western Cities with Different Levels of Fluoride in Their Drinking Water

Abdalraof M. Nasr [1], Dalia M. Moheb[2] and Eman S. El Masry [3]

[1] M.Sc. of Pediatric Dentistry, Faculty of Oral Medicine and Dental Surgery, Al-Zawia University, Libya.
[2] Lecturer of Pediatric Dentistry, Faculty of Oral and Dental Medicine, Cairo University.
[3] Professor of Pediatric Dentistry, Faculty of Oral and Dental Medicine, Cairo University.
dr_3bdalraof@yahoo.com

Abstract: Background: Dental caries is one of the commonest oral diseases in children. Despite this fact, not much attention has been given to studies on this issue among libyan school children. **Objectives:** To assess prevalence and severity of dental caries among 6-12 years old children in relation to fluoride concentration levels in drinking water. **Design:** Cross-sectional observational study, done in two cities, Libya (endemic fluoride belt). **Subjects and Methods**: 2000 children; aged 6-12 years (969 boys, 1031 girls*)* were examined from four randomly selected public schools. Dental caries was measured using the WHO diagnostic criteria (1997). Water fluoride levels were determined from samples obtained from drinking water sources. **Results:** Overall caries prevalence was 60.8%, off all the three groups (Group I 6-8 years old = 55%; Group II 9-10 years old = 64.2% and Group III 11-12 years old = 61.5%) with the highest caries prevalence in group III and lowest in group I. The overall mean DMFT, deft and dmft indices were 1.01 (SD ± 1.48), 1.35 (SD ± 1.84) and 1.45 (SD ± 2.39), respectively for all subjects. There was a statistically significantly negative correlation in overall mean DMFT scores of children at various water fluoride levels (10.73 ± 0.36 ppm)($P = 0.020$). Caries experience was more among girls than boys ($P = 0.021$). **Conclusion:** The caries prevalence among schoolchildren was very high, and that there was a negative correlation between caries experience and fluoride concentration for the entire study population. In high fluoride areas, there was a positive correlation between fluoride concentration and dental caries. Water defluoridation on an urgent basis is a priority in Libya than water fluoridation. Effective oral health promotion strategies need to be implemented to further improve the dental health of school children.

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1.Introduction

Dental caries is a multifactorial, irreversible microbial disease of the calcified tissues of the teeth, characterized by demineralization of the inorganic portion and destruction of the organic substance of the tooth, which often leads to cavitation. ***(Latoo et al., 2009)***.

Indeed, the use of fluoride is recognized as one of the most successful measures for caries prevention in the history of public health. The inverse relation between the fluoride concentration of drinking water and dental caries has been known for decades and fluoridation of drinking water for caries prevention is recommended by health authorities ***(Petersen and Lenon, 2004).*** However, "*fluoride is often termed a double edged weapon*" the optimal and judicious use of which offers maximum caries protection, whereas injudicious and excessive systemic consumption may lead to chronic fluoride toxicity, which manifests as dental and skeletal fluorosis ***(Gazzano et al., 2010).***

The main action of fluoride in reducing dental caries is through the ionic exchange between enamel surface and the fluoride. This reaction will change the surface calcium hydroxyapatite of enamel to calcium fluoroapatite which is more resistant to dissolution in acids (***Featherston, 2008*)**.

The safe and acceptable concentration of fluoride in drinking water was indicated to be 1.13 ppm, which would lead to maximum caries protection with least amount of esthetically objectionable fluorosis at that level ***(Marya et al., 2010).***

Libya has been cited as an endemic fluoride belt ***(Mameri et al., 1998; Fawell et al., 2006; Brindha and Elango, 2011).*** Unfortunately the literature on the prevalence of dental caries and especially dental fluorosis among school children in this area, where the fluoride concentration in drinking water exceeded the optimal level is scanty. For that reason the present study was carried out with an objective of determining the relationship between prevalence of dental caries and fluoride concentration in drinking water among 6 to 12 years school children, living in different fluoride areas of two Libyan western cities.

2. Subjects and Methodos

A total number of 2000 Libyan children were included in this study, their ages ranged from 6-12 years old. These children had lived continuously since birth in their respective communities. Before starting the study an approval and permission to the study was given by the local School Health and Education Directorate authorities after explaining the aim of the study, and an informed consent was obtained from the principals of the selected schools who were also requested to inform the parents about the study to give them the possibility for negative consent prior to the examination.

