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

Oral Health and Iron-Related Dietary Patterns in Preschool Children with and without Black Staining

Ralitsa Bogovska-Gigova

Abstract: ***This cross-sectional study investigated oral health status and dietary patterns in preschool children aged 4–6 years with and without black staining on their teeth. Sixty children were assessed using the dmft index, plaque index, gingival index, and salivary pH, along with a dietary questionnaire. Results showed that children with black staining exhibited significantly lower dmft scores and plaque accumulation, though no difference in gingival index was observed. Dietary analysis revealed higher consumption of iron-rich foods and supplements among the black-stain group. These findings suggest that black staining, while primarily an esthetic concern, may be linked to protective microbial environments and dietary patterns, warranting further investigation.***

Keywords: Black stain, dental caries, primary teeth, salivary pH, iron-rich diet

1. Introduction

Black staining (from chromogenic bacteria) on primary teeth is associated with a distinct form of extrinsic dental discoloration, typically presenting as a dark line or dots along the cervical third of the tooth, often following the gingival margin (1). The microflora of these stains is dominated by chromogenic bacteria, most notably Actinomyces spp., with additional contributions from genera such as Prevotella melaninogenica, Corynebacterium, Rothia, Kingella, and Pseudopropionibacterium (2, 3).

The pigmentation is believed to result from iron compounds (such as ferric sulfide) formed by bacterial metabolism interacting with salivary iron, which is often elevated in affected individuals (1, 2, 4). The microbial diversity within black stain is generally lower than in non-discolored plaque, and the overall community structure is less complex (5, 6, 7).

The most commonly associated oral condition with black stain caused by chromogenic bacteria on primary teeth in children is a lower prevalence of dental caries. Multiple studies have demonstrated that children with black stain have fewer carious lesions and lower counts of cariogenic bacteria (2, 4, 8, 9). This relationship is well established and is attributed to the unique microbial composition of black stain, which is dominated by Actinomyces spp. and characterized by lower levels of cariogenic bacteria such as Streptococcus mutans and Lactobacillus spp. The protective effect may be related to the unique microbial composition and higher salivary pH and mineral content observed in these children (2, 4, 10). Additionally, children with black stain often exhibit higher salivary concentrations of calcium, phosphate, and iron, as well as increased salivary pH and buffering capacity, all of which contribute to a less cariogenic oral environment (2, 4, 6, 8, 9).

Black stain in children has been associated also with other oral conditions and factors. Notably, children with black stain often exhibit a lower visible plaque index, suggesting either better oral hygiene practices or a less pathogenic plaque biofilm (11). Additionally, higher salivary mineral content, including elevated levels of calcium, phosphate, iron, and copper, is frequently observed, which may contribute to black stain formation and increased resistance to caries (1, 3). Furthermore, black stain is linked to altered oral microbial diversity, characterized by reduced microbial diversity and a less complex plaque community structure compared to non-discolored plaque (8, 9). Importantly, the medical literature does not indicate a consistent association between black stain and an increased risk of gingivitis or periodontal disease in children (1).

Preschool-aged children (typically ages 3–6 years) are most commonly affected by black staining caused by chromogenic bacteria on primary teeth. Prevalence rates in this age group vary geographically, ranging from approximately 2.4% to 18% in different populations (4, 11, 12, 13). The condition is observed equally in males and females (1, 2, 4).

Several demographic factors are associated with an increased prevalence of black stain in children. Higher parental education and better socioeconomic status are linked to a greater occurrence of black stain, potentially due to differences in oral hygiene practices and dietary habits (11). Dietary factors also play a role, with consumption of iron-rich foods, such as soy sauce, and the use of iron supplements during pregnancy or early childhood being associated with an increased risk, likely because iron contributes to the formation of the characteristic stain (4, 13). Geographic location influences prevalence as well, with studies reporting rates ranging from 3% to over 12% across different countries and cities, and children born in urban centers, such as Shanghai, showing higher rates (11, 12). Additionally, black stain is associated with better oral hygiene, as evidenced by a lower visible plaque index and reduced use of nursing bottles, suggesting that children with improved oral hygiene practices may be more likely to develop the condition (11). The composition of water consumed also matters, with higher iron content and elevated pH in water being linked to an increased risk (14).

