Study of the risk factors for the development of dental caries and creation of a system for assessment the risk of caries in children in Bulgaria

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Summary

In the last 15 years, the assessment of the risk of caries is a basic element of the prevention, control and treatment of caries. The contemporary approch in the study of caries stresses the importance of management of the condition, of preventive nonaggressive treatment, of the "manipulation" of the biological and chemical oral environment.

It is the aim of the present study to determine the relative weight of the most important factors for assessment of the risk of caries in children and to work out adequate instruments for the risk prediction of caries, appliable to the children in Bulgaria.

High risk factors for the development of caries are the oral hygiene, carbohydtate nutrition, the viscosity of the saliva, the buffer capacity, the ðÍ of the saliva, the incidence of caries in parents, the social status. Moderate risk factors are the insufficient fluoride prophylaxis and some parameters of the salivary current, such as the buffer capacity and the viscosity of the saliva. When the intake of carbohydrates is high, the way of intake of carbohydrates and the frequency of meals makes no substantial difference.

On the basis of the results obtained the most important risk factors were selected and then supplemented by factors used in different systems of assessment, as presented by the relevant literature. With their help a system of instruments for the assessment of the risk of caries was worked out, our basic aim being easy usage of the instruments and comparabilty of the results in time.

Key words: dental caries, risk prediction, risk factors, the risk of caries, oral hygiene, carbohydtate nutrition, the viscosity of the saliva, the buffer capacity, the ðÍ of the saliva, the caries in parents, the social status.

Dental caries is a multifactor infectious condition emerging when a disbalance between the aggressive factors in the local defence surrounding the enamel occurs. Causes for caries are the basic etiological factors (resistence of the enamel, the microorganisms and the carbohydrates), additional factors (timing and role of the saliva) and a number of other conditions and prerequisites (knowledge, training, habits, behaviour, social milieu, etc.) that modify the manifestation of the basic factors [1, 2, 3, 10].

In the last 15 years risk prediction is major aspect of the prevention, control and treatment of caries. The preventive approach in modern cariesology stresses the importance of caries management, of nonagressive treatment, of oral biological and chemical environment "manipulation" [4, 5, 6, 8, 9, 1, 12, 13, 14, 23].

Conventional "drilling and filling" methods of caries treatment are being superseded by modern methods of nonagressive dental caries management. The efficiency of such methods of treatment has been proven by a number of researches. If nonagressive treatment is to be successful sophisticated risk prediction indicators must be employed. Such indicators are there to measure the correlation between risk and defence factors, considered that each human individual has unique constitutional characteristics. All kinds of different factors are relevant to the concrete oral situation of the individual or the population [15, 16, 17, 19].

In the beginning the process of caries is dynamic and irreversible. Cycles of demineralisation and remineralisation alternate daily and after each meal on the surface of the enamel. The degree of the condition is determined by the balance

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between the two cycles. Clinically, the two processes show in visible phenomena such as changes of the colour, brightness and texture of the surface enamel. If the local oral environment is positively influenced before cavitation and the process of remineralisation becomes predominant the initial lesion may begin to regress or stop to progress. Nonagressive preventive treatment is basically a matter of influencing the biological and chemical environment of the tooth. Individual risk prediction and the adequate diagnosis of initial caries lesions is what makes preventive treatment possible [18, 20, 21, 22].

There exist different systems for the risk prediction of caries, the variations depending on what basic factors the different authors choose to rely on. Different age groups and people living in different social economic conditions are studied by means of specific criteria.The Americam Pediatric Academy has its own system of risk prediction of caries. There is also the Swedish model of risk prediction of caries in which a special computer program named „Cariogram" is employed [1, 7,14]. Featherstone's conception of "balanced caries" is yet another system of risk prediction [10,11].

The study aims at determining the most important factors for the occurrence of dental caries in children in Bulgaria as well as at creating a system of indicators for the risk prediction of children's caries in the country.

Materials and methods

57 children (32 girls & 25 boys) were examined.

A form was prepared for recording the risk factors and for registering the patient's dental status. The „Saliva-Check" produced by „GC" was used for quick testing of the quality of the saliva of each child. We examined the connection between the basic risk factors and the incidence of caries in the children studied.

