

Perception and Practice of shade selection principles among Post graduates and Dental practitioners in India: A cross sectional survey

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Abstract

Objectives

Main purpose of present survey is to analyze the perception and practice of shade selection principles among postgraduates and dental practitioners in India.

Methods

A well-formulated questionnaire consisting a total of 25 questions was disseminated among the postgraduates (Conservative dentistry and Endodontics, Prosthodontics, Pedodontics) general practitioners, specialist practitioners (Conservative dentistry and Endodontics, Prosthodontics, Pedodontics). The questionnaire includes knowledge and practice about shade selection principles and techniques. A total of 530 replies were accepted over google forms. Responses were obtained from 266 postgraduates, 176 specialist practitioners, 88 general practitioners. Data was analyzed in SPSS V25. Descriptive statistics were represented with percentages. Chi-square test, Fisher Exact test were utilized to find the association between level of knowledge and level of practice with demographic variables. ($P < 0.05$)

Results

Among 530 respondents, 412(77.7%) have poor/average knowledge and 118(22.3%) have good knowledge of shade matching principles. 418(78.9%) respondents utilized poor/average practices on shade matching. 112(21.1%) respondents utilized good methods of practice on shade selection.

Conclusion

Amongst specialist practitioners, postgraduates, and general practitioners, the specialist practitioners had satisfactory knowledge and practices on shade selection. Knowledge and practice regarding the shade matching principles among the dentists were not adequate and CDE programs on principles of shade analysis are recommended to regularly update the knowledge among the dental practitioners.

Clinical Relevance

Knowledge and practice regarding the shade matching principles play pivotal role for success of esthetic restorations.

Introduction

Shade matching in dentistry is perplexing and comprises both visceral and objective phenomena.^[1] Color perception is claimed to be associated with factors involving visceral and emotional senses. It is a consolidation of physical perception which includes a wavelength of light, psychophysical recognition which encompasses the recognition of light wavelength by the eye, and psychologic perception which

includes discernment of light wavelength by the brain.^[2] Cones and rods on the retina are responsible for the recognition of color, lightness, and darkness. Recognized wavelengths are then delivered as signals to the brain which decipher the signals into colors.^[3] According to Albert Munsell, color is measured by hue, value, and chroma.^[4] Hue is the interpretation of one color from another. Value is that quality by which we segregate a light color from a dark color.^[5] "Low" values describe dark colors; "high" values describe light colors. Chroma is the degree of intensity of the color tone (hue).^[6] Accompanying the above measurements, translucency should be added which is a decisive factor for the esthetic outcome for dental restorations. As the incisal edges of human teeth are translucent, the meticulous scrutiny and reproduction of translucency are vital for their natural appearance.^[6]

Well-trained general practitioners and specialist practitioners can generally identify correctly value and hue when presented separately. However, difficulties arise when they are coupled together, resulting in disagreement in value determinations in the selection of shade for esthetic restorations. Several factors influence the individual's color perception and evaluation including, clinical lighting conditions, availability of natural light, color blindness, eye fatigue, age of the individual, binocular differences, timing and method of shade matching, surrounding environment, condition of the tooth, patients opinion and patients skin texture.^[7-9] But, even in the absence of the above factors, each individual will depict the color individually based on his/her past experiences in color conception during shade analysis. Hence meticulous training and education on color perception and shade selection principles should be the principal step that results in the predictable esthetic outcome of dental restorations.^[10] There is scarcity of literature regarding the color perception and shade selection principles in Indian context. Hence, the present survey aimed to evaluate the same among the general practitioners, specialist practitioners and postgraduate students in India.

Materials And Methods

This cross-sectional survey was systematically conducted in the month of August 2021 and the study got approved by the institutional ethical committee (Pr.55/IEC/SIBAR/2021). A well-structured questionnaire with various options was prepared and every question marked as obligatory was distributed using simple random sampling. A total of 25 questions began with an introductory revelation of the objective of the survey and emphasized the anonymity of each participant. [Table 1], [Table 2], [Table 3], [Table 4].

