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Dental caries management by risk assessment among children

Dobrinka Mitkova Damyanova, Siyana Atanasova
Department of Pediatric Dental Medicine, Faculty of Dental Medicine, Medical University of Varna Prof. Dr. P. Stoyanov, Varna, Bulgaria

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ABSTRACT

Dental caries is the highest-frequency oral disease. The purpose of this study is to assess the risk of developing dental caries for groups of children aged three to six in the city of Varna, Bulgaria, taking into account clinical risk factors. The population of this study included 300 children aged 3 to 6 years. Hence, as many 30 children for the experimental and 30 children for the control groups were included in the study with saliva tests. After that, standardized means of decayed, filled surfaces (DFS) index was estimated. The teeth of the children in the experimental group were covered for three months with Clinpro™ White Varnish. The Research Ethics Committee at the MU-Varna University approved the study. We applied the Greene and Vermillion oral hygiene index. Biostatistics was conducted with a specialized package for statistical analyzes was used StatSoft, STATISTICA manual (Software system for data analysis STATISTICA 10.0, 2010. The results in our study show the strong influence of carbohydrate nutrition and poor oral hygiene on the development and progression of the caries process. The results of the study of the frequency of caries lesions on surfaces show a value of 6.35±0.65. Caries lesions on 1 and 2 surfaces predominate (23.75%). Almost 100% of the children in the control group had *Streptococcus mutans* and a high risk of caries. From the risk assessment results obtained for each child patient, individual prevention programs are prepared for children.

Corresponding Author:

Dobrinka Mitkova Damyanova
Department of Pediatric Dental Medicine, Faculty of Dental Medicine, Medical University of Varna
84, Tsar Osvoboditel, 9000 Varna, Bulgaria
Email: dr_damyanova@abv.bg, Dobrinka.Damyanova@mu-varna.bg

1. INTRODUCTION

Dental caries is the highest-frequency oral disease, affecting both children and adult patients worldwide. The high prevalence of primary and secondary caries in at-risk populations, and accounts for significant life expectancy and disparate costs. In addition to the Journal of the American Dental Association in 2006, the American Dental Association Council on Scientific Affairs published definitions of risk categories for children and adults. Through the dental caries classification, we have to develop therapeutic strategies for patients according to their individual risks, if the pathology is diagnosed [1].

The general concept is also the risk profile, but it includes different ways of assessing oral health [2]. The American Academy of Pediatric Dentistry issues a consensus and supports the implementation of caries management by risk assessment in clinical methods of examinations and primary diagnosis, using the following principles, such as oral flora modification, patient health education, remineralization, and minimal surgical intervention. Approved assessment strategies and tools, as well as caries risk assessment methods, allow pediatric dentists to apply a systematic and evidence-based approach to accurately assess and thoroughly document all changes in a patient's caries risk status in an attempt to stop the disease [3], [4].

The risk profile can be made at several levels: Public or group for a given population [5]; Individual; and local for certain teeth [6]–[8]. According to the Consensus of the National Association of Pediatric Dentists for the treatment of caries of temporary teeth in 2013. "There are nine important risk factors. Medium or high levels of *Streptococcus mutans* and *Lactobacillus Acidophilus*; visible plaque on the teeth; more than three snacks throughout the day; deep pits and fissures; inadequate qualities of saliva-salivary current, pH, buffering capacity; factors reducing salivary secretion; orthodontic appliances; caries of parents; low social status [9]–[11].

Caries risk assessment systems have been introduced, such as the one recommended by the American Academy of Pediatrics or the Swedish Caries Risk Assessment Model using the Cariograme computer program. The caries risk assessment tool for Children in Bulgaria, created and approved by the Department of Pediatric Dentistry at the Faculty of Dental Medicine, Medical University of Sofia [12], [13], is also used to assess the risk of caries.

A list of scholars who participated in the composition of the consensus is also included [14], [15]. Risk assessment is the first step in developing a comprehensive protocol for oral child health and care. Caries prevention approaches must be integrated based on knowledge and understanding of predicted risk. The risk model is used to determine the etiological factors called risk factors, but it cannot predict the outcome of caries. The prediction model estimates the risk of caries progression in future periods of the child's growth. Because the disease process is multifactorial and behavioral, risk models that account for multiple variables end up with better predictions [16].

