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Prevalence of black stain in 3 to 14 years children in Bengaluru city and its correlation with dental caries: A cross sectional study

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Abstract

Background: Black stain (BS) is a distinct extrinsic discolouration commonly seen in children, characterised by dark lines or dots near the gingival margin. Most studies have assessed BS in isolated dentitions.
Methodology: We conducted a cross-sectional study among 5019 children across four zones of Bangalore. Oral examinations assessed black stains and caries using Lobene and DMFT/deft indices respectively. Salivary samples were analysed for their pH.
Aim: To determine the prevalence of BS in children aged 3–14 years in Bangalore and evaluate its association with dental caries and salivary pH.
Results: Prevalence of black stain was 22.1%, the highest being in primary dentition (25.5%), followed by permanent dentition (21.2%) and mixed dentition (19.8%). An inverse relationship was observed between BS and caries. Children with BS had higher salivary pH, suggesting a less cariogenic oral environment.
Conclusion: This study found a 22.1% prevalence of black extrinsic stains (BS) among 3–14-year-old children in Bengaluru, with the highest occurrence in the primary dentition. Children with BS had significantly lower dental caries experience and higher salivary pH, suggesting a less cariogenic oral environment. These findings support a potential protective role of BS against caries.

Keywords: Black stain, Salivary pH, Dental caries.

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1. Introduction

Tooth discolouration is a common paediatric dental concern with aesthetic and psychosocial implications. Among the types—extrinsic, intrinsic, and internalised—extrinsic stains are the most prevalent, often caused by plaque, chromogenic bacteria, dietary factors, and medications.[1] Black stain, the most frequent form, appears as dark lines or dots near the gingival margin and is composed of ferric salts, ferrous sulphide, calcium, phosphate, and proteins. Its formation results from a reaction between bacterial hydrogen sulphide and iron in saliva or gingival exudate, with *Actinomyces* commonly identified as the predominant microorganism while once thought to be protective against caries, black stains have shown mixed associations in recent research.[2,3] Reported prevalence varies globally from 2.4% to 26%, with limited studies examining all dentition stages collectively.[4] Black extrinsic stains were observed across all age groups, with varying prevalence depending on the dentition stage. The highest occurrence was noted in children with mixed dentition, likely due to the coexistence of both primary and permanent teeth and the transitional oral environment. Children in the primary dentition stage showed a moderate prevalence, whereas those in the permanent dentition group demonstrated a relatively lower frequency. Zone-wise analysis revealed regional differences, with [insert zone] showing the highest number of cases. Overall, the distribution pattern suggests that black stain is more commonly seen in the early to middle childhood years, coinciding with mixed dentition phases, potentially influenced by oral hygiene practices, dietary habits, and microbiological flora. Muthu et al in 2019 found a prevalence of 7% among 0 to 3-year-old children in South India. However, most studies on Black stains have been focused on either primary, mixed or permanent dentition separately. There is a lacuna of studies assessing black stains in all three-

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dentition period. This cross-sectional study aims to assess the prevalence of black extrinsic stains in children aged between 3- 14 years across primary, mixed, and permanent dentitions and to investigate their association with dental caries.

2. Materials and Methods

Children between the age groups of 3-14 years attending various public schools, private schools and Anganwadi center in Bengaluru city were included in the city. Selection criteria included healthy cooperative children with parental consent. Whereas those children with any systemic disease or an any medication including chlorhexidine and antibiotics for at least 1 month were excluded from the study.

5,019 school children from four different zones of Bangalore were included in the study. The study was explained to parents, and written consent was obtained. Prior permission from the school authorities was taken to carry out the oral examination. The children were examined under natural light for stains and dental caries, which were recorded using Lobene Stain indices[5] and DMFT, deft indices,[6] respectively. Self-administered questionnaires were distributed to the children to be filled by their parents.

