International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

Developing a Periodontal Risk Profile in Children Aged 10 to 14 Years: A Cross-Sectional Study

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Abstract: ***Objective: This study aimed to assess periodontal risk and build a comprehensive risk profile among children aged10to14. Material and Methods: A total of 457 students were evaluated for factors such as oral hygiene, plaque levels, bleeding on probing, carious lesions, and orthodontic anomalies. For the assessment of plaque accumulation, the FMPS index was used, and for the evaluation of gingival status, BOP was utilized. Results: The findings revealed that poor oral hygiene and provoked gingival bleeding were the most common risk factors, while systemic conditions and reduced gingival width had minimal influence. These insights support the need for individualized preventive strategies and early habit formation to ensure long - term periodontal health. Conclusion: The assessment of the periodontal risk profile in children aged 10 - 14 is crucial for their future periodontal health, which can be achieved through an individualized approach and psychological influence in the development of healthy habits.***

Keywords: periodontal risk, periodontal health in children, risk factors for gingival inflammation

1. Introduction

Gingival inflammation is a common finding in childhood and adolescence, with the prevalence of gingivitis affecting half of the children aged 4 - 5 years and peaking during puberty [1], [2]. Gingival and periodontal tissues during the primary, mixed, and permanent dentition undergo morphological changes associated with normal growth and development that accompany growth [3], [4].

Good dental practice focusing on the periodontal health of children includes not only an objective assessment of the oral and gingival status of adolescents according to the morphological characteristics of their dentition, but also risk assessment and appropriate decision - making based on the age and clinical condition in the management of periodontal diseases. Maintaining periodontal health during childhood and adolescence is a prerequisite for the future periodontal health of the individual [3], [4].

In healthcare, the concept of "risk" is defined as the probability that an individual will develop a specific disease or pathology over a certain period of time [5], [6]. Risk factors are individual characteristics that may contribute to an increased risk of developing a particular disease [5], [6]. Regarding periodontal health, risk factors are complex due to the multifactorial nature of periodontal pathology, and can be biological, behavioral, and clinical.

Risk assessment for periodontal pathology involves identifying all risk factors that place a child at increased risk of developing periodontal disease against the background of physiological changes accompanying the stabilization of the periodontium [3], [4], [6]. This assessment ensures the correct clinical decisions are made and allows for the application of an individualized treatment or prevention plan according to the specific needs of each child.

However, tools for assessing periodontal risk are based on scientific evidence primarily obtained from studies on adult patients, which limits their accurate application in childhood and adolescence, or requires modifications based on the morphological and physiological changes characteristic of this period. Emphasize that early identification of risk profiles allows for tailored preventive care and improved outcomes in adolescent dental health.

Objective:
This study aims to evaluate key risk factors contributing to gingival inflammation in children and to formulate a risk profile based on clinical and behavioral indicators in children aged 10 - 14 years

2. Materials and Methods

Material
The study was conducted on a total of 457 children aged 10 - 14 years, students from 144th Primary School in Sofia. The inclusion criteria for the children in the study were the presence of signed informed consent from parents for participation, approved by KENIMUS with protocol No.12/14.05.2020.

Methodology
The children were examined through an assessment of risk factors for periodontal health, grouped as follows:

- **Systemic factors** – through targeted anamnesis for systemic diseases that could lead to the development of periodontal diseases.
- **Behavioral factors for oral health** – through anamnestic data. An evaluation of oral hygiene habits related to frequency, duration, choice of toothbrush and paste, and brushing technique. The evaluation was made in two categories: good and poor oral hygiene habits.
- **Microbial factor (dental biofilm)** – through clinical examination of oral hygiene status. The assessment of plaque accumulation was conducted using the full mouth plaque score (FMPS) index. The methodology includes scraping with a WHO periodontal probe on the vestibular and oral surfaces of the tooth crown for all fully erupted permanent teeth. The presence/absence of dental biofilm

was recorded in four gingival - adjacent fields – mesio - vestibular, vestibular, disto - vestibular, and oral. The index calculates the relative proportion of the surfaces covered with dental biofilm.