A total of 530 replies were accepted over google forms. Responses were obtained from 266 postgraduates (Conservative dentistry and Endodontics, Prosthodontics, Pedodontics), 176 specialist practitioners (Conservative dentistry and Endodontics, Prosthodontics, Pedodontics), 88 general practitioners. Inclusion criteria for the participants included being postgraduates from departments of conservative dentistry and endodontics, Prosthodontics, and Pedodontics, general practitioners, and specialist practitioners from departments of conservative dentistry and endodontics, Prosthodontics, and Pedodontics, who perform esthetic procedures on a routine basis after taking consent. To check the validity of the questionnaire, they were sent to 20 experienced dental practitioners. Sociodemographic

and professional components of the respondents were collected. The questionnaire evaluated knowledge and practice regarding color perception and techniques of shade selection.

Statistical analysis

Data were documented in MS-Excel and scrutinized in SPSS V25. Descriptive statistics were described with percentages. Chi-square test, Fisher Exact test were applied to find the association between level of knowledge and demographic variables, level of practice and demographic variables. $P < 0.05$ was considered statistically significant.

Results

A total of 530 responses included 266 (50.2%) postgraduates, 176 (33.2%) specialist practitioners and 88 (16.6%) general practitioners. Most of the participants were aged between 20–30 years (352, 66.4%). The greater part of them was female (320, 60.4%) [Table 1].

Among 530 responses, 412(77.7%) participants have poor/average knowledge and 118(22.3%) participants have good knowledge of shade matching principles [Figure 1]. 418(78.9%) respondents utilized poor/average practices on shade matching. 112(21.1%) respondents utilized good methods of practice on shade selection [Figure 2].

Association between level of knowledge and demographic variables: [Graph 1]

A statistically significant difference ($p < 0.001$) was noticed among specialist practitioners (30.7%) postgraduates (22.2%) and general practitioners (5.7%) in terms of knowledge. No statistically significant difference was noticed in gender and among different age groups in terms of knowledge.

Association between level of practice and demographic components: [Graph 2]

Statistically, a significant difference was noticed amidst different age groups ($p = 0.03$) with 18.2%, 37.5%, and 20% having good practice principles in the age groups of 20–30, 41–50, and 51–60 years respectively. A statistically significant difference ($P < 0.001$) was remarked amidst specialist practitioners (31.8%), postgraduates (19.9%), and general practitioners (3.4%) in terms of the practice of shade principles. No statistically significant difference was remarked between gender and practice of shade principles.

Discussion

Color perception predominantly relies upon human physiology which involves the cone-shaped receptor cells. The selection of the shade ideally is done within 5–7 seconds because cone receptors in the retina undergo fatigue and become sensitive to further stimulation. 222(41.8%) respondents prefer to select the shade within 5–7 seconds. Eyes do not fixate at a single spot but rather wander the optical field continuously, especially when you are presented with two adjacent areas with different colors, resulting in

the formation of overlapping afterimages. To overcome this, break is given to the eyes by looking at neutral grey or blue backgrounds.^[11] 378(71.3%) dentists prefer to observe at neutral grey or blue cards if time extends during shade matching. In this study, 283(91.1%) dentists prefer to take patients' opinions during shade analysis and it has been recommended to take patients' opinions whenever shade selection is being made.^[11]

Precise color perception and shade analysis are achieved with a lighting intensity of 150–200 foot candles with a color temperature of 5500 kelvin.^[12] Intensity and quality of light in the operative field can be evaluated using a light meter and a color temperature meter respectively.^[11] The highest proportion of respondents 512(97.9%) felt natural daylight is the ideal source of light for shade analysis. Best color perception can be achieved with color corrected lighting tubes with D 55 illuminants which produce the closest depiction to the natural sunlight.^[13] 409 (77.1%) dentists prefer to perform shade matching at 10 am to 2 pm which is the best time to perform shade matching. Use of dental chair light and incandescent bulbs is not recommended in the shade analysis because of a greater amount of yellow light eminence.^[11]

Perception of color is affected by the surrounding environment including relative lightness, color, and saturation. Contrast effects are optical phenomena that can significantly modify color conception.^[11] For best shade analysis, it is preferred to select the lighter shades for patients with lighter tones and vice versa to prevent the effects of value contrast effect.^[14] In the present study, 437(82.4%) respondents felt that the surrounding environment have a profound effect during shade analysis. It has been recommended to remove the cosmetics that are applied on the lips, as they affect the perception of the color during shade analysis.

