

Shade Matching Ability and Repeatability among Dental Students and the Related Effective Factors

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Article info

Received: 18 June, 2024

Accepted: 13 August, 2024

Published: 21 December, 2024

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Abstract

Background and objectives: Choosing the wrong shade is a common reason for the failure of prosthetic treatments. Shade selection ability varies from person to person and in different situations. The current study aimed to evaluate tooth shade selection ability and repeatability among dental students in the School of Dentistry, Zahedan University of Medical Sciences and to assess the effect of gender, academic year, and wearing eyeglasses, or contact lenses on shade perception.

Materials and methods: In this cross-sectional study, each student selected the shades of mid-cervical and mid-incisal parts of the maxillary canine tooth of a patient using the Vita Classical shade guide (Vita zahnfabrikBad, Säckingen, Germany) and their ability was evaluated as poor, moderate, or good. After one month, the shade selection was repeated for the same patients to examine shade selection repeatability. The Chi-square and Fisher's exact tests were applied to analyze the data ($P < 0.05$).

Results: The final sample consisted of 60 students: 28 sixth-year students (12 males, 16 females) and 32 fifth-year students (12 males, 20 females). It was observed that 75% and 25% of the students had poor and moderate shade selection abilities, respectively. None of the participants showed good ability. Intra-rater repeatability was 10%. There was no statistically significant association between shade-selection ability with any of the variables of shade-selection repeatability ($P = 0.16$), gender ($P = 0.22$), academic year ($P = 0.07$), and the use of eyeglasses ($P = 0.48$) or contact lenses ($P = 1.00$).

Conclusion: Considering the poor shade selection ability and repeatability among dental students in Zahedan City, actions should be taken to develop educational interventions concerning shade selection. Gender, academic year, and wearing eyeglasses or contact lenses did not have a significant effect on shade perception.

Keywords: Clinical competence; Dental students; Prosthodontics; Shade matching.

Please cite this paper as:

Ebrahimi N, Yaghoobi N, Mostafavi AS. Shade Matching Ability and Repeatability among Dental Students and the Related Effective Factors. Journal of "Regeneration, Reconstruction & Restoration" (Triple R). 2024; Volume 9: e13. Doi: 10.22037/rrr.v9.45602

1. Introduction

An aesthetic restoration should bring suitable biological, morphologic, and optical features to satisfy patients (1). Teeth are polychromatic and the characteristics related to

hue, chroma, and value differ between different layers of a tooth. In addition to intrinsic and extrinsic colorations, the color of adjacent teeth, the materials used as core, and the luting agent affect the tooth color. Therefore, matching the color of a tooth with dental materials is

quite a challenge (2). Choosing the wrong shade is the second most common reason for the failure of prosthetic treatments (3).

Visual shade matching is routinely performed as a chairside procedure and is more economical and easily available. This method brings some subjective and objective errors but it can be improved by increasing the knowledge of shade matching, clinical experience, and training (4). It is also affected by some variables such as optical conditions, shade-guide characteristics, age, sex, eye fatigue, color blindness, metamerism and tooth characteristics, and the light source (5-8). Instrumental method, particularly the spectrophotometer, is more accurate. The main problem with the instrumental method is that it is expensive and dentists may not be able to afford it (4). It has been reported that the knowledge of shade selection is more important than the type of device (9).

Concerning visual method, different shade guides are used for tooth shade selection. Each shade guide includes some color standards that mimic the color of natural teeth (10). Although a shade guide cannot represent the full spectrum of colors in natural teeth, it is believed that the difference between the natural colors of a tooth with the most similar color sample is not distinguishable to the human eye (11). Vita Classical shade guide (Vita Zahnfabrik, Bad Sackingen, and Germany) is widely used among dentists in Iran (12). In this shade guide, shades are categorized into four groups (A, B, C, D) according to three color properties introduced by Munsell which are hue, chroma, and value (13,14).

The ability for shade selection varies from person to person and in different situations (15). Previous studies have shown dissimilar results regarding shade-selection ability and repeatability in different populations and settings (12,15-21). Some studies have shown no significant difference in shade selection between people in terms of gender (16, 17, 22), while others have concluded that women are more capable of selecting the right shade (23,24). Also, the results of the previous studies about the effect of clinical experience on color selection are contradictory (15-18,22,23,25-28).