Study areas

This cross-sectional observational study was conducted in two cities at various distances from Tripoli (Capital of Libya), Al Zawia city which is located 35 km and Al Zahra city was 20 km western of the capital, both cities depend on underground water sources for domestic use and presumed to have similar socio-economic conditions. Two public primary schools from each city were randomly selected to obtain the desired sample size.

Child's selection and grouping

Children were selected according to their ages from those attending primary schools and classified into 2 main groups (males and females). Each group was subdivided according their ages into three subgroups. Children belonging to 6-8 years were classified into Group I, 9-10 years into Group II and 11 – 12 years into Group III.

Dental examination

Clinical examination was carried out to assess the child's caries experience. It was conducted in the respective schools while the child was sitting on an ordinary chair in day light facing a window in the class room. The clinical examination was carried out using disposable mouth mirrors and sharp explorers.

Dental caries was assessed using dmft index for primary dentition, deft index was utilized in mixed dentition and DMFT index for permanent teeth following the diagnostic criteria of World Health Organization ***(WHO, 1997)***. Examination of child was done by only one examiner to avoid inter-examiner variability, and recoding of data was done by a trained person who assisted throughout the study. Immediate care was given and referral was made when required.

Background information

Prior to the clinical examination the children were interviewed regarding age, sex, place of birth and source of drinking water. Only children living in the study areas since the age of 1 year were included in the study. Examination chart was used to record the children personal and clinical data.

Collection and analysis of drinking water

In order to determine fluoride level, drinking water samples (500 mL) were collected from water sources (water supplies wells) consumed by the study subjects of the selected areas and stored in clean bottles before being analyzed.

Fluoride content in water samples was analyzed using an ion-selective electrode **(Fluoride Portable Meter / ISE meter)** using direct calibration method, which allows optimum analysis of fluoride concentration in the aqueous solution in the range of parts per million (ppm) ***(Heilman et al., 2011).***

3.Results

Epidemiological survey was conducted for 2000 school children. Their ages ranged from 6 -12 years old; 969 (48.5%) males and 1031 (51.5%) females, and mean of age were 9.4 ± 1.9 years. Out of the study population 547 children were aged 6 – 8 years old (27.4%) belong to group I, 799 children aged 9 – 10 years old (40%) belong to group II and 654 children aged 11 – 12 years old (32.7%) belong to group III. In total, dental caries was encountered in 1216 (60.8%) of study population. When the caries prevalence of groups was interrelated the difference was found statistically significant and there was no statistically significant difference between mean DMF and def in different age groups [Table 1].

Table 1: Showing age group distribution, dental caries prevalence and indices in different age groups.

Age groups	Group distribution		Caries prevalence		Caries indices			
					DMF		def	
	No.	%	No.	%	Mean	±SD	Mean	±SD
Group I (6 – 8) years	547	27.4	301	55	0	0	1.67	2.11
Group II (9 – 10) years	799	40.2	513	64.2	0.03	0.21	1.35	1.81
Group III (11 – 12) years	654	32.7	402	61.5	0.06	0.30	1.00	1.46
Total	2000	100	*P*-value	0.003*	*P* -value	0.668	*P* -value	0.395

Comparison between males and female

When the males and females were interrelated in respect to mean DMF there was a statistically significant difference evident showing females showed higher mean DMF in comparison to males (*P*= 0.021*). However there was no statistically significant difference between mean def and dmf values in males and females [Table 2].

[Table 2]: Showing the comparison between caries indices in males and females.

Caries index	Males		Females		*P* - value
	Mean	±SD	Mean	±SD	
DMF	0.97	1.51	1.05	1.44	0.021*
def	1.30	1.76	1.41	1.91	0.458
dmf	1.36	2.96	1.53	1.90	0.147

*: Significant at $P \leq 0.05$

Water Fluoride level and caries indices

The mean and standard deviation values of water fluoride levels in schools participating in the present study were 10.73 ± 0.36 ppm with a minimum of 10.2 ppm and a maximum of 11 ppm.

