Original Article

Knowledge, Attitude, and Practice of Dentists Regarding Green Dentistry - A cross-sectional study in Eastern Province of Kingdom of Saudi Arabia

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ABSTRACT

Objective: This study aimed to assess the knowledge, attitudes, and practices of dental practitioners regarding green dentistry in the Eastern Province of Saudi Arabia.
Study Design: Cross-sectional study
Place and Duration of Study: This study was conducted at the Department of Oral and Maxillofacial Surgery and Diagnostic Sciences, King Faisal University, Al-Ahsa, Kingdom of Saudi Arabia from 22.05.2023 to 21.05.2024.
Methods: A cross-sectional survey was conducted with 140 dental practitioners using a self-administered, 13-item questionnaire distributed via WhatsApp and email. Data were analyzed using SPSS (version 21), with a significance level set at $p < 0.05$.
Results: The results revealed that 92.14% of participants were aware of the concepts in green dentistry. Surprisingly, despite the high level of awareness, environmentally harmful practices, including the widespread use of single-use disposables 94.29% of practitioners used disposable suction tips, and 82.86% used disposable drapes. Though digital radiography was adopted by 79.3% of respondents, sustainable practices such as water-saving faucet sensors (45.71%) and plant oxygenation (26.43%) were less implemented.
Conclusion: The study highlights a gap between awareness and the implementation of green practices in clinical settings. These findings emphasize the need for targeted educational initiatives and policy interventions to reduce disposable waste and encourage more sustainable practices in dental clinics.
Key Words: Green Dentistry, Sustainable Dentistry, Environmental Impact, Dental Practices, Saudi Arabia

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INTRODUCTION

Environmental sustainability has become an elemental global concern, with industries across all sectors being urged to reduce their impact on the environment. In healthcare, including dentistry, there is an increasing focus on adopting sustainable practices to limit environmental harm. Environmental sustainability encompasses the preservation of global ecosystems and the prudent use of natural resources to improve societal well-being and long-term prosperity.

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Within the dental profession, actively contributing to the transition toward a green economy is a critical responsibility. By implementing sustainable development principles into routine dental practices, the profession can significantly improve public health outcomes and encourage well-being across all age groups[1]. Dentistry contributes to environmental pollution through waste generation, particularly single-use plastics, and the energy consumption required for operations[2,3]. Given the rising awareness of climate change and pollution, "green dentistry"—an approach aimed at minimizing the environmental impact of dental practices—has gained significant attention in recent years[4].

Green dentistry encompasses a range of eco-friendly practices, including reducing plastic waste, efficient energy use, and promoting sustainable materials. Such practices not only reduce the environmental footprint of dental clinics but also enhance the health and safety of patients and practitioners by minimizing exposure to harmful substances[5]. Despite the growing recognition of these benefits, the adoption of green dentistry practices remains uneven across different regions and professional groups[6,7].

In many Western countries, the adoption of sustainable dental practices has been more prevalent. Studies have reported that dental practitioners in the UK are increasingly adopting eco-friendly measures, driven by both awareness and regulatory pressures[8]. However, the situation in other regions, particularly in the Middle East and South Asia, is less clear. Research in Saudi Arabia suggests that while dental professionals are generally aware of green dentistry, actual implementation is still limited[9,10]. The barriers to adopting green dentistry in these regions include a lack of knowledge, limited availability of eco-friendly products, and the perceived high cost of sustainable practices[11,12].

Furthermore, research from Greece and India has shown that dental students and practitioners exhibit varying levels of commitment to eco-friendly practices, often influenced by their education, environmental awareness, and cultural context[13,14]. These findings underscore the importance of examining local attitudes and practices within specific regions to understand the factors that hinder or promote the adoption of green dentistry.

In Saudi Arabia, the dental profession is evolving rapidly, yet there is limited data on the specific attitudes, knowledge, and practices regarding green dentistry. Recent studies have highlighted the need for more research to evaluate the extent of sustainable practices in Saudi dental clinics and to identify the barriers preventing their adoption[9,10]. The growing environmental awareness among Saudi dental students and faculty provides a promising foundation for exploring the potential for green dentistry in the region[9].

