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The Effect of Water Fluoride Concentration on DMFT Index in Vardar Population in Macedonia

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Abstract

The aim of this study is to determine the correlation between the DMFT index of 12-year-old children and the concentration of fluorine in drinking water from the populated areas where children live.

Material and method: In the examination, 85children were enrolled, out of 2 central and 2regional primary schools, at which the DMFT index was determined. The children live in 2 different cities and 2 different villages. Four water samples were taken from the examined area to determine the fluorine concentration by using the electrochemical method using the pH/ISE Meter-Thermo-Orion with a special F-electrode (Thermo Orion Ion Plus Fluoride Electrode) at the Institute for public health. Spearman's method was used to determine the correlation between the specified variables.

Results: The total number of children in the examined sample was 85, out of which45 were male and 40 were female. The average DMFT index in this group of children was 2.75 with a standard deviation of ±2.56. Maximum concentration of fluorine in drinking water of 0.39ppmF was determined in the village Vinicani, while the minimum (0.17ppmF) in the city Veles and (0.20 ppmF) in the village Melnica. Correlation of the DMFT index in children from the Vardar region and the concentration of fluorine in the drinking water has a negative, indirect correlation, with the value of the coefficient r=-0.393.

Conclusion: The correlation between the DMFT index and the concentration of drinking water is a negative, indirect and correlation is highly significant

Keywords: Dental caries, School children, Drinking water, Fluoride, DMFT index, Oral epidemiology.

Introduction

Dental caries is an ancient disease that dates back to the time when agriculture replaced the hunt as the main source of food, although its prevalence and severity were at much lower levels at that time compared to prevalence of dental caries today. Previous studies showed the decline of dental caries by using fluoride in the developed countries. On the hand, the lack of public awareness and motivation, inadequate resources for sophisticated dental treatments and changing eating habits causes higher significantly caries prevalence in undeveloped and developing countries [1]. Indeed, the use of fluoride has been recognized as one of the most successful measures to prevent dental caries in the history of public health. Indeed, the use of fluoride has been recognized as one of the most successful measures to prevent dental caries in the history of public health.

But "fluoride is often referred to as a double blade weapon" - the optimal and reasonable use of fluorine offers maximum protection against cavities, while unwanted and excessive systemic exposure can lead to chronic fluoride intoxication, which is manifested as dental and skeletal fluorosis [2]. In view of this, a more precise definition of the optimum concentration of fluorine in drinking water (which is not a universal constant and varies depending on environmental conditions) becomes even more important. Clinical trials of the effects of fluoride on humans could not be feasible due to ethical and many other practical obstacles. Endemic areas, where people are naturally exposed to increased amounts of fluoride, serve as natural laboratories to study the effect of fluoride concentration on dental caries and dental fluorosisat the same time [3].

In the past in the Republic of Macedonia, there were three endemic fluorotic regions (Kumanovo, Veles and Prilep region). Tsarchev et al., in 1992 [4] conducted a study in which the dependence of fluoride in drinking water and caries frequency in endemic areas were investigated. This has prompted us to undertake this study in order to determine the prevalence of dental caries in 12-year-olds from the Vardar region.

Material and Methods

The clinical trial consisted of defining the DMFT of the 12-year old children in accordance with the basic criteria for assessment of oral and dental health and the need for rehabilitation, which is recommended by the World Health Organization (WHO, ORAL HEALTH ASSESSMENT FORM, 1997). We estimate the intensity of dental caries according to the generally accepted Klein-Palmer index "DMF", which is a set of decayed, missing and filled teeth. The examinations were carried out by two dentists in accordance with the

recommendations stemming from the basic criteria for assessment of oral and dental health recommended by the WHO [5].
The 12-year-old children who were included in the examination were from the following elementary schools in the eastern region: OU Dame Gruev from city Gradsko, regional primary school Dame Gruev from village Vinicani, regional primary school Todor Janev from village Melnica and central primary school OU Jordan Konstantinov Dzinot from city Veles.

For the determination of the fluorine concentrations by laboratory examination, we used samples of water from all urban and rural settlements, where the children from the Vardar region of the Republic of Macedonia live.