Based on plaque accumulation, the children were divided into three categories:

1) Presence of plaque accumulation affecting up to 30% of the gingivally adjacent tooth surfaces (insignificant);
2) Presence of plaque accumulation affecting 30% to 69% of the gingivally adjacent tooth surfaces (moderate);
3) Presence of plaque accumulation affecting more than 70% of the gingivally adjacent tooth surfaces (significant).

Risk factors of dental origin – through clinical examination of oral status. We recorded carious lesions according to the ICDAS with codes 04 and 05 [7], and the following were evaluated:

- DMF (T+t) – overall caries rate of the examined children;
- D risk – presence of carious lesions that are risky for gingival health, located near the gingival margin, leading to increased plaque accumulation and direct irritation of the gingiva – proximal and cervical carious lesions.

Orthodontic anomalies and treatment – we recorded the presence/absence of orthodontic anomalies through observation and with the help of a graduated probe, according to the accepted classification for dental and maxillofacial deformities and anomalies, or the presence of orthodontic treatment at the time of examination [8]. We examined: Sagittal deviations; Tooth crowding; Transversal deviations; Vertical deviations.

Gingival factor – reduced width of the attached gingiva – through clinical examination, we recorded the presence/absence of this. Using a graduated periodontal probe, the distance between the marginal gingival margin and the free gingiva was measured in the lower anterior teeth area. A width of less than 2mm was considered as reduced.

Gingival status – through clinical examination of provoked bleeding using the bleeding on probing (BOP) index with the help of a WHO mechanical periodontal probe.

For the purposes of the study, we examined all fully erupted permanent teeth in four gingival points – mesio - vestibular, vestibular, disto - vestibular, and oral. We recorded the presence/absence of bleeding, which indicates the spread of gingival inflammation as the relative proportion of gingival units affected by inflammation.

According to the values of the bleeding on probing index, the children were divided into three categories based on the current classification of periodontal diseases [9]:

- Up to 10% of gingival units affected – gingivally healthy children;
- 10 - 30% of gingival units affected – localized gingival inflammation;
- Over 30% of gingival units affected – generalized gingival inflammation.

Statistical Methods:

Data processing was performed using the specialized software IBM SPSS, version 19.0, and MS Excel 2019. The adopted critical significance level for testing the null hypothesis (H0) was $\alpha = 0.05$.

The following methods were used to objectify the results of the conducted analyses:

- Descriptive analysis;
- Independent T test for comparison of independent groups;
- Pearson Chi - Square test ($\chi 2$);

3. Results

1) Assessment of Risk Factors for Gingival Health in Children Aged 10 - 14

Gingival Status:

The following table and diagram present the data on the distribution of children according to their gingival status, demonstrating the severity of gingival tissue involvement (Table 1/Diagram 1).

Table 1: Distribution of children according to gingival status

	BOP							
	Up to 10%		Up to 30%		Over 30%		Total	
Sex	N	%	N	%	N	%	N	%
Boys	66	14%	97	21%	60	13%	223	49%
Girls	97	21%	85	19%	52	11%	234	51%
Total	163	35, 7%	182	39, 8%	112	24, 5%	457	100%