The current study aimed to assess tooth shade selection ability and repeatability among dental students and to evaluate the influence of gender, academic years spent, and wearing eyeglasses or contact lenses on shade selection ability. The null hypotheses to be tested were as follows: 1) Dental students show good ability and repeatability in shade selection on average, 2) Gender significantly affects shade selection ability, 3) The

student's academic year, repeatability status, and wearing eyeglasses or contact lenses are not factors that significantly affect shade perception.

2. Materials and methods

The sample size was calculated by using PASS software; power and type one error was set equal to 90% and 0.05, respectively. The effect size was set to 0.5. The minimum required sample size was calculated to be 51. Considering a 20% loss to follow-up in the repeatability stage, the final sample size was estimated to be 61 students. In this descriptive-analytical study, 61 Zahedan University of Medical Sciences dental students were randomly selected. The inclusion criteria were as follows: the participants must be sixth-year or fifth-year students who had passed practical courses in fixed prosthodontics and have the desire to participate in the study. The exclusion criteria consisted of those who were unwilling to participate or who had color blindness according to the Ishihara test. To eliminate possible errors caused by color vision impairment, the color blindness test (Ishihara test) was taken from the students before the shade selection process.

One week before shade selection, students were given an instructional booklet about choosing the right shade using the Vita Classical shade guide tab. Ten volunteer patients were selected for the shade selection process. All the patients had maxillary right canine teeth with no restorations or caries. Patients' teeth were polished before shade selection to remove existing stains. Shade selection was performed in the Prosthodontics department of Zahedan Dental School in daylight (6500°K) with the window of the room facing north and between 10 and 12 noon. The color of the walls and ceiling was neutral gray. Patients' lipstick was removed before the procedure. The patients were positioned in the dental chairs in a way that their teeth were at the level of the operator's eye and the operator stood directly in front of the patients. The distance from the oral cavity was between 60 cm to 1 meter which is considered suitable (4). Using the VitaClassical shade guide system, each student selected the shades of mid-cervical and mid-incisal areas of the maxillary right canine tooth of one patient. The canine has the highest chroma for the dominant hue of the natural dentition, therefore it's better to use canine teeth for shade comparison (29). There was no time limit on the evaluation but the participants were warned about the possibility of eye fatigue if they stayed fixed on the teeth. If the selected shades of both areas of the tooth were

correct, the shade selection ability was considered good. Accordingly, for the correct selection of one area, the ability was determined to be moderate and for the wrong selection of both areas, the ability was considered poor. The selected shades by the students were evaluated by the joint opinion of two specialists.

One month after shade selection, the repeatability stage of the study was performed in which the students selected the shades of the same teeth of the same patients for the second time. The shade selection was evaluated as poor, moderate, and good as before. To prevent the memory effect, the shade sample tabs were hidden in both stages and were given different numbers.

The data collection tool in this study was a two-part checklist which consisted of one part for asking the students' gender, academic year, and if they wore eyeglasses and contact lenses. The other part was designed to record the selected shades of two areas of the patient's canine teeth in both stages of the study.

Data analysis was performed using SPSS Statistics Ver. 22.0 software adopting 95% as the confidence level ($P < 0.05$) (SPSS, Chicago, IL). The Chi-square test of independence was applied to analyze the association between shade selection ability and gender or academic year. Fisher's exact test of independence was applied to analyze the association between shade selection ability and the variables of wearing eyeglasses, contact lenses, and repeatability. (The variables of shade-selection repeatability, wearing eyeglasses or contact lenses had more than zero cells with an expected count of less than 5, therefore, the chi-square test could not be applied for these variables and Fisher's exact test of independence was applied instead).

3. Results

Sixty-one students of Zahedan Dental School were randomly selected to participate in the study. All the students met the inclusion and exclusion criteria except one person who had color blindness according to the Ishihara test, therefore the student was excluded and whose data was not analyzed. The final sample consisted of 60 students: 28 sixth-year students (12 males, 16 females) and 32 fifth-year students (12 males, 20 females). Fourteen students (23.33%) wore eyeglasses and three students (5%) wore contact lenses (Table 1).

After conducting the study, no one showed good ability in shade selection; Fifteen (25%) and forty-five (75%) students showed moderate and poor ability in shade selection respectively. All 60 students participated in the repeatability stage too. Concerning repeatability, only six students (10%) were able to select the same shade for the second time. Based on the results of the Chi-Square test of independence, there was no significant association between shade- selection ability and gender ($P = 0.22$) or academic year ($P = 0.07$). According to the results of Fisher's exact test, no significant difference was found between the two groups (moderate and poor ability) concerning repeatability status ($P = 0.16$), wearing eyeglasses ($P = 0.48$), and wearing contact lenses ($P = 1.00$) (Table1).