In our study, an electrochemical procedure was used to determine the concentration of fluoride with an ion-selective electrode. A major part of the ion-selective electrode is the lanthanum membrane fluoride. When the membrane is in contact with the solution containing fluoride (in this case water), the difference in potential is measured. This potential depends on the amount of free fluoride ions and is described by the Nernst formula

$$E=Eo-ClogA$$

E-measured potential of the electrode
E-reference potential (constant)
A-quantity of fluoride in the solution
C-slope of the electrode

The samples were collected in 100 ml polyethylene containers with a cap that had threads. The measurement was carried out as soon as the water samples arrived in the laboratory. After shaking the water bottle, 1 ml of each sample is taken and mixed with 0.1 ml Total Strength Adjusting Buffer. The fluorine concentration of all samples was determined using the ionic-selective electrode (Thermo Orion Ion Plus Fluoride Electrode) and the ionometer (pH / ISE meter-Thermo-Orion) at the Public Health Institute. For chemical analysis 10% of TISAB Aluminon was used. Fluoride standards with a concentration of 0.01 to 1.00 mg / l were used to calibrate the measurements. Before the starting of the fluorine measurement, some preparations must be made to check the correctness of the measuring instrument and the slope of the electrode. This is done according to the manufacturer's instructions. When the instrument is ready, the measurement can begin.

Results

The group of 12-year-old respondents from the Vardar Region consists of 85 children, of which 52.94%are male and 47.06% are female. In the ethnic structure, the Macedonians dominate, with 65 (76.47 %) respondents, followed by the Turks, represented by 11 (12.94%) respondents.

More than half of the respondents from this group are from the city, 37.65% of the children live in Veles, 21.2% in the municipality of Gradsko, while the children from villages Melnica and Vinicani make up the group of 41.2% children at the age of 12, originating from a rural area (**Table 1**).

Figure 1 and **Figure 2** show the distribution of the presence of decayed, extracted and filled permanent teeth in the group of 12 year old children from the Vardar region. Thirty five of them do not have cavities 35 (41.2%), while from the group of 50 (58.8%) children with cavities, the greatest number of children were with two decayed teeth - 16 (18.8%) registered.

In 10 (11.8%) children from this group, teeth extractions were performed, and in 7 children, one tooth was removed, and in 3 children two teeth were extracted. Without filled teeth were 54 (63.5%) children, while in the group with filled teeth the highest number of children were with two filled teeth -12 (14.1%).

	N = 85	%
Gender of the children		
Male	45	52.94%
Female	40	47.06%
Nationality		
Macedonians	65	76.47%
Turks	11	12.94%
Roma	2	2.35%
Bosnians	7	8.23%
Place of living		
City	50	58.82%
Village	35	41.18%
Name of the city/village		
Veles	32	37.65%
Gradsko	18	21.18%
Vinicani	25	29.41%
Melnica	10	11.76%

Table 1: Distribution of the children in relation to the gender, nationality and the place of living.

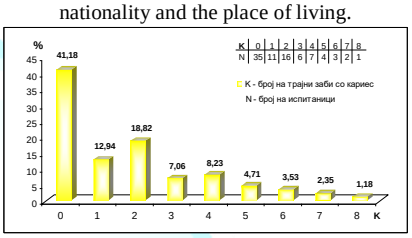


Figure 1: Distribution of the children in relation to the number of the decayed permanent teeth.

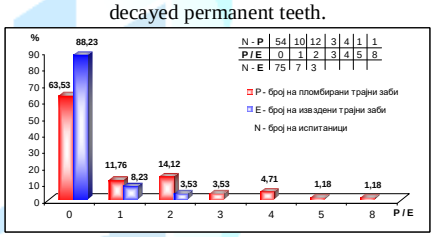


Figure 2: Distribution of the children in relation to the number of filled and missing permanent teeth.

The descriptive statistics on the number of decayed, extracted and filled teeth was presented in **Table 2**. The number of decayed and filled permanent teeth ranges between 1 and 8, the number of missing teeth ranges from 1 to 2, while half of the 12-year-old children from the Vardar region have dental caries on more than 2 teeth, have extraction on more than one tooth, and have fillings on more than 2 teeth.