METHODS

This study was conducted following approval from the King Faisal University Research Ethics Committee (Approval Number: KFU-ETHICS874) and adhered to the principles of the Declaration of Helsinki. All participants provided informed electronic consent prior to participating, and their confidentiality and anonymity were maintained throughout the study.

Study Design and Population: This cross-sectional survey aimed to assess the knowledge, attitudes, and practices (KAP) related to green dentistry among dental practitioners in the Eastern Province of the Kingdom of Saudi Arabia. The target population included licensed dentists actively engaged in clinical practice within the region.

Data Collection Tool: A structured, closed-ended questionnaire consisting of 13 questions was developed in English based on a thorough review of relevant literature. The questions were designed to evaluate three domains:

Knowledge: Awareness and understanding of green dentistry concepts.

Attitudes: Perceptions and beliefs about the importance of environmentally sustainable dental practices.

Practices: Adoption of eco-friendly measures in dental clinics.

Pilot Study and Validation: A pilot study was conducted with 15 dental practitioners to assess the clarity, reliability, and validity of the questionnaire. Based on feedback and consultations with experts in statistics and epidemiology, modifications were made to improve the instrument. The finalized version of the questionnaire demonstrated robust internal consistency, with a Cronbach's alpha coefficient of 0.83.

Survey Administration: The finalized questionnaire was distributed electronically using Google Forms via WhatsApp and email to ensure ease of access and a broader reach. The survey introduction provided participants with a concise explanation of the study's objectives, and voluntary participation was emphasized.

Statistical Analysis: The collected data were analyzed using IBM SPSS Statistics for Windows, Version 21.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics, including frequencies and percentages, were calculated to summarize participant responses. Associations between demographic variables and KAP regarding green dentistry were evaluated using Pearson's chi-square test. A p-value of <0.05 was considered statistically significant.

This robust methodology ensured the reliability and validity of the results while maintaining ethical and scientific standards.

RESULTS

Table: 1 shows the participant's demographic information. There were 140 respondents in total, 127 were undergraduates, 11 were postgraduates and 2 PhD. Among them78% of them were male.

Table No.1: Demographic pattern of Participants

Demographic Characteristics	No. of participants	Percentage
Gender		
Male	110	78.6%
Female	30	21.4%
Total	140	100%
Qualifications		
General dentist	127	90.7%
Master's degree	11	7.9%
PhD	2	1.4%
Total	140	100%

Knowledge of Green Dentistry: The findings reveal that 92.14% of respondents were aware of the concept of green dentistry. This high level of awareness highlights the recognition of eco-friendly practices within the dental community. However, 7.86% of participants demonstrated limited understanding or were unaware of the term.

Attitudes Toward Eco-Friendly Practices: Most respondents expressed a positive attitude toward adopting environmentally friendly practices in their clinical settings. The majority agreed that integrating green dentistry is a professional obligation to reduce environmental harm. Despite these favorable attitudes, a gap was observed between their beliefs and the implementation of sustainable practices.

Current Practices in Green Dentistry:

Several eco-friendly practices were identified:

Disposable Materials: The use of single-use disposable suction tips was reported by 94.29% of respondents, and disposable drapes were used by 82.85%.

Electronic Documentation: Digital record-keeping was prevalent among practitioners, with 86.43% adopting this method.

Amalgam Use: Only 0.71% of practitioners still utilized dental amalgam, reflecting a shift toward alternative materials.

Digital Radiography: Approximately 79.3% of practitioners had transitioned to digital radiography, reducing the environmental impact associated with traditional film-based radiography.

Challenges in Implementing Green Dentistry:

While practitioners demonstrated awareness and a positive attitude toward green dentistry, the widespread reliance on disposable items indicated a significant barrier to sustainable practice. Participants cited limited access to reusable and sterilizable alternatives, cost constraints, and insufficient