



## Black Stains in Children and its Correlation to Dental Caries

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**Received:** September 21, 2020

**Published:** December 09, 2020

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### Abstract

**Aim:** This study assessed the prevalence of black stain on teeth of Egyptian school-children and determine the possible correlation with dental caries.

**Method:** Six primary schools were included. About 1615 children of 4 - 12 years were clinically examined for the presence of black stain (BS) and recorded according to Koch criteria. DMFT and dft were assessed in children using WHO criteria. Data were statistically analyzed using student t test and spearman correlation test.

**Results:** The prevalence of black stain was 8.4%. No correlation was observed between the presence of black stains and age and gender of children. Also, no correlation was found between black stain and dental caries, frequency of teeth brushing and iron supplementation.

**Conclusion:** The prevalence of BS in Egyptian school-children was 8.4%. No association was found between black stain and dental caries, children age and gender. Oral hygiene and iron supplementation may not have a role in promoting BS formation.

**Keywords:** Black Stain; Children; Caries; Iron; Age; Gender

### Introduction

Teeth discoloration is a clinical and esthetic problem which may occur in both primary and permanent dentition. Tooth discoloration can cause psychological and social problems that reduce self-confidence of children. It differs in etiology, appearance, composition, location, severity and degree of adherence [1]. Basically, there are three types of tooth discolorations: intrinsic stain that incorporated in tooth structure, extrinsic stain formed on outer tooth surface and related to metallic or nonmetallic factors and internalized stain where extrinsic stain infiltrates through the defects in the tooth structure [2].

Black tooth stain (BS) is an extrinsic discoloration. The attraction of materials to tooth surface is crucial to its formation. How-

ever, the mechanism that determines the adhesion strength is not clearly understood. These attractive forces include electrostatic and van der Waals forces, hydration forces, hydrogen bonds and hydrophobic interactions [2].

BS is diagnosed clinically as pigmented, dark lines parallel to the gingival margin or as dark dots extending beyond the cervical third of the crown [3]. Several studies have been conducted to identify the etiological factors of BS. It is considered a special form of dental plaque because it contains an insoluble ferric sulfide and a high content of calcium and phosphate. Chemical analysis of black stain using wavelength dispersive spectrometry showed high concentration of sulfur and copper/iron [4]. Also, a higher level of iron in BS compared to standard plaque was confirmed using coupled plasma-mass spectrometry [5].

Ferric sulfide is probably formed by the reaction between the hydrogen sulfide produced by bacterial action and iron in the saliva or gingival exudates. In a study of Spanish children, black stain was found in children who consumed a significantly higher proportion of iron supplements. Also, it was found that, children with black stain showed higher consumption of specific foods rich in dairy products, eggs, iron and vegetables [6]. Furthermore, a positive correlation was found between black stain and the concentration of iron in water sources [7]. An association between black tooth stains and the bacteria has been reported by PCR study that analyzed plaque samples of children with BS and showed significantly higher number of *Actinomyces* and lower number of *Lactobacillus* [8]. Another study reported low levels of *Streptococcus mutans* in black stain biofilm, and this may account for the decreased susceptibility to caries [9].

In PCR study, the absence of chromogenic bacteria such as *Porphyromonas gingivalis* in black stain was reported [10]. However, several studies, demonstrated the reduced microbial diversity in BS compared to standard plaque, with increased the number of certain bacterial species (*Actinomyces*, *Cardiobacterium*, *Haemophilus*, *Corynebacterium*, *Tannerella* and *Treponema*) [11,12].

Several epidemiological studies reported that, children with BS teeth had lower caries prevalence or experiences [13,14]. Also, a Brazilian study suggested that BS might be a protective factor for dental caries development [15]. Mutsaddi, *et al.* [16] investigated the association of dental caries and BS, they showed lower caries experience in patient with BS. Also, significantly lower number of *Streptococcus mutans* and *Lactobacillus* was observed when compared to non-stained plaque.

The prevalence of black stains varies from 2.5 to 19%. Several factors may be considered such as study region, age of population enrolled, and dietary habits [17-19]. A prevalence of BS has been reported 19.9% for 7 - 15 years Swedish school children, 4.6% in German schoolchildren 6 - 10 years and 9.3% for 6 to 13 years Brazilian children [20].

However, most studies of BS have focused on permanent teeth, and there are few data regarding the prevalence and clinical characteristics of black stain on the primary teeth or its possible association with dental caries. There was no such study available in Egypt, therefore, this study was performed to evaluate the prevalence and possible association of black stains and dental caries among a sample of Egyptian schoolchildren.