The following basic caries related factors were measured and recorded:

- Incidence of caries; General illnesses; Food regimen;
- Frequency of meals;
- Incidence of caries in parents;
- Social status;
- Visits to a dentist;
- The occurrence of new caries during the past year;
- Oral hygienic status;
- Oral hygienic habits;
- Fluoride prophylaxis;
- Salivary secretion – stimulated saliva;
- Salivary secretion – nonstimulated saliva;
- Consistency of the saliva;
- pH of the saliva;
- Buffer capacity of the saliva.

A three-grade scale was created for the evaluation of each risk factor, the saliva being assessed with the methodology of the „Saliva-Check" - „GC" *(Table 1).*

Oral higiene was objectified in terms of the Green-Vermllion oral-higiene index.

The data obtained were processed by means of variational analysis. Results were correlated with the help of Student's T-criterion.

Results and analysis

I. Determination of the most important factors for the occurrence of caries in children in Bulgaria.

1. Assessment of the general health condition

It turned out when the general health condition of the children was assessed that only two of them had a general illness that was moreover not a factor for dental caries. These two children had an intensity of the caries that was within the average for the group studied.

2. Assessment of the intake of carbohydrates

No child in the research group restricted itself in the intake of carbohydrates. There was no control group of children restricting themselves in the intake of carbohydrates either. Consequently, no comparison can be made between children with correct and incorrect consumption of carbohydrates.

The children were divided into two groups – children who occasionally consume carbohydrates and children who frequently consume simple saccharides.

There's no statistically verifiable difference between the two groups. The incidence of caries and the number of obturated teeth in both groups is equal. In both groups children were not restricting themselves in the consumption of carbohydrates. Hence the big number of caries and obturated teeth. The intake of carbohydrates undoubtedly increases the risk of caries. The effect different patterns of intake of carbohydrates have on the incidence of caries were impossible to study, though.

In accordance with the number of meals a day,

Table 1. Scale of risk factors evaluations

	Risk factors	**Scale of assesment**
Incidence of caries	DMF-T	
General illnesses	0 – healthy	1 - yes – indirect influence; 2 – yes – direct influence.
Food regimen	0 – limiting the carbohydrates; 1 – taking them with the basic meals.	2 – rarely between the meals; 3 – frequent consumption of simple saccharides
Frequence of meals	0 1 - 3-5 times a day	- 3 times a day; 2 - 7 times a day 3 >7 times a day
Oral higiene	OHI 0 - OHI (0-1) 1 - OHI (1-2) 2 – OHI (2-3)	Oral higiene habits 0 - excellent 1 - good 2 - satisfactory 3-unsatisfactory
Fluoride prophylaxix	0 – optimum 1 – F-tooth paste + some other fluoride prophylaxis	2 - F-tooth paste 3 – absence of fluoride prophylaxis
Stimulated saliva	0 - norm ->5ml /5min; 1 - weak current (3,5-5ml/5min);	2 – very weak current (<3,5 /5min);
Not stimulated saliva	0 -under 1 min-norm;	1-over 1 min- weak current
Consistency of the saliva	0 - liquid (norm); 1 – with bubbles – medium;	2 – thick – viscous;
pH	0- green – normal (neutral pH); 1- yellow-mildly acid; 2- 2 – red – acid;	
Buffer Capacity	0- 10-12 p – normal; 1- 6-9 p - weak buffer; 2- 2 - 0-5 p – very weak;	
Incidence of caries in parents	0 - with occasional obturations; 1 - 6-10 obturations, sanitised, 1-2 extractions; 2 - many obturations, sanitised; 3 - many obturations and extractions, not sanitised.	
Social status	0 - over the average standard; 1 - average standard for Bulgaria; 2 - families of unemployed or disabled people, people from an underprivilleged ethnic minority.	
Visits to the dentist	0 – 2 times a year; 1 -1 time a year; 2 – occasionally, only in case of need.	
Caries in the past year	0 – no caries; 1 – has at least one caries.	

Table 2. Importance of the intake of carbohydrates for the incidence of caries in the group of children studied

	Intake of carbohydrates	
	Occasionally – between meals	**Frequently – simple saccharides**
Number	33	24
DMF	8,45	7,87
σ	4,88	3,4t
	T=0,53	P>0,05

σ-standard deviation

the children studied were divided into two groups. Children in the first group had three meals a day, while children in the second group had 3-5 meals a day.

