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 fluoride in drinking water from the populated areas where children live.

Material and method: In the examination, 85 children were enrolled, out of 2 central and 2 regional primary schools, at which the DMFT index was determined. The children lived in 2 different cities and 2 different villages. Four water samples were taken from the examined area to determine the fluoride 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 which 45 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 fluoride in drinking water of 0.39 ppmF was determined in the village Vinicani, while the minimum (0.17 ppmF) 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 fluoride 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 fluoride 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 fluoride in drinking water (which is 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 fluorosis at the same time [3].

In the past in the Republic of Macedonia, there were three endemic fluorotic regions (Kumanovo, Veles and Prilep region). Tsarcev 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:

$$ E = E_0 - \frac{RT}{F} \ln [F^-] $$

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 ion-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.

<table>
<thead>
<tr>
<th>Table 1: Distribution of the children in relation to the gender, nationality and the place of living.</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 85</td>
</tr>
<tr>
<td><strong>Gender of the children</strong></td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td><strong>Nationality</strong></td>
</tr>
<tr>
<td>Macedonians</td>
</tr>
<tr>
<td>Turks</td>
</tr>
<tr>
<td>Roma</td>
</tr>
<tr>
<td>Bosnians</td>
</tr>
<tr>
<td><strong>Place of living</strong></td>
</tr>
<tr>
<td>City</td>
</tr>
<tr>
<td>Village</td>
</tr>
<tr>
<td><strong>Name of the city/village</strong></td>
</tr>
<tr>
<td>Veles</td>
</tr>
<tr>
<td>Gradsko</td>
</tr>
<tr>
<td>Vinicani</td>
</tr>
<tr>
<td>Melnica</td>
</tr>
</tbody>
</table>

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, 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.

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

**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).

**Table 3**: Descriptive statistic/DMFT index of the permanent teeth.
Female children at the age 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).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male (n %)</td>
<td>Female (n %)</td>
</tr>
<tr>
<td>D-decayed permanent teeth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not exist</td>
<td>23 (51.11%)</td>
<td>12 (30%)</td>
</tr>
<tr>
<td>exist</td>
<td>22 (48.89%)</td>
<td>28 (70%)</td>
</tr>
</tbody>
</table>

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.

### Table 5: Descriptive Statistics - DMFT (index of permanent teeth)

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>mean±SD</th>
<th>95% confidence interval of means</th>
<th>Min</th>
<th>max</th>
<th>median</th>
<th>Lower-upper quartiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>45</td>
<td>2.27 ± 2.43</td>
<td>1.54 - 2.99</td>
<td>0-90</td>
<td>2</td>
<td>0-4.0</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>40</td>
<td>3.3 ± 2.62</td>
<td>2.46 - 4.14</td>
<td>0-130</td>
<td>3</td>
<td>2-4.5</td>
<td></td>
</tr>
</tbody>
</table>

### Table 6: Distribution of the concentration of fluoride 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 fluoride 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 fluoride in water, the prevalence of caries decreases, and vice versa. For a value of p <0.01, and statically this connection is confirmed as highly significant, i.e. highly significant.

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

**Dependent variable: DMFT index**

Citation: Ambarkova V. The effect of water fluoride concentration on DMFT index in vardar population in Macedonia (2018) Dental Res Manag 2: 56-60
In the endemic area, the average DMFT index was 2.30, and in the control settlement 6.24. In the Prilep Endemisk Region (Novofo Lagoovo village), the mean mg/mL in drinking water in October 1985 was 1.93, and in June 1986 1.60, while in the control settlement (village Berezovci) it was 0.20 mg/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 fluoride 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, with reduced number of children in the population. These are the villages in the municipalities of Veles, Negotino, Prilep, Bitola, Kratovo, Kriva Palanka, Sveti Nikola, 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 fluoride quantities. The waters are from the springs of Shar Planina, Suva Gorâ, Bukovik, Korab-Deshat, Shkopska Gorâ, Jablanica. In the eastern part of our country and partly in the groundwater in the Vardar Valley, Ovchepelovo, along the river Bregalnica, there are some higher values, which are close to the optimal fluoride 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 natural fluoride-containing 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 fluoride 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 fluoride 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 fluoride compared to those of smaller depths. Water with less hardness also contains less fluoride, while hard waters have higher fluoride 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 tooth 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 fluoride, 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.

References