Dental caries have hereditary characteristics and genetic associations. Early studies have shown that: The presence of the major allele for TAS2R4-rs2234001 and TAS2R9-rs3741845 was associated with lower means, tumor necrosis factor alpha (TNF-α), interleukin one beta (IL-1β), carious, missing, and filled teeth (DMFT) index, and have 5 times more carious, missing, and filled teeth [DMFT/DMFS (carious, missing, and filled surfaces)] than those with other variations of this gene and the likelihood of missing teeth [17], [18]. Based on the risk assessment results, individual prevention programs are prepared for each patient. The aim of this study is to assess the risk of developing dental caries for groups of children aged three to six in the city of Varna, Bulgaria, taking into account clinical risk factors.

2. RESEARCH METHOD

The study involved a population of 300 children between the ages of three and six. From the sample, we selected 30 patients for the experimental group and 30 for the control group, who were included in the study with the salivary tests - We applied the “Saliva-Check Buffer” and the "Saliva-Check Mutans R" of the company GC. The study is authorized by the Commission for Ethics of Scientific Research at Medical University of Varna with protocol-decision No. 40/ 30.10.2014. Patients are clinically healthy. The teeth of the study children in the experimental group will be coated with Clinpro™ White Varnish with Tri-Calcium phosphate by 3M (CV). Our task in this study is to analyze the degree of clinical risk factors in children aged three to six years and compare them with the control group. Tables 1 and 2 show the characteristic of population based on age gender distribution.

Table 1. Statistics of data of age distributions and relative share

Age	Number	Cumulative frequency	%
4	100	101	33.77926
5	100	199	32.77592
6	100	300	33.44482

Table 2. Frequency distribution for sex relative share

	Number	Cumulative frequency	%
Boys	160	160	53.17726
Girls	140	300	46.82274

The research is to analyze first the standard risk factors for the development of dental caries, and second-individual-specific risk factors of each child. Important risk factors can be: 1. Medium or high level of streptococci and lactobacilli in the oral cavity; 2. Visible plaque on the teeth; 3. More than 3 intermediate meals daily; 4. Deep pits and fissures; 5. inadequate qualities of saliva - saliva flow, pH, buffer capacity; 6. Factors reducing salivary secretion; 7. Orthodontic appliances; 8. High caries of the child; 9. High caries of the parents; 10. Low social status. Biological factors that create prerequisites for the future development of a carious process, and then a carious lesion. Much can be done about the risk factors and prevent the realization of a risk.

Factors used in caries risk assessment: caries risk factors; protective against caries; factors which could be both according to their quantitative characteristic.

The object of observation: Patients from three to six years with the need for prophylaxis and treatment of dental caries of the primary dentition. The children were included in the study after signing an informed consent from their parents. The study was approved by the Commission on Ethics of Research (KENI) at the Medical University, "Prof. Dr. P. Stoyanov" in the city of Varna and declared informed consent document was obtained from each parent.

i) Clinical methods, clinical examinations were conducted in the doctoral dental office at the University Medical and Dental Center-Varna on a professional dental chair with directional lighting, water, and air. After that, standardized means of decayed and filled surfaces (DFS) index were estimated.

ii) Caries risk assessment, we used a special clinical card "Tool for caries risk assessment of children in Bulgaria", created and approved by the Department of Pediatric Dental Medicine in Medical University of Sofia for caries risk assessment.

Low caries risk: children who brush their teeth daily with fluoride toothpaste, alone and /or under parental supervision more than once a day, who visit a dentist regularly, have fluoride applications and others, without any or with less than three intermediate intakes of sugar-containing snacks and beverages throughout the day, parents of high social status and no active caries lesions are considered at low caries risk.