There was a statistically significant negative (inverse) correlation between water Fluoride level and DMF i.e. an increase in water Fluoride level was associated with a decrease in DMF [Table 3 / Fig 1]. There was no correlation between water Fluoride levels, def and dmf. When the two districts were interrelated District A showed statistically significant higher mean water Fluoride level compared to District B [Table 4].

Table 3 : Showing caries experience in relation to water Fluoride levels.

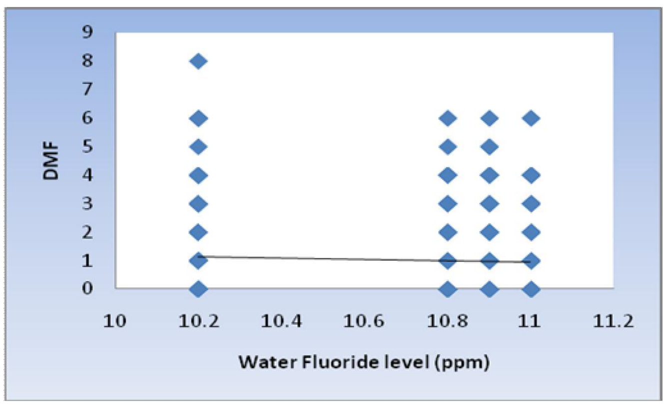
Variables	Correlation coefficient	*P* - value
Water Fluoride level & DMF	-0.053	0.020*
Water Fluoride level & def	0.043	0.078
Water Fluoride level& dmf	-0.056	0.657

*: Significant at $P \leq 0.05$

Table 4: Showing the comparison between water Fluoride levels in the two districts.

	District A		District B	
Water Fluoride level (ppm)	Mean	±SD	Mean	±SD
	10.84	0.12	10.61	0.39
	P-value		<0.001*	

*: Significant at $P \leq 0.05$



[Fig 1]: Scatter diagram representing inverse correlation between water Fluoride level and DMF.

4. Discussion

The current study was the second for Libyan schoolchildren aged 6-12 years old while the first one was published in 1996 ***(Hawew et al., 1996)***. They recorded caries prevalence and correlated it to fluoride concentration in drinking water. This study design was a cross-sectional observational study that was carried out in two Libyan western cities and took place from October to November 2012.

In the current study the **overall prevalence of dental caries** among the examined students was (60.8%). This finding is in agreement with several studies that revealed higher caries prevalence in this age group (6-12 years); in Lithuania (72%) ***(Narbutaite et al., 2007)***, and Brazil (78%) ***(Auad et al., 2009)***. The high prevalence of dental caries at these communities may be due to difference in dietary pattern, Lack of dental awareness, high consumption of cariogenic foods, level of parent's education and difference in fluoride exposure. Furthermore, the absence of dental health education and public caries prevention programmes in Libya may have contributed to the high prevalence of dental caries ***(Ali, 2004)***.

On the other hand, other studies revealed low caries prevalence in this age group (6-12 years), in Sweden (32.0%) ***(Gerdin et al., 2008)***, and India (10%) ***(Bradley and Wendell, 2009)***. The most accepted reasons for this decline were the wide spread use of fluoride, the periodic examinations for school children and the dental awareness by this age groups.

In this study caries prevalence showed an increase with the increase in age from group I (6-8 years, 55%) to group II (9-10 years, 64.2%), this in agreement with the studies by ***Saravanan et al., (2008) and Gasgoos et al., (2012)***. High caries prevalence with advancing age appears to be due to newly erupted teeth in oral cavity that is associated with increased exposure of the susceptible teeth to poor oral hygiene conditions. However, in this study, the caries prevalence has decreased from group II (9-10 years, 64.2%) to group III (11-12 years, 61.5%), this result is in accordance to the results of ***Saravanan et al., (2003)*** and in direct contradiction to the studies of ***Gaikwad and Indurkar (1993) and Rao et al., (1999).***

The decreased caries prevalence in group III can be explained by the increase in the level of manual dexterity of the child improving the oral hygiene, increased awareness about oral health ***(Saravanan et al., 2008; Grewal et al., 2009).*** Also as the tooth erupts into the oral cavity it undergoes the process of post eruptive maturation, which makes the tooth more resistant to caries as compared to immature tooth, though the exact mechanism is not fully understood saliva has been thought to play key role in this process ***(Singh and Spencer, 2004; Singh et al., 2007 and Shingare et al., 2012).***

