Can black extrinsic tooth discoloration predict a lower caries score rate in young adults?

Tom Shmuly, DMD¹/Avraham Zini, DMD, MPH, PhD²/Michael Yitschaky, DMD³/Oded Yitschaky, DMD, MA³

Objective: The aim of this study was to examine the association between black extrinsic tooth discoloration and caries prevalence in an adult population. This association has been previously shown in children and adolescents but has never been examined in an adult population. Method and Materials: Young adults, aged 18 to 29 years old, were examined for black extrinsic tooth discoloration and caries prevalence. The study group included 110 young adults with black stain; the control group consisted of 170 young adults without black stain. The decayed, missing, or filled teeth (DMFT) index score was determined for each subject. The mean DMFT score was calculated for both groups and compared between groups (independent t test). Multiple logistic regression analysis was applied to identify independent influences (age, pigmentation, gender, and smoking) on DMFT. Results: Mean DMFT score was 4.2 ± 3.9 for the study group and 5.98 ± 4.8 for the control group, which was statistically significant (P < .001). Mean D score (untreated caries) was 1.6 ± 2.5 (study) and 2.4 ± 3.5 (control) (P < .05). Age had a positive correlation with the DMFT score; however, gender and smoking were negatively correlated. Conclusion: The association between black stain and reduced rates of dental caries was demonstrated in a young adult population for the first time. (Quintessence Int 2014;45:439–444; doi: 10.3290/j.qi.a31535)

Key words: black stain, caries prevention, DMFT index, extrinsic tooth discoloration

Black extrinsic tooth discoloration, also referred to as black stain, has interested clinicians and researchers for more than a century (Fig 1), with many aspects only partially understood.¹⁻⁴ Black stain does not cause any pathology, and treatment is only indicated for esthetic reasons. Professional scaling and polishing can clear the black stain, but it tends to reappear after several months.⁵,⁶ Since the etiology, diagnosis, and classification are still not completely understood,⁷ the relationship between black stain and caries prevalence remains unclear.⁴,⁸,⁹ Lower caries scores have been found in patients with black extrinsic stain.²,⁷,¹⁰⁻¹⁴ However, not all of the studies have proven a statistical association between caries prevalence and black stain appearance.¹⁵,¹⁶ The above studies consisted of children from preschool age to adolescence, with only a few adults included.

To the best of our knowledge, this is the first study that examines the association between black stain and caries prevalence exclusively in an adult population. Since black stain tends to disappear with age, and caries scores tend to rise with age, examining a young adult population could be significant.
The decayed, missing, or filled (DMF) index is universally accepted for measuring caries rates, and has been previously used to examine the association between black stain and caries prevalence. This score when applied to the whole tooth, and not specifically to the tooth surface, is referred to as DMFT.

Careful characterization of black stain etiology, epidemiology, and microbiology, and proving a relationship between black stain and low caries prevalence, might provide an insight into caries pathogenesis and prevention. The aim of this study was to investigate the association between the DMFT score and black stain in young adults serving in the Israel Defense Forces (IDF).

METHOD AND MATERIALS

The study population consisted of 280 young soldiers, 175 (62.5%) males and 105 (37.5%) females, age 18 to 29 years. There were 110 subjects with black stain (study group), and 170 randomly selected subjects without black stain (control group). An experienced examiner (TS) examined all subjects at the same IDF dental clinic facility between January and December 2010. It was estimated that the minimal sample size to report outcomes of interest with an acceptable error of 5% and a power of 90% (expected difference between groups = 1.6 DMFT) was 266 subjects. A detailed medical history questionnaire, full clinical examination, and bilateral bitewing radiographs were included for each subject.

Clinical examination included dental caries experience by DMFT, which was conducted by one dentist with the aid of a plain mouth mirror and a World Health Organization (WHO) probe in daylight. Input data were derived from the subjects’ files. All subjects included in the study had not received professional tooth cleaning at least 6 months before the examination. All specified whether they were smokers, the number of years they had smoked, and the number of cigarettes per day. One experienced examiner (TS) reviewed the bilateral bitewing radiographs in a dark room, using a white-light viewer and magnifying glass (×2 magnification). Only high-quality radiographs were included.

Black stain was dichotomized as an all-or-none phenomenon: either the subject had black stain or not. Black stain was differentiated from other stains, such as chlorhexidine or coffee, by the clinical appearance as explained by Ronay et al. DMFT scores represented the number of teeth with decay (D), missing due to caries (M), or filled (F). The same clinician examined the posterior teeth, both clinically and radiographically. Since the
third molar teeth were not included, the possible DMFT score range was 0 to 28.

