



Severity of Extrinsic Black Stain and prevalence of Dental Caries

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Teeth discoloration is one of the most common problems among individuals nowadays. It can be caused by a variety of circumstances and can result in cosmetic problems as well as low self-esteem and dental caries. Hence the present was conducted to investigate the correlation between the severity of Black stains and the prevalence of caries, number of missing teeth, crowns, restorations, and Endodontically-treated teeth in adult patients at Riyadh Elm University Dental Clinics.

Materials and Methods: The study consisted of 84 participants with age ranging from 18 to 60 years, with no gender preference. The subjects included in the study had not received any professional teeth scaling and polishing at least 6 months prior to the examination. Participants with an anterior fixed partial denture or any kind of restoration anteriorly with more than two incisors crowns or more than two missing incisors for each quadrant were excluded. Clinical examination was done by the single investigator who was calibrated by practicing it on 5 patients.

Results: In the present study majority 64 (76.2%) of the participants aged between 18-32yrs, more than half 50 (59.5%) of them were male and the rest of them were female 34 (40.5%). A high percentage of subjects 34 (40.5%) were having a university level of education. Age, gender showed significant association with Intensity, extensity and composite scores of stains ($p < 0.05$). Income was associated statistically significantly with extensity of stains ($p < 0.05$). A correlation was found between the patient decayed teeth number and stains; however, this relation wasn't statistically significant. The study found that endodontically treated teeth had a statistically significant link between its number increase and the extent and intensity of stains.

Conclusion: From the present study it was concluded that age and gender was statistically associated with intensity, extensity and composite scores and income also had an impact on extensity of stains. More investigation is recommended to gain more understanding of the correlations of dark stains.

Keywords: Dental caries; extrinsic stains; esthetic.

1. INTRODUCTION

Teeth discoloration can be one of the main concerns of people nowadays. It can be caused by 'many factors and may lead to aesthetic issues and develop low self-esteem. Stains differ in etiology, appearance, composition, location, severity, and degree of adherence to teeth [1]. Teeth discoloration is divided into Extrinsic and Intrinsic. Extrinsic stains are found on the outer surface of teeth whereas the intrinsic stains are found within the inner structure of teeth [2]. Extrinsic and intrinsic stains can also exist concurrently [3].

Extrinsic staining forms due to chromogenic bacteria, staining by food and chemical transportation of pellicle [4]. Various factors modify the occurrence of extrinsic stains like enamel defects, poor oral hygiene, pits and fissures [5]. Furthermore, it has been observed that the prevalence of extrinsic stains does not increase with age [6].

Black Stain (BS) can be classified as an extrinsic stain, which tends to be a thin or wide black line firmly attached to the tooth surface. It is difficult to be removed with a toothbrush and dentifrice and usually has a tendency to recur after removal. It is mainly found on the facial and lingual surfaces adjacent to the gingival margin. It is caused by the chromogenic bacteria *Actinomyces* [1]. Also, Dental plaque is considered a form of black stain [7-10]. The dark color in black stains can be due to iron, copper or sulfur complexes. Some studies suggested that possibly metallic ions and sulfur complexes are responsible for the black color of stains [7,11]. Another study confirmed that the black compound is probably ferric sulfide, formed by

the reaction between hydrogen sulfide produced by bacteria and iron in saliva or gingival fluid [7]. Studies have shown that there is no difference between males and females in Black Stain (BS) occurrence prevalence [8,9].

Black stains play a role in dental caries which has attracted attention over a century [12-14]. Most authors suggest that black stain is associated with lower caries experience. [15,16]. *Pickerill* stated that black stain is "a sign of immunity to caries" [17]. *Actinomyces* bacteria were found to be higher than *Lactobacillus* in pediatric patients with black stain [18]. Phosphate concentrations were also higher in the BS group [7]. In a study done by *Koch et al.* children with BS were examined and they found no correlation between the presence of BS and age. They also found out that children with BS had fewer decayed permanent teeth than other children without BS [6]. *Hunrich, et al.* carried out a study in the Philippines that proved that caries prevalence and caries experience were significantly lower in children with BS compared to children without BS [19]. *Bahat et al.* conducted a study in India that showed caries prevalence and experience were significantly lower in the BS group in comparison to the non-BS group [16]. The majority of published results demonstrated the presence of a dark extrinsic tooth stain is associated with a lower caries experience when compared to those whose dentitions have other colors or no apparent colored extrinsic tooth stains. This observation is true for both the deciduous [13] and the permanent dentitions [17,20]. However, some results do not confirm that black extrinsic tooth stain is always associated with a low caries experience [21,22].

