RÉSUMÉ
Étude sur la consommation alimentaire de minéraux chez les enfants atteints de carie dentaire dans la petite enfance

Introduction. L’alimentation pendant la petite enfance est de la plus haute importance pour les processus de germination dentaire, la formation de la matrice organique, la minéralisation et la maturation des structures dentaires. L’implication d’éléments inorganiques dans le développement des os et des tissus dentaires chez l’enfant est un processus essentiel pour la réalisation de leur densité maximale. Étant donné l’intérêt scientifique actuel pour la santé bucco-dentaire, avec accent mis sur la petite enfance et l’augmentation de la propagation des cavités à cet âge, il est nécessaire d’examiner plus en profondeur le problème de la petite enfance.

L’objectif de l’étude était d’étudier l’apport alimentaire en éléments de l’organisme chez les enfants atteints de carie dentaire dans la petite enfance.

Matière et méthodes. L’étude a porté sur l’apport alimentaire en éléments minéraux (calcium, phosphore, magnésium, fluorure, sodium et fer) chez 53 enfants de 3 à 6 ans qui ont été diagnostiqués avec carie dentaire dans la petite enfance.

Résultats. Les résultats de l’étude ont révélé les apports moyens en calcium de 473,4 ± 222,5 mg, phosphore de 745 ± 177 mg, fluorure de 0,8 ± 0,37 mg, magnésium de 139 ± 43 mg, fer de 6,7 ± 4,64 mg, et de sodium de 1159 ± 529 mg.

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INTRODUCTION

According to the World Health Organization (WHO) data, caries is among the most frequently diagnosed diseases, involving 60-90% of children in pre-school and school age. Carious destruction in child age causes a number of sequels, such as changes in chewing performance, disturbed speech, deteriorated esthetics and development of orthodontic deformations.

The term “early childhood caries” (ECC) is used to describe a type of caries developing in children aged 1-5 years. The relationship between a rich carbohydrate diet and lower mineral intake, and caries process initiation has been proven. ECC develops at non-predilection points - vestibular and lingual surfaces of the upper front teeth and progresses passing through several major stages. The disorders in teeth structures, especially in the front sectors, affect the child's general health status, self-confidence and life quality.

The consumed nutrients affect teeth structures by two mechanisms - post-resorptive and pre-resorptive. The resorbed nutrients exert endogenous impact on the teeth before tooth break. This affects tooth dentition, formation of organic matrix and mineralization processes.

According to Psoter, chronic malnutrition in childhood can cause delayed tooth breaking and replacement of milk teeth as well as increased risk for development of caries and occurrence of enamel and dentin hypoplasia. The pre-resorptive effect of food follows tooth break and is associated with the establishment of cariogenic or caries-protective oral environment.

Some researchers have found that foods and beverages, such as milk and dairy products (white cheese, yellow cheese) and fluorinated mineral water exerted caries-protective effect. Those products increase the amounts of calcium, phosphorus, fluorine and proteins in the plaque, stimulate saliva electric currents through altering the oral pH, mitigate the hazardous carbohydrate effect and ensure the remineralization processes of the attacked dental surfaces.

Bakardziev's data obtained from a survey of children's dietary habits showed that 16.77% did not like milk, 27% did not like white cheese and 25% did not like yellow cheese. This means that many children do not consume enough minerals for teeth building-up and protection.

It is known that carious injuries affect chewing efficacy that is a prime cause for restriction of some food intake, inadequate primary nutrient processing, initiation of gastrointestinal disorders, etc.

According to Sheiham, untreated carious lesions cause pain and discomfort at eating. Certain deviations occur in the quality and quantity of consumed nutrients - the patients restrain only to several types of consumed foods that usually are insufficient to satisfy the physiological needs of the organism at this age.

Clarke et al proved that all examined children with ECC have malnutrition signs - low weight compared to referent values for the age group. The study performed by Abolfotoou et al supported that finding confirming that young children with low weight had higher rate of caries incidence in a temporary dentition compared to those with normal weight.

Conclusions. The detected lower intake of calcium, magnesium, fluorine could be considered as risk factor for caries development and the other elements are associated with children's general health status. The specificity of the needs and health status requires complex caries treatment starting in early childhood together with adequate diet.