Average DMFT and D scores, and standard deviations were calculated for both groups (with and without black stains) and the means compared by an independent t test. Subjects were categorized into three groups: caries-free (DMFT = 0), third quartile (1 to 8), and fourth quartile (above 8). The cutoff of DMFT 8 was determined by the third quartile. Differences in pigmentation appearance by categorical independent variables (gender and smoking) were univariately analyzed using chi-square analysis. A multiple logistic regression analysis was applied to multivariably identify independent influences (age, pigmentation, gender, and smoking), on dichotomized DMFT by median. A statistical test was considered significant when \( P < .05 \). Data were entered into Excel software (Microsoft) and SPSS 15.0 (SPSS) for data analysis.

The Ethical Committee of the Medical Corps of the IDF approved the study. Informed consent was provided by the participants.

### RESULTS

The research sample included 280 subjects, 175 (62.5%) males and 105 (37.5%) females. There were 204 (72.9%) nonsmokers and 76 (27.1%) smokers. There was no association between pigmentation and either gender or smoking; the Pearson chi-square results were 0.752 and 0.753 respectively.

Black stain was found among 110 subjects (study group), and 170 subjects were without black stain (control group). Age difference between groups was not statistically significant (22.0 ± 2.4 years for subjects with black stain and 21.0 ± 2.7 for subjects without black stain) (Table 1).

Mean DMFT scores were 4.2 ± 3.9 with median of 3.5 (study group) as compared with 6.0 ± 4.8 with median of 6 (control group), \( P < .001 \) (Table 1). The percentage of subjects without any past history of caries (DMFT = 0) was twice as high in the study group compared to the control group (\( P < .01 \), Pearson chi-square). The percentage of high DMFT (above 8) is twice as high in the control group compared to the study group.

![Fig 2](image-url)  
**Fig 2**  
Decayed, missing, and filled teeth (DMFT) index distribution differs between subjects with black stain and control subjects. The percentage of caries-free subjects without any past history of caries (DMFT = 0) is twice as high in the study group compared to the control group (\( P < .01 \), Pearson chi-square). The percentage of high DMFT (above 8) is twice as high in the control group compared to the study group.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Comparison of the study (black stain) and control groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Number examined</td>
<td>280</td>
</tr>
<tr>
<td>Age (mean ± SD)</td>
<td>21.6 ± 2.5</td>
</tr>
<tr>
<td>DMFT (mean ± SD)</td>
<td>5.3 ± 4.4</td>
</tr>
<tr>
<td>D (mean ± SD)</td>
<td>2.1 ± 3.1</td>
</tr>
</tbody>
</table>

*Independent t test. NS, not significant.
was 16 for the black stain group and 25 for the control group. A significance was found also on the D component of the DMFT score with a mean D of 1.6 ± 2.5 (study group) and 2.4 ± 3.5 (control group), \( P < .05 \) (Table 1).

Multiple logistic regression analysis manifested a higher caries prevalence in older subjects (odds ratio [OR] = 1.275). The possibility of a subject with black staining to have a DMFT above the median score was 2.5 times lower than for a subject without black staining (OR = 2.538). Gender and smoking did not significantly predict the rate of DMFT (Table 2).

### DISCUSSION

Tooth extrinsic black discoloration is well known in the dental literature. The relationship between black stain and low caries prevalence has been shown in preschool children and adolescence.\(^3,7,10-14\) The current study is the first to examine the relationship of black stain and low caries prevalence in young adults, from 18 to 29 years, and to indicate that there is a positive association between them. Gasparetto et al\(^{16}\) did not find a statistical relationship between low caries prevalence and black stain appearance. However, the DMFT scores of both the control and study groups were low (2.27 total DMFT for the entire sample), and the mean DMFT score was lower by about 1 score for children with black stain (1.46 versus 2.42).\(^{16}\) The combination of the small sample (263 subjects) and low DMFT scores could result in a false statistical association between black stain and low caries prevalence. In the present study, the sample size was similar (280 subjects), but there was a higher rate of DMFT, which indicates that the association between black stain and DMFT is valid. A significant negative correlation between the severity of the black stain and DMFT scores has been shown by Gasparetto et al,\(^{16}\) which supports that there is a valid relation between caries prevention and black stain. Leung\(^{15}\) failed to demonstrate a significant difference of caries score rates between children with and without stain, but he did examine different kinds of stains and found that the number of children with black stain was low. The present study focused only on black stain, which was defined as dark pigmented exogenous substance in lines or dots parallel to the gingival margin and firmly adhered to the enamel at the cervical third of the tooth crowns. Our conclusion drawn from both reading the literature and from our study results is that there is lower caries prevalence in subjects with black stain. Extending the research to young adult populations might help the dental practitioner in clinical decisions such as individually timing the recommended check-up visits, and scheduling radiographic examination accordingly in patients with black stain.