Observed and expected counts of the Chi- square test are shown in Figure 1. As Figure 1 demonstrates the observed count for each category does not vary significantly from what would be expected if there was no association between the variables.

Table 1. Comparing the shade selection ability of students according to gender, academic year, and wearing eyeglasses or contact lenses.

		Moderate shade-selection ability (n= 15) Number (Percentage)	Poor shade-selection ability (n= 45) Number (Percentage)	Statistical values
Wearing glasses	Yes	2 (3.33%)	12 (20.00%)	P = 0.48
	No	13 (21.66%)	33 (55.00%)	
Wearing contact lenses	Yes	1 (1.66%)	2 (3.33%)	P = 1.00
	No	14 (23.33%)	43 (71.66%)	
Gender	Male	4 (6.66%)	20 (33.33%)	X ² = 1.48 P = 0.22
	Female	11 (18.33%)	25 (41.66%)	
Students 'academic year	sixth- year students	4 (6.66%)	24 (40.00%)	X ² = 3.21 P = 0.07
	fifth- year students	11 (18.33%)	21 (35.00%)	
Repeatability	Yes	3 (5.00%)	3 (5.00%)	P = 0.16
	No	12 (20.00%)	42 (70.00%)	

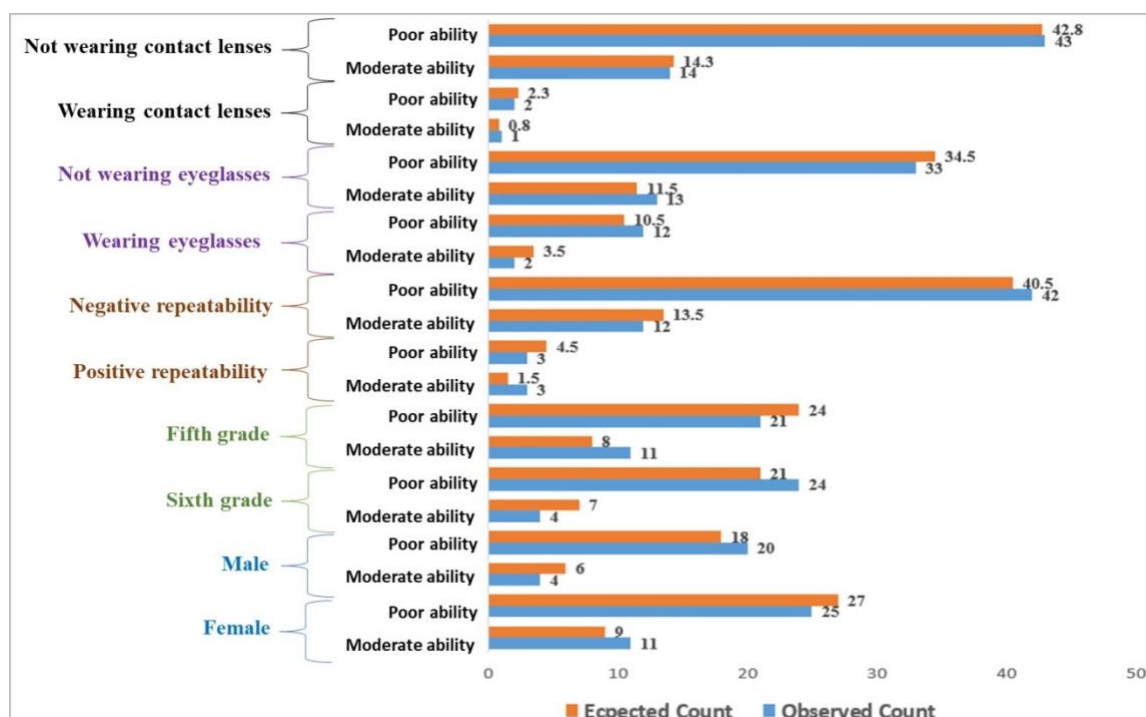


Figure 1. Bar chart showing the expected and actual counts for different variables concerning shade selection ability according to chi-square analysis (n = 60).

4. Discussion

In the current study, 75% and 25% of the students showed poor and moderate ability respectively and no one showed good ability. Other studies conducted in this field found conflicting results. Studies conducted by Aswini et al. (16), Bahannan et al. (17), and Jaju et al. (18) reported a higher percentage of shade selection ability among dental students than in the current study. Better education and training could explain higher levels of shade selection ability among dental students in these studies. Unlike the current study, in the studies conducted by Aswini et al. and Bahannan et al., students matched the shades of artificial teeth; this might be another reason for the difference between the results.