Pearson χ^2=6, 998 p<0, 05

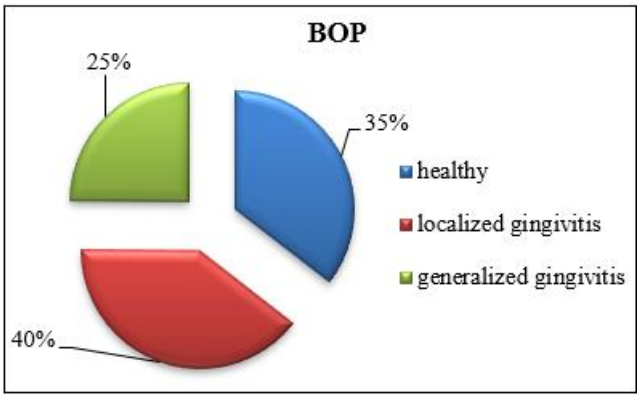

Diagram 1: Gingival Status

From the table and graph, it can be seen that 35.7% of the children were recorded with periodontal health, with provoked gingival bleeding affecting less than 10% of the gingival units. In 39.8% of the children, a localized form of gingival inflammation was found, with provoked bleeding spreading to 30% of the gingival units. Generalized gingivitis with provoked gingival bleeding affecting more than 30% of the gingival units was the least common among the children we examined. No differences in gingival status were observed between the two sexes.

Systemic Factors:

The targeted anamnesis for assessing systemic diseases that are risk factors for periodontal health revealed that the children participating in the study were clinically healthy

and had no accompanying diseases related to periodontal health.

Behavioral Factors for Oral Hygiene:

Anamnestic data on oral hygiene habits according to the severity of inflammation are presented in the following table (Table 2).

Table 2: Behavioral factors for oral hygiene

BOP	Oral hygiene habits					
	Good		Poor		Total	
	N	%	N	%	N	%
Up to 10%	130	79, 8%	33	20, 2%	163	100%
Up to 30%	128	70, 3%	54	29, 7%	182	100%
Over 30%	89	79, 5%	23	20, 5%	112	100%
Total	347	75, 9%	110	24, 1%	457	100%

Pearson χ^2=5, 193 p>0, 05

From the table, it can be seen that 75.9% of all the children examined reported good oral hygiene habits, according to the surveyed children. In children with periodontal health, good oral hygiene habits were reported in nearly 80%. Among children with localized gingival inflammation, good oral hygiene habits were reported in more than two - thirds of the children, and in children with generalized gingival inflammation, this was observed in 79.5% (p > 0.05). The high percentage of good oral hygiene habits among all children, regardless of their gingival status, is most likely the result of the subjective nature of the information, which differs from their actual oral hygiene status. In this context, this risk factor should not be considered significant when assessing periodontal risk. Protocols for objectively examining oral hygiene habits could be developed, which will be the subject of future publications.

Microbial Factor:

The microbial factor was objectified using the plaque index – FMPS. The following table presents the data on the oral hygiene status of the children, categorized according to the severity of gingival inflammation (Table 3).

Table 3: Microbial Factor

BOP	Plaque accumulation - FMPS							
	Insignificant		Moderate		Significant		Total	
	N	%	N	%	N	%	N	%
Up to 10%	108	66, 25%	51	31, 28%	4	2, 54%	163	100%
Up to 30%	51	28, 02%	112	61, 53%	19	10, 43%	182	100%
Over 30%	9	8, 03%	74	66, 07%	29	25, 90%	112	100%

Pearson χ^2=120, 753 p<0, 05

From the table, it can be seen that in children with periodontal health, plaque accumulation is most commonly insignificant – 66.25%. In just over 1/3 of them, moderate plaque accumulation is recorded, while only 2.54% show significant plaque accumulation (p < 0.05).

In children with localized gingival inflammation, moderate plaque accumulation predominates, affecting 61.53% of the gingivally adjacent tooth surfaces (p < 0.05). Limited plaque accumulation was recorded in 28% of these children, while significant accumulation was observed in 10%.

In children with generalized gingival inflammation, moderate plaque accumulation is most commonly found – 66.07%, followed by significant plaque accumulation in 25.9% of them and insignificant accumulation in 8% (p < 0.05).

A clear relationship between the dental biofilm and the severity of inflammation is observed, with greater severity of gingival inflammation associated with higher plaque accumulation. These data support the conclusion that the microbial risk factor is a key risk factor for gingival inflammation in children and should be considered a marker of inflammation severity when forming a risk profile for periodontal health in children aged 10 - 14 years.

Dental - Origin Risk Factors

The following table presents data on overall caries (DMF - T) and carious lesions that are risky for gingival health (D risk), categorized according to the severity of gingival inflammation (Table 4).

