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Knowledge, Attitude and Practice of Green Dentistry among Dental Professionals in Saudi Arabia: A Cross-sectional Study

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ABSTRACT

Introduction: Green dentistry is an evolving practice that focuses on sustainability, prevention, and a minimally invasive, patient-centric approach. It aims to preserve the environment by reducing the ecological footprint of dental practices. The most common waste products used in dental practice are amalgams from restorative materials, radiographic chemicals, plastic/paper barriers, and disinfectant solutions, all of which can adversely affect the environment and human health.

Aim of Study: Despite these pressing concerns, awareness and implementation of green dentistry among dental professionals in Saudi Arabia are lacking. This knowledge gap is particularly maximum among graduates and postgraduates, who possess limited understanding of green dentistry principles. The aim of this study was to assess the knowledge of green dentistry concepts and practices among dental professionals and identify the barriers and facilitators for promoting sustainable dental practice in the country.

Materials and Methods: This cross-sectional, questionnaire-based study conducted among 190 dental practitioners in the Kingdom of Saudi Arabia; the questionnaire was distributed online.

Results: Among the 190 respondents, the majority were male practitioners (72%), with most of them holding master's degrees (39.5%) and working as specialists (47%). The overall awareness of green dentistry was higher, and most dentists followed eco-friendly practices and proper waste disposal methods.

Conclusion: Green dentistry is a multidisciplinary approach that emphasizes efficient resource practice within dental offices, thereby reducing the impact of dental practice on the environment through the adoption of eco-friendly practices.

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Introduction

The practice of dentistry has a significant environmental impact arising from multiple factors. Some of these factors include the high electricity demand for dental equipment, large amount of water requirement, effects of biomaterials, radiation exposure, and generation of hazardous waste [1]. Dental practitioners are becoming increasingly concerned about the potential impact of dentistry on the environment. They frequently take preventive measures to reduce waste production and ensure proper waste disposal in their practices. Thus, adopting green dentistry principles offers a practical approach that will allow dental professionals to attain environmental sustainability and social responsibility in an era of growing public environmental concern and protective legislation [2].

Green dentistry is currently transforming the field of dentistry by decreasing its harmful impact on nature, promoting eco-friendly practices, and reducing waste production. Currently, recognizing the importance of eco-friendly practices in all aspects of our lives, including dental practice, is crucial, considering its huge impact on the environment. This emphasizes the thrust to move towards "green dentistry" [3].

Recently, three initiatives launched in Riyadh, the Kingdom of Saudi Arabia (KSA), aiming to contribute to environmental protection, energy transformation, and sustainability programs for a greener future. These initiatives include the Saudi Green Initiative, Youth Green Summit, and Middle East Green Initiative. The Saudi Green Initiative is a roadmap for the KSA to achieve its "VISION 2030" in protecting earth by increasing its reliance on clean energy, offsetting the impact of fossil fuels, and conserving the environment. The Middle East Green Initiative is a regional collaboration led by Saudi Arabia aimed at achieving global targets

for combating climate change by restoring land, reducing carbon emissions, and increasing renewable energy capacity [4, 5].

The present study aimed to assess the knowledge, attitude, and practices related to eco-friendly green dentistry among dental practitioners in the KSA.

Material and Methods

This cross-sectional survey conducted to determine the level of awareness of green dentistry among 190 dental practitioners across Saudi Arabia. A pilot survey done including 20 volunteer dentists to pretest the data collection methods and determine the reliability of the survey. Dentists who participated in the pilot study were excluded from the final sample. Based on their feedback, the questionnaire was modified to improve its clarity to ensure collection of correct responses and align with the study’s objectives. The study received consent and ethical approval from the institutional review board. It was conducted from November 2022 to mid-January 2023.

Study Design and Study Population: This study was designed as an observational, cross-sectional, multi-institutional questionnaire study conducted online.

Study Methods and Questionnaire: The questionnaire consisted of 17 questions regarding awareness of green dentistry and the procedures involved in implementing them, as previously published, with a few modifications to suit the study’s objectives [6]. The first part of the questionnaire was aimed at collecting demographic or professional details, and the second part focused on assessing awareness of green dentistry, its associations, strategies implemented in practice, and the practitioners’ attitude towards this concept. The collected data was verified by both researchers regularly for the reliability, uniformity, and correctness. Minimum required demographic details were also included in the questionnaire.

Inclusion Criteria: This study included dentists who were active in the clinical and academic fields, with varying levels of educational qualifications and experience.

