

## Analysis of Environmental and Person-Oriented Factors Influence on Dental Caries Intensity among Children Population of Transcarpathia

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### Abstract

Objective of the research was to analyze the impact of environmental and person-oriented factors on dental caries intensity trends among different age groups of children living at the ecologically stressed zone of Transcarpathia region with fluorine and iodine deficiency. Retrospective design of the study covered two phases: 1) clinical evaluation of dental patients of childhood age, who were permanent residents of Transcarpathia with the aim of caries intensity level registration; 2) analysis of answers collected after adapted questionnaire survey among clinically evaluated children with the aim to verify potential subjectively noted risk factors.

Considering inclusion and exclusion criteria study sample was formed out of 842 participants. Odds ratio for caries intensity increase tendency under the influence of low frequency of oral hygiene care was OR=1.56 (95% CI: 1.32-1.79), under the influence of frequent stressful situations – OR=1.12 (95% CI: 1.05-1.23), under the influence of deficiency of vitamins in the daily diet – OR=1.39 (95% CI: 1.25-1.76), under the influence of low frequency of food consumption per day – OR=1.49 (95% CI: 1.28-1.87), under the influence of frequent sugar snacks per day – OR=1.61 (95% CI: 1.47-1.93) among overall sample.

Obtained results demonstrated that caries intensity increase trend shown changeable pattern of dependencies regarding different factors of influence in different age and gender groups, thus realization of different prevention strategies among different age and gender categories of children living within ecologically-stressed zone could be reasoned, but specific argumentation of such need to be validated as perspective hypothesis in further in-depth studies.

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### Introduction

National and regional caries prevention programs, even though being established considering influence of various caries-risk factors and being formed based on complex risk modeling algorithm, characterized with different levels of success and efficiency during the outcomes monitoring in short- and long-terms perspective.<sup>1,2,3,4,5</sup> Variations of obtained results regarding successfulness of caries prophylaxis programs potentially could be associated with modifiable personal habits changes,

environmental conditions changes, general climate, geographical and anthropogenic-associated alterations.<sup>4,5,6</sup> Relevant caries prevention strategies should contain adaptation options due to the changes within the impact levels of different factors, but practically it is problematically to prognose how changes within influence of one person-oriented or environmental factor would disturb complex system of relationship with number of other factors that considered to demonstrate crucial input on oral health status.<sup>9,10,11,12,13</sup>

Segmentation of different caries-risk models at separate, but continuously connected levels, based on age, territory-associated residence, initial caries status, registered progression and other similar criteria, could represent a significant perspective for the verification of the most critical phases and ranges of values associated with turning points regarding

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caries prevalence and intensity parameters changes.

Despite present approaches for caries prevention strategies modification, it is clear that residents of territory-associated deficiency of some macro- and microelements are exposed to much greater risk of caries pathology compare to people living within average environmental conditions.<sup>6,7,8,14</sup> Due to the previously reported data the worst epidemiological situations with high levels of caries prevalence and intensity recorded specifically within areas with deficiency of macro- and micronutrients in water, soil and food products, especially during the lack of fluorine and iodine.<sup>6,7,8,14</sup> Territories of Subcarpathia and Transcarpathia located at the western part of Ukraine have been previously described as those characterized with environmental stress due to the specific microelement deficiencies. According to the available literature, the prevalence of caries among children and young adults with the permanent residence within Transcarpathian region reaches 63.3%-98.3%, while intensity varies in range of 0.9-7.1.<sup>6,7,8,14</sup> Previously provided analysis of each influential factor related with the prevalence and intensity parameters of the caries demonstrated that negative impact of lifestyle, genetic factors, biogeochemical factors, climatic factors and medical factors are distributed in the manner of near 50%, 20%, 11%, 9% and 10% respectively.<sup>6,7,8,14</sup>