## Materials and Methods

This cross sectional designed study was conducted in full accordance with ethical committee of Mansoura University. Children participated in this study were selected randomly from six primary schools of Mansoura city, Dakahlia, Egypt. These schools were selected by simple random sampling technique, while the children were selected from the schools using cluster sampling technique. A total of 1700 children aged between 4 - 12 years were invited to participate in this study. An informed consent was taken from 1615 parents along with the child's approval to participate. The parents were given clear explanation about the objective of the study. Children who lacked informed consent or were absent from school on the day of the exam, or were unable to cooperate during the examination, were excluded. Parents completed a questionnaire, including questions regarding the following data: name, age, sex, or numbers of teeth brushing per day and iron supplementation. Clinical examinations of the children were performed by one dentist to record dft and DMFT index and the presence or absence of black stain. Cohen's kappa ( $\kappa$ ) test was used to measure the intra-examiner reliability and the kappa ( $\kappa$ ) values was greater than 0.9.

The dental caries examination was visual-tactile and carried out with plane mouth mirrors and explorers under natural light in the school environment. DMFT and dft was recorded according to World Health Organization criteria for caries diagnosis [20] together with the presence or absence of black stains. The criterion for scoring black stain was recorded according to Koch, *et al.* [3]. Score 1: presence of pigmented dots or thin lines with incomplete coalescence parallel to gingival margin; score 2: continuous pigmented lines, which were easily observed and limited to half of the cervical third of the tooth surface; score 3 : presence of pigmented stains extending beyond half of the cervical third of the tooth (Figure 1-3).



**Figure 1:** Score 1 black stain.



Figure 2: Score 2 black stain.



Figure 3: Score 3 black stain.

**Statistical method**

Data were collected and analyzed using the spss statistical software (spss, version 20). Association between occurrence of black stain and dental caries was carried out using Spearman correlation test. Student t test was used to compare between mean DMFT and dft of two groups, Statistical significance was considered at 5% level.

**Results**

About 1700 children were invited for the study, the parents' of 1615 children completed the informed consent. No significant difference in age or gender distributions between children was recorded ( $P > 0.05$ ; Table 1). The prevalence of black stains was observed in 8.4 % of the studied sample. The prevalence increased with age, although the difference was not statistically significant. Also, no significant difference in the prevalence of BS was observed between males and females (Table 2). Children with black stain showed lower caries experience than the children without black stain and the difference was insignificant ( $p > 0.05$ . Table 3 and 4). However, no association was detected between the presence of BS and age, gender and caries. ( $P = 0.107, 0.863, 0.06, 0.09$  respectively (Table 5 and 6). No significant differences were recorded between children with or without BS regarding frequency of teeth brushing and iron supplementation ( $P > 0.05$ ).

Variable	Number %	P value
<b>Age</b>		
4 - < 8 years	897 (55.5%)	0.369
8 - 12 years	718 (44.5%)	
<b>Gender</b>		
Male	935 (57.9%)	0.196
Female	680 (42.1%)	
Total	1615 (100%)	

Table 1: Demographic data of the studied sample.

Variables	Stain					P value
	No stain	Black stain	Dots	Third	More	
Age						
4- < 8	831 (51.5%)*	66 (4.1%)	7 (0.4%)	(3%)	10 (0.62%)	0.000*
8 - 12	648 (40.1%)*	70 (4.3%)	44 (2.7%)	20 (1.2%)	7 (0.4%)	0.000*
P value	0.003*	Total (8.4%)	0.07	0.385	0.296	
Gender						
Male	867 (53.6%)*	68 (4.2%)	11 (0.6%)	49 (3.03%)	8 (0.5%)	0.000*
Female	612 (37.9%)*	68 (4.2%)	(2.6%)	9 (0.6%)	9 (0.6%)	0.000*
P value	0.171		0.076	0.043*	0.296	

Table 2: Prevalence of black stain among the study sample.

Variable	Caries		P value
	No caries	Caries	
<b>Age</b>			
4 - < 8	64 (97%)	2 (3%)	0.000*
8 - 12	64 (91.4%)	6 (8.6%)	0.000*
P value	0.769	0.11	
<b>Gender</b>			
Male	63 (92.6%)	5 (7.4%)	0.000*
Female	65 (95.6%)	3 (4.4%)	0.000*
P value	0.874	0.396	

**Table 3:** Prevalence of dental caries among children with black stain.

Variable	Caries			P value
	No caries	Caries 1-5	Caries >5	
<b>Age</b>				
4- < 8	425 (26.3%)	301 (18.64%)	171 (10.6%)	0.128
8 - 12	365 (22.6%)a	267 (16.6%)b	86 (5.3%)ab	0.01*
P value	0.781	0.272	0.157	
<b>Gender</b>				
Male	388 (24.02%)a	391(24.2%)b	156 (9.4%)ab	0.039*
Female	288 (17.8%)	276(17.08%)	116 (7.2%)	0.084
P value	0.479	0.354	0.619	