2. MATERIALS AND METHODS

The present cross sectional observational study was among participants from Saudi Arabia region. The study sample number consisted of 84 samples with ages ranging from 18 to 60 years, with no gender preference. The subjects included in the study had not received any professional teeth scaling and polishing at least 6 months prior to the examination. Any participant with anterior fixed partial denture or any kind of restoration anteriorly was excluded from this study. Additionally, any participant had more than two incisors crowns or more than two missing incisors for each quadrant were excluded. The third molars teeth were excluded as well.

A minimum sample of (N=80) was considered based on the prevalence of the extrinsic stains and acceptable margin of error of 5%, a confidence level of 95%.

Consents were signed by all participants confirming their willingness to participate in the study. An OPG X-ray, two bitewing x-rays on each side for both the premolars and molars areas were taken for each participant. Then, participants were examined by single, skilled investigator, collecting data starting with Age, Gender, Education level, Monthly income. Using the previously taken radiographs, a thorough examination was carried away, recording the number of teeth with caries, number of restorations, missing teeth, number of endodontic treatments, and number of crowns. Stains recorded based on the modified tooth stain index [23,25]. The examiner cleaned the teeth before taking the reading by using water and cotton roll to remove any plaque or food debris. The instrument that used in the examination was the World Health Organization (WHO) periodontal probe. Based on the modified tooth stain index, only teeth number 11, 12, 21, 22, 31, 32, 41 and 42 were recorded. If an incisor was missing, the nearest canine will substitute for it [24]. Each tooth consisted of dividing each aspect into 4 separate sites (Fig. 1):

- 1 Gingival (G): 2 mm wide strip running parallel to the gingival margin. The limit towards the incisal edge given by the end of the interdental papilla.
- 2 Body of tooth (B): central area of buccal/lingual aspect, between gingival and

distal/mesial sites, extending to incisal edge.

- 3 Mesial (M): visible area between line angle and adjacent tooth, ending at the interdental papilla (i.e. start of gingival site).
- 4 Distal (D): As for mesial (M) site.

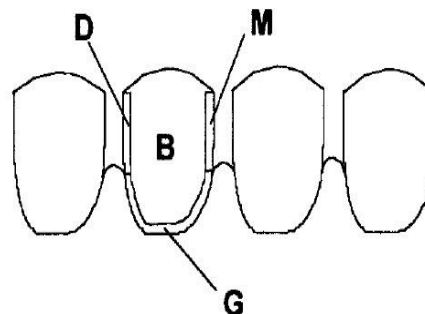


Fig. 1. The stain sites of a lower anterior tooth: body (B) Gingival (G), mesial (M) and distal (D)

The stain was recorded by using 2 separate characteristics, namely (intensity) and area (extent) as suggested by Lobene and the modified tooth stain index [24,25]. The criteria and codes for intensity:

- 0=no stain present, natural tooth coloration
 1=faint stain
 2=clearly visible stain, orange to brown
 3=dark stain, deep brown to black

The area (extent) of the stain was recorded only if an intensity score of 2 or 3 was given. The area criteria and codes for the extensivity of the buccal/labial and lingual/palatal surfaces:

Buccal/labial code surfaces

- 1 = stain limited to pits/grooves
- 2 = stain outside pits/ and grooves, up to 10% of area affected
- 3 = stain outside pits/ and grooves, more than 10% of area affected

Lingual/palatal code surfaces

- 1 = up to 1/3 of area affected
- 2 = between 1/3 and, 2/3 of area affected
- 3 = more than 2/3 of area affected

The same scoring criteria was used for the other 2 sites also.