Based on above-mentioned information, it could be resumed that there is a need to provide adaptation of specific caries-prevention program within Transcarpathia region in Ukraine that should consider influence of different person-oriented and environmental factors in the different categorization groups regarding criteria of age, gender, residence and adherence to the oral care. Also, regarding prognostic value of caries-prevention strategy, it seems logical to evaluate impact of different influential factors primary within children population to minimize further caries prevalence among adult residents. Moreover, child's organism is highly physiologically sensitive to different changes occurrence within environmental or personal patterns and corresponds to such with clinically prominent variations in dental and general health status.<sup>8,15</sup>

That is why present research objective was to analyze the impact of environmental and

person-oriented factors on dental caries intensity trends among different age groups of children living at the ecologically stressed zone of Transcarpathia region with fluorine and iodine deficiency.

## Materials and methods

Retrospective design of the study covered two phases: 1) clinical evaluation of dental patients of childhood age, who were permanent residents of Transcarpathia with the aim of caries intensity level registration; 2) analysis of answers collected after adapted questionnaire survey among clinically evaluated children with the aim to verify potential subjectively noted risk factors.

Primary cohort of dental patients of childhood age was formed out of number of University Dental Clinic patients due to the next inclusion criteria: 1) age range within 7-18 years; 2) permanent residence within city, suburban or village located at the Transcarpathian region, which is characterized with established geographically-associated fluorine and iodine deficiency in the environment; 3) lack of any significant form of somatopathology or general medical condition that potentially could critically compromise oral health status (registered by the anamnesis data), thus forming extramarginal deviations in distribution of income description parameters within formed study sample; 4) personal agreement of child to undergo control clinical examination with purpose to register caries intensity and without objective of any kind of intervention provision, evidenced with signed informed consent form; 5) personal agreement of child to answer 10 questions provided within adapted questionnaire form, evidenced with signed informed consent form; 6) personal agreement of parents with allowance for their child to take part in the survey considering its retrospective design. Exclusion criteria addressed next aspects: 1) age out the 7-18 years range; non-permanent habitation within Transcarpathia region; 3) compromised anamnesis in means of present/previously existed/being in remission general medical pathology that demonstrated direct or indirect critical impact on oral health; 4) child's or parents' disagreement to take part in clinical examination or to answer questionnaire form because of any kind of reason; 5) child's or parents' refusal to sign informed consent form despite previously

provided personal agreement. Considering inclusion and exclusion criteria study sample was formed out of 842 participants.

Caries intensity parameter was interpreted by the classical calculation methodology of DMF/dmf index with the interpretation algorithm described in previous studies.<sup>8,16</sup> Clinical examination and completion of medical documentation was provided by trained and calibrated clinical dentists, representatives of Pediatric Dentistry Department (Uzhhorod National University), who previously took part in epidemiological studies and were qualified for objective evaluation of dental status.

Adapted questionnaire form included 10 questions. First three questions were dedicated to the verification of residency type (urban, suburban, village), time of last dental visits (<6 months, 6-12 months, 12-24 months, >24 months) and frequency of hygienic oral care procedures per day in means of toothbrushing frequency per day (none, once, twice or more per day). Next seven questions included those dedicated to the evaluation of possible influential factors impact:

- Questions #4: Do you have adequate vitamins supplement in daily diet?
- Questions #5: Do you involved in frequent stressful situations?
- Questions #6: Do you sleep enough?
- Questions #7: Are your parents motivate you to brush your teeth?
- Questions #8: Does your food intake frequency enough per day?
- Questions #9: Do you have any bad habits?
- Questions #10: Do you have frequent sugar-snacks per day?

Answers on questions 7-10 were presented by dichotomy variants of only “Yes” or “No”. Such approach was provided to optimize and facilitate child’s answers on above mentioned questions. Also, during questionnaire answering doctor provided full informational support and explanation for the child and parents to make questions “easy-to-understand”, while in several cases also using “gamified” approach of interaction with children. Exacts form and formulations of questions 4-10 were modified during provided survey to make them understandable for the children and to get clear answers “Yes” or “No” on them, but essence of

them represented in above mentioned list of questions.