Concerning the **caries experience**, the present results revealed that the mean dmft value for primary dentition was (1.45 ± 2.39), while the mean deft values for mixed dentition were (1.67 ± 2.11, 1.35 ± 1.81 and 1.00 ± 1.46) for age groups I, II and III respectively. The mean DMFT values for permanent dentition were (0.03 ± 0.21 and 0.06 ± 0.30) for age groups II and III respectively. In the present study deft score decreased with increase age which is obviously normal because the number of primary teeth decreases in time due to normal exfoliation. This finding is in agreement with several studies ***(Rakha, 2006 and Al-Haddad et al., 2010).*** On the contrary, the DMFT scores in the present study significantly increased with age. This is due to irreversibility and accumulative nature of the disease.

The (mean DMFT) **caries experience** for 12 years old children (0.06 ± 0.30) was noted as very low according to caries severity scales ***(Sousa et al., 2005)***. In Libya many observational studies revealed **very low to low** caries experience among (12 years old) children. The mean DMFT has shown an upward trend from 0.78 in ***(Omar, 1989)*** to 1.17 in ***(Hawew et al., 1996)*** to 1.63 in ***(Al-Sharbati et al., 2000)*** and 1.68 in ***(Huew et al., 2011).***

The overall (mean **DMFT)** in the present study was much lower (1.01 ± 1.48) than that reported by previous studies conducted in other developing countries; in Hungary ***Szoke and Petersen, (2000)*** reported (3.8)**,** in Saudi Arabia ***Al-Dosari et al. (2004)*** reported (5.06)**,** in Oman ***Al-Ismaily et al. (2004)*** reported (3.23)**,** in Kuwait ***Behbehani and Scheutz, (2004)*** reported (2.6)**,** in Philippines **Yabao *et al., (2005)*** was (3.68) and Brazil ***Auad et al. (2009)*** reported (3.95)**.** The discrepancy in caries experience between these studies and the current study may be due to the varying dietary habits and water consumption with varying fluoride concentration ***(Elias et al., 2007).***

With respect to **gender**, the mean DMFT in girls (1.05) was higher of that in boys (0.97), the difference was statistically significant (P< 0.021).This might be partially explained by the fact that generally there is a trend towards earlier permanent tooth eruption in girls than boys and thus they are exposed to risk factors of dental caries for a longer period of time than boys. However, the variation could also be attributed to differences in eruption times, age group and geographic locations that may result in clinical difference. Similar findings have been reported by other studies. In Tanzania ***(Mwakatobe and Mumghamba, 2007),*** Brazil ***(Auad et al., 2009),*** Egypt ***(Ramadan, 2010)*** and Libya ***(Huew et al., 2011)***. This finding was not in agreement with the results of other studies. In Saudi Arabia ***(Al-Dosari et al., 2004),*** Romania ***(Nuca et al., 2009),*** and India ***(Shekar et al., 2012)*** who found that the caries experience was high among the boys. In other studies no gender difference was determined ***(*Al-Sharbati *et al., 2000 and Sudha et al., 2005*).**

The result of the present study showed that **fluoride concentrations in drinking water** in two study areas varied from (10.2 ppm) to (11 ppm). The mean of water fluoride level was found higher at District A (10.84 ppm) than District B (10.61 ppm), with statistically significant difference ($P< 0.001$). This variation in fluoride concentration may be due to the difference in the source of drinking water from one area to another which depends on the nature of the geological structures in the areas, or on the rocks that contain a high rate of fluoride compounds ***(Bordsen et al., 1996 & Fawell et al., 2006).*** Furthermore, the earth's crust in Iibya has too much amounts of the fluoride found throughout the world. Therefore, these areas are endemic for fluorosis resulting from high fluoride concentration in groundwater ***(Brindha and Elango, 2011).***

When the dental caries experience was correlated to water fluoride level in present study, it was found that the mean value of DMFT decreased gradually with increasing water fluoride level. A statistically significant difference with negative correlation between them for the entire study population ($P< 0.020$) was found. This inverse relationship has been reported in previous study in Libya ***(Hawew et al., 1996)*** and other countries, e.g., Ireland ***(Whelton et al., 2004),*** Australia ***(Armfield, 2005)***, Denmark ***(Kirkeskov et al., 2010)*** and India ***(Shekar et al., 2012).***