Black staining caused by chromogenic bacteria on primary teeth in preschool-aged children primarily exerts a psychosocial impact due to its esthetic appearance rather than any direct health consequences. The dark discoloration is often perceived as unsightly by both children and their families, leading to concerns about social stigma, embarrassment, and negative self-image, especially in settings where oral appearance is valued (1, 2). Parents frequently seek dental care for removal of the stain, motivated by cosmetic concerns rather than medical necessity (2, 11).

Children themselves may experience teasing or social exclusion, particularly in environments with heightened attention to appearance (1, 2).

The first-line treatment for black staining is repeated professional mechanical removal, most commonly with ultrasonic scaling or polishing. This approach is preferred due to its effectiveness in removing the stain and its safety profile when performed carefully to avoid enamel damage, which is especially important in young children (1, 2). Alternative and adjunctive methods have been explored, including photodynamic therapy, peroxide-based treatments, oral probiotics, and lactoferrin application, but these lack robust evidence for routine use and are not considered standard of care (2). Virgin coconut oil has also been suggested, but its efficacy remains unproven in controlled studies (2). The decision to treat should balance esthetic concerns with the risk of enamel abrasion from frequent mechanical removal.

This study is significant in highlighting the potential protective role of black stain in early childhood caries and its association with dietary factors, contributing to more nuanced approaches in pediatric dental prevention.

The aim of the study was to compare the oral health and dietary habits of children aged 4 to 6 years with and without black staining on their teeth.

2. Materials and Methods

The study included 60 children aged 4 to 6 years, divided into two groups of 30 children each, according to whether or not they had black staining on their teeth. Inclusion criteria included children with primary dentition, no systemic illnesses, no antibiotic use in the preceding 3 months, and parental consent. Exclusion criteria were uncooperative children, those with recent dental treatments, or incomplete data.

Each child underwent an oral examination performed by a pediatric dentistry specialist, following the standard protocol, under directed light using a standard oral examination kit after drying the teeth. The dental status was recorded, and carious lesions were classified according to the International Caries Detection and Assessment System (ICDAS II). For diagnostic threshold, code 1 of ICDAS II was applied. For each child, the **dmft index** was calculated – the sum of all decayed and filled teeth (due to caries) in the dentition. The values of the index were recorded in the patient's dental status chart.

For all examined children, the plaque index (Silness and Löe), the salivary pH and gingival index were also measured.

Methodology for recording and evaluating the plaque index: To determine the child's oral hygiene status, the Silness and Löe plaque index was used. It assesses plaque thickness in the cervical area of the tooth. The vestibular surfaces of all maxillary incisors and canines were examined. Each representative tooth was assessed for plaque visually and by scraping with a probe in the cervical third of its vestibular surface. The data were recorded using the codes presented below:

- 0– No plaque after scraping
- 1– Small amount of plaque on the free gingival margin and around it on the vestibular surface. Plaque becomes visible after scraping with a probe
- 2– Moderate plaque accumulation on the free gingival margin and around it on the vestibular surface, visible without scraping
- 3– Abundant plaque in the gingival sulcus and on the free gingival margin and around it on the vestibular surface

Methodology for collecting saliva samples to determine salivary pH: Parents and children were instructed to refrain from consuming food and beverages (except water) for 1 hour prior to the examination, as well as from performing oral hygiene on the morning of the sample collection day. A special product developed by GC – Saliva-Check Buffer was used, which is a routine test for saliva characteristics in dental practice. The test followed the manufacturer's standard instructions.

Methodology for measurement of the Gingival Index (GI): The Gingival Index (GI) is assessed to quantitatively evaluate gingival inflammation in the primary dentition of children. The examination focuses on the buccal, lingual, mesial, and distal surfaces of the index teeth, specifically the maxillary and mandibular incisors and first molars. Examinations are conducted under standardized conditions using adequate lighting, with visual inspection and gentle probing.