**Table 4:** Prevalence of dental caries among the study sample.

Brushing Technique	No stain	Black stain	P-value
No brushing	15%	17%	0.74
Number of brushes/day			
Once	35.7%	37.1%	0.88
Twice	40.3%	38.4%	0.85
Three	9%	7.5%	0.72
Iron supplement (yes)	6.5%	8.5%	0.61

**Table 6:** Questionnaire analysis regarding frequency of teeth brushing and iron supplementation.

### Discussion

Black tooth stain is common among children and influences the aesthetics of their teeth. It is difficult to be removed with a toothbrush and tends to recur after scaling. In this study, the prevalence of black stain in Egyptian school-children was 8.4%. However, data from previous studies on black stain from different countries varies considerably. In Filipino children, the prevalence of black stain in permanent dentition was 16%, 14.8% for Brazilian children

Variable	Pearson correlation	P value
Black Stain and age	0.04	0.107
Black Stain and gender	0.004	0.863
Black Stain and total dft	0.011	0.06
Black Stain and total DMFT	0.075	0.09
Stain and number of decayed teeth	0.021	0.11
Stain and number of filled teeth	0.009	0.12

**Table 5:** Correlation between black stain and different variables.

ages 6 to 12 years, 6.3% of Italian children from 6 to 12 years, and Franca-Pinto., *et al.* found that, 3.48% of children at age 5 years had black stain [3,14,15,21]. The differences in prevalence may be due to variations in diagnostic criteria of black stain and different age groups in different places or countries. To our knowledge, there is no previous data of black stain prevalence for Egyptian children to be compared with our result.

In this study, no association was found between the age of children, gender and presence of black stain, and this agrees with several studies [3,13,15]. However, Chen., *et al.* [13] suggested that, the severity of BS increased with age, as the number of teeth with black stain was three times greater in children more than 5 years old. Also, higher prevalence of black stain was recorded in males.

The present data found no correlation between the presence of black stain and dental caries in primary and permanent dentition. Previous studies reported positive association between BS and lower frequency of caries [13,22]. However, Koch and Gasparetto., *et al.* [3,21] did not find a significant lower dmft in children with

black stains, also Zhang, *et al.* [23] showed no significant difference between children with and without black stain involving age and gender, and caries status which agree with the outcome of the present study. Early studies of BS suggested chromogenic bacteria as etiologic factor for the occurrence of black stain [8,24]. Another study concluded that, black stain in the primary dentition may be correlated to alteration of the microbial plaque. Actinomyces was more abundant in plaque samples of children with black stain [11]. Also, Zhang, *et al.* [5] revealed the association between metabolic microbiota and BS. Slots [25] attributed low caries occurrence with BS to the lower numbers of *Streptococcus* which is the main pathogens of dental caries. While Reid and Beeley [4] explained the reduction in caries frequency in black tooth stains group due to increased calcium and phosphate level of the biofilm of the stain which reduced enamel dissolution and increased buffering capacity.

Since black stain is an extrinsic discoloration, several studies evaluated influence of oral hygiene, but there is conflicting data. Garcia Martin, *et al.* [6] reported that, using fluoride toothpaste encourages stain formation. However, another study found no correlation between BS and the type of toothpaste or frequency of brushing [4]. Our result agreed with this result as no significant difference was found between children with black stain and those without black stain regarding frequency of teeth brushing. Prathap and Prathap [26] reported that, BS was more prevalent in patients with good oral hygiene and suggested that, the associated bacteria may not be the sole etiology for these stains.

Black stain is probably ferric sulfide salt formed by the reaction between hydrogen sulfide of bacteria and iron from saliva or gingival fluid. Tantbirojn, *et al.* [27] found traces of iron and copper in the composition of black stain of extracted teeth. By using spatial chemistry analysis, high iron and copper concentrations was found corresponded to areas of high concentration of sulfur. This agreed with Reid, *et al.* studies [4] who suggested that, ions and sulfur complex are responsible for the black color of stains

The result of this study agrees with previous study that found no statistically significant association between the consumption of iron supplementation and black stain [28]. However, another research suggested that, the regular consumption of foods rich in iron and the use of iron supplements during the pregnancy and the early childhood, could favor the development of the chromogenic microbiota [6].

The present study has certain limitations as no microbiological investigations was carried out, which may be needed in further research and certain factors like diet, and salivary pH, demographic, social, and drinking water content were not assessed that may be etiologic factors in black stain.

## Conclusion

Based on the result of this study, the prevalence of BS in Egyptian school-children was 8.4%. No association was found between black stain and dental caries, children age and gender. Oral hygiene and iron supplementation may not have a role in promoting BS.

## Acknowledgement

We are thankful to all children and their parents who participated in this study. We would like to express great thanks to Dr Salwa Hegazy (professor of preventive and dental public health) for her great help in data statistical analysis.

## Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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