Children residing in these fluoride endemic areas receive high rate of fluoride intake than the mean optimal level. Hence they are highly prone to the effect of dental and skeletal fluorosis and had confluent pitting because of severe fluorosis. This morphological alteration in the teeth may facilitate retention of food, predisposing the tooth surface for caries. This may be the possible reason for high caries experience in the very high fluoride area. As study by ***Budipramana et al., (2002)*** found the prevalence of dental caries to be more in high fluoride areas than in optimal fluoride areas. Our study results were in agreement with this study as well as studies by ***Fejerskov et al., (1996), Ibrahim et al., (1997), Grobler et al., (2001)*** and ***Shekar et al., (2012).***

In contrary to that, in Indonesia ***Budipramana et al., (2002)*** and Turkey ***Ermis et al., (2003)*** found that increasing water fluoride level had no influence on caries experience. This contradiction may be due to the fact that dental caries is a multifactorial disease affected by many factors (dietary habits, oral hygiene, and anatomical variation) rather than fluoride concentration in the drinking water.

However, this study indicates that dental caries increases with excessive fluoride intake. Thus, it is important to monitor total fluoride exposure and protect children from excessive flouride intake, especially during the years of tooth development ***(Xianga et al., 2009).***

Conclusions

The caries prevalence among school children was very high, and that there was a negative correlation between caries experience and fluoride concentration for the entire study population. However, in high fluoride areas, there was a positive correlation between fluoride concentration and dental caries. Water defluoridation on an urgent basis is a priority and should be performed in areas with fluoride exceeding the internationally recommended fluoride level in water. Effective oral health promotion strategies need to be implemented to further improve the dental health of school children.

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References

1. Al-Dosari A, Wyne A, Akpata E and Khan N. (2004) Caries prevalence and its relation to water fluoride levels among school children in Central Province of Saudi Arabia.Int Dent J. 54: 424–28.
2. Al-Haddad KA, Al-Hebshi NN and Al-Akhali MS. (2010) Oral health status and treatment needs among school children in Sana'a City, Yemen. Int J Dent Hygiene. 8: 80–85.
3. Ali F. (2004) The frequency of tooth brushing habit on a group of Libyan children. Cairo Dent J. 20: 247–49.
4. Al-Ismaily M, Al-Busaidy K and Al-Khussaiby A. (2004) The progression of dental disease in Omani schoolchildren. Int Dent J. 54: 409–10.
5. Al-Sharbati M, Meidan T and Sudani O. (2000) Oral health practices and dental caries among Libyan pupils Benghazi (1993–94). East Mediterr Health J. 6: 997–1004.
6. Armfield JM. (2005) Public water fluoridation and dental health in New South Wales. Aust N Z J Public Health. 29: 477-83.
7. Auad S, Waterhouse P and Nunn J. (2009) Dental caries and its association with socio demographics, erosion, and diet in school children from southeast Brazil. Pediatr Dent. 31: 229–35.
8. Behbehani J and Scheutz F. (2004) Oral health in Kuwait. Int Dent J. 54: 401–08.
9. Bordsen A, Bjorvtn K and Selvig KA. (1996)Variability in fluoride content of subsurface water resevoirs. Acta. Odont. Scand. 54: 34.
10. Bradley C and Wendell E. (2009) Has urbanization become a risk factor for dental caries in Kerala, India: a cross-sectional study of children aged 6 and 12 years. Int J Paediatr Dent. 19: 330–37.
11. Brindha K and Elango L. (2011) Fluoride in Groundwater: Causes, Implications and Mitigation Measures. https:// www. Nova publishers.com/catalog/product_info.php?products=15895
12. Budipramana ES, Hapsoro A, Irmawati ES and Kuntari S. (2002) Dental fluorosis and caries prevalence in fluorosis endemic area of Asembagus, Indonesia. J Pediatr Dent. 12(6): 415-22.
13. Elias AR, Psoter W, Elias-Viera AE, Jiménez P and Toro C. (2007) Relationship between dental caries experience and dental fluorosis among Western Saharan children. Community Dent Health 23(4): 244-50.
14. Ermis RB, Koray F and Akdeniz BG. (2003) Dental caries and fluorosis in low- and high-fluoride areas in Turkey. Quintessence Int. 34: 354–60.