391(73.7%) participants prefer to maintain a distance of 25-35cm at the time of shade analysis. Tooth close to the viewer will appear larger and lighter and posterior teeth turn up darker. Hence, a 25 cm distance should be maintained from the patient's mouth to obtain a stable result.^[11]

In the current study, 367(69.2%) respondents practice shade matching by placing the shade tabs adjacent to the tooth to be matched. When two objects are placed adjacent to each other with uniform illumination, a binocular color discrepancy occurs, i.e., one object turns up lighter than the adjacent object. During shade analysis, it is considered to placing the shade tabs either below or above the tooth to be matched, will helps to eradicate the binocular color discrepancy.^[11]

246(46.4%) respondents prefer to delay the shade analysis for one week after bleaching. Bleaching results in dehydration, brightening, and removal of pigmented stains between the hydroxyapatite crystals, thereby decreasing translucency and increasing the opacity of the enamel. Hence, shade analysis should be postponed for at least one month after bleaching for rehydration of enamel and to restore translucency.^[11]

180(33.9%) dentists felt that value is the most critical dimension for color perception in shade rendering. In the newly erupted teeth, the superficial enamel is highly reflective with high opacity and increased value. Underlying dentin which represents the chroma of the tooth will be lower due to the overlying young enamel. As the age increases, upper layers of the enamel are worn, the value decreases, and chroma increases due to the secondary dentin formation. Value is the important color rendering element and should be measured first.^[11]

292(55.0%) respondents prefer to do the shade analysis before the initiation of treatment. Shade analysis must be done before you turn on the dental chair light and before initiation of treatment. Rods and cones in the retina of the eye are perceptive to light and result in eye weariness and glare.^[11] 343(64.7%) dentists prefer to select the shade for each of the three distinguishing color zones gingival third, body, and incisal third. Color transitions in the surface change from one surface to another due to the difference in the thickness of enamel and dentin. To achieve the ideal color perception, the clinician must evaluate each of the three sections of the tooth, gingival, body, and incisal.^[11]

217(40.9%) respondents are not following any isolation method during shade analysis. 213(40.1%) respondents chose cotton rolls, 19(3.5%) used Teflon tape for isolation during shade analysis and 81(15.2%) used rubber dam. The dark value of the rubber dam sheet will trick the eyes into recognizing the tooth shade as being lighter. The final shade of the restoration will be too dark in consonance with the adjacent tissues.^[15] 232(43.7%) respondents prefer to dry the teeth while shade matching. Chroma and translucency decrease and value increases on dehydration of teeth. Shade analysis must be carried out after cleaning the debris and the teeth must be in moist condition.^{[16], [17]}

Most of the participants in the current study preferred to use manual shade selection over digital shade selection. Similar observations were made by Dagg et al and Alruwaili et al.^{[18], [19]}

206(38.8%) respondents felt that the shade tabs in the shade guide represent hue with increasing chroma within groups. 158(29.8%) respondents surmised that shade tabs represent hue with increasing chroma within groups or value. 56(10.5%) respondents felt that tabs in the shade guide illustrate only value. 110(20.7%) practitioners have no idea what the shade tabs in the shade guide depict. Generally, shade tabs are arranged according to the value from lightest representing high value to darkest delineating low value, hue, and chroma, depending on the design of the shade guide. Shade analysis is better executed in the order value, chroma, and hue.^[11]

269(50.7%) practitioners prefer to use VITA Classical A1-D4® shade guide, 149(28.1%) practitioners use VITA System 3-D MASTER shade guides®, 32(6.0%) practitioners use VITA Linear guide 3-D MASTER® for shade analysis. 14(2.6%) respondents practice computer-assisted shade analysis. It is advantageous to use independent shade guides for composite and ceramic restorations.^[20] 276(52.0%) respondents prefer to use separate shade guides for composite and ceramic restorations. 254(47.9%) respondents use the same shade guide for both composite and ceramic restorations.