Categorization by age criteria was provided due to the established parameters of 7, 12 and 15 years (considering WHO guidelines for clinical-statistical study designs)<sup>8</sup> with forming following age subgroups: 7-11 years, 12-14 years and 15-18 years.

The study protocol was approved by the Ethics Committee of Dental Faculty (Uzhhorod National University, Ukraine) on September 24, 2015 and received serial number №24102015.

Statistical processing of obtained data was carried out using Statistica software (statsoft.com), while tabulation and primary clustering was held via Microsoft Excel software (Microsoft Office 2019, Microsoft) with the use of additional statistical add-ons.<sup>17,18</sup> Primary distribution was provided due to income parameters of age, gender, residence and frequency of hygienic oral procedure (in means of tooth brushing) per day. Pearson’s coefficient was used to statistically interpret potential inter-relations between increase trend of caries intensity (established in clinical examination) and impact of influential factors (established by the questionnaire answers analysis) with p-value < 0.05 considered as statistically significant. Odds ratio for caries increase trend were calculated considering influence of different patient-oriented and environmental factors based on established values of caries intensity, registered questionnaire answers and their co-distribution among different age groups with 95% confidence interval.<sup>19</sup>

## Results

Parameter	Indicator	n (%)
Gender	Female	431 (51.2%)
	Male	411 (48.8%)
Residence	Village	224 (26.6%)
	Suburban	214 (25.4%)
	Urban	404 (48.0%)
Last dentist visit	<6 months	389 (46.2%)
	6-12 months	211 (25.1%)
	12-24 months	108 (12.8%)
	>24 months	134 (15.9%)

**Table 1.** Distribution of study sample considering gender, residence and last dentist visits.

Among 842 participants included in the study 431 (51.2%) were females and 411

(48.8%) were males. Distribution of study sample over different age groups was following: 7-11 years – 326 patients (38.7%), 12-14 years – 251 patients (29.8%) and 15-18 years – 265 patients (31.5%).

Detailed description of sample distribution due to the chosen income studied parameters presented in the Table 1.

Mean number of teeth affected by the caries in the 7-11 years age group was 10.6±1.6, in the 12-14 years age group – 4.4±0.7, in the 15-18 years age group – 5.6±0.9.

Statistically significant difference was noticed considering gender-associated distribution of patients due to the registered schedule of dental control appointments: 237 females vs 152 males visited dentist in last 6 month ( $p < 0.05$ ), while only 34 females visited dentist more than 24 months ago compare to 100 males, who visited dentist analogically more than 2 years ago ( $p < 0.05$ ). Analogically female subjects demonstrated statistically greater adherence to oral hygiene care compare to male subjects in means of tooth brushing frequency per day ( $p < 0.05$ ). Children with urban residence demonstrated higher adherence to the oral hygiene care in means of tooth brushing frequency compare to suburban and village residents, which was statistically argued ( $p < 0.05$ ), while such was not noted during the comparison of subjects living within village and suburban ( $p > 0.05$ ).

Parameters		Frequency of hygienic oral care		
		None per day	Once per day	Twice and more per day
Gender	Male	21 (5.11%)	198 (48.17%)	192 (46.71%)
	Female	7 (1.62%)	178 (41.30%)	246 (57.07%)
	General	28 (3.33%)	376 (44.66%)	438 (52.01%)
Residence	Village	36 (16.1%)	103 (46.0%)	85 (37.9%)
	Suburban	30 (14.0%)	91 (42.5%)	93 (43.5%)
	Urban	51 (12.6%)	153 (37.9%)	200 (49.5%)

**Table 2.** Distribution of study sample considering frequency of hygienic oral care (in means of tooth brushing frequency per day) in relation to gender and residence criteria gender.

