

FACTORS AFFECTING FAILURE IN SHADE SELECTION OF RESTORATIONS; A CROSS-SECTIONAL STUDY AMONG RIYADH-BASED DENTISTS

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ABSTRACT

The most important and difficult part of restorative dentistry is matching the teeth to their natural shade. The wrong colors have ruined many restorations. The goal at this stage is to create visually acceptable restorations and match the patient's existing dentition as closely as possible. The aim of the study was to determine the awareness of Saudi dentists towards the factors associated with failure in shade selection. The online questionnaire was constructed consisting of questions related to demographic data followed by questions including factors associated with failure in shade selection. Collected data were analyzed using SPSS version 22, where descriptive as well as inferential statistics were conducted. This study revealed that 60.4% of the dentists replied that patients consider changing the restoration when shading changes and the effect of knowledge of pigment colors 79% of the dentists admitted. The results conclude that 89% of the dentists accepted that knowledge of primary, secondary, and complementary colors is essential. More research showed that specialists had a deeper understanding of the factors behind tooth color selection compared to dental students, interns, and general dentists.

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Introduction

The most important and difficult part of restorative dentistry is matching the teeth to their natural shade [1-3]. The wrong colors have ruined many restorations. When restoring or replacing the front teeth, especially with composite or ceramic materials, the final restoration's hue should resemble the tooth's natural color as closely as possible [4]. The most challenging aspect of prosthetic dentistry is finding a shade for replacement teeth that blends in with natural teeth and gums (emergence profile). The significance of color choice in aesthetic dentistry is shown by the rise in patient desire for aesthetically pleasing results, especially when it comes to tooth restoration with laminates and veneers [5].

The human brain can see and interpret a wide range of hues and shades in real teeth because it is polychromatic. Replicating a tooth's natural features in a lab isn't always easy. The dentist has to have an eye for aesthetics to distinguish between slight

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differences in each tooth. It's clear that this therapeutic decision involves more than just picking an "A" or "B" and a "1" or "2" and that it has a major impact on the ultimate aesthetic result. Hue, chroma, and value are the three dimensions that combine to produce color. Hue refers to the primary label by which an observer identifies a certain hue, such as green, red, yellow, or blue. Numbers and letters indicate colors in dentistry on resin tubes (A, B, C, and D). In dentistry, values representing the chromatic intensity (or "chroma") of colors like "light blue," "dark blue," and "royal blue" follow a crescendo-shaped scale. In terms of the dynamic dimension of the bodies, the value refers to the brightness of the color and is proportional to the quantity of existing white or black pigments [6].

Historically, dentists had difficulty making sense of, evaluating, communicating, and recreating color. Lightness or value (luminous intensity of a color), hue (color appearance or perception of an object's color, for example, red or green), and chroma (color saturation or purity) are the three properties of color that Munsell introduced in 1904. They radically altered how people thought about color [7].

Restoration processes often begin with the choice of color. The goal at this stage is to create visually acceptable restorations and match the patient's existing dentition as closely as possible. It's best to devote significant time to choosing the right shades to get the best results. A checklist and form have been developed to ensure no mistakes during the shade-choosing process. Consequently, dentists and lab technicians can better communicate, leading to more successful and visually acceptable restorations [8].

Several external elements, surroundings, the tooth's structure, layers, the dentist's aesthetic assessment, and patient considerations, all have a role in determining the final shade of restoration, as well as documented in the literature. It's a personalized evaluation that varies widely across individuals [9].

When attempting to restore a patient's smile to its original state, choosing the proper tooth color has historically proven difficult for dentists. Lighting, tooth transparency, eye tiredness, old age, and color vision impairments are some elements that might affect the final color chosen. To achieve desired aesthetic results, you must thoroughly understand the idea of shades and the procedure for selecting them. The highest aesthetic quality may be performed by focusing on these four fundamental factors: pinpoint positioning, form, surface, and color [10].

The observer's viewpoint may alter the apparent hue of an item. Perceived permeations, saturations, and colors may be affected by one's surroundings and context. Color differences between the oral setting and the shade sample may be caused by several factors, including the patient's appearance, makeup, the reflection of dental tools, and even the color of the walls. Therefore, it is recommended that the patient's makeup be removed and any dental tools that create reflection be put away to create a neutral grey backdrop before shade measuring a tooth. This will help to minimize the impact of surrounding colors and ensure an accurate shade match [11].