Table 3. Importance of the number of meals for the incidence of caries in the group of children studied

	3 times a day	3 - 5 times a day
Number	39	18
DMF	7,38	7,66
σ	3,29	7,13
T	T=0,18	P>0,05

Children in the having only three meals a day prevail in the group of children studied. There is no statistically verifiable difference in the DMF in the two groups. This is to say that the difference in the number of meals a day does not represent a substantial factor for the occurrence of caries.

3. Assessment of the influence of heredity on the incidence of caries

The incidence of caries in parents is considered an important risk factor. The children were divided into two groups. The first group included children whose parents had occasional obturations and children whose parents had a DMF of 6 - 10. The second group included children whose parents had a very high DMF - over 20.

Table 4. Influence of the incidence of caries in parents on the incidence of caries in children

	Moderate incidence of caries	High incidence of of caries
Number	21	36
DMF	4,57	9,5
σ	3,65	4,5
t	T=7,27	P>0,001

It turned out that most parents of the children studied had a high incidence of caries. It was the children of this category of parents that had an extra-high incidence of caries. The statistical verifiability of this correlation is pretty high. That is why the incidence of dental caries in parents can be considered an important risk factor for the incidence of dental caries in children.

4. Assessment of the importance of social status for the incidence of caries in children

The social status of the children studied is an important factor for the occurrence of caries. The children were divided into two groups. The first group included children with medium and higher social status (with regard to the conditions in Bulgaria), while the second group included children with low social status (children of unemployed or disabled parents, children from an underprivilleged ethnic minority, abandoned children).

Table 5. Influence of social status on the incidence of caries

	Medium and higher social status	Low social status
Number	15	42
DMF	2,8	9,35
σ	2,48	3,86
t	T=7,52	P>0,001

Around 4/5 of the children studied came from families with low social status. It was established with a great degree of statistical verifiability that such children have a much greater incidence of caries. Social status is clearly an important factor for the occurrence of caries.

5. Assessment of the influence visits to the dental doctor have on the incidence of caries within the past year

As far as prophylaxis is concerned, the chidren were divided into two groups. The first group included children who had regularly visited a dentist, while the other group included children who had visited a dentist only in case of need.

Table 6. Influence of regularity of dental check-ups on the incidence of caries in children

	Regular visits	Occasional visits – only in case of need
Number	12	45
DMF	2,5	9,53
σ	2,87	3,72
t	T=7,1	P>0,001

Only a small part of the children had regularly visited a dentist. The incidence of caries in these children is very low. This importance of this factor is pretty obvious. So is its link with the social status.The same correlation makes itself conspicuous when it comes to the children's visits to the dentist during the past year.

Table 7. New caries with the past year

	No caries	At least one caries
Number	9	39
DMF	2	9,46
σ	1,41	2,59
T	T=12,03	P>0,001

Not all children provided us with an answer to this question. Hence the small number of children with no caries within the past year.

6. The importance of oral hygiene for the incidence of caries in the children studied

The children were divided into two groups. The first group included children with good oral hygiene, while the other group included children with bad oral hygiene.

Table 8. Influence of oral hygiene on the incidence of caries in children

	Up to 1 caries	2-3 caries
Number	12	45
DMF	3,25	9,33
σ	2,48	4,12
T	T=6,53	P>0,001

Under 1/4 of all children turned out to have good oral hygiene. Bad oral hygiene is a serious risk factor for the development of caries. There is a big verifiable difference in the DMF between the two groups. Children with bad oral hygiene have a noticeably bigger number of caries and obturations.

7. Assessment of the influence of fluoride on the incidence of caries in children

Depending on the form of flouride prophylaxis used, the children were divided into two groups. The first group included children that had received optimum fluoride prophylaxis or had not only been using fluoride toothpaste but were also receiving an additional prophylactic procedure. The second group included children that had only been using fluoride toothpaste or had not been using fluoride toothpaste at all.

Table 9. Influence of fluoride prophylaxis on the incidence of caries in children

	Satisfactory F-prof.	Unsatisfactory F-prof.
Number	27	30
DMF	6,11	9,1
σ	3,92	4,84
T	T=2,6	P>0,05

The distribution of the children between the two groups is almost even. Those who had received unsatisfactory fluoride prophylaxis had higher incidence of caries. In statistical terms, the correlation is not strongly corroborated, though. This is probably due to the relatively small number of children studied.