Only 230 (27.32%) of interviewed children used oral hygiene aids (dental floss, irrigators, mouth washes, dental floss).

In age group 7-11 years caries intensity parameters among males were statistically associated with frequency of oral hygiene care ( $r = -0.72$ ;  $p < 0.05$ ) and frequency of stressful

situations ( $r = 0.27$ ;  $p < 0.05$ ). Caries intensity parameters among females in the same 7-11 years age group demonstrated statistically argued relationship with presence of bad habits ( $r = 0.85$ ,  $p < 0.05$ ), amount of vitamins in the daily diet ( $r = -0.83$ ,  $p < 0.05$ ), and frequency of oral hygiene care ( $r = -0.59$ ,  $p < 0.05$ ).

Caries intensity parameters among male subjects of 12-14 years age group demonstrated statistically significant correlation with compliance to the oral hygiene care ( $r = -0.81$ ), and among female of the same age group with the amount of vitamins in the daily diet ( $r = -0.60$ ).

Males of 15-18 years old were characterized with statistically significant caries intensity parameters adherence to the frequency of meals per day ( $r = -0.98$ ) and frequency of oral hygiene care procedure ( $r = -0.80$ ), while females' caries intensity values were statistically related with amount of vitamins in the daily diet ( $r = -0.95$ ) and frequency of oral hygiene ( $r = -0.88$ ). Correlation levels between specific factors of influence and caries intensity among examined and interviewed children population aged 7-18 years old with permanent residence within Transcarpathia region, registered for all study sample in general demonstrated in Table 3.

Factor	Pearson coefficient	p-value
Oral hygiene frequency	-0.96	$p < 0.05$
Vitamins amount in daily diet	-0.88	$p < 0.05$
Stress situations frequency	0.71	$p < 0.05$
Bad habits	0.85	$p < 0.05$
Sleep duration	0.26	$p > 0.05$
Subjective motivation provided by parents	0.52	$p > 0.05$
Number of sugar-containing snacks per day	0.71	$p < 0.05$
Meals frequency per day	-0.79	$p < 0.05$

**Table 3.** Correlation between specific factors influence and caries intensity among examined and interviewed children population aged 7-18 years old with permanent residence within Transcarpathia region.

Considering all above-mentioned levels of correlation, data from questionnaire answers analysis, specific distribution of caries intensity level among persons of different age and gender, we calculated odds ratio for caries intensity increase tendency under the influence of different factors considering general effect of such on all sample and on specific age and gender subgroups. Odds ratio for caries intensity increase tendency under the influence of low frequency of oral hygiene care was OR=1.56 (95% CI: 1.32-1.79), under the influence of frequent stressful situations – OR=1.12 (95% CI:

1.05-1.23), under the influence of deficiency of vitamins in the daily diet – OR=1.39 (95% CI: 1.25-1.76), under the influence of low frequency of food consumption per day – OR=1.49 (95% CI: 1.28-1.87), under the influence of frequent sugar snacks per day – OR=1.61 (95% CI: 1.47-1.93) among overall sample. Further statistical analysis helped to register different impact of above-mentioned factors among specific age and gender groups with representation of the most significant among them in Table 4.

Age group	Gender	Specific influential factor	OR, 95% CI	Gender	Specific influential factor	OR, 95% CI
7-11 years	Male	Low frequency of oral hygiene care	1.79 (1.53-2.11)	Female	Presence of bad habits	1.95 (1.73-2.44)
		Frequent of stressful situations	1.23 (1.05-1.57)		Deficiency of vitamins in the daily diet	1.74 (1.59-2.11)
					Low frequency of oral hygiene care	1.54 (1.30-1.82)
12-14 years	Male	Low frequency of oral hygiene care	1.90 (1.72-2.41)	Female	Deficiency of vitamins in the daily diet	1.56 (1.32-2.18)
15-18 years	Male	Low frequency of food consumption per day	2.05 (1.86-2.49)	Female	Low frequency of oral hygiene care	1.88 (1.79-2.10)
		Low frequency of oral hygiene care	1.87 (1.66-2.23)		Deficiency of vitamins in the daily diet	2.08 (1.93-2.28)

**Table 4.** Odds ratio for caries intensity increase tendency under the influence of the most influential factors in different age and gender groups.