High caries risk: children with unsatisfactory and poor hygiene (measured by the OHI Green & Vermillion index, Oral Hygiene Index - modified) are at high risk of developing active carious lesions, with high amounts of Str. mutans and who do not brush their teeth daily with fluoride toothpaste (alone and/or under parental supervision more than once a day), do not visit a dentist regularly, do not have fluoride applications with clinical means, have three or more intermediate intakes of foods or beverages containing sugar, have parents with low social status and have active caries lesions.

The diagnostics of the caries process and caries lesions was performed by assessing the risk of developing dental caries by standard risk factors: age; frequency of caries; carbohydrate nutrition; oral hygiene; fluoride prophylaxis; prophylactic examinations; social status of parents; caries of parents; new caries lesions that have appeared in the last year; saliva properties and the amount of *Streptococcus mutans*.

iii) Assessment of the oral hygiene status, The Greene and Vermillion Oral Hygiene Index (Simplified, 1964) was used to determine oral hygiene status. The following rating scale was used to determine the level of oral hygiene: good (OHI≤1); satisfactory (OHI=1-2); bad (OHI≥2).

The data of each of the examined children was registered in an outpatient card, questionnaire and a clinical card "Tool for caries risk assessment". Evaluation of saliva properties was assessed using GC's Saliva-Check Mutans R [19], following the methodology for each test.

Due to the preliminary design of the study, the following risk factors were excluded from the caries risk assessment map: children falling asleep with a bottle containing natural or added sugar; children with special needs; and children refusing to take the test.

Biostatistics was conducted with a STATISTICA 10.0 was used. [StatSoft, Inc., STATISTICA manual (data analysis software system), Version 10.0, 2010]. Through descriptive statistical analysis, the frequency distribution of the considered signs, presented by research groups, the mean values and standard deviations and 95% confidence intervals of the changes in the mean values are tabulated. Student's test (t-test) for two independent samples and to establish a statistically significant difference in the mean values of the studied factors in control and experimental groups: K. Prodanova, Lecture Notes in Statistics, TU-Sofia, 2008, p. 1 -11. Analysis of ANOVA was applied to determine the presence/absence of influence of two or more factors (the probability of making a first-order error, namely rejecting the null hypothesis when it is true null hypotheses of equality of means by t-test and ANOVA, p=0.05 was chosen as the level of significance). Pearson Correlation index was applied for correlation between OHI, risk, age, and dft/DFS in primary teeth. In statistical data processing, the parametric theory for estimating statistical hypotheses is applied by comparing relative values from two samples. Depending on the results, we will conclude the assessment of the risk of caries in the examined children.

3. RESULTS

In modern scientific literature, caries is defined as a process that begins long before a clinically detectable lesion is reached, which is actually only one symptom of this disease. The caries process includes changes in the oral environment, the behavior of the individual, factors, and accompanying circumstances that lead to the development of micro- and macroscopically visible caries lesions. Caries as a multifactorial disease includes the mutual influence of these factors both between them and the change in the balance of the oral environment. The addiction between protective and risk factors determines whether the (period of

development) caries process, will continue until the clinical level of carious lesion is established or the carious lesion will become stationary (inactive lesion).

According to the results, we will make the conclusion for the risk assessment. Thus, we will implement a protocol for the management of white d1 and d2 carious lesions, which we treat with fluoride varnish, and develop an individual program for the prevention and treatment of each patient - a child from three to six years included in the study. We exclude the factors that we do not consider children who refuse to be examined, children with special needs, and children sleeping with a pacifier.

The first important risk factor is the frequency of caries. Data on the distribution of children by degree of risk are shown in Figure 1. The data in Figure 1, show that the majority of children are at high risk of developing dental caries lesions. Reversible active carious lesions indicate a highly cariogenic oral environment of the primary teeth. The Figure 1 shows, that all children are at risk of developing dental caries. A larger number of the examined patients are at high risk of development as shown in Figure 1. Frequency distribution of DFS (carious and filled surfaces) for patients from 3 to 6 years with more than one dental caries are: Frequency distribution of DFS 0/ N=54/ Cumulative frequency 54, and % of all 18.060; Frequency distribution of DFS 1-5/ N=119/ Cumulative frequency 173, and % of all 39.799; Frequency distribution of DFS 5-10/ N=71/ Cumulative frequency 244, and % of all 23,746; Frequency distribution of DFS 10-15/ N=26/ Cumulative frequency 270, and % of all 8,696; Frequency distribution of DFS 15-20/ N=25/ Cumulative frequency 295, and % of all 8.361; Frequency distribution of DFS 20-22/ N=4/ Cumulative frequency 300, and % of all 1.334, and the corresponding histogram is below, as the number is already in 2 ie. 0; (1; 2); (2; 4).