Exclusion Criteria: Participants who declined to participate or submitted incomplete questionnaires were excluded from the study.

Ethical Considerations: This research was part of a non-funded staff research project, approved by the Scientific Research Ethics Committee of University of Taif (number: 45-018 dated, 04/09/2022). Study information with details was provided in digital format along with the questionnaire and required mandatory forms. The participation in the research was voluntary and anonymous. Those who completed and submitted the questionnaire was considered as consented to be part of the study. No monetary or non-monetary compensation was provided for participation.

Data Analysis and Statistics: The data collected were tabulated in Microsoft Excel 2016 and analyzed using SPSS (Statistical Package for Social Sciences) (version 23.0; Raleigh, North Carolina, USA). The significance level was set at 5% ($\alpha = 0.05$). Descriptive statistics (chi-square test) were used to present the results based on the responses received from the practitioners.

Results

Among the 190 respondents, 54 were graduates, 31 held board certificates, 75 held master’s degrees, and 30 were Ph.D. holders

[Table 1]. Complete demographic details, including age, sex distribution, education level, work category, sector, and experience of dental professionals, were collected. Most dentists included in the study were male practitioners (72%), held master’s degrees (39.5%), and worked as specialists (47%). Table 1 summarizes the demographic data and distribution of the dental professionals involved in the study.

Table 1: Demographic data and distribution of Dental Practitioners details

Age	Number	%
• 25-35 years	71	37.37%
• 36-45 years	63	33.16%
• Above 45 years	56	29.47%
Total	190	100.00%
Gender		
• Female	53	27.89%
• Male	137	72.11%
Total	190	100.00%
Degree		
• Bachelor	54	28.42%
• Board Certificate	31	16.32%
• Masters	75	39.47%
• PhD	30	15.79%
Total	190	100.00%
Profession		
• Consultant	42	22.11%
• General Dentist	58	30.53%
• Specialist	90	47.37%
Total	190	100.00%
Sector		
• Government primary care	36	18.95%
• Government specialty	56	29.47%
• Government-general hospital	2	1.05%
• Private- Multi speciality	10	5.26%
• Private-Group practice	5	2.63%
• University Hospital	81	42.63%
Total	190	100.00%
Experience		
• 0-5 years	61	32.11%
• 11-15 years	39	20.53%
• 6-10 years	23	12.11%
• More than 15 years	67	35.26%
Total	190	100.00%

Table 2 presents a comprehensive overview of the responses regarding the awareness, knowledge, and responsibility of dental professionals towards eco-friendly (green) dental office practices within the KSA. Overall awareness of green dentistry was higher in all groups, except for bachelor’s degree holders, and this difference was highly statistically significant ($P = 0.00001$). However, a significant proportion of dentists, other than those with Ph.D. qualifications, did not implement green dentistry practices in their clinical setting [question 2; Table 2].