Even for seasoned dental professionals, picking the right tooth color is difficult when it comes time to create a restoration. Taking a patient's shade may be affected and made more difficult by several variables, including the nature and strength of the light source, the time of day and year, the angle of incidence, the patient's clothing, and the color of the operator's furnishings. The finished shade will reflect the complexity and thoroughness of the ceramic piece's planning and construction [12].

Materials and Methods

Study Hypotheses

Dentists' awareness of the factors associated with failure in shade selection is low.

Aims of the Study

To determine the awareness of Saudi dentists towards the factors associated with failure in shade selection.

Study Design

This is a cross-sectional study conducted among Saudi dental professionals using an online survey.

Study Sample

323 dentists from Riyadh city were utilized in this study.

Confidence level: 95%

Population Size: 2000

Margin of Error: 5%

Sample size: 323

Study Instrument

Online questionnaire was constructed consisting of questions related to demographic data followed by questions including factors associated with failure in shade selection. The questionnaire consisted of closed-ended questions. Consent was taken from the participants before beginning to answer the questions. Google forms were utilized as a mode of questionnaire building and distributing. Data were kept confidential and stored until its use.

Instrument Validity and Reliability

A pilot study was conducted by sending the survey to 20 participants, and the data was inserted in SPSS version 22 to

determine the reliability by using Chronbach's coefficient alpha. The validity of the questionnaire was tested by sending it to experienced researchers in REU, and changes were made according to their feedback and comments.

Statistical Analysis

Collected data were analyzed using SPSS version 22, where descriptive as well as inferential statistics were conducted. Comparisons between groups were made with the value of significance kept under 0.05. A test for normality was conducted, and the selection of statistical tests was decided depending on the normality.

Results and Discussion

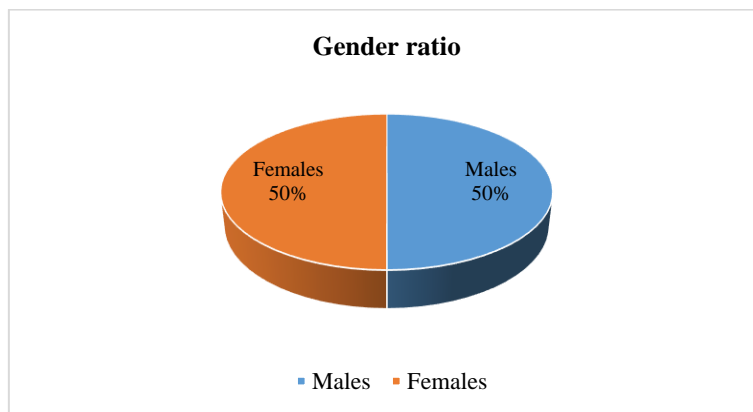


Figure 1. Gender ratio of study participants

Figure 1 represents the gender ratio of participants in the present study. In the current survey, 50% were females, and 50% of the participants were males.

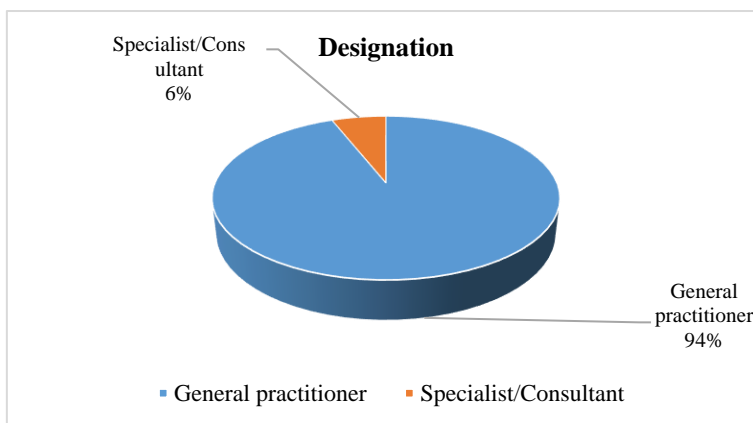


Figure 2. Designation of study participants

Figure 2 shows the designation of the participants involved in the research. The statistics show that 6% of the participants are specialists, and 94% are general practitioners.