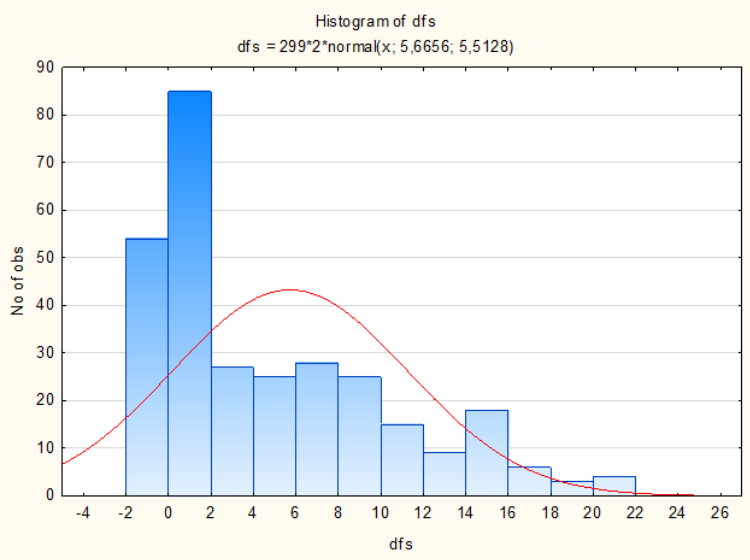

Figure 1. Distribution of the risk factor, the frequency of dental caries on the tooth surfaces of the examined teeth of patients. The distribution is through 2 with % for the index “DFS”

The results of the study of the frequency of caries lesions on surfaces show a value of 6.35+0.65. This means that caries lesions on surfaces 1 and 2 are predominant (23.75%). Caries of the sum of more surfaces of the temporary dentition are also high - 7 and 8 surfaces (9.36%), as well as those of 11 and 12 surfaces (8.03%) of the entire primary dentition. This is due to the large number of carious teeth that are affected as shown in Figure 1. All reversible lesions may regress or become stagnant, reducing the accumulated pathology above this diagnostic level. The comparative analysis of caries according to the number of teeth in the dentition shows that there is a demonstrated statistical significance significant in caries in children with different numbers of teeth in their dentition ($F=27.48$, $p<0.001$). The children with 19 temporary teeth (4.21) have the highest caries, and those with 20 teeth (1.74) have the lowest.

The assessment of the cariogenic microflora was performed with a simplified microbiological test, which can be performed next to the patient's chair and does not require special training. We applied the “Saliva-Check Buffer” and the "Saliva-Check Mutans R" of the company GC [19], Table 3. Microbiological assessment of the cariogenic microflora establish, that almost 100% of the children in the control group had *Streptococcus mutans* and were at high risk of caries between three and six years of age. The risk factor is indicative of risk assessment and is very high. A statistically significant difference is demonstrated in the two risk groups.

From our available literature, we know that effective oral hygiene has a preventive effect on dental caries. The quality of cleaning is significantly more important than the frequency of plaque biofilm brushing. Professional tooth polishing at regular intervals of 6 months can be a preventive method against caries on all tooth surfaces. Assessment of the risk of dental caries and periodontitis in childhood by determining the risk factor level of oral hygiene with the examination of the Greene & Vermillion plaque index(modified), (OHI) is shown in Table 4.