### Discussion

Caries as a relevant worldwide problem of current dental practice arguments the need for improvement, modification and adaptation of present preventive and treatment strategies and development of new ones, considering established risk factors influence and their inter-relation between each other.<sup>3,6,7,8</sup> Current approaches of data processing and statistical analysis support identification and objectification of impact provided by various factors, while differentiating their effect among groups of patients with distinct income characteristics.<sup>9,10,11</sup>

Obtained results demonstrated that caries intensity increase trend demonstrated changeable pattern over different age and gender groups. Among overall study sample increase tendency of caries intensity parameters was related to the low frequency of oral hygiene care, frequent stressful situations, deficiency of vitamins in the daily diet, low frequency of food consumption per day and frequent sugar snack

per day. In-depth analysis of different age and gender groups demonstrated that only low frequency of oral hygiene care could be considered as universal significant risk factor for every study subject regardless his/her age or gender affiliation.

In previous study provided by Borges et al. authors noted that odds ratio of caries development were associated with low parental education level toward their children oral hygiene care, possibility to get dental help and frequency of hygienic procedures.<sup>20</sup> Based on obtained results author proposed to include knowledge of those factors impact during dental preventive and educational program development.<sup>20</sup> In our study we also have noted that low frequency of oral hygiene care in means of tooth brushing procedure frequency per day demonstrated statistically significant influence on caries intensity increase trend in all age and gender groups. But in contrast to Borges' findings, we have not noted influence of subjective motivation provided by parents toward oral hygiene measures of their children that was statistically argued. Such difference in outcomes could be related to the fact of subjective nature of answers provided by children during questionnaire processing.

Due to the systematic review and meta-analyses of case control and cohort studies early childhood caries was related with sugar snack at least once a day at the level of pooled odds ratio of 0,69 (0.16, 3.00) at upper-middle-income countries, and with intake of sugar snacks daily at the level of 1.56 (1.42, 1.71), with intake of sugar beverages at the level of 1.67 (0.25, 3.92), with brushing less than one time per day at the level of 1.08 (0.61, 1.92) at high income countries.<sup>21</sup> Relatively analogical odds ratio of caries intensity increase trend was noted in our study considering frequent sugar snack per day, while we also noted more pronounced negative influence of low frequency of oral hygiene procedures compare to meta-analysis results. Such difference in outcomes could be argued by the survey of specifically early childhood caries in systematic review, while in our study we surveyed children from 7 to 18 years old. Another systematic review and meta-analysis found inverse relationship between dental caries and socioeconomic indicators among Iranian children.<sup>22</sup>

On the other hand, Mejare et al. noted that multivariate models of caries risk demonstrated better performance among preschool population, while considered to have restricted prognostic value among adolescents.<sup>9</sup> But till now there is a lack of superiorly efficient method for caries prediction with deficiency of evidences to support some specific approach, methodology or program. Previously authors mentioned that primary caries assessment should be carried out during first child's dental visit, while further formulated model should be adapted in regard to the changes occurred during clinical monitoring.<sup>11</sup>

Age group of 7-11 years old children was characterized with the presence of the greatest number of potential and statistically argued risk factors compare to 12-14, 15-18 age groups, which could be related to the sensitive nature of child organism in above-mentioned age period associated with its growth and development. Age groups of 12-14 and 15-18 years despite ongoing formation of child's organism characterized with relatively more stable condition of oral environment and less pronounced changes, which in turn has shown association with less potential risk factors. But it worth to mention that obtained results should be interpret with caution, since we were able to identify influence of specific risk factors and odds ratio of caries intensity trend increase based only on formulated design of the study and received subjective respondents' answers. Absolute amount of associated risk factors for caries intensity increase is much greater and include various aspects, ongoing far beyond formulated questionnaire both for study sample in general and for specific age and gender groups particularly.