The study was conducted across Bangalore City, which was strategically divided into four different zones to achieve geographic coverage. These zones included North (N = 1427), East (N = 1214), West (N = 1232), and South (N = 1146), making for a diverse sample population. The participants were further categorized based on their dentition status into three distinct groups: Primary dentition (N = 1590), Mixed dentition (N = 1806), and Permanent dentition (N = 1623). Each of these dentition categories was then subdivided into a Control group and a Study group

40 children from each of the study and control groups were selected for the evaluation of salivary pH. Unstimulated whole saliva samples were collected in sterile test tubes. Each child was instructed not to eat or drink anything for 2 hours prior to the collection. Salivary pH levels were measured using a single-electrode digital pH meter (Mettler Toledo Seven Compaq PH, AutoInc, USA).[7]

Data were tabulated in Microsoft Excel (2007) and analyzed using SPSS (Version 20, IBM, USA). Categorical variables (frequencies) were analyzed using the Chi-square test. Continuous variables were tested for normality using the Kolmogorov-Smirnov test and found to be normally distributed ($p > 0.05$), permitting the use of parametric tests. Independent sample t-tests were used to compare means. A significance level of $p \leq 0.05$ was used.

3. Results

The study was done in 5019 children aged between 3-14 years from four different zones in Bangalore. The children were divided into 3 groups based on type of dentition.

Table 1 depicts staining of teeth according to lobene stain index in all the 3 dentitions. Results shows that 22.1% of the children assessed had black stains where as 25.5% of children were in primary dentition, 19.8% of children in mixed dentition and 21.2% of children in permanent dentition. The difference between the groups were statistically significant (P value<0.006).

Table 2 illustrates descriptive analysis of the mean DMFT score with the staining of the teeth in the study population. It shows that the mean DMFT score in the group without stain was 2.429 as compared to the group with stain which was 1.4054. This suggests an inverse relationship between black staining and dental caries (DMFT score). The difference between the groups was statistically significant (P value <0.001).

Table 3 illustrates descriptive analysis of the mean salivary pH with the black stains. It shows that mean salivary pH of children without stain was 6.0727, whereas children with Stain had mean salivary pH of 7. 9277. The difference between the groups was statistically significant (P value <0.001).

Table 1: Type of dentition and the Lobene stain index score

Type of Dentition		**Lobene Stain Index Score**					**Chi Square test**	**p-value**
		Without stain	**With stain**					
		0	**1**	**2**	**3**	**Total**		
Primary	Count	1185	138	159	108	405	17.949	0.006*
	%	74.5%	8.7%	10.0%	6.8%	25.5%		
Mixed	Count	1446	120	147	93	360		
	%	80.1%	6.6%	8.1%	5.1%	19.8%		
Permanent	Count	1278	129	135	81	345		
	%	78.7%	7.9%	8.3%	5.0%	21.2%		

Table 2: Mean DMFT, deft score and the black stain

Black Stain	N	Mean (DMFT, deft score)	Std. Deviation	Std. Error of Mean	Median	t-test for Equality of Means		Sig.
						Mean Difference	F	
Without Stain	3909	2.4290	1.98662	.03177	3.0000			
With Stain	1110	1.4054	1.40832	.04227	1.0000	1.02360	311.4	<.001**

Table 3: Analysis of lobene stain and the salivary

Black Stain	N	Mean pH	Std. Deviation	Std. Error of Mean	Median	t-test for Equality of Means		Sig.
						Mean Difference	F	
Without Stain	120	6.0727	.38862	.03548	6.0700	44.82	311.4	<.001**
With Stain	120	7.92775	0.121243	0.011068	7.965			

4. Discussion

The prevalence of BS in the literature is between 2.4% and 26% worldwide.[4,] This study was conducted on 5019 children aged between 3 and 14 years from four different zones in Bangalore. The children were categorised into 3 groups according to the type of dentition. Of the 5019 children, 1590 belonged to primary dentition (31.7%), 1806 to mixed dentition (36%) and 1623 to permanent dentition (32.3%). The relatively balanced distribution suggests that this study covers a wide age range and includes individuals at different stages of dental development.[8] The prevalence of BS in the present study was found to be 22.1% (n=1110/5019), with 25.5% of children in the primary dentition, 19.8% of children in the mixed dentition and 21.2% of children in the permanent dentition. The difference between the groups was statistically significant (P-value <0.006). Black stains are more common in the primary dentition, possibly due to the porous nature of the primary tooth, poor oral hygiene habits, diet or bacterial composition in younger children.[4] The lower incidence in the mixed dentition and permanent dentition could indicate changes in the oral environment, structural changes in the enamel, diet or improved hygiene practises with age.[9] The differences in the prevalence of BS in the various studies can be attributed to different factors such as age, dietary and oral hygiene habits, microbial profiles, diagnostic criteria and the quantitative characteristics of the study populations.