2.1 Data Analysis

A descriptive statistics of frequency distribution, mean (Standard Error) were calculated for the variables. Normality of the data was checked and data showed non-normal distribution, hence non-parametric tests of Mann-Whitney U and Kruskal -Wallis tests were applied to compare the mean scores between two groups and more than two groups. Further, Spearman's test was applied to find out correlation between the stain parameters (intensity, extensity and composite scores) with other variables (decayed teeth, missing teeth, restored teeth, number of endodontically treated teeth and number of fixed crowns). Data was transferred from excel sheet to the statistical analysis software SPSS version 25 for further analysis. A p value of less than ($p < 0.05$) was considered significant for all analysis purposes.

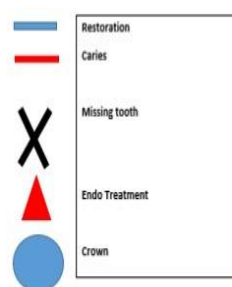
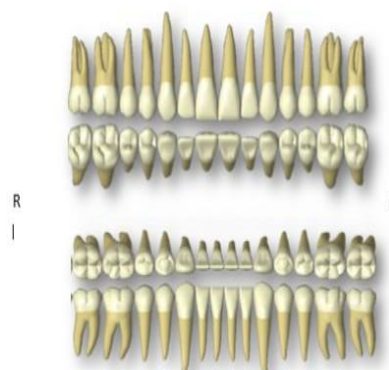
3. RESULTS

In the present study, the majority of the participants were between 18-32 years old (64 participants, 76.2%); 50 participants were male

and 34 participants were female. 40.5% of participants had a university level of education. Most of the participants reported having less than 5000 SAR of income per month. Frequency and severity of decayed, missing, restored teeth, endodontically treated teeth, and crowns were noted. Mean (SE) scores of stain intensity 0.78 (0.06), extensity 0.31 (0.05) and composite score 0.44 (0.08) were observed (Table 1).

Distribution of the mean intensity, extensity and composite stain scores across different age groups, gender, education, and income groups are shown in (Fig. 1). From this, it is obvious that subjects aged 33-46 years old, male gender, and those having elementary school education having income above 15000 SAR showed higher stain intensity scores. Similarly, extensity scores were found to be high in subjects aged 33-46 years old, male and those having secondary education, and income above 15000 SAR. Composite stain score was high in subjects aged 47-60 years, male subjects, having secondary education and income above 15000 SAR.

Age	<input type="checkbox"/> 18-32 <input type="checkbox"/> 33-46 <input type="checkbox"/> 47-60							
Gender	<input type="checkbox"/> Male <input type="checkbox"/> Female							
Education	<input type="checkbox"/> Elementary <input type="checkbox"/> Intermediate							
	<input type="checkbox"/> Secondary <input type="checkbox"/> Bachelor and above							
Monthly income	<input type="checkbox"/> <5 Thousands <input type="checkbox"/> 5-15 Thousands							
	<input type="checkbox"/> >15 Thousands							
Intensity	Buccal				Lingual			
	D	B	M	G	D	B	M	G
#11								
#12								
#21								
#22								
#31								
#32								
#41								
#42								
Extensity	Buccal				Lingual			
	D	B	M	G	D	B	M	G
#11								
#12								
#21								
#22								
#31								
#32								
#41								
#42								



(Fig 2-3) The clinical sheet that was used in the recording
Fig. 2 &3. Clinical analysis of Lingual/palatal code surfaces

Table 1. Frequency distribution of the study variables (n=84)

Variables		n	%
Age	18-32yrs	64	76.2%
	33-46yrs	17	20.2%
	47-60	3	3.6%
Gender	Male	50	59.5%
	Female	34	40.5%
Education	Elementary	2	2.4%
	Intermediate	15	17.9%
	Secondary	33	39.3%
	University	34	40.5%
Income (SAR)	Less than 5000	54	64.3%
	5000-15000	27	32.1%
	Above 15000	3	3.6%
Decayed teeth	Absent	5	6.0%
	Present	79	94.0%
Missing teeth	Absent	48	57.1%
	Present	36	42.9%
Restored teeth	Absent	27	32.1%
	Present	57	67.9%
Endodontically treated teeth	Absent	53	63.1%
	Present	31	36.9%
Number of crowns	Absent	64	76.2%
	Present	20	23.8%
Mean Decayed teeth (SD)		6.63 (0.46)	
Mean Missing teeth (SD)		1.18 (0.22)	
Restored teeth mean (SD)		2.76 (0.34)	
Endodontically treated teeth		1.00 (0.20)	
Crowns mean (SD)		0.45 (0.10)	
Stain intensity mean (SD)		0.78 (0.06)	
Stain extensity mean (SD)		0.31 (0.05)	
Stain composite score mean (SD)		0.44 (0.08)	