Descriptive Statistics - (number of permanent teeth N=234)				
Variable	**N(%)**	**median**	**min-max**	**Lower-upper quartiles**
D-decayed	149(63.68%)	200%	1,0 - 8,0	2,0 - 4,0
M-missing	13(5.55%)	100%	1,0 - 2,0	1,0 - 2,0
F-filled teeth	72(30.77%)	2	1,0 - 8,0	1,0 - 3,0

Table 2: Descriptive statistic /number of permanent teeth.

The value of the DMFT index of permanent teeth in the group of 12-year-old children from the Vardar region is shown in table number 3 and ranges from 0 to 13, and on average it is 2.75 ± 2.56 (**Table 3**).

Descriptive Statistics - DMFT(index of the permanent teeth)						
variable	N	mean±SD	95% confidence interval of means	min-max	median	Lower-upper quartiles
DMFT	85	2.75 ± 2.56	2.2 - 3.31	0 - 13.0	2	1.0 - 4.0

Table 3: Descriptive statistic/DMFT index of the permanent teeth.

Female children at the aged of 12 years from the Vardar region significantly more often than male children have dental caries on permanent teeth (p = 0.049), they have more frequently extracted teeth (p = 0.38), but not significantly and have more fillings on teeth (p = 0.52), but also not significantly (**Table 4**).

Variable	Gender	
	Male (n %)	Female (n %)
D-decayed permanent teeth		
Not exist	23 (51.11%)	12 (30%)
exist	22 (48.89%)	28 (70%)
Pearson Chi-square: 3.89 df=1 p=0.049* p<0.05		
M-missing permanent teeth		
Not exist	41 (91.11%)	34 (85%)
exist	4 (8.89%)	6 (15%)
Pearson Chi-square: 0,76 df=1 p=0,38		
F-permanent teeth with fillings		
Not exist	30 (66,67%)	24 (60%)
exist	15 (33.33%)	16 (40%)
Pearson Chi-square: 0,41 df=1 p=0,52		

Table 4: Distribution of decayed, missing and filling permanent teeth in relation to gender.

The average value of the DMFT index of permanent teeth in the group of male children was 2.27 ± 2.43, while in the group of female children the average value of DMFT was 3.3 ± 2.62. The gender of 12 year old children from the Vardar region has significant impact on the value of the DMFT index of permanent teeth (p=0.039) as a result of significantly higher DMFT values in the female respondents group (**Table 5**). **Table 6** shows the values of the fluoride concentration in drinking water from all places were the children live.

Descriptive Statistics - DMFT (index of permanent teeth)						
Variable	N	mean±SD	95% confidence interval of means	Min-max	median	Lower-upper quartiles
Male	45	2.27 ± 2.43	1.54 - 2.99	0-9.0	2	0.0-4.0
Female	40	3.3 ± 2.62	2.46 - 4.14	0-13.0	3	2.0-4.5

Table 5: Descriptive statistics of the DMFT index of the permanent teeth/differences in gender.

Places of living	Concentrations of the F in water
Veles	0.17
Gradsko	0.3454
Vinicani	0.3894
Melnica	0.2

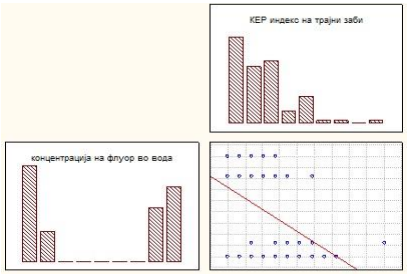
Table 6: Distribution of the concentration of fluorine in water in relation to the place of living.

Figure 3 shows the correlation between the value of the DMFT index of permanent teeth within 12-year-old children and the concentration of fluorine in drinking water from the Vardar region. The value of Spearman's coefficient of rank correlation of R = - 0.393 shows that there is a negative or indirect correlation between these two variables. Which means, by increasing the concentration of fluorine in water, the value of the DMFT index of permanent teeth decreases, and vice versa. For a value of p <0.01, and statically this connection is confirmed as highly significant, i.e. highly significant.