481(90.7%) respondents have shown interest to participate in the CDE program on esthetic restorations. 150(28.3%) members have not attended any CDE program. CDE programs play a pivotal role in understanding the potential factors affecting the perception of color and principles for shade analysis thereby allowing the dental practitioners to redeem for them to attain the accurate shade analysis.^[21] Overall, specialist practitioners showed better knowledge and practice compared to postgraduates and general practitioners. This is in accordance with a study conducted among Nigerian dentists by Enone et al.^[22]

Conclusion

In comparison with postgraduates and general practitioners, the specialist practitioners had satisfactory knowledge and practices on shade selection. Most dental practitioners were not well trained in the color perception and use of shade principles due to the lack of knowledge in color science. CDE programs focusing on evidence based aesthetic dentistry, short courses on principles of shade analysis are recommended to regularly update the knowledge among dental practitioners.

Declarations

Funding declaration: No funding.

Ethics approval: Study got approved by the institutional ethical committee (Pr.55/IEC/SIBAR/2021).

Consent to participate: Consent was taken from every participant in question format (Question: I have received information about the purpose of this study and I am giving my informed consent to contribute-yes/no) in google form which was approved by institutional ethical committee.

Conflict of interest: The authors declare no competing interests.

Authors contribution:

Ram Chowdary Basam- Conception and design, acquisition of data, analysis and interpretation of data, Drafting the manuscript.

Sravanthi Tammineedi- Revising the article, analysis and interpretation of data.

Nagesh Bolla- Analysis and interpretation of data, Final approval of the manuscript.

Sayesh Vemuri- Analysis and interpretation of data, Final approval of the manuscript.

Ch.Ram sunil- Revising the article, analysis and interpretation of data.

Lakshman Chowdary Basam- Revising the article, analysis and interpretation of data.

Yamini Bandaru- Revising the article, analysis and interpretation of data.

References

1. Carsten DL. Successful shade matching: What does it take? *Compend Contin Educ Dent* 2003;24:175–8.
2. Sproull RC. Color matching in dentistry. I. The three-dimensional nature of color. *J Prosthet Dent*. 1973;29(4):416–24.
3. Lamb T, Bourriau J (eds). *Colour: Art and Science*. Cambridge, UK: Cambridge University Press, 1995.
4. Magne P, Holz J. Stratification of composite restorations: Systematic and durable replication of natural aesthetics. *Pract Periodontics Aesthet Dent* 1996;8:61–8.
5. Terry DA. Dimensions of color: Creating high-diffusion layers with composite resin. *Compend Contin Educ Dent* 2003;24 (2 Suppl):3–13.
6. Berns RS. *Billmeyer and Saltzman's Principles of Color Technology*, 4th ed. New York: John Wiley & Sons, 2000.
7. Chu SJ. The science of color and shade selection in aesthetic dentistry. *Dent Today* 2002;21(9):86–89.
8. Joiner A. Tooth color: A review of the literature. *J Dent* 2004;32 Suppl 1:3–12.
9. Jahangiri L, Reinhardt SB, Mehra RV, Matheson PB. Relationship between tooth shade value and skin color: An observational study. *J Prosthet Dent*. 2002;87(2):149–52.
10. Beltrami R, Colombo M, Chiesa M, Bianchi S, Poggio C. Scattering properties of a composite resin: Influence on color perception. *Contemp Clin Dent* 2014;5(4):501–6.
11. Stephen JC, Alessandro D, Adam M. *Fundamentals of color: shade matching and communication in esthetic dentistry*. 2nd ed. Chicago: Quintessence. 2004:28–30.
12. Chu SJ. Color. In: Gürel G (ed). *The Science and Art of Porcelain Laminate Veneers*. 1st ed. Chicago: Quintessence, 2003:158–206.
13. Barna GJ, Taylor JW, King GE, Pelleu GB Jr. The influence of selected light intensities on color perception within the color range of natural teeth. *J Prosthet Dent* 1981;46(40):450–3.
14. Albers J. *Interaction of Color*. New Haven, 50th ed. CT: Yale University Press, 1971.
15. Passon C, Lambert R. Tooth-shade shift after rubber-dam isolation. *Gen Dent*. 1994; 42(2): 148–52.
16. Russell MD, Gulfranz M, Moss BW. In vivo measurement of color changes in natural teeth. *J Oral Rehabil* 2000;27(9):786–92.
17. Alvin G. Description of color, color-replication process, and esthetics. In: Rosenstiel SF, Land MF, Fujimoto J, editors. *Contemporary Fixed Prosthodontics*. 4th ed. New Delhi: Elsevier; 2007. p. 709–39.
18. Dagg H, O'Connell B, Claffey N, Byrne D, Gorman C (2004): The influence of some different factors on the accuracy of shade selection. *J Oral Rehabil.*, 22:900–4.