Table 4: Dental - Origin Risk Factors – Caries

BOP	Caries rate				Independent T test
	DMF		D risk		
	N	Mean	N	Mean	
Up to 10%[1]	163	2, 21±2, 39	163	0, 50±1, 09	
Up to 30%[2]	182	2, 26±2, 57	182	0, 59±1, 25	$t_{1,2}$=0, 14 p>0, 05
Over 30%[3]	112	2, 62±2, 41	112	0, 65±1, 15	$t_{1,3}$=0, 47 p>0, 05
Total	457	2, 33±2, 47	457	0, 58±1, 17	$t_{2,3}$=0, 07 p>0, 05

From the table, it can be seen that, on average, 2.33 teeth per child are affected by the carious process, with no statistically significant difference in caries between children with different degrees of gingival inflammation (p > 0.05). Carious lesions that are risky for gingival health are, on average, 0.58 per child, with no differences in their number among children with different degrees of gingival inflammation (p > 0.05).

The results indicate that this risk factor is not significant for assessing periodontal risk in this age group, as children aged 10 - 14 years are in the stage of forming their permanent

dentition, which is relatively new and influenced by the oral environment. This explains the recorded initial carious lesions in a limited number of children, and even more rarely, the presence of carious lesions that are risky for periodontal health. In the evaluation of the risk profile for gingival health in children aged 11 - 14 years, this risk factor would have a minimal impact.

The following table presents data on orthodontic anomalies in children, categorized by the severity of gingival inflammation (Table 5).

Table 5: Risk Factors – Orthodontic Anomalies

BOP	Orthodontic Anomalies					
	Presence		Absence		Total	
	N	%	N	%	N	%
Up to 10%	66	40, 49%	97	59, 51%	163	100%
Up to 30%	70	38, 46%	112	61, 54%	182	100%
Over 30%	33	29, 46%	79	70, 53%	112	100%
Total	169	37, 0%	288	63, 0%	457	100%

Pearson χ^2=3, 748 p>0, 05

From the table, it can be seen that just over 1/3 of all the children examined have orthodontic anomalies, with no statistically significant difference according to the severity of gingival inflammation (p > 0.05). Orthodontic anomalies are a prerequisite for increased plaque accumulation, which is a major risk factor for gingival inflammation in children.

The following table presents data on orthodontic anomalies according to the degree of plaque accumulation (Table 6).

Table 6: Orthodontic Anomalies According to the Degree of Plaque Accumulation

FMPS	Orthodontic Anomalies					
	Presence		Absence		Total	
	N	%	N	%	N	%
Insignificant	67	39, 9%	101	60, 1%	168	100%
Moderate	80	33, 8%	157	66, 2%	237	100%
Significant	22	42, 3%	30	57, 7%	52	100%
Total	169	37%	288	63%	457	100%

Pearson χ^2=2, 298 p>0, 05

From the table, it can be seen that nearly 2/3 of the children with orthodontic anomalies show significant and moderate plaque accumulation, while in the remaining 1/3, plaque accumulation is insignificant (p > 0.05). Although there is no statistical significance, we believe that our data support the relationship between orthodontic anomalies and plaque accumulation in retention areas and hard - to - clean spots, which indirectly affects gingival health. We would assess orthodontic anomalies in children aged 10 - 14 years as a risk factor with a moderate degree of influence on the risk profile for gingival health.

Reduced Width of the Attached Gingiva

The following diagram presents data on the reduced width of the attached gingiva in the lower anterior region of the dentition, which is a risk factor for recessions, according to the severity of gingival inflammation (Diagram 2).