In the current study, the intra-rater repeatability was 10%. Other studies showed conflicting results; some studies showed an approximately similar repeatability percentage (19,20). Contrary to the current study, in the study reported by Hammad et al., intra-rater repeatability among general dentists and prosthodontists was 35% and 62% respectively using Vita Lumin Vacuum and Vitapan 3D-Master shade guide (21). This study demonstrated that the type of shade guide and practitioner specialty has a significant effect on the intra-rater repeatability of shade selection, which may justify the relatively high percentage of repeatability in this study compared to the current study. In Negahdari et al. study in 2015, dental students

selected the shades of Vitapan classical shade guide samples with Vita 3D master shade guide and vice versa. The color codes of samples were hidden. Shade selection was randomly repeated one week later. The repeatability percentages were 50.9% and 63% with the Vita classical and Vita 3D master respectively (12). The difference with the results of the current study could be attributed to the fact that in the Negahdari et al. study, the shades of a shade guide were matched with another guide, while the current study was conducted in real clinical settings and the color of natural teeth was matched with a shade guide. As discussed, the first null hypothesis was rejected.

Previous researchers have obtained contradictory results regarding the influence of gender on shade selection. Some similar studies were consistent with the current study, indicating that gender has no statistically significant effect on shade selection ability (12,16-18,20,22,26,27,30-33); Other studies stated a better performance in women (23,24,34,35) while some have shown that men are better (15,36). Considering the contradictory results about the role of gender in shade selection, future studies that evaluate this issue more accurately would be proposed. According to the results of this study, no significant difference was found between the two groups concerning the use of eyeglasses or contact lenses, similar to other studies conducted by Capa et al. (22,37).

In the current study. Fifth- and sixth-year dental students

were involved. No significant difference in shade perception was found between students of different academic years. The studies reported by Bahannan et al., Jaju et al., and Garg et al. showed that there was no significant difference in shade perception between dental students with dissimilar levels of clinical experience (17,18,28), conforming to the current results; Although in Jaju's study, the rate of correct responses for complex clinical cases increased from first year to the fourth year (18). In contrast, some other studies found that the level of clinical experience has a significant effect on shade selection in dental students (25,26). One study reported that student's educational level does not have an association with shade selection knowledge but it has a significant effect on the clinical practice of shade matching (26). In the study reported by Miranda et al., undergraduate and postgraduate dental students matched 16 pairs of ceramic discs according to shades. The risk of wrong answers was 23.08% among the postgraduates and 38.02% among the undergraduates, indicating a significant difference (15). In contrast to Miranda et al. study, all the participants in the current study were undergraduates and the two groups differed by only one academic year; therefore, considering the results of Miranda et al. study it can be concluded that the difference in the experience level of the two groups in the current study might not have been large enough to affect the shade selection quality significantly. As discussed, the third null hypothesis was accepted.

The results of the previous studies regarding shade-selection ability, repeatability, and the related effective factors, particularly gender, were contradictory. The authors suggest that further research should be done in this area in other populations in Iran. High-quality systematic reviews and meta-analyses are suggested. The more articles in this field, the higher the statistical power of their meta-analysis.

5. Limitations

In the present study, the selected shades by the students were evaluated by the joint opinion of two calibrated specialists. One of the limitations of the current study was that the operators might have chosen the wrong shade for a patient although they were calibrated and had expertise in this field. A spectrophotometer was not available due to a lack of facilities. The results of the current study should be considered in light of its limitations.

6. Conclusion

On average, Shade selection ability and repeatability was poor among dental students of Zahedan Dental School. Gender, academic year, and wearing eyeglasses or contact lenses did not have a significant effect on shade perception.

Acknowledgements

None.

Ethics

It is worth mentioning that informed consent was obtained from all the students and the patients who participated in the study. The identity of the participants was kept confidential. The study was reviewed and approved by the institutional board and the Ethics Committee of Zahedan University of Medical Sciences. (Ethical code: IR.ZAUMS.REC.1391.5737).

Author contributions

Negar Ebrahimi: Writing- Original draft, Visualization, Data curation, Investigation, Formal analysis.

Negin Yaghoobi: Writing- Review & editing, Investigation.

Azam Sadat Mostafavi: Supervision, Project administration, Resources, Conceptualization, Methodology.

Conflict of interest

The authors declare no conflicts of interest.

Funding

None.

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