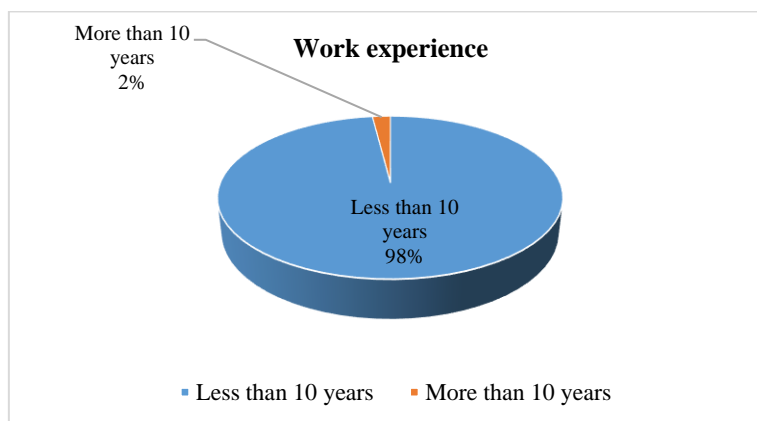


Figure 3. Work experience of study participants

The research participants' work experience can be observed in **Figure 3**. The result shows that 98 % of the participants have less than 10 years of experience and 2% have more than 10 years of experience.

Table 1. Responses to survey questions

Questions	Responses
When does the patient consider changing the restoration?	When shade changes: 60.4% Any other reason: 33.3% Never does: 6.3%
Do you use shade guides?	Yes: 81.3% No: 18.8%
Do you have an understanding of pigment colors?	Yes: 79.2% No: 20.8%
Knowledge of primary, secondary, and complementary colors is important	Yes: 89.6% No: 10.4%
Do you consider the white of the eye as a guideline?	Yes: 47.9% No: 52.1%
Do you know about mixing and matching restorative materials?	Yes: 58.3% No: 41.7%
Do you let the patient decide their shade?	Yes: 54.2% No: 45.8%

Responses to survey questions are shown in **Table 1**. The patient's response to changing the restoration tells that 60.4% of patients are those who agree when shade changes and 6.3% of the participants in the present research disclosed that patients did not consider changing the restoration. The following survey question was whether the dentists used shade guides, 81% of the participants agreed, while 18.8% of the dentists did not use shade guides. The result of other survey questions shows that 79% of dentists have knowledge about pigments, but 20.8% did not have knowledge of shade colors.

The results of other questions reveal that 89% of the dentists accepted knowledge of primary, secondary, and complementary colors, and 10.4% admitted that they did not know primary, secondary, and complementary colors. The statement was white of the eye as a guideline, and the outcome is that 58.3% agreed. 52% of the participants did not use the white of the eye as a guideline. The consequence of the talk asked question shows that 58.3% said yes to the statement about mixing and matching restorative materials, and 41% of the participants said no to the information about mixing and matching restorative materials. The important discussion asked in the survey is that patients decide their shade, and most results show that 54% of people agreed, while others did not.

The discussion of the above result shows that the debate is about dentists' awareness of shade selection during teeth restoration. Different survey questions are discussed, and other marks are evaluated, which are discussed above. Many patients have a problem with color selection, and many patients have no such problem. In the discussion about patients changing the restoration, 60.4% of patients considered changing the restoration when the shade changed, and 6.3% of the participants in the present research disclosed that patients did not consider changing the restoration.

Dos Santos *et al.* reveals that the majority (55%) of anterior restorations (recurrent caries = 54%) and almost 40% (recurrent caries = 26%) of posterior restorations were done due to caries. In both the anterior and posterior regions, the leading causes of replacements were caries and marginal breakdown/restoration fractures, accounting for 88% and 84% of replacements, respectively [13]. Dentists did not all have the same reasons for replacing a restoration, with the variations being statistically significant only for posterior restorations ($X = 23.7$, $P = .005$).

The subsequent survey question was whether the dentists used shade guides, 81% of the participants agreed, while 18.8% of the dentists did not use shade guides. The previous survey by Iqbal *et al.* reveals the participants' responses regarding their preferred technique of shade choosing [14]. Most people say they have trouble choosing the right shade of something "sometimes" or "always." Similarly, 88.3 percent of people said they rely on their eyes "always" or "sometimes" when choosing a color. After the process, more than half of the dentists choose the color. More than 90% of respondents said they occasionally or always asked patients for input when making color decisions.