R Square = 0,188	F=19,157 p=0,000					Durbin-Watson = 1,599	
	Unstandardized Coefficients		Standardized Coefficients			95% CI for B	
	B	Std.Err.	Beta	t	Sig.	Lower Bound	Upper Bound
Constant	5.829	0.746		7.809	0	4.344	7.313
Concentration of fluorine	-11.176	2.553	-0.433	-4.377	0	-16.255	-6.098

Dependent variable: DMFT index.

Table 7: Linear Regression Analysis - DMFT/concentration of fluorine.



Spearman Rank Order Correlations R= - 0,393 p<0,01

Figure 3: Correlation-DMFT index of the permanent teeth /concentration of the fluorine in the water.

Table 7 shows the results of the Linear regression analysis for quantifying the significant relationship between the value of the DMFT index of permanent teeth for a group of 12 year old children as the dependent variable and the concentration of fluorine in the water in the Vardar region. The R Square value of 0.188 implies that 18.8% of the changes in the DMFT index can be explained by the concentration of fluorine. The coefficient β, whose value is -11.176, shows that with each increase in unit of the fluorine concentration, the value of the DMDT index decreases by an average of 11.176 (16.255-6.098).

Discussion

The Correlation between DMFT score of the permanent teeth of 12-years old children from the Vardar region and the concentration of fluoride in drinking water was negative, with the value of the Spearman-Conn's rank correlation coefficient of R = - 0.393, which showed that between these two variables, the correlation was negative or indirect. For the value of p<0.01, this relationship was confirmed as a highly statistically significant or highly significant.

Markovic N, et al., in their cross-sectional study conducted in 2004 on the territory of Bosnia and Herzegovina within the group of 1,120 children at the age of 6 and 12, found the mean dmft/DMFT index of 4.16 ± 2.92 in 12 years old, and 6.71 ± 3.89 in 6 year old children. Non-restored decayed teeth constituted the bulk of the DMFT index, 45.43% for 12-year-old and 88.79% for 6-year-old children [6]. Hysi D et al. in their study examined the average DMFT index in a group of 372, 12 year old children from Tirana and found that it was 3.8. The significant caries index in the same group of children was 7.06, while the prevalence of children without caries was 14.5% [7]. In the course of 2006, Djuričković M et al conducted a survey of 455 pupils at the age of 12 in the northern, middle and southern regions of Montenegro. The average DMFT index of 12-year-old from Montenegro was 3.43, the SiC index was 6.35, while the prevalence of caries was 88.35% [8]. The results of another study in Montenegro show an increase in caries prevalence with age. Thus, 91% of 12-year-olds have one or more carious lesions, with a maximum value of 97% for 15 years old and 98% for children at the age of 18, respectively, the average DMFT index for 12 years is 4.4, year, 8.25 and 18-year-olds, 10.9 [9].

In the past in the Republic of Macedonia there were three endemic fluorotic regions (Kumanovo, Veles and Prilep region). Tsarchev et al. in 1992 [4] conducted a study in which the dependence of fluoride in drinking water and caries frequency in endemic areas and other control settlements. In the Kumanovo endemic region (from Tromedje, from AjudckaCheshma, from Puckovo and from BeleiGramadi), the mean mgF / L in the drinking water from the wells was 2.75, and from the taps 1.48, while in the control settlement (Staro Nagorichane) was 0.20 mg F / L. In the endemic area, the average DMFT index ranged from 0.79 to 1.92, while in the control settlement it was 5.92. In the Veles endemic region (v. Vinicani) the mean mgF / L in the drinking water of all objects were 1.24, and in local wells 0.58, while in the control settlement (village Gradsko) was 0.58 mgF/L.

In the endemic area, the average DMFT index was 2.30, and in the control settlement 6.24. In the Prilep Endemisk Region (Novovo Lagoovo village), the mean mg mg/l in drinking water in October 1985 was 1.93, and in June 1986 1.60, while in the control settlement (village Berezovci) was 0.20 mgF/L. In this endemic region, the average DMFT index was 2.10, while in the control settlement 3.83 [4].

The studies of numerous authors have found that fluoride concentration in drinking water of 0.8-1.5 mg / L can lead to a reduction in dental caries by more than 60% [5,10,11]. Drinking water in the Republic of Macedonia, and especially those consumed in larger cities, contain fluoride concentrations, usually less than 0.2 mg / L [12-14].