Each surface is scored based on the following criteria:

- 0- Normal gingiva, characterized by no signs of inflammation, no color change, and absence of bleeding on probing.
- 1- Mild inflammation, indicated by slight color change and minor edema, with no bleeding on probing.
- 2- Moderate inflammation, presenting as noticeable redness, edema, and glazing, with bleeding observed upon probing.
- 3- Severe inflammation, marked by pronounced redness, significant edema, ulceration, and/or spontaneous bleeding.

For each child, the GI score is calculated by recording the scores for all examined surfaces of the index teeth and computing the mean GI score. This average provides a quantitative measure of the severity of gingival inflammation across the assessed dentition.

Dietary Questionnaire: A short survey was conducted to determine the dietary habits of the participants. Parents completed a questionnaire indicating whether their children often consumed the following foods:

Does your child often (more than once per week) consume the following foods? (mark with X):

Food type	Yes	No
Meats rich in iron (red meats, liver)		
Dairy products		
Vegetables rich in iron (spinach)		
Iron supplements/vitamins		
Iron-rich water		
Foods rich in Vitamin C		

Statistical Analysis: Data were analyzed using SPSS version 26. Descriptive statistics (means, standard deviations, frequencies) were used to summarize variables. Independent t-tests or Mann-Whitney U tests compared continuous variables between groups, while chi-square tests analyzed categorical data. Significance was set at $p < 0.05$.

3. Results

A total of 60 children aged 4–6 years were included in the study, with 30 children presenting black staining (BS group) and 30 children without black staining (non-BS group). The groups were balanced for age (mean: 5.1 ± 0.8 years) and sex (50% male and 50% female in each group). Table 2 compares the oral health parameters between the groups,

Table 2: Comparison of oral health parameters between groups

Parameter	BS group	Non-BS group	p-value
dmft index	1.82 ± 1.23	2.36 ± 1.12	0.002
Plaque index	0.73 ± 0.42	1.34 ± 0.63	<0.001
Gingival index	0.55 ± 0.37	0.62 ± 0.26	0.41
Salivary pH	7.90 ± 0.46	7.71 ± 0.62	0.12

The data in Table 2 indicate significant differences in oral health parameters between children with black staining (BS) and those without (Non-BS). The BS group exhibited a lower dmft index ($p = 0.002$) and plaque index ($p < 0.001$), suggesting reduced caries experience and better oral hygiene or less pathogenic plaque biofilm. No significant difference was observed in the gingival index ($p = 0.41$), supporting the lack of association between black staining and gingival inflammation. The salivary pH was slightly higher in the BS group (7.90 ± 0.46 vs. 7.71 ± 0.62), but this difference was not statistically significant ($p = 0.12$).

Table 3 presents the dietary habits of the children.

Table 3: Dietary habits based on parental questionnaire

Food type	BS group	Non-BS group	p-value
Meats rich in iron (red meats, liver)	56.66%	26.7%	0.02
Dairy products	70%	66.7%	0.78
Vegetables rich in iron (spinach)	46.66%	20%	0.03
Iron supplements/vitamins	23.33%	6.7%	0.04
Iron-rich water	16.66%	13.33%	0.74
Foods rich in Vitamin C	50%	53.3%	0.80

The BS group showed significantly higher consumption of iron-rich meats (56.66% vs. 26.7%, p=0.02) and of iron-rich meats vegetables like spinach (46.66% vs. 20%, p=0.03). The use of iron supplements/vitamins was more frequent in the BS group. No significant differences were observed for dairy products or vitamin C-rich foods. The consumption of iron-rich water was slightly higher in the BS group (16.66% vs. 13.33%, p=0.74).