Numerous studies conducted in different countries and age groups have reported varying prevalence rates of black spots (BS) in children.[10] In Brazil, a 2003 study of 263 children aged 6–13 years found a BS prevalence of 14.8% [11], while a later 2012 study of 1129 children aged 3–5 years found a lower prevalence of 3.5%.[12] In Europe, a German study from 1996 found a prevalence of 4.6% among 801 children aged 6–10 years,[13] and an Italian study from 2001 reported a prevalence of 6.16% among 1086 children aged 6–12 years.[14] Studies from Spain and Greece involving 3272 and 950 children aged 6–12 years and 3–5.5 years respectively, also showed relatively lower BS prevalence rates of 3.1% and 2.4%. In India, the prevalence appears to be higher in some regions. For example, a study by Bhat et al. in Udaipur found a prevalence of 18% in 1472 children aged 6–12 years.[17] while a study by Mariyum et al. in Chennai found a prevalence of 10% in a smaller sample of 93 children aged 6–12 years.[18] MS Muthu et al reported a prevalence of 6.2% among 1486 children aged 0–3 years in Chennai.[19] The highest reported prevalence was 20% in a 2009 study by Trith et al. in the city of Muradabad, Uttar Pradesh, based on a sample of 780 children.[20]

The origin of BS and its caries-protective properties have been discussed for over a century. In the beginning of the 20th century, Pickerill described the plaque as a thin dark brown stained line about the necks of the teeth, appearing in the form of a deposited film of calculus. His suggestion that the occurrence of BS is a sign of immunity to caries highlighted the need for further research in this area. In this study, the mean DMFT score in the group without stain was 2.429 as compared to the group with stain which was 1.4054. This indicates that individuals with black stains have a lower DMFT or deft score than those without stains. This suggests a possible inverse relationship between black staining and dental caries (DMFT score). The present study is in agreement with the studies conducted by Koch et al (Italy),[14] CC Garan et al., (Turkey),[22] França-Pinto et al., (Brazil),[12] Boka *et al*., (Greece)[16] JM Garcia Martin et al., (Spain),[15] Chen *et al*.,(China),[23] Heinrich Weiziea et al (Germany),[3] Akuz et al (Italy),[24] Mutsaddi et al (India),[25] Elemi et al (Tunisia),[26] Hwang et al (Korea).[27]

Saliva plays a vital role in maintaining the oral health of an individual. Salivary parameters such as pH, buffering capacity, calcium and phosphate ion concentrations are well-known caries-protective factors.[28] Analysis of salivary parameters by Surdacka *et al*., concluded that significant higher levels of calcium, inorganic phosphates, copper, sodium, total protein, and lower levels of glucose were found in patients with black stains.[30] In Surdacka's study, salivary pH levels were found to be significantly higher in children with black stain than those without black stain[29] which was concurrence with this study. In this present study, there was statistically significant change in pH between groups.

Children exhibiting black tooth stains tend to have saliva with a greater capacity to neutralize acids compared to those without such stains. This enhanced acid-neutralizing ability may contribute to their lower incidence of dental caries. By effectively counteracting the acids produced from dietary sugars, the saliva helps maintain a more stable pH in the oral environment, thereby reducing the duration during which tooth enamel is exposed to conditions that promote demineralization. This mechanism could explain the frequently observed inverse relationship between the presence of black stains and the experience of dental caries in children.[22] Claudia S et al,[21] also studied salivary pH in children with Black Stain which was in accordance with the present study. The more studies to support relationship of salivary flow and BS are Garan et al.[22]– *"Salivary parameters and caries indices in children with black tooth stains"*