Studies of childhood patients show that oral hygiene is a high-risk factor for the development of initial dental caries in a large number of the examined children, OHI(Oral hygiene index – modified)=1.073. The oral hygiene index as an indicator of the level of compliance with oral hygiene and the degree of accumulation of dental biofilm also demonstrates a statistically significant correlation with risk assessment. Dental biofilm plays an active role in the caries process. From the results of the risk assessment obtained for each child patient.

Table 3. Influence of cariogenic microflora on caries risk assessment with "Saliva-Check Mutans R" test

Risk factor Cariogenic microflora	Number of children patients N	Low risk 0-low ($<10^5$)	Medium risk Average ($>10^5$)	High risk High ($>>10^5$)
Children between 3 and 6 years with fluoride varnish application	30	0%	20%	80%
Children between 3 and 6 years without fluoride varnish application	30	0%	0%	100%
t				t= 2.66, t > 1.96

Table 4. Assessment of the risk of dental caries and periodontitis in childhood result

	Descriptive statistics						
Risk factor: Level of oral hygiene	Number of children	Average Value	95% left end Confidence interval	95% right end Confidence interval	Min.	Max.	Std. Dev.
OHI Greene & Vermillion (modified)	300	1.072910	0.996521	1.149299	0.300000	2.600000	0.671197

The obtained coefficient of determination is 0.97, which proves the adequacy of the model. The p-levels for both explanatory variables were less than 0.05, which determined that the dft variable depended on both the OHI (modified) values and the age factor. The increasing logarithmic dependence of dft on OHI is dft=3.759+3.6789*log10 (OHI). This is probably due to the fact that the dental biofilm contains two etiological factors for the caries process, which are microorganisms, carbohydrates and acids in close proximity to the enamel, providing the necessary time for action and isolating them from the buffer systems of saliva.

4. DISCUSSION

The results in our study show the strong influence of carbohydrate nutrition and poor oral hygiene on the development and progression of the caries process in the primary dentition, index DFS=6.35 (±0.65). From all the factors considered, we found that children are at high risk of developing dental caries and carious lesions in the early stages. The most important risk factors for prevention the children of the studied age period (three to six years old) are dental caries, poor oral hygiene, frequent intake of low-molecular carbohydrates and early infection with *Streptococcus mutans*. Applied saliva tests and analysis of cariogenic microflora assessment data from microbiological tests proved that practically- 100% of children in the control group had high microbial counts and high caries risk between three to six years of age.

From the indicators of caries risk to the clinical condition of the patient in childhood, the following also apply. Caries lesions were visible with X-ray examination, Conducting orthodontic treatment of the patient and diagnosed hypoplasia or dysplasia of the enamel of the teeth. These factors and patients were not included in this study. Plaque biofilm studies using Genetic Study of the Cell Nucleus (DNA sequencing) and detection of microorganisms have shown about 40 bacterial species to date that have pathogenicity in the development of dental caries. This microbial diversity has been shown to continue to grow. The microbiome was defined with 246 species between the groups, which accounted for about 80.7% of all scientifically proven species [20]. The studies of predominant genera showed significant interactions between oral microbiota and demonstrated more complex and aggregated bacterial correlations in patient groups, even without dental caries [19]. In recent independent studies, scientists have identified species such as Bifidobacterium; Scardovia wiggsiae; Slackia, and Propionibacterium acidifaciens [20], [21].

Microbiological studies of randomly collected plaque biofilm samples removed from dental crowns and during polishing showed that in the oral cavity, the most common oral bacteria in dental plaque was *Streptococcus mutans*, followed by *Streptococcus sobrinus* [V. Kim Kutsch 2014] [22], [23]. The risk of developing dental caries is generally associated with only a few common factors, and these factors lead to general patterns of dental disease [24], [25]. Modern strategies can be organized into three categories. Reparative strategies, therapeutics, adhesives and modern materials such as fluoride depots and changes in the frequency of clinical visits related to the children [26], [27] and their parents are applied [28]–[35].