15. Fawell J, Bailey K, Chilton J, Dahi, E and Fewtrell L. (2006) Fluoride in drinking water, WHO. IWA publishing. 141-44.
16. Featherstone JD. (2008) Dental caries: a dynamic disease process. Australian Dental Journal 53: 286–91.
17. Fejerskov O, Ekstrand J and Burt B. (1996) Fluoride in dentistry, 2nd ed. Copenhagen: Munksgaard, 20-21.
18. Gaikwad RS and Indurkar MS. (1993) Prevalence of dental caries in school going children of Aurangabad in the year 1992. J Indian Dent Asso. 64:325-26.
19. Gazzano E, Bergandi L, Riganti C, Aldieri E, Doublier S. (2010) Fluoride effects: the two faces of janus. Curr Med Chem. 17(22): 2431-441.
20. Gasgoos SS, Al-Sayagh GD and Jazrawi KH. (2012) Evaluation of Dental Caries Prevalence among Children in Mosul City Center Using Significant Caries Index. Al–Rafidain Dent J. 12(1): 191-97.
21. Gerdin Elisabeth W, Angbratt Marianne, Aronsson Kerstin, Eriksson Elin and Ingegerd J. (2008) Dental caries and body mass index by socio-economic status in Swedish children. Community Dent. Oral Epidemiol. 36: 459-65.
22. Grewal H, Verma M and Kumar A. (2009) Prevalence of dental caries and treatment needs in the rural child population of Nainital district, Uttaranchal. J Indian Soc Pedod Prev Dent. 27(4):224-26.
23. Grobler SR, Louw AJ, Van W and Kotze TJ. (2001) Dental fluorosis and caries experience in relation to three different drinking water fluoride levels in SouthAfrica. Int J Paediatr Dent. 11:372–79.
24. Hawew RM, Ellwood RP, Hawley GM and Blinkhorn AS. (1996) Dental caries in children from two Libyan cities with different levels of fluoride in their drinking water. Community Dent Health 13: 175–77.
25. Heilman J.R, Cury J.A, Katz B.P, Levy S. M, Li Y,Maguire A, Margine and O'Mullane D. (2011) Development of Gold Standard Ion-Selective Electrode-Based Methods for Fluoride Analysis. Caries Res. 45:3–12.
26. Huew R, Waterhouse P, Moynihan P, Kometa S and Maguire A. (2011) Dental caries and its association with diet and dental erosion in Libyan school children. Int J Paediatr Dent. 22(1):68-76.
27. Ibrahim YE, Bjorvatn K and Birkeland JM. (1997) Caries and dental fluorosis in a 0.25 and a 2.5 ppm fluoride area in Sudan. Int J Paediatr Dent. 7: 161–66.
28. Kirkeskov L, Kristiansen E, Bøggild H and Hallermund F.(2010) The association between fluoride in drinking water and dental caries in Danish children. Linking data from healthregisters. Community Dent Oral Epidemiol. 38(3): 191–86.
29. Latoo S, Shah A, Suhail M J, Qadir S and Ahmed AR. (2009) Dental caries – An overview http://www.articlesbase.com/medicine-articles/dental-caries1304303.html
30. Mameri N, Yeddou AR, Lounici H, Grib H and Belhocine D. (1998) Defluoridation of septentrional Sahara water of North Africa by electro coagulation process using bipolar aluminum electrodes. Water Res. 32 (5):1604–610.
31. Marya CM, Dhingra S, Marya V and AshokkumarBR. (2010) Relationship of dental caries at different concentrations of fluoride in endemic areas. An epidemiological study. J Clin Pediatr Dent. 35(1):41-5.
32. Mwakatobe AJ and Mumghamba EGS. (2007) Oral health behavior and prevalence of dental caries in Dar-es-Salaam. Tanzania Dent J. 14:17.
33. Narbutaite J, Vehkalahti MM and Milciuviene S. (2007) Dental fluorosis and dental caries among 12-yr-old children from high- and low-fluoride areas in Lithuania. Eur J Oral Sci. 115: 137–42.
34. Nuca C, Amariei C and Borutta A. (2009) Prevalence and severity of dental caries in 6-12 year-old children in Constanta District (urban area), Romania. Oral Health and Dental Management 8: 19–24.
35. Omar S. (1989) A point prevalence investigation of aspects of dental health in rural and urban Libyan children. PhD thesis, University Of Dundee 145–56.
36. Petersen PE and Lenon MA. (2004) Effective use of fluorides for the prevention of dental caries in the 21st century: the WHO approach. Community Dent Oral Epidemiol 32: 319–21.
37. Rakha SI. (2006) Prevalence of caries and developmental defects of enamel (fluorosis) in permanent teeth in primary school children living in Ismailia governorate with different water fluoride level. M.Sc. Thesis, Faculty of Dentistry, Suez Canal University.
38. Ramadan RI. (2010) Prevalence of dental fluorosis and dental caries among a group of preparatory schools children in Zagazig center. M.S. Thesis, Faculty of Dentistry, Al-Mansoura University, 2010.