Table 2: Responses to Questionnaire by Dental Practitioners

Questions	Bachelor		Board Certificate		Master	
1. Are you aware of the benefits of Green Dentistry?	No.	%	No.	%	No.	%
• No	40	74.07%	12	38.71%	26	34.67%
• Yes	14	25.93%	19	61.29%	49	65.33%
Total	54	100.00%	31	100.00%	75	100.00%
2. Do you follow Green Dentistry in your practice/clinic?						
• No	43	79.63%	15	48.39%	40	53.33%
• Yes	11	20.37%	16	51.61%	35	46.67%
Total	54	100.00%	31	100.00%	75	100.00%
3. Do you think dental practice has an impact on the environment?						
• May be	20	37.04%	12	38.71%	14	18.67%
• Yes, negative (-ve) impact	7	12.96%	4	12.90%	25	33.33%
• Yes, positive (+ve) impact	27	50.00%	15	48.39%	36	48.00%
Total	54	100.00%	31	100.00%	75	100.00%
4. How do you document patient details and medication prescriptions?						
• Digital (computer)	44	81.48%	25	80.65%	51	68.00%
• Paper (hard copy)	10	18.52%	6	19.35%	24	32.00%
Total	54	100.00%	31	100.00%	75	100.00%
5. Do you keep plants in clinics to increase oxygenation?						
• No	42	77.78%	25	80.65%	44	58.67%
• Yes	12	22.22%	6	19.35%	31	41.33%
Total	54	100.00%	31	100.00%	75	100.00%
6. What type of flooring is used in the clinic?						
• linoleum/cork	28	51.85%	11	35.48%	17	22.67%
• Polyester Berber carpet	5	9.26%	3	9.68%	11	14.67%
• Polyvinyl chloride	21	38.89%	17	54.84%	47	62.67%
Total	54	100.00%	31	100.00%	75	100.00%
7. What type of light used in the clinic?						
• LED/CFL	32	59.26%	21	67.74%	48	64.00%
• Normal light/Luminescent	22	40.74%	10	32.26%	27	36.00%
Total	54	100.00%	31	100.00%	75	100.00%
8. What type of lab coats and patient drape/cover used?						
• Disposable	46	85.19%	24	77.42%	62	82.67%
• Reusable	8	14.81%	7	22.58%	13	17.33%
Total	54	100.00%	31	100.00%	75	100.00%
9. What type of suction tips are used in the clinic?						
• Both	7	12.96%	9	29.03%	21	28.00%
• Metal	0	0.00%	1	3.23%	1	1.33%
• Plastic (Disposable)	47	87.04%	21	67.74%	53	70.67%
Total	54	100.00%	31	100.00%	75	100.00%
10. What types of cups are used for patients?						
• Biodegradable	1	1.85%	2	6.45%	10	13.33%
• Plastic	53	98.15%	27	87.10%	64	85.33%
• Reusable	0	0.00%	2	6.45%	1	1.33%
Total	54	100.00%	31	100.00%	75	100.00%
11. Which type of radiograph do you use in the clinic?						
• Both	4	7.41%	1	3.23%	11	14.67%
• Conventional	19	35.19%	0	0.00%	3	4.00%

• Digital	31	57.41%	30	96.77%	61	81.33%
Total	54	100.00%	31	100.00%	75	100.00%
12. What are common restorations done in the clinic?						
• Amalgam	2	3.70%	0	0.00%	0	0.00%
• Composite	34	62.96%	21	67.74%	54	72.00%
• GIC	17	31.48%	7	22.58%	20	26.67%
• Others	1	1.85%	3	9.68%	1	1.33%
Total	54	100.00%	31	100.00%	75	100.00%
13. How often are amalgam restorations done in the clinic?						
• Not at all	41	75.93%	23	74.19%	27	36.00%
• Rarely	11	20.37%	7	22.58%	44	58.67%
• Very often	2	3.70%	1	3.23%	4	5.33%
Total	54	100.00%	31	100.00%	75	100.00%
14. Are you aware of mercury toxicity to patients, operators, and the environment?						
• no	3	5.56%	0	0.00%	2	2.67%
• Yes	51	94.44%	31	100.00%	73	97.33%
Total	54	100.00%	31	100.00%	75	100.00%
15. Do you use water faucet sensors to reduce water wastage in the clinic?						
• No	42	77.78%	16	51.61%	32	42.67%
• Yes	12	22.22%	15	48.39%	43	57.33%
Total	54	100.00%	31	100.00%	75	100.00%
16. Do you purchase supplies in bulk packaging to reduce waste disposal?						
• No	24	44.44%	7	22.58%	14	18.67%
• Yes	30	55.56%	24	77.42%	61	81.33%
Total	54	100.00%	31	100.00%	75	100.00%
17. Do you follow proper waste disposal methods in the clinic?						
• No	8	14.81%	2	6.45%	4	5.33%
• Yes	46	85.19%	29	93.55%	71	94.67%
Total	54	100.00%	31	100.00%	75	100.00%

Most dentists followed eco-friendly green dentistry practices, including the use of digital radiographs and dental record keeping with medical prescriptions, employing light-emitting diode (LED)/compact fluorescent lamp (CFL) bulbs, opting for non-amalgam restorations, making bulk purchases to reduce waste, and following proper waste disposal methods [questions 4,7,11,12,13,14,16,17; Table 2]. However, most dentists employed non-eco-friendly practices, including with use of disposable patient drapes, lab coats, water cups at spittoons, and suction tips in their clinic or hospital [questions 8,9,10; Table 2].

A highly significant difference was observed in the awareness and adoption of green dentistry practice strategies, as presented in Table 2 ($P > 0.05$).

Discussion

Green dentistry is a practice in the field of dentistry aimed at minimizing the environmental impact of dental procedures and materials by adopting eco-friendly strategies, such as energy and water conservation, waste reduction, and use of biocompatible materials [1, 7].