19. Alruwaili MN, Alanazi AO, Albilasi RM, Alruwaili YK, Alanazi AH, Almusieb FF. Knowledge, attitude and practice of dental students, practitioners and specialist on composite shade matching in Al-jouf, KSA. *The Egyptian Journal of Hospital Medicine*. 2018 Jul 1;72(2):4017-20.
20. Stevensen B. Current methods of shade matching in dentistry: A review of the supporting literature. *Dent Update* 2009;36(5):270–6.
21. Alkhudairy R, Tashkandi E. The effectiveness of a shade–matching training program on the dentists’ ability to match teeth color. *J Esthet Restor Dent* 2017;29:E33–43.
22. Enone LL, Oyapero A, Makanjuola JO. Perception and practices with regard to tooth shade selection for composite restoration among dentists in Southwest, Nigeria. *Indian J Dent Sci* 2020;12:80–6.

Tables

Table-1: Title: Sociodemographic characteristics of dentists (n=530)

Variable	Frequency (%)
1. Age group (years)	
20-30 years	352(66.4%)
31-40 years	128(24.2%)
41-50	40(7.5%)
51-60	10(1.9%)
2. Gender	
Male	210(39.6%)
Female	320(60.4%)
3. Cadre	
Post graduates	266(50.2%)
General practitioners	88(16.6%)
Specialist practitioners	176(33.2%)

Table -2: Title : Knowledge about color perception and techniques of shade selection (n=530)

Variable	Frequency (%)
1. Best time to perform shade matching	
10 am-2pm	453(85.4%)
Any time	49(9.2%)
No idea	15(2.8%)
4pm-7pm	13(2.4%)
2. Ideal light source during shade matching?	
Natural day light	
Dental chair light	519(97.9%)
LED light	5(0.9%)
No idea	3(0.5%)
	2(0.3%)
3. Which of the following is ideal light with color temperature for shade selection?	
No idea	
5,500 kelvin	252 (47.5%)
7,500 kelvin	234(44.1%)
	44(8.3%)
4. Distance of the clinician eye to tooth while shade matching?	
25-35cm	
10 cm	391(73.7%)
No idea	93(17.5%)
	46(8.6%)
5. Which of the following plays a key role in shade matching?	
Value	180(33.9%)
Hue	174(32.8%)
Chroma	124(23.3%)
No idea	52(9.8%)

6. Do you think is it important need to take patients skin texture into consideration while shade matching?

Yes	
No idea	467(88.1%)
No	32(6.0%)
	31(5.8%)

7. What does the shade tabs A1-D4 (Example: A1, A2, B1, B2, C1, C2, D1, D2) in shade guide represents?

Represent hue with increasing chroma within groups	
Represents both hue with increasing chroma within groups or value	206(38.8%)
No idea	
Represent value	158(29.8%)
	110(20.7%)
	56(10.5%)