The etiology of black stain is still unclear, as is the possible explanation for the association between black stain and low caries prevalence. Several explanations have been suggested, including change in saliva composition, different oral microflora composition, or both.\(^7\) A higher concentration of calcium and phosphate has been found in the gingival debris of children

### Table 2

<table>
<thead>
<tr>
<th>Multiple logistic regression analysis for the effect of independent variables on DMFT above median (median = 0.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B coefficient</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Mandibular</td>
</tr>
<tr>
<td>Smoking (nonsmoking vs smoking)</td>
</tr>
<tr>
<td>Age (continuous)</td>
</tr>
<tr>
<td>Gender (female vs male)</td>
</tr>
<tr>
<td>Black stain (positive vs negative)</td>
</tr>
<tr>
<td>Constant</td>
</tr>
</tbody>
</table>

CI, confidence interval; OR, odds ratio; SE, standard error.
with black stain.\textsuperscript{20} Higher concentrations of inorganic minerals can facilitate enamel remineralization and prevent dental caries.\textsuperscript{21} Further research is needed to determine the connection between the stain and higher ion concentrations, and to validate the availability of these ions to enamel remineralization.

The present study not only compared the results of the clinical examination of subjects with or without black stain, but also added bilateral bitewing radiographs to the examination for a more accurate evaluation of caries existence and past experience. Normally the DMFT index is used as a clinical index, and as such it underestimates the rate of untreated caries. Thus, interproximal caries lesions can be more accurately diagnosed by bilateral bitewing radiographs. Zadik and Bechor\textsuperscript{22} claim that bilateral bitewing radiographs also help to diagnose hidden occlusal caries. The radiographs incorporated into the score are expected to provide higher DMFT scores, compared to past clinical surveys of a similar population. However, in a survey conducted in the mid-1990s, Sgan-Cohen et al\textsuperscript{23} found an average DMFT score of 8.49 ± 4.95, which was higher than the average DMFT score found in our research. Bilateral bitewing radiographs incorporated into the score would eliminate the tendency of the DMFT index to be artificially higher in a well-treated population compared to a non-treated one. The downside of including radiographs reduces the potential number of subjects in a study sample, and narrows the sample to a treated population, since bilateral bitewing radiographs are taken for diagnostic purposes. A sample that includes subjects who voluntarily come to the dental office could skew the DMFT score higher. DMFT scores also increase with the use of bilateral bitewing radiographs, which diagnose proximal decay lesions that are often unseen in clinical examination. In the present study, the mean DMFT score of 5.3 ± 4.5 was lower than the score measure by Sgan-Cohen et al\textsuperscript{23} 15 years before; an average of 2.25 ± 2.90 untreated carious teeth (D) found by Sgan-Cohen et al\textsuperscript{23} was slightly higher than the 2.1 ± 3.1 untreated carious teeth (D) score in the present sample.\textsuperscript{23} Further research is needed to examine a possible reduction of caries prevalence in the Israeli population over the past 15 years that is compatible with the predictions of Sgan-Cohen et al.\textsuperscript{23}

Since IDF soldiers were examined in this study, it does not represent the whole Israeli population. For example, Israeli Arabs and ultra-Orthodox Jews do not serve in the IDF and are not represented in this study. Thus, DMF scores can be compared to past research of soldiers, but not to surveys of the whole Israeli population.

A study conducted by only one examiner has the advantage of better consistency. However, the downside is a smaller sample and the results could reflect personal diagnostic bias, calling into question the absolute DMFT score. Such a bias would equally influence the DMF scores of both the study and control groups, but would not affect the comparison between them. The main conclusion deduced from such a comparison with only one examiner to nullify the interexaminer error strengthens the results of the present study. Another disadvantage of this research is the use of one examiner for both staining and determination of the DMFT score.

The Israel Center for Disease Control conducted a survey on smoking habits of the Israeli adult population and found that 23.1\% were smokers.\textsuperscript{24} Smoking stains could be diagnosed as black stains by mistake.\textsuperscript{2,5} In the present sample, the percentage of smokers was 27.1\%, which was higher than expected. Smokers in the study group (28.2\%) were comparable to that of the control group (25.9\%). Smoking was not related to pigmentation (Pearson chi-square = 0.753), nor to caries rate (logistic regression).

Gender distribution among the study and control groups was equal, with obvious advantage to men in both groups. This gender distribution represents the treated population in the military clinic in which the study took place.

CONCLUSION

The association between black stain and low caries prevalence was validated, and extends to the adult
population. It is hoped that future research will find the mechanism behind this association and will use the understanding to develop new ways to reduce the prevalence of caries and promote dental health.

ACKNOWLEDGMENT

The authors wish to thank Rita Lazar, Scientific Editor, MR Associates, for editorial assistance and Dr Yehuda Zadik, Department of Oral Medicine, Hebrew University-Hadassah School of Dental Medicine, for critically reading this article before submission.

REFERENCES