4. Discussion

The findings of this study confirm that black staining (BS) on primary teeth in preschool children aged 4–6 years is associated with distinct oral health and dietary characteristics. The BS group exhibited significantly lower dmft index and plaque index (table 2), supporting existing evidence that black stain correlates with lower caries prevalence (2, 4, 8, 9). Bibby reported black pigmentation in ten 4-year-old girls and noted that many older children in the same institution were caries-free, suggesting a protective effect (15). This protective effect is likely due to the unique microbial composition of BS, characterized by a dominance of Actinomyces spp. and lower levels of cariogenic bacteria such as Streptococcus mutans and Lactobacillus spp. (2, 4). The lower plaque index in the BS group aligns with prior observations of better oral hygiene or a less pathogenic plaque biofilm, potentially driven by altered oral flora or saliva composition (11, 14).

No significant difference was found in the gingival index, reinforcing the lack of consistent association between black stain and gingival or periodontal disease in children (1). The slightly higher salivary pH in the BS group was not statistically significant, which contrasts with some studies reporting significantly higher pH and buffering capacity in BS cases (2, 4). Ortiz-López et al. identified high salivary pH as a factor influencing black stain, alongside high iron content and pH in drinking water (14). The lack of significance in our study may be attributed to the small sample size or variability in salivary measurements, suggesting a need for larger cohorts to confirm this trend.

Dietary habits revealed significant differences, with the BS group consuming more iron-rich meats, spinach, and iron supplements (table 3). These findings align with detailed dietary data from other studies, who found that children with black stain consumed diets low in carbohydrates (e.g., cakes, cookies), high in fruits and vegetables, and with minimal snacking between meals (15). Specific foods associated with black stain include iron-rich items (e.g., vegetables, legumes, dairy, eggs), fruits, vegetable-based soy sauce, beets, and cheese (11, 16, 17). Notably, Mesonjesi reported that most children with black stain consumed over 50 g of cheese daily, suggesting that bovine lactoferrin in dairy products binds to salivary iron, contributing to stain formation (17). However, our study found no significant difference in dairy consumption (table 3), which may reflect population-specific dietary patterns or limited statistical power.

The role of drinking water was less clear, with no significant difference in iron-rich water consumption (table 3). This contrasts with Ortiz-López et al. (14), who found that tap or reverse-osmosis water, with higher iron content (70.8 µg/dL vs. 20.7 µg/dL) and pH (7.4 vs. 6.9), was a risk factor for black stain (relative risk of 13). França-Pinto et al. also reported higher black stain prevalence among children drinking tap water in Pelotas, Brazil, compared to those using mineral or well water (18). The non-significant finding in our study may be due to uniform water sources in our urban sample or underreporting of water composition by parents.

Limitations include the cross-sectional design, which precludes causality, and the small sample size, which may have reduced the power to detect differences in salivary pH or water consumption. Future studies should incorporate microbial sequencing to characterize the BS-associated microbiome and longitudinal designs to assess dietary and environmental impacts over time. Exploring fluoride use and

salivary iron levels could further clarify their roles in BS formation.

5. Conclusion

This study confirms that black staining (BS) caused by chromogenic bacteria on primary teeth in preschool children aged 4–6 years is associated with reduced dental caries prevalence and lower plaque accumulation. Dietary habits, particularly the consumption of iron-rich foods such as meats, spinach, and iron supplements, were significantly linked to BS, supporting the role of iron in stain formation. No association was found with gingival inflammation, consistent with the absence of periodontal pathology in BS cases. Future research should employ longitudinal designs and microbial sequencing to further elucidate the protective mechanisms and explore environmental factors like water composition and fluoride use to better understand BS etiology and guide clinical approaches.

References

[1] Janjua U, Bahia G, Barry S. Black staining: an overview for the general dental practitioner. *Br Dent J*. 2022;232(12):857-860. doi:10.1038/s41415-022-4345-0

[2] Al-Shareef A, González-Martínez R, Cortell-Ballester I, Jovani-Sancho M, Sheth CC, Veses V. Current perspective on dental black stain of bacterial origin: A narrative review. *Eur J Oral Sci*. 2025;133(3):e70007. doi:10.1111/eos.70007

[3] Hirtz C, Mannaa AM, Moulis E, et al. Deciphering Black Extrinsic Tooth Stain Composition in Children Using Metaproteomics. ACS Omega. 2022;7(10):8258-8267. Published 2022 Feb 25. doi:10.1021/acsomega.1c04770