39. Rao A, Sequeira SP and Peter S. (1999) Prevalence of dental caries among school children of Moodbidri. J Indian Soc Pedod Prev Dent. 17(2): 45-48.
40. Saravanan S, Anuradha KP and Bhaskar DJ. (2003) Prevalence of dental caries and treatment needs among school going children of Pondicherry, India. J Indian Soc Pedod Prev Dent. 21(1):1-12.
41. Saravanan S, Kolyani V, Vijayarani M P, Jayakodi P, Felix J, Aunmozhy P and Sampath KP. (2008) Caries prevalence and treatment needs of rural school children in Chidambaran Taluk, Tamil Nadu, South India. Indian J Dent Res. 19(3):186-90.
42. Shekar C, Cheluvaiah MB and Namile D. (2012) Prevalence of dental caries and dental fluorosis among 12 and 15 years old school children in relation to fluoride concentration in drinking water in an endemic fluoride belt of Andhra Pradesh. Indian J Public Health 56(2):122-28.
43. Shingare P, Jogani V, Sevekar S and Patil S. (2012) Dental Caries Prevalence among 3- to 14-Year-Old School Children, Uran, Raigad District, Maharashtra. Journal of Contemporary Dentistry 2(2):11-14.
44. Singh KA and Spencer AJ. (2004) Relative effects of pre- and post-eruption water fluoride on caries experience by surface type of permanent first molars. Community Dent Oral Epidemiol. 32(6):435-46.
45. Singh KA, Spencer AJ and Brennan DS. (2007) Effects of water fluoride exposure at crown completion and maturation on caries of permanentfirstmolars. Caries Res. 41: 34–42.
46. Sousa M, Wada R and Cypriano S. (2005) Evaluation of simplified DMFT indices in epidemiological surveys of dental caries. Rev Saüde Püblica. 39: 1-7.
47. Sudha P, Bhasin S and Anegundi RT. (2005) Prevalence of dental caries among 5 to13-year-old children in Mangalore. J Indian Soc Pedod Prev Dent. 23(2):74-9.
48. Szoke J and Petersen P. (2000) Evidence for dental caries decline among children in an East European country (Hungary). Community Dent Oral Epidemiol 28: 155–60.
49. Whelton H, Crawley E, Mullane D and Kelleher V. (2004) Dental caries and enamel fluorosis among fluoridated and non-fluoridated populations in the Republic of Ireland in 2002. Community Dent Health 21: 37-44.
50. World Health Organization. (1997) Oral health survey Basic Method. Geneva: WHO Technical Report series, NO.713.
51. Xianga Q, Zhoua M, Wua M and Zhoub X. (2009) Relationships between daily total fluoride intake and dental fluorosis and dental caries. Journal of Nanjing Medical University 23(1):33-39.
52. Yabao RN, Duante CA, Velandria FV, Lucas M, Kassu A, Nakamori M and Yamamoto S. (2005) Prevalence of dental caries and sugar consumption among 6-12-y-old schoolchildren in La Trinidad, Benguet, Philippines. Eur J Clin Nutr. 59(12):1429-438.

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