Keywords: nutrition, inorganic substances, early childhood, caries.
THE AIM OF THE STUDY was to investigate the dietary intake of inorganic elements – calcium, phosphorus, magnesium, fluorine, sodium and iron of children with early childhood caries.

MATERIAL AND METHODS

The studied group consisted of a total of 53 patients (25 boys, 28 girls), aged 3 – 6 years (mean age 4.08±0.96 years). All children, after a total dental examination, were diagnosed with childhood caries.

During the examination the children and their parents described in details the foods and beverages consumed for a 24-hour period. The dietary intake was assessed on the basis of the amount consumed food products referring to their composition data listed in the Bulgarian Tables of Foods Chemical Composition. The data were processed with Alimenta software, calculating the daily intake of calcium (mg), phosphorus (mg), fluorine (mg), magnesium (mg), iron (mg) and sodium (mg).

The results were processed statistically with SPSS v 20.0 software, applying descriptive statistics, \( \chi^2 \) – criterion, Fisher’s exact test, t-test and variation analysis. The graphic presentation was made using MS Excel 2010.

RESULTS

Calcium intake

Almost all examined children (81.1%) reported calcium intake under the age-related reference values. Only 13.2% showed calcium intake complying with the referent values and the other 5.6% consume more than the age needs.

The average daily calcium intake was 473.4±222.5 mg, that was with 327 mg less than the amount recommended for this age group (800 mg)\(^6\). The established difference was statistically significant (\( P = 0.000 \) (Fig. 1).

Phosphorus intake

The evaluation of the dietary phosphorus intake showed that the greatest percentage rate (71.7%) of the children had phosphorus intake exceeding the age-related reference values. Less than ¼ of the young patients (22.6%) reported amount of dietary phosphorus complying with the age-related reference values for adequate intake. The remaining 5.7% showed low phosphorus intake.

A mean daily intake with standard deviation of 745±177 mg was established for all investigated children – exceeding by 195 mg the age-related

Fig. 1. Mean daily and recommended calcium intake (mg)
Fig. 2. Mean daily and recommended phosphorus intake (mg)

Fig. 3. Mean daily and recommended fluorine intake (mg)
Fluorine intake
When investigating the dietary fluorine intake, it was established that the consumption of 58.5% of the children did not reach up to the age-related physiological limit (1 mg). In 28.3% the intake complied with the recommendations and in 13.2% it exceeded the age-related reference value.

The mean daily fluorine intake values in the studied children’s group were 0.8±0.37 mg. The resulting values were below the recommended limits (1.0 mg). The difference was statistically significant (p = 0.000) (Fig. 3).

Magnesium intake
The investigation of magnesium intake showed that none of the children exceeded the age-related reference values. The magnesium intake of 83% of all studied young patients was below the reference values and the remaining 17% were within the recommended limit.

The mean daily magnesium intake values were 139±43 mg, by 91 mg less than the age-related recommended limit of 230 mg. The lowest recorded value was 68 mg and the maximal one 261 mg. A statistically significant difference (p = 0.002) revealed between the recorded intake and the reference value was proven (Fig. 4).

Iron intake
A high rate (77.4%) of the children examined by us showed iron intake under the age-related recommended limit. The dietary iron intake was within the limits for 13.2% of the group and 9.4% reported intake higher than the recommendations.

A mean daily intake of iron of 6.7±4.64 mg was calculated, which did not reach up to the physiological recommended limit of 10 mg. The lowest reported value was 1.1 mg and the maximal one 28.5 mg. The difference between the reported intake and the recommended limits was statistically significant (p = 0.002) (Fig. 5).

Sodium intake
Of all examined children 28.3% had sodium intake greater than the age-related recommendation. Adequate intake was determined in 26.4% of the group and 45.2% showed intake below the recommended limits.
Fig. 5. Mean daily and recommended iron intake (mg)

Fig. 6. Mean daily and recommended sodium intake (mg)
The analysis of the mean daily intake showed that the children consumed 1159±529 mg as a mean daily, which complied with the age-related physiological needs (1200 mg) with more than 3/4 (79.3%) of the children with low calcium intake had also low fluorine intake. On the other hand, all children with high calcium intake had also high fluorine intake (Fig. 7).

A similar trend was observed concerning sodium and fluorine import ($\chi^2=0.036$, $p>0.05$), where more than 3/4 of the children with low sodium intake level (78.9%) showed also inadequate fluorine intake. It should be emphasized that 81.8% of the young patients...
with above-limit sodium intake had fluorine intake values below the limits (Fig. 8).