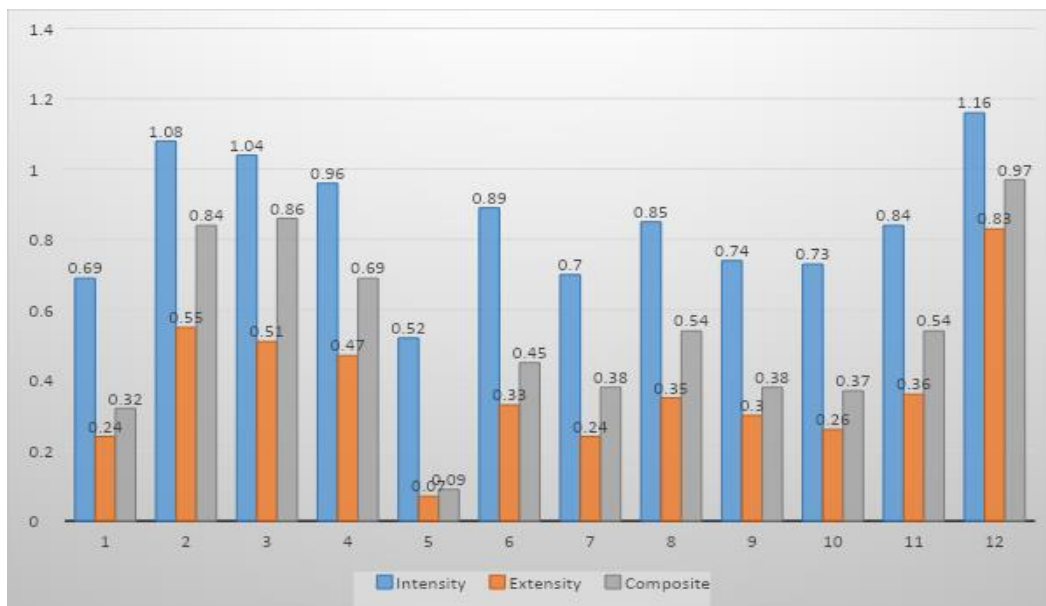


Fig. 4. Distribution of mean intensity, extensity and composite stain scores

Table 2. Comparison of stain intensity, extensity and composite score between different variables

Variables		Intensity			Extensity			Composite scores		
		Mean	SE	P	Mean	SE	P	Mean	SE	P
Age ^b	18-32yrs	0.69	.06	0.039	0.24	.05	0.009	.32	.08	0.006
	33-46yrs	1.08	.14		0.55	.12		.84	.23	
	47-60	1.04	.47		0.51	.38		.86	.70	
Gender ^a	Male	.96	.08	0.000	0.47	.07	0.000	.69	.12	0.000
	Female	.52	.06		0.07	.04		.09	.07	
Education ^b	Elementary	.89	.48	.788	0.33	.33	.721	.45	.45	.715
	Intermediate	.70	.15		0.24	.11		.38	.20	
	Secondary	.85	.10		0.35	.08		.54	.15	
	University	.74	.08		0.30	.07		.38	.12	
Income ^b (SAR)	Less than 5000	.73	.07	.187	0.26	.05	0.040	.37	.10	.051
	5000-15000	.84	.11		0.36	.09		.54	.17	
	Above 15000	1.16	.05		0.83	.28		.97	.35	