Female subjects in each age group were presented with associations between caries intensity increase trend and deficiency of vitamins in the daily diet, while such was not noted in different male age groups. Based on answers received from male subjects the potential relation was identified regarding caries intensity upgrowth trend and frequent stressful situations (in age group of 7-11 years) and with low frequency of food consumption per day (in age group of 15-18 years). Such different outcomes could be provoked by the effect of subjective answering provided by the respondents, or by the fact that parents support

female children with more attention toward vitamin, and male children with more attention toward their behavior and food consumption.

During the personal conversations with children and parents we were also able to identify products that are most widely used among age group of 7-18 years, which include chocolate and other sweets (contain sugar and starch), bananas, apples (contain organic acids and carbohydrates), green peas and figs (have the ability to linger in the oral cavity for a long time), mousse, jelly, all kinds of cereals (contain a large amount of sticky substances that precipitate on the teeth in the form of plaque), fruit juices (mostly provided canneries and contain a high concentration of sugars and acids). Generally, an increase in the frequency of food intake has a positive effect on the health and increases the resistance of hard tooth tissues, but frequent intake of specifically sugar-containing snacks during the day highly induces the risk of progressive caries intensity increase.

Due to the high incidence and prevalence of caries process among the studied age groups, it is advisable for parents to provide systemic control of their children' oral health by dental specialist. Also, it is important to modify the diet, mainly by eliminating or limiting the harmful habits associated with increased consumption of sweets. For children population of Transcarpathian region, as ecologically stressed zone with fluorine and iodine deficiency, we recommend four rules to improve culture of sweet's intake: 1) do not eat sweets at night; 2) do not eat sweets as a last meal; 3) do not eat sweets between the main meals; 4) if either of these three rules is violated, child should either brush your teeth, eat solid fruit or vegetables, or rinse mouth thoroughly.

Limitations of provided survey is related to its retrospective and questionnaire-based design, and also associated with subjective nature of answers obtained from interviewed respondents of childhood age. Nevertheless, such approach helped to verify mutable interdependencies trends between caries intensity increase and impact of environmental and person-oriented risk factors in different age and gender groups, along with the risk factors influence affiliated with caries intensity parameters within study sample in general. But obtained results support further perspective of future in-depth analysis considering caries-risk

model adaptation based on different income characteristics of various cohorts. The fact that we should modify formulated questions in the form of “game-play dialogue” during children’s interview also could be considered as a limitation of the study, but due to the fact that possible answers were related to strict dichotomy identification of “Yes” or “No” respond, it didn’t significantly influence received outcome, just took greater time expenditures.

Future perspectives include potential use of obtained results regarding changeable pattern of risk factors influence on caries intensity increase trend, as starting point for caries prevention and treatment strategies adaptation among different groups of patients with various income characteristics in the means of such risk factors correction and levelling.

### Conclusions

Due to the limitations of provided study, associated with its retrospective and questionnaire-based design, it was found that trend of caries intensity increase among different age and gender groups of children living within Transcarpathia region as environmentally-compromised region related to the different impact of various person-oriented and environmental factors, such as low frequency of oral hygiene care, frequent stressful situations, deficiency of vitamins in the daily diet, low frequency of food consumption per day and sugar snack per day. Noted variations of impact value of each of mentioned factors could be related with the subjective grading of their influence during questionnaire answering. Nevertheless, obtained results demonstrated that caries intensity increase trend shown changeable pattern of dependencies regarding different factors of influence in different age and gender groups, thus realization of different prevention strategies among different age and gender categories of children living within ecologically-stressed zone could be reasoned, but specific argumentation of such need to be validated as perspective hypothesis in further in-depth studies.

### Declaration of interest

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