Considering the iron intake, 80.6% of the children with low iron values had the same level for fluorine and 66.7% of those with iron exceeding the recommended limits had reduced fluorine intake \( \chi^2=0.327, p>0.05 \).

**DISCUSSION**

The analysis of the data concerning calcium intake showed that a great number of the examined children did not consume sufficient amounts of that inorganic element. The results derived by us confirmed the evidence communicated by other researchers17,18, proving that children with four and more caries had definitely lower mean daily calcium intake (496 and 511 mg, respectively).

Phosphorus has an essential role in the formation of the organic matrix of dental structures - it is a major structural unit of the apatite crystal. The mean daily intake of phosphorus of the children engaged in the survey was greater than the recommended limits. Some studies supported that this intake could reduce calcium levels in the organism as phosphorus and calcium effects were interrelated and interdependent because of their ability to form insoluble calcium phosphates19,20. The values of dietary phosphorus, listed by other studies were even higher than those stated in the present survey17,21.

The data for magnesium intake in our investigated group was lower than the age-related recommended limits. According to Gupta20, the reduced intake of this inorganic element could disturb calcium-phosphorus metabolism thus causing decreased resistance of apatite crystals in dental structures. The obtained intake values of 139 mg have been confirmed by other study29.

Fluorine ions are capable to displace calcium and hydroxyl groups in the apatite crystal of enamel and dentin, thus improving its resistance to carious processes2. Its adequate dietary intake is particularly important for the proper development of dental structures. Besides that, we have to emphasize on its exogenous effect through preventive products providing caries-protective effect normalizing saliva pH22.

Fluorine intake of the studied group did not comply with age-related physiological limits. Certain studies in this field23,24 have also confirmed that children with multiple caries had mean daily fluorine intake not more than 0.74 mg per day.

The determined low dietary intake of inorganic elements responsible for dental structures strength can be explained with lack of variety of food products in the diet in spite of the current possibilities of the food market.

This study also covered investigation of iron and sodium intake as those inorganic elements are associated directly with the general health status and indirectly with the carious processes.

Our data for iron intake corresponded to the results determined up to now by other studies20, indicating enhanced risk for deficiency of this mineral in young children.

According to some sources it is difficult to find a relationship between iron deficiency and later caries predisposition; nevertheless, an experiment with rats has proven20 that even mild deviations from the adequate intake could cause outlined susceptibility to development of caries. Besides that, certain studies26,27 on iron serum levels and incidence/prevalence of caries in childhood (Decayed, Missing, Filled Teeth (DMFT) index) have confirmed that children with iron deficiency have much higher DMFT index than those with adequate iron intake.

The recommended sodium intake limit for children aged 3 – 7 years is 1.2 g. According to the World Health Organization28, the mean daily consumption of sodium should not exceed 5 g/day. The children from our studied group reported sodium intake complying with the age-related recommended limit.

The identification of the role of each trace element for dental health is difficult because it is not possible to isolate the effect of each effect in the diet. The particular inorganic substances are contained in various amounts and ratios in the different foods. Some studies29,30 on the identification of the role of the individual minerals in the resistance of dental enamel have revealed that sometimes even small amounts of a particular trace element, in combination with others of the kind, could have beneficial effect. The effect of each of the presented elements could be modulated through dietary effect.

Based only on the content of minerals in the dietary intake it is difficult to assess the level of sufficiency complying with physiological needs as their bio accessibility and bio availability have also particular importance.

**CONCLUSION**

The examined children have reduced dietary intake of inorganic substances, such as calcium, magnesium, iron and fluorine, normal sodium intake and elevated intake of phosphorus.

The obtained data can be included in the relevant data bases for exchange of information on ECC. The data are useful in building up adequate diets pursuing the treatment of the risk group of children with caries.

Complying with WHO recommendations for more comprehensive studying of oral diseases, we
initiated the presented study on the role of dietary components in the development of ECC and the need to modulate children's diet, aiming at achieving higher level of prevention efficacy.

**Compliance with Ethics Requirements:**

“The authors declare no conflict of interest regarding this article”

“The authors declare that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008(5), as well as the national law. Informed consent was obtained from all the patients included in the study”

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