**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.

2Lecturer 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.](http://www.ncbi.nlm.nih.gov/pubmed?term=%22Marya%20CM%22%5BAuthor%5D),* *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 exceededtheoptimal levelis 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 mirrorsand 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 ــ 8 years old (27.4%) belong to group I, 799 children aged 9 ــ 10 years old (40%) belong to group II and 654 children aged 11 ــ 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 |  |
| Mean | ±SD | Mean | ±SD | P -value |
| 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 ≤ 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* ≤ 0.05

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

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

\*: Significant at *P* ≤ 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](http://www.ncbi.nlm.nih.gov/pubmed?term=Hawew%20RM%5BAuthor%5D&cauthor=true&cauthor_uid=8897743) 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),*** andIndia (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 otherstudies. 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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