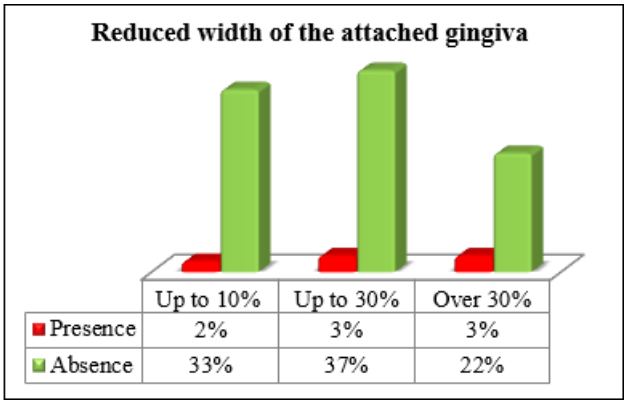

Diagram 2: Reduced Width of the Attached Gingiva

From the diagram, it can be seen that reduced width of the attached gingiva is found in an average of 2 - 3% of children with varying degrees of gingival inflammation, with no statistically significant differences ($\chi 2$ = 2.210, p > 0.05). It can be concluded that this risk factor does not significantly affect the risk profile for gingival health in the studied age group. However, when it is registered, it is a risk factor for the individual, especially in cases of orthodontic treatment in this area of the dentition.

2. Risk Profile for Gingival Health in Children Aged 10 – 14

Based on the study of the significance and severity of all risk factors for gingival health in children aged 10 - 14 years, we created a risk profile for the children according to the severity of gingival inflammation. The data is presented by calculating the relative proportion of each factor's severity for the respective group and displayed in a graph showing the relationship between them.

The following table presents data on risk factors for gingival health in children with varying degrees of gingival inflammation (Table 7).

Table 7: Risk Factors for Gingival Health in Children with Varying Degrees of Gingival Inflammation

BOP / **Risk Factors**	Up to 10%	Up to 30%	Over 30%
Microbial factor– FMPS	14, 46%	47, 4%	76, 1%
Behavioral factor – OH habits	23, 8%	22, 4%	32, 7%
Bleeding factor– BOP	8, 6%	21, 6%	37, 9%
Systemic Factors	0%	0%	0%
Caries lesions risky for gingival health	1%	1%	1%
Gingival factor – reduced width of the attached gingiva	8, 9%	8, 9%	3, 8%
Orthodontic anomalies	39, 9%	33, 8%	42, 3%

Based on the data from the table, we present the following diagram for the assessment of the risk of gingival inflammation in children aged 10 - 14 years (Diagram 3).

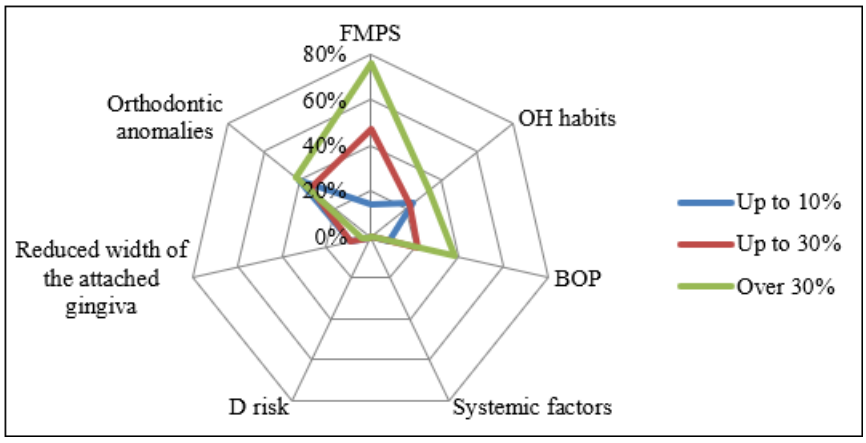

Diagram 3: Risk Gingival Profile According to the Severity of Inflammation

The risk gingival/periodontal profile in children aged 11 - 14 years shows that poor oral hygiene status, along with provoked gingival bleeding, are the most common risk factors in these children and are the primary ones that should be controlled through preventive measures. Orthodontic anomalies are also an important risk factor with a moderate degree of risk, which can be controlled through orthodontic treatment and an individualized preventive approach to oral hygiene, tailored to the areas difficult for plaque removal.