The preventive approach, if it starts much earlier with a change in the balance in the factors of the oral environment, the pathology of primary teeth and irreversible carious lesions will be less. The benefits for children's physical and mental health are significant. Prevention and non-invasive treatment will reduce the occurrence of carious pathology in the permanent dentition. Easy and painless non-operative treatment creates a positive attitude in children towards dental manipulations, treatment methods and dental medications [36]–[38]. Assessing the risk of caries in children based on the assessment of risk factors is very important. During this time, clinicians will identify preventive and/or therapeutic approaches to implement, which in turn will reduce or stop and hold completely the development of dental caries. Clinically, fluoride medications, pastes with casein phosphopeptide and amorphous calcium phosphate, zinc biomimetic hydroxyapatite products, or products containing self-assembling oligopeptide SAP-P11-4 can be applied. Regarding the clinical approach, the questionnaire should be added to describe the child's eating habits during the day, diet for 7 days. Also, describe the oral hygiene habits of the children patients and after assessing the risk of dental carious lesions in the child allows a reduction of the decayed, missing, filled teeth (DMFT) index or the International Caries Detection and Assessment System (ICDAS index) on a large scale [39].

5. CONCLUSION

The risk assessment is the basis for preparing individual preventive programs for each patient from three to six years of age. This is an easy and clinically accessible task. This is the modern approach to prevention, early diagnosis and treatment of caries. Determines the degree of risk of developing carious lesions. It helps to identify the etiological factors that have led to caries or could lead to one. Determines the possibility of developing the disease in a certain period. It helps in the clinical decision about the type of prophylaxis and treatment. Improves the reliability of the prognosis in the planned treatment. Evaluates the efficacy of the proposed prevention plan at follow-up visits. Creates an opportunity to model the negative factors and strengthen the protective ones. Creates an opportunity to manage the carious process during treatment.

We can obtain an accurate treatment plan for each patient by: Developing detailed data for each clinical case, including dental caries risk assessment, the placement of diagnosis, differential diagnosis and making the treatment plan. To determine deadlines for control examinations and justification for the selected period for remotivation, control and description of the expected results.

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BIOGRAPHIES OF AUTHORS

Dobrinka Mitkova Damyanova has gained her Master degree of Dental Medicine in the year 1997 in Medical University, Faculty of Dental Medicine of Sofia, Bulgaria. She has specialization in General Dentistry and Pediatric Dentistry. D-r Dobrinka Damyanova graduated from the PhD at the Medical University, Prof. Dr. Paraskev Stoyanov, Faculty of Dental Medicine, Varna, Bulgaria in 2017. Since 2008, she is an Assistant in the Department of Conservative Dentistry and Pediatric Dentistry and since 2013 she is working in the Department of Pediatric Dentistry, Faculty of Dental Medicine of Medical University of Varna. She has 40 publications and 15 participations in scientific congresses. She is the Member of Bulgarian Dental Association (BDA), Bulgarian Scientific Dental Association (BSDA), the National Association of Pediatric Dentistry Doctors, European Organisation for Caries Research (ORCA), Union of Scientists in Bulgaria. Her research interests include Pediatric Dentistry, Restorative Dentistry and Operative Dentistry. Since 2018, she is an Chief assistant Professor in the Medical University of Varna, Bulgaria, Faculty of Dental Medicine, Department Of Pediatric Dental Medicine. From April 2021, she holds the position of associate professor at the University of Medicine in Varna, at the Faculty of Dental Medicine. She can be contacted at email: dr_damyanova@abv.bg, Dobrinka.Damyanova@mu-varna.bg.

Siyana Georgieva Atanasova is an Assistant Higher School, Dr., who works in the Department of Pediatric Dentistry at the University of Medicine in the city of Varna and the Faculty of Dental Medicine. Born on 07.12. 1993, in the city of Burgas. In 2012, Dr. Atanasova graduated from secondary education at GPAE "Geo Milev" in the city of Burgas, a foreign language profile. In 2018, she completed her higher education – a master's degree in dental medicine at the Medical University of Varna. Since 2018, she has been a full-time assistant in the Department of "Pediatric Dentistry" at the Faculty of Dental Medicine of the Medical University of Varna. She has 2 publications and 5 participations in scientific congresses. She can be contacted at email: Siyana.Atanasova@mu-varna.bg, sadent93@abv.bg.