Results from the study clearly show that fluoride prophylaxis reduces the risk of caries.

8. The importance of saliva with regard to incidence of caries in children

8.1. Salivary current. Two kinds of measurment were made so that the role of the salivary secretion could be determined – of stimulated and not stimulated saliva.

Once the not stimulated saliva was measured, two groups of children formed – children with normal salivary current and children with very weak salivary current. Those who had very weak salivary current had a much stronger incidence of caries. Clearly, reduced salivary current is a risk factor for the development of caries. Once the saliva was stimulated, the children divided into a group of children with weak salivary current and a group of chioldren with very weak salivary current. There were no children with normal salivary current amongst those whose saliva was stimulated, as far as the criteria of the producer of the test are concerned (the norm being 1-1,6 ml/min or more than 5ml in 5 min). According to us, a lower indicator

Table 10. Influence of the salivary current on the incidence of caries in children

	Not stimulated saliva		Stimulated saliva	
	Normal current	Very weak current	Weak current	Very weak current
Number	33	24	18	39
DMF	7,36	10,12	7	8,76
σ	4,26	3,47	3,51	4,35
T	T=2,7	P>0,05	T= 1,16	P>0,05

for normal salivary current in children would be more appropriate. There is no statistical difference between the incidence of caries in the two groups of children.

8.2. Viscosity of the saliva. The viscosity of the saliva is an imporatant risk factor for the emergence of caries. The children were divided into two groups. The first group included children with fluid saliva, while the second group included children with medium saliva (with bubbles) and viscous saliva.

Table 11. Influence of the viscosity of the saliva on the incidence of caries in children

	Fluid	**Medium and viscous**
Number	24	33
DMF	4,25	10,27
σ	2,83	3,86
T	T=5,49	P>0,001

It is evident from the study that the medium and viscous saliva is found in children with much higher DMF. The correlation is statistically pretty clear, which makes us reiterate this risk factor as particularly important.

8.3. Buffer capacity. A drop in the buffer capacity of the saliva can only be a risk factor for the development of caries. Depending on the buffer capacity of their saliva, the children were divided into two grouops. The first group included children with weak buffer capacity, while the second group included children with normal buffer capacity.

Table 12. Influence of the buffer capacity of the saliva on the incidence of caries in children

	Weaker buffer capacity	**Normal buffer capacity**
Number	36	21
DMF	8,5	5,5
σ	3,4	4,52
T	T=3,36	P>0,001

It was found out that the majority of children had weak buffer capacity. Children from this group had a much bigger incidence of caries than the children with normal buffer capacity. Hence the conclusion that buffer capacity is an important risk factor for the development of caries in children.

8.4. pH of the saliva. The acidness of the saliva of the children was studied. Depending on the results obtained, the children were divided into three groups – with neutral saliva (6,8 - 7,8), with mildly acid saliva (6,0 - 6,6) and with acid saliva (5,0 - 5,8). Since no noticeable differences were found between the groups with neautral and mildly acid saliva, the two groups were united into a single group, the comparison being ultimately made between two groups only.

Table 13. The influence of the pH of the saliva on the incidence of caries in children

	Neutral and mildly acid saliva	**Acid saliva**
Number	45	12
DMF	6,81	2,75
σ	3,4	3,96
T	T=4,79	P>0,001

The study shows that the share of children with acid PH of the saliva is relatively small - around 1/5 of the children studied. This small subgroup has a much greater incidence of caries, though, in comparison with the rest of the children. The statistical verifiability of this fact is pretty high. Hence the inference that acidness of the saliva is a serious risk factor for the development of caries.

The following conclusions can be made from the results and analysis of the study:

1. The incidence of caries is strongly influenced by the following risk factors:
   - oral hygiene;
   - carbohydrate nutrition;
   - viscosity of the saliva;
   - buffer capacity;
   - pH of the saliva;
   - incidence of caries in the parents;
   - social status.
2. The fluoride prophylaxis and the salivary current have a medium effect.
3. At this stage we cannot gauge the effect of:
   - the way of intake of carbohydrates;
   - the frequency of meals.