Caries lesions that are risky for gingival status are a minor risk factor in this age group. Systemic risk factors and the reduced width of the attached gingiva are also insignificant risk factors, based on their frequency in the studied age group. However, in specific cases, when they are present, a tailored approach for treatment and prevention is necessary.

4. Discussion

According to the epidemiological study, 35% of children aged 10 - 14 years have gingival inflammation within the limits of clinical health, which is a prerequisite for maintaining this condition through specialized preventive programs for periodontal health.

In the remaining cases, the predominant form of inflammation is initial, mainly localized, and in ¼ of the children, it is generalized, but without the presence of severe forms of gingivitis, which in all cases is plaque - induced, as this study demonstrates.

The prevalence of gingival inflammation among adolescents varies significantly in relative terms due to differences in methods for clinical assessment of gingival health, which significantly complicates the comparison of results from different epidemiological studies and the ability to make an accurate assessment of the differences in the prevalence of gingivitis. Kingman et al. consider that the gold standard in clinical periodontal examination is the recording of the condition of all teeth, rather than just representative ones [10]. In children, this includes all fully erupted permanent teeth with a stabilized periodontium, which was also the subject of this study.

An author team found a lower relative proportion of localized (23%) and generalized (5%) forms of gingival inflammation in 7600 children aged 6 - 12 years. The scientists examined all permanent teeth using the GI index, employing provoked bleeding as an objective criterion for gingival status [11]. We believe that the differences are a result of the younger age of the examined children and, consequently, the smaller number of teeth that are subject to examination. Additionally, the methodology for the study differs from ours.

Our study confirmed that the main risk factor for gingival health in children aged 10 - 14 years is poor oral hygiene, which is also established by other author teams [12], [13]. On one hand, the dental biofilm leads to irritation of the gingival tissues and triggers an inflammatory response, and on the other hand, plaque accumulation occurs much faster around areas of inflammation compared to healthy tissues [14]. This further contributes to the severity of this risk factor. The more plaque accumulation detected in a child's mouth, the greater the likelihood of exacerbating gingival inflammation [15].

Orthodontic anomalies also increase the risk of developing gingival pathology due to increased plaque accumulation and difficulties in cleaning certain areas of the dentition, which, combined with improper oral hygiene habits, pose a serious risk to the gingival health of adolescents [16], [17]. Tiam et al. found that the presence of some orthodontic anomalies is associated with significant loss of epithelial attachment or reduced width of attached gingiva, which directly compromises the periodontal space and creates a risky terrain for severe inflammatory - destructive changes in the long term [18].

A serious risk factor for the gingival health of adolescents is poorly developed health behavior. Lack of sufficient motivation and neglect of daily oral health care is a triggering factor for all other risk factors related to gingival risk in children aged 10 - 14 years. Although in this study, we found good oral hygiene habits, we consider the assessment to be highly subjective based on the obtained objective data for both oral hygiene and gingival status. This provides grounds for the development of appropriate protocols for the objective examination of oral hygiene habits in children and adolescents. This is a prerequisite for preventive treatment, with a focus on children's oral hygiene habits. At this age, they are at a stage of development that is suitable for creating and establishing health habits through appropriate psychological methods, such as motivational

interviewing. Therefore, we recommend expanding traditional protocols for maintaining periodontal health with a focus on building lasting behavioral skills for oral health.

Lang & Tonetti believe that in order to assess the risk of periodontal pathology, it must be based on a number of clinical and behavioral parameters, with none playing a more important role than the others [19]. The entire spectrum of risk factors and risk indicators should be evaluated simultaneously, which was also the goal of our study. Based on the analysis of the main risk factors encountered in this age group, we developed a risk periodontal profile for children aged 10 - 14 years.

5. Conclusion

Early identification and profiling of periodontal risk in children aged 10–14 is vital for implementing preventive strategies that promote lifelong oral health. Tailored interventions based on individual risk factors can significantly enhance periodontal outcomes.

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