8. Do you think colour of the background in dental office will effect the shade selection?

Yes	
No	437(82.4%)
No idea	54(10.1%)
	39(7.3%)

Table -3: Title: Practice about color perception and techniques of shade selection (n=530)

Variable	Frequency (%)
1. Your preferred time to perform shade selection in your clinical practice?	
10 am	
Any time	
4pm	409(77.1%)
6pm	95(17.9%)
	23(4.3%)
	3(0.5%)
2. Do you think the use of the artificial light have any effect on the selection of shade?	
Yes	
No	499(94.1%)
No idea	17(3.2%)
	14(2.6%)
3. Do you take patients opinion during shade selection?	
Yes	
No	483(91.1%)
	479(8.8%)
4. Your preferred condition of the tooth while shade selection?	
Dry	
Wet	232(43.7%)
Both dry and wet	150(28.3%)
	148(27.9%)
5. Method of isolation you prefer during shade selection?	
Not following any isolation method	
Cotton rolls	217(40.9%)
Rubber dam	213(40.1%)
Teflon tape	81(15.2%)
	19(3.5%)

6. What is the method that you follow during shade selection?

Manual

Combination of both 442(83.3%)

Digital 82(15.4%)

7(1.3%)

7. Your preference of time interval for shade matching?

5-7 seconds

10 seconds 222(41.8%)

20 seconds 169(31.8%)

30 seconds 66(12.4%)

No idea 44(8.3%)

29(5.4%)

8. If the time extends for shade selection, what is the procedure you prefer?

Observe neutral grey or blue card between trails

Continue to evaluate shade

No idea 378(71.3%)

81(15.2%)

71(13.3%)

9. During manual shade selection, where do you place shade tabs?

Adjacent to the tooth to be matched

Below the tooth to be matched 367(69.2%)

Above the tooth to be matched 111(20.9%)

No idea 45(8.4%)

7(1.3%)

10. Your opinion on judgement of shade selection

More desirable to select the shade before initiation of treatment

More desirable to select both before initiation of treatment and after completion of treatment 292(55.0%)

More desirable to select the shade after completion of treatment. 183(34.5%)

	55(10.3%)
<hr/>	
11. Which procedure do you follow during shade selection?	
Shade selection at incisal third, middle third and cervical third of the tooth	
Shade selection as a single unit	343(64.7%)
No idea	
	174(32.8%)
	13(2.4%)
<hr/>	
12. If you fail to select the shade in the appointment, which of the following method you follow?	
Recall the patient	
Select the shade at try-in stage	272(51.3%)
Select randomly as A1 shade or B1 shade or any shade	216(40.7%)
	42(7.9%)
<hr/>	
13. Which of the following shade guide are you using in your routine practice?	
VITA Classical A1-D4®shade guide(manual)	
VITA System 3-D MASTER shade guides®(manual)	
No idea	269(50.7%)
VITA Linear guide 3-D MASTER®(manual)	
Automatic, Instrumental Shade Selection Techniques	149(28.1%)
	66(12.4%)
	32(6.0%)
	14(2.6%)
<hr/>	
14. Do you prefer to use separate shade guides for ceramic restorations and for composite restorations?	
Yes	
No, universal shade guide for both ceramic restorations and composite restorations.	

	276(52.0%)
	254(47.9%)
<hr/>	
15. Your opinion on waiting time for shade selection after bleaching procedures?	
1 week	
One month	
No idea	246(46.4%)
Selecting the shade immediately after bleaching procedure	159(30%)
	105(19.8%)
	20(3.7%)

Table-4: Title: Opinion of respondents on attending CDE programs

Variable	Frequency (%)
<hr/>	
1. Are you interested in attending CDE (Continuing Dental Education Program) on esthetic restorations?	
Yes	
No	481(90.7%)
	49(9.2%)
<hr/>	
2. When did you attend your last CDE (Continuing Dental Education Program) on esthetic restorations?	
Not attended any CDE program	
Last 3 months	150(28.3%)
Last 1 year	140(26.4%)
Last 2 years	91(17.1%)
Last 6 months	85(16.0%)
	64(12.0%)