II. The creation of instruments for measuring the risk of caries in children

On the basis of the risk factors studied and with the additional help of the factors most frequently used according to the existing literature, a set of instruments were devised for the assessment of the risk of caries. The aim was the instruments to

make it possible for us to work easily with them and easily compare them throughout the years. That is why a three-grade numerical scale was introduced by us for each risk factor. Such a scale makes possible the reduction of the risk of caries by means of tracing the risk indicators and taking appropriate measures.

Each factor is registered with the corresponding code as the card on the child is filled out. The child is categorised in some of the three groups –

Table 14. Instruments for assessment of the risk of caries in children in Bulgaria

Risk factors	Low risk-code 0	Medium risk-code 1	High risk- code 2
Risk ages **1-2 years** **5-7 years** **11-14 years**	 No No No		 Yes Yes Yes
1. Incidence of caries DMF	0 – 2 DMF	1 – 4 DMF	2 – over 4 DMF
2. Active caries	0 - no	1- yes, one	2- yes, more than one
3. General illnesses	0 - no	1 – yes, but unrelated to the caries	2 – yes
4. Food regimen	0 – Restrictions on the intake of carbohydrates with the main meals	1 – occasionally between the meals	2 – frequent intake of simple saccharides
5. Oral higiene /GreenVermillion/ Oral higiene-habit	 0- Oral higiene <1 0 - excellent	 1- Oral higiene 1-2 1 - good	 2- Oral higiene>2 2 – unsatisfactory
6. Fluoride prophylaxis	0 – optimumF -prophylaxis	1 - only F -toothpaste	2 – no F-prophylaxis
7. Incidence of caries in children	0 – with occasional obturations	1 - 6-10 obturations, sanitised, 1-2 extractions	2 – many obturations and extractions, not sanitised
8. Social status	0 – higher than the average standard	1 – medium (average family) status	2 – unemployed, disabled, minority family background
9. Visits to the dentist	0 – 2 times a year	1 - 1 time a year	2 – occasionally, in case of need
10. Occurrence of caries in the past year	0 – no caries	1 – at least one new caries	2 – more than one new caries
11. Stimulated saliva[1]	0 - norm >5ml /5min	1 – weak current-3,5 -5ml/5min	2 – very weak current <3,5ml / 5min
12. Not stimulated saliva[1]	0 – occurrence of saliva on the lower lip within less than a minute		2 – occurrence of saliva on the lower lip within less than a minute
13. Saliva consistency[1]	0 - fluid (norm)	1 – with bubbles	2 -thick, viscous
14. pH[1]	0 – green – neutral	1 – yellow – mildly acid	2 – red - acid
15. Buffer capacity[1]	0 – 10 –12 points	1- 6-9 points- weak buffer	2 - 0-5points – very weak
16. Micro-organisms[2] S.mutans, Lactobacilli	few	medium	many

[1] *The „Saliva-Check"- „GC" test can be used*

[2] *The S. mutans,Lactobacilli –Vivadent test is used*

with low, medium or very high risk. The column of indicators is seen as filled out when there is at least one answer given. If there is more than one column filled out, the column with the higher risk is taken as valid for the child.

The data comprising the assessment are recorded in the "Card for registration of the assessment of the risk for caries". Also described are the measures to be taken for reduction of the risk of caries.

During each following visit of the patient the assessment is done anew. The observation of the measures prescribed is controlled, new measures being recommended. The sum total of the points is indicative of the patient's condition.

The assessment of the risk of caries is carried out hand in hand with a clinical diagnosis of the caries-related oral pathology (especially of the intial caries-related lesions) of the child. The diagnosis is part of the prosess of drawing up a strategy for dental treatment.

The strategy can be the foundation for a nonagressive, prophilactic treatment of the dental caries. The therapy can be carried out independently or in combination with an operative or micro-invasive treatment.

Because of the dynamic of processes in the mouth cavity of children as well as because of the postinterruptive mineralisation of the tooth enamel, this approch is particularly adequate.

Table 15. Card for registration of the assessment of the risk for caries

Nr. of the invoice	**Code (points)**	**Measures for control of the risk of (done by the dental doctor)**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
Name: .....date.....visit Nr.....		
Caries risk .....sum total of points.....		
Date of the next visit.....		

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