A recent systematic review evaluating green dental practice and its effects revealed that only five studies have been conducted globally [8]. This study demonstrated a similar sex distribution as observed in Al-Qarni et al. study, with 72% of the participants

being male practitioners [7]. Among the 190 dental practitioners, more than 70% (Table 1) with a bachelor's degree were unaware of and did not practice green dentistry, which is consistent with the findings of Agrasuta and Nelson, who reported that 83.5% of their respondents had not heard of green dentistry [9]. However, in this study, 57% of the participants were aware of green dentistry, but only 43% of them followed it. These findings are comparable to those of a recent study, which revealed 64% of dentists are aware of green dentistry, and most of them (84.4%) have a positive attitude towards adopting it. However, nearly half of these practitioners find it difficult to switch to green dentistry [6, 10]. Moreover, Prathima et al [11], reported that only 40.6% of the dentists know about green dentistry.

In contrast, a study from Thailand demonstrated that although most (83.5%) dentists are unaware of green dentistry, they routinely practice eco-friendly dentistry by using alternatives to amalgam filling (98%), LED bulbs (91%), unplugging electronic devices when not in use (96%), employing digital radiography (78.6%), and using reusable lab coats (89%) in their daily practice [9].

The results of the present study revealed that most dentists employed digital radiographs (76.7%) and digital dental record keeping (74.2%), used LED/CFL bulbs (62.1%), adopted non-amalgam restorations, and made bulk purchases (73.7%) to reduce waste generation and follow proper waste disposal methods.

[questions 4,7,11,12,13,14,16,17; Table 2]. These findings are consistent with those of previous studies related to the use of digital radiographs, record keeping, LED sources [6, 12-14].

Another important aspect of green dentistry is the reduction of waste generation and disposal in dental practice. Green dentistry advocates the use of biodegradable, non-toxic, and mercury-free materials and products to reduce the amount and toxicity of dental waste. It also advocates the implementation of waste management protocols that ensure proper segregation, collection, storage, transportation, treatment, and disposal of dental waste in compliance with local regulations [1].

The results of the present study revealed that less than 2% of the participants chose amalgam restorations over other alternatives. In contrast, 98% of practitioners preferred non-amalgam restorations, such as glass ionomers and composites, to prevent mercury toxicity. These findings are similar to those of a previous study [13]. However, the results of Sawair et al., study are contradictory, where 76% of Jordanian general dental practitioners were reported to be using amalgam [15].

Even though, the use of amalgam restoration is not popular and not encouraged now a days, majority of dental practitioners use it in Saudi Arabia and found it safe. Whereas the patients are not aware or have slight information about the adverse effects and problems with the amalgam [16]. Promoting the use of eco-friendly practices, including the use of metal suction tips, reusable drinking cups, cloth lab coats, and patient drapes, is essential. In the present study, the use of reusable lab coats and drapes (19.4%), cups (1.6%), and suction tips (2.1%) was very low, similar to the findings of Al Shatrat et al [14]. The decreased use of these items could be due to the ease of availability or necessity for extra equipment or sanitization associated with metal suction tips and reusable cups, which require additional staff to meet the requirements and maintain good hygiene standards.

A similar study from India concluded that the younger generation dental professionals are keen to green dentistry practice. Integration and application of many innovations in green dentistry is more economical, increases productivity, reduce waste and preventing pollution [17, 18].

The practice of “green dentistry” decreases the damage to the environment and highlights the actions that are required by dental professionals. This moderately new concept is basically choosing recyclable or reusable materials and the concept of adopting digital technology is so significant.

The most important point to highlight is that the authors also believe that the recent COVID-19 pandemic outbreak may have had a significant influence on the use of plastic or disposables.

Summary and Conclusion

Efficient use of energy and water in dental clinics is one of the main aspects of green dentistry. Green dentistry is a growing trend that reflects the increasing awareness and responsibility of dental professionals towards environmental sustainability. It reduces waste and pollution; saves energy, water, and money; incorporates technological innovations; and focuses on well-being and integrative practices. This study highlighted the importance of incorporating social values, fostering community care, engaging stakeholders, reaping economic benefits, developing policies and providing leadership in transforming the concept of green dentistry into a practical reality. Furthermore, it emphasizes the essential

role of continuous education and training on the concept of green dentistry for clinical practitioners, academics and students.

Limitations: The present study’s reliance on a self-reported questionnaire survey may have introduced some inherent bias. The personal views of dental professionals are subjected to influence by individual preferences, and further studies involving larger samples may be required.

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Conflict of Interest: None. The authors declare no conflicts of interest.

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