a= Mann-Whitney U test, b= Kruskal-Wallis test

Table 3. Spearman's correlation test

Variables	Correlation	Intensity	Extensity	Composite S
Decayed	Correlation Coefficient	-.090	-.060	-.081
	Sig. (2-tailed)	.413	.586	.464
	N	84	84	84
Missing	Correlation Coefficient	.009	-.024	-.009
	Sig. (2-tailed)	.936	.832	.937
	N	84	84	84
Restored	Correlation Coefficient	-.037	-.077	-.072
	Sig. (2-tailed)	.740	.487	.514
	N	84	84	84
Number of endodontically treated teeth	Correlation Coefficient	.269*	.105	.130
	Sig. (2-tailed)	.013	.344	.239
	N	84	84	84
Number of crowns	Correlation Coefficient	.214	.144	.164
	Sig. (2-tailed)	0.050	.191	.136
	N	84	84	84

Age was seen as to be statistically significant with the Intensity, extensity and composite scores ($p < 0.05$). When stain intensity was compared between male vs. female [0.96(0.08) vs. .52 (.06) participants a statistically significant difference was observed ($p = 0.000$). Similarly, male's vs female showed significant differences in stain extensity [0.47(0.07) vs. 0.07 (.04)] ($p = 0.000$) and composite [0.69 (0.12) vs. .09 (0.07)] ($p = 0.000$) scores. Only stain extensity score showed significant difference ($p = 0.040$) across different income groups. On the contrary, stain intensity, extensity and composite scores did not differ significantly across various educational levels, as shown in (Table 2).

Spearman's correlation test was performed to evaluate the correlation between stain intensity, extensity and composite scores with decayed, missing, restored teeth, number of endodontically treated teeth and number of crowns. The number of endodontically treated teeth showed significantly positive correlation with the stain intensity ($r = 0.269$, $p = 0.013$). On the contrary, none of the variables showed significant correlation with stain intensity, extensity, and composite score.

4. DISCUSSION

Dark stains are still not fully understood in dentistry. There are lot of previous studies trying to explain these stains, and trying to find a link or correlation between teeth stains and multiple factors, including caries prevalence, bacterial toxins, chromogenic microorganisms, genetics, dietary habits, and substance abuse. Although some studies have shown an existing correlation, it wasn't fully proven on a scientific basis.

In this current study, as is concurrent with previous studies, a correlation was found between the patient decayed teeth number and stains; nevertheless, this relation wasn't statistically significant. A possible explanation is that poor oral hygiene and patient's negligence in taking proper oral care would naturally increase the bacterial and diet depositions on teeth surfaces, increasing the likelihood of developing stains, and on the other hand, the carious activity would increase as well due to the same reason.

Thomson et al. showed increased oral hygiene negligence among young adults, especially males [26,27]. That is in concurrence with the current study where participants aged 18 to 32 years old and mostly males had the highest intensity and extensity among other age groups.

In addition to that, it was found that university educated participants had a higher prevalence of dark stains when compared to others with lower education. A most likely explanation is that university students consume high amounts of coffee while studying. Coffee is a recognized staining source, and would increase the susceptibility of stains among individuals from this particular group of people [28-30].

Age and gender in the present study was significantly associated with stains but not the dental caries, the same results have been reported by Shmuly T et al and Parnas L et al, where they concluded that those youngsters who have more stains have less dental caries.

The results of the present study should be viewed in the light of its limitations. The sample size in the present study might not be representative of the entire population, moreover the study was confined to one geographic region and hence the external validity of the study could not be generated [31,32]. The history given by the study participants sometimes can't be correct, owing to the memory bias, if the event was not significant. Still the study gives important information regarding the external stains and its prevalence among untreated teeth and endodontically treated teeth. Further longitudinal, multi-centric studies with more sample size are warranted for better results and conclusions.

5. CONCLUSION

Although dark stains couldn't be verified as a significant factor in caries reduction, a link between the prevalence of both conditions was seen in this current study. Endodontically treated teeth had a statistically significant link between its number increase and the extent and intensity of stains. More investigations are recommended to gain more understanding about the correlations of dark stains.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

The ethical clearance to conduct the study was obtained from the ethical review board of Riyadh

Elm University with IRB proposal number RC/IRB/2018/1173.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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