[4] Żyła T, Kawala B, Antoszewska-Smith J, Kawala M. Black stain and dental caries: a review of the literature. Biomed Res Int. 2015; 2015: 469392. doi:10.1155/2015/469392

[5] Li Y, Zhang Q, Zhang F, Liu R, Liu H, Chen F. Analysis of the Microbiota of Black Stain in the Primary Dentition. *PLoS One*. 2015;10(9): e0137030. Published 2015 Sep 4. doi:10.1371/journal.pone.0137030

[6] Chen Y, Dou G, Wang D, et al. Comparative Microbial Profiles of Caries and Black Extrinsic Tooth Stain in Primary Dentition. *Caries Res*. 2021;55(4):310-321. doi:10.1159/000517006

[7] Veses V, González-Torres P, Carbonetto B, et al. Dental black plaque: metagenomic characterization and comparative analysis with white-plaque. *Sci Rep*. 2020;10(1):15962. Published 2020 Sep 29. doi:10.1038/s41598-020-72460-2

[8] Heinrich-Weltzien R, Bartsch B, Eick S. Dental caries and microbiota in children with black stain and non-discoloured dental plaque. *Caries Res*. 2014;48(2):118-125. doi:10.1159/000353469

[9] Feng J, Yu S, Zhou N, et al. Dental Caries and Extrinsic Black Tooth Stain in Children with Primary, Mixed and Permanent Dentitions: A Cross-Sectional Study. *Int J Paediatr Dent*. 2025;35(4):725-735. doi:10.1111/ipd.13284

[10] Han R, Yue J, Lin H, et al. Salivary Microbiome Variation in Early Childhood Caries of Children 3-6 Years of Age and its Association with Iron Deficiency Anemia and Extrinsic Black Stain. *Front Cell Infect Microbiol*. 2021; 11: 628327. Published 2021 Mar 23. doi:10.3389/fcimb.2021.628327

[11] Chen X, Zhan JY, Lu HX, et al. Factors associated with black tooth stain in Chinese preschool children. *Clin Oral Investig*. 2014;18(9):2059-2066. doi:10.1007/s00784-013-1184-z

[12] Zheng L, Cao T, Xiong P, Ma Y, Wei L, Wang J. Characterization of the oral microbiome and gut microbiome of dental caries and extrinsic black stain in preschool children. *Front Microbiol*. 2023; 14: 1081629. Published 2023 Mar 31. doi:10.3389/fmicb.2023.1081629

[13] Garcia Martin JM, Gonzalez Garcia M, Seoane Leston J, Llorente Pendas S, Diaz Martin JJ, Garcia-Pola MJ. Prevalence of black stain and associated risk factors in preschool Spanish children. *Pediatr Int*. 2013;55(3):355-359. doi:10.1111/ped.12066

[14] Ortiz-López CS, Veses V, Garcia-Bautista JA, Jovani-Sancho MDM. Risk factors for the presence of dental black plaque. *Sci Rep*. 2018;8(1):16752. Published 2018 Nov 13. doi:10.1038/s41598-018-35240-7

[15] Bibby BG. A Study of a Pigmented Dental Plaque. Journal of Dental Research. 1931;11(6):855-872. doi:10.1177/00220345310110060401

[16] Prskalo K, Klarić Sever E, Alerić I, Antonić Jelić T, Žaja I. Risk Factors Associated with Black Tooth Stain. *Acta Clin Croat*. 2017;56(1):28-35. doi:10.20471/acc.2017.56.01.05

[17] Mesonjesi I. Are extrinsic black stains of teeth iron-saturated bovine lactoferrin and a sign of iron deficient anemia or iron overload? *Med Hypotheses*. 2012;79(2):219-221. doi:10.1016/j.mehy.2012.04.044

[18] França-Pinto CC, Cenci MS, Correa MB, et al. Association between black stains and dental caries in primary teeth: findings from a Brazilian population-based birth cohort. *Caries Res*. 2012; 46 (2): 170-176. doi:10.1159/000337280