In her research, Kolevska et al has found the highest fluorine values in the groundwater in Pelagonia, Ovche Pole,Vardar and in some spring waters of Belasica and Osogovo. She noted that in most of these cases, there are many small sources intended for water supply of settlements that are in decline of population and with an unfavorable age structure, withthereduced number of children's population. These are the villages in the municipalities of Veles, Negotino, Prilep, Bitola, Kratovo, KrivaPalanka, Sveti Nikole, Stip and Probistip. Municipalities in which the villages show demographic expansion with a large number of children are predominantly located on sites with water sources containing mostly small fluorine quantities. The waters are from the springs of Shar Planina, Suva Gora, Bukovik, Korab-Deshat, SkopskaCrna Gora, Jablanica. In the eastern part of our country and partly in the groundwater in the Vardar Valley, Ovchepolyeto, along the riverBregalnica, there are some higher values, which are close to the optimal fluorine concentration, but as a rule, the mineralization is higher. Natural fluoride-containing sources are, as a rule, of small or very low capacity. These sources are mainly found in eastern Macedonia where there is a triangle with a geological composition of erupted rocks and where a significant number of the investigated waters have a concentration close to the optimal (the municipalities of Kumanovo, Kocani, Stip, Radovish, Strumica and Sv.Nikole) [14].

Recent research in Lithuania indicates lower values of the average DMFT index 2.0 in 12-year-old children from regions (1.7 ppm) with high level of fluorine in drinking water, and higher values of an average DMFT of 3.5 in areas with low fluoride levels (0.2 ppmF) [15].

Our results show that spring waters have relatively low fluorine content. Greater content is found in well water, while the surface water content is also low. The waters that originate from deeper depths are richer with fluorine compared to those of smaller depths. Water with less hardness also contains less fluorine, while hard waters have higher fluorine content. The content of fluoride in water depends on the geological composition of the land with which the water comes in contact with its movement [16].

All official data on dental caries, both nationally in Macedonia (Department of Dental Health Protection within the Ministry of Health) and internationally (World Health Organization, WHO), register caries only when manifested as cavity, while (the initial carious lesion is not registered [17]. In the complex interaction of predisposing factors, the urban and rural environment significantly affect the prevalence of caries.

The school time is a period when habits are permanently created and when health education measures are most beneficial. Children must be convinced that the mouth and teeth mirror health and that there is no complete health in the absence of oral health. Wennhall I et al. showed that adjusted preventive programs for children living in a multicultural society with low socio-economic development are cost-effective and of great benefit to society as well as great benefit for the individual [18].

The nutrition is part of the everyday life of every living creature, and even of man, which affects not only the oral, but also the health as a whole. Dental caries risk is directly related to the frequency and amount of carbohydrate intake, especially in the time intervals between meals [19,20].

In fact, it is well known for many years that the lack of regular oral hygiene habits plays a significant role in the development of dental caries. Oral health of children can be influenced by the attitudes and behavior of parents towards oral health, as well as by their parents oral health [21-23].

On the Macedonian market, toothpastes containing fluoride can be easily found, but as a consequence of irregular hygiene and lack of teeth brushing, the benefits of this measure for the prevention of dental caries are insufficient.

Fluoride tablets are also available on our market, but despite being on the positive list of drugs, they are not prescribed regularly enough in children with a high caries risk profile and in caries-active children by dentists, gynecologists and pediatricians. Fluoride gels and varnishes for professional use contain high levels of fluorine, but due to the privatization process of dental practice, dental dentists do not pay enough attention to this preventive measure, so its benefits are missing. They need to apply to children with high caries risk, and this is a strictly controlled process by pediatric dentists where the child is being treated.

Good health is an important resource for social, economic and personal development. Political, economic, social, cultural, environmental, behavioral and biological factors can improve or worsen health. Health promotion actions are directed towards taking appropriate measures, making these conditions suitable for health [24].

We hope that this study will help the decision makers to improve oral health by studying the unwanted causes that have led to oral health state in our country and will act in a way to improve the situation and adequately prevent and treat dental caries in the children's population.

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