Figures

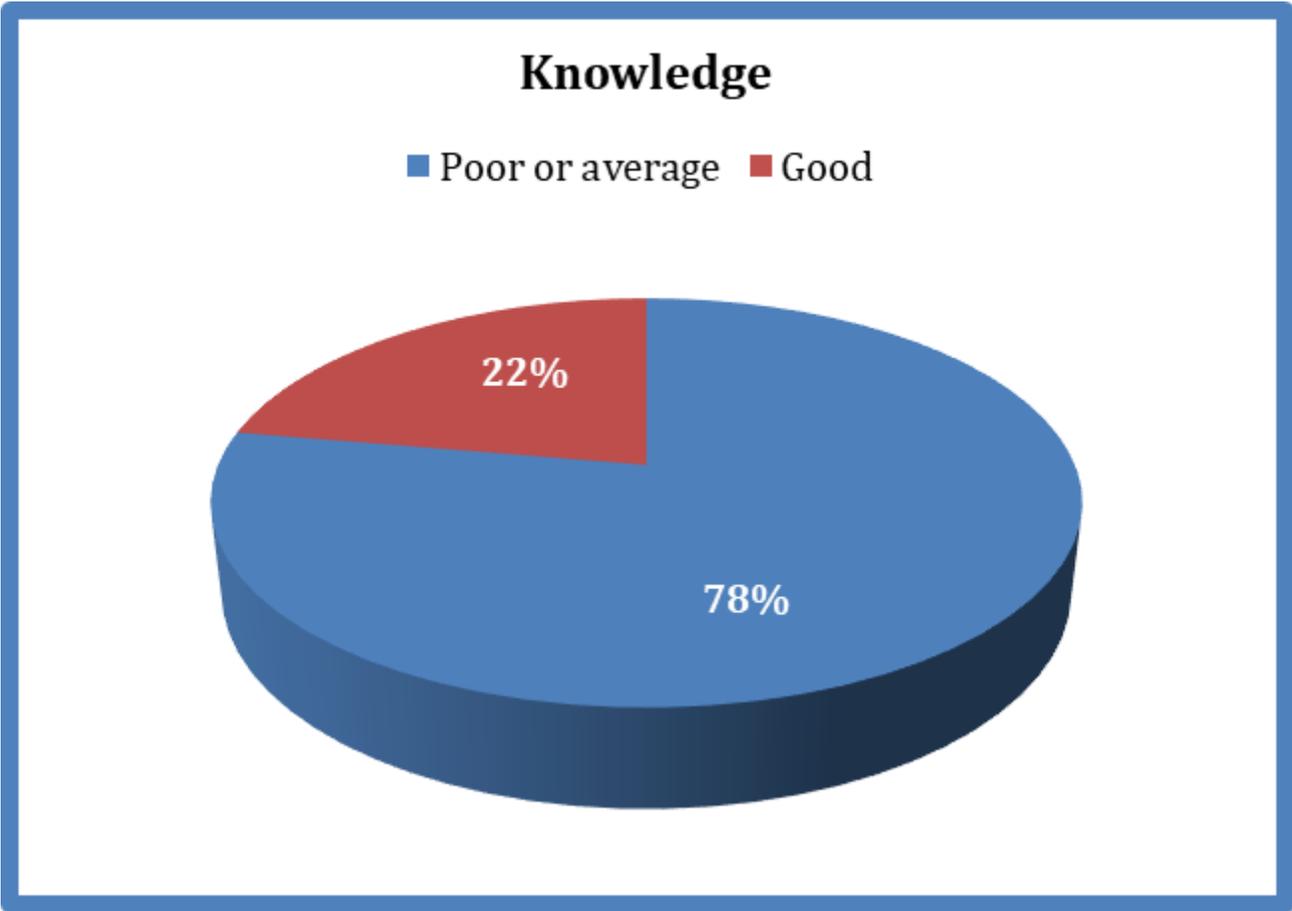


Figure 1

Level of Knowledge on shade selection

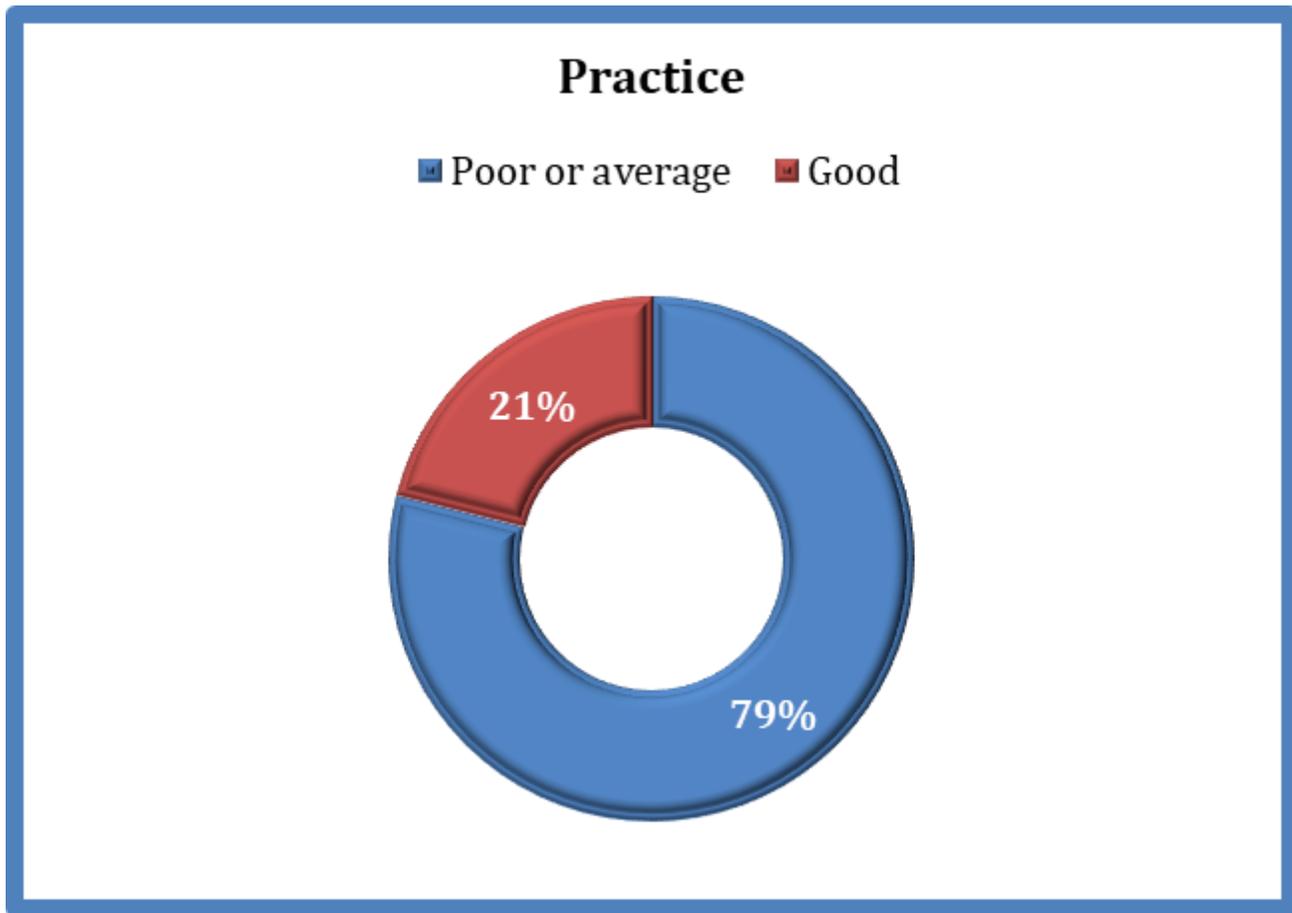


Figure 2

Level of practices on shade selection

Supplementary Files

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- [Graph1.png](#)
- [Graph2.jpeg](#)