Iqbal *et al.* reported that it is essential to our study to determine whether or not the participants understand the significance of the letters A, B, C, and D and the NUMERICAL 1, 2, 3, and 4 presented on the shade tab, as the Vitapan shade guide is considered the standard in dental practice among Practitioner because easy to use a system follows worldwide [14]. A numerical scale represents color from 1–4; the letters A–D represent the hue (a = reddish brown, b = reddish yellow, c = grey, and d = reddish grey). Simultaneously, the other three digits indicate the saturation and intensity of the color.

The discussion shows that knowledge and proper understanding of pigments are also fundamental. The most important argument is that many dentists are taught that knowledge of primary, secondary, and complementary colors is vital, and distinguishing them is very important. Training had a statistically significant effect on outcomes ($f = 39.340$, $P = 0.001$). For dental students, shade recognition training is especially important [15].

Analysis of variance showed that the influence of the shade guidance system and specialty training on intra-rater repeatability interacted significantly ($P = 0.0001$). When using the Vita Lumin Vacuum shade guide, prosthodontists demonstrated much stronger intra-rater repeatability than general practitioners ($P = 0.0001$, test). General practitioners'

interrater repeatability was much higher when using the Vitapan 3D-Master shade guide than when using the Vita Lumin Vacuum shade guide ($P = 0.0005$). However, prosthodontists did not show a statistically significant increase in this area ($P = .2861$) [15].

The discussion is about whether the white of the eye is a guideline. Most of them answered that they disagreed with this statement. Habib *et al.* investigated that most of the retina comprises cones sensitive to color, the central field of vision is considered the eye's most color-sensitive and color-perceptive part. Viewing the patient at eye level has been suggested by researchers so that the central retina may be utilized for color discrimination [11]. Students in the current research only seldom gave this consideration, revealing a lack of awareness of the significance of standing at the patient's eye level.

The debate about the next survey question shows that 58% of dentists know about mixing and matching restorative materials. In comparison, 47% of the participants didn't know about mixing and matching restorative materials. According to the data collected by Forss *et al.*, private practitioners asked their adult patients for input on restorative material choices in 26% of cases [16]. In contrast, their public sector counterparts only did so in 11% of cases ($P < 0.001$). Patient feedback led to a rise in the use of resin composite restorations and a fall in the use of amalgam and glass ionomer. Replacement restorations accounted for 40% of all dental work done by public dentists and 69% by private dentists ($P > 0.001$) [15].

The debate on the statement let the patient decide their shade, and the survey showed that 45% of the participants did not let the patients choose their teeth shade, and 54.2% agreed. It means most people agree with the statement. Previous research by Habib *et al.* found that inspecting prosthodontists were much less happy with the shade match than patients [11]. Compared to the prosthodontist's opinion, patients were far more likely to judge restorations as having a good shade match and much less likely to rate them as having a poor shade match. There is crucial therapeutic importance to this variation in satisfaction ratings.

The present survey displays that about half of the dentists in the study said they always or almost always ask their assistants for advice before making any major decisions. Patients are more likely to be happy with the chosen shade, and the dentist will save time and money by not having to repair or adjust the restoration if they confer with their assistants about it before treatment begins. Female dentists were also more concerned with their patients' happiness with the chosen hue than male dentists were [17].

Research done by Habib *et al.* displays the results of a statistical comparison of the participants' education and experience [11]. The results demonstrate that the specialized group's replies significantly differed from the other groups' replies ($p < .05$). However, there were no statistically significant differences ($p > .05$) between the general dentists, interns, and students.

Conclusion

The primary study shows that the factors that affect the restoration are pigments, shade changing, knowledge of primary, secondary and tertiary color, white eye as a guideline, and restorative materials. This study concluded that 60.4% of the dentists replied that patients consider changing the restoration when shading changes, and the effect of knowledge of pigment colors 79% of the dentists admitted. The results conclude that 89% of the dentists accepted that knowledge of primary, secondary, and complementary colors is important. The research cleared that 47% of the participants considered white of the eye as a guideline. In the present survey, it is observed that 58% of dentists know about mixing and matching restorative materials. The result showed that 54% of the dentists let the patient decide their shade.

Because dentists are enthusiastic about attending training sessions in this field because accurate, persistent, and continuous learning in color science and the manner of selection and match of teeth shade between restorative materials and original teeth enhance the quality of aesthetic dental services to boost patient happiness, it is recommended that education, health, and treatment policies emphasize such training.

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Ethics statement: This study fulfills the ethical requirements of Riyadh Elm University.

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