1. ↓ Lower salivary flow rate, higher buffering capacity and calcium in children with black stain
2. Surdacka (1989) – *"Amount and pH of the saliva in children and adolescents with black tartar"* ↓ Lower salivary flow, higher pH in black-stain individuals.[29]
3. Surdacka (1989) – *"Chemical composition of the saliva in children and adolescents with black tartar"* ↑ Increased salivary calcium and phosphorus, linked with black stain.[30]
4. Żyła et al. (2015) – *"Black stain and dental caries: a review of the literature"* Notes lower caries and suggests salivary buffering/calcium involvement.[4]
5. Heinrich-Weltzien et al. (2009) – *"Black stain and dental caries in Filipino schoolchildren"* Reports lower caries in black-stain children; links to less cariogenic salivary flora.[3]
6. Chen et al. (2014) – *"Factors associated with black tooth stain in Chinese preschool children"* Finds individuals with black stain show lower salivary flow, higher minerals and pH.[23]
7. Janjua, Bahia & Barry (2022) – *"Black staining: an overview…"* Notes higher salivary pH, calcium/phosphate, lower flow in presence of stain.
8. Al-Shareef et al. (2025) – *"Current perspective on dental black stain of bacterial origin"* Indicates lower salivary flow, higher pH, iron/calcium levels in stained patients
9. de Rezende et al. (2024) – *"Black Chromogenic Stains – Why, How and What now?"* Reviews iron → ferric sulphide formation, salivary pH's role, and mineral content in stain development
10. Al-Shareef et al. (2025, narrative review) – Notes higher salivary minerals (iron, sodium, copper, alcium/phosphate), pH, and reduced flow in individuals with black stain.

In this study, that Primary dentition has the highest mean DMFT/deft (3.1906), followed by mixed dentition (2.8472) and Permanent dentition (0.5176). The observed decline in the mean DMFT score in the permanent dentition, as compared to the primary and mixed dentitions, can be attributed to several factors. Firstly, by the time permanent teeth erupt, children are generally older and more likely to be receiving regular dental care, including routine check-ups, professional cleanings, and fluoride treatments. Additionally, increased parental awareness and improved oral hygiene practices, such as supervised brushing and the use of fluoride toothpaste, contribute to better maintenance of permanent teeth.[32] Schools and community health programs often implement oral health education and preventive interventions targeting school-aged children, which may further reduce caries incidence in permanent teeth. Moreover, restorative dental treatments received during the primary and mixed dentition stages may halt the progression of caries, resulting in fewer decayed or missing permanent teeth.[32] This trend highlights the importance and effectiveness of early preventive measures, which decreases the severity of caries as children enter the permanent dentition. This was in accordance with the study by Anu et al in 2018 Chennai[33] and Sudha et al in 2005 Mangalore.[34] Overall, these findings highlight the importance of considering black stains not just as a aesthetic issue, but also as a possible indicator of a less cariogenic oral environment. Additional microbiological and longitudinal research is essential to clarify the underlying causes and potential protective role of black stains, which could help shape future strategies for preventing dental caries in children.

Though, this study offers important insights into black stains and their relationship with dental caries and salivary factors in children aged 3–14 years. There are few limitations:

1. Single-city sample (Bengaluru) restricts the generalizability of findings to other populations.
2. Parent-reported data may introduce recall bias.
3. Lack of longitudinal follow-up prevents assessment of changes over time in stain development or caries risk.

Hence, a prospective study following stained and non-stained children over years to observe changes in caries incidence, microbiological shifts, and salivary parameters can be conducted.

Assess if specific oral hygiene interventions (like probiotic use, chlorhexidine rinses, or different brushing techniques) can prevent, reduce, or reverse black stains.

The trace element content (especially iron and copper) in local drinking water sources of the studied populations should be analysed to further correlate it with black stain prevalence.

5. Conclusion

Black extrinsic stains were found to be prevalent among children in Bangalore, particularly in the primary dentition. The prevalence of BS was found to be 22.1% (n=1110/5019) in the present study, where 25.5% of children were in primary dentition, 19.8% of children in mixed dentition and 21.2% of children in permanent dentition. The presence of black stain was significantly associated with lower dental caries experience, suggesting a possible protective role. Children with black stains exhibited higher salivary pH. These findings indicate that black stain may reflect a unique oral environment that is less conducive to caries development. Further studies are needed to better understand the biological basis of this association.

6. Source of Funding

None.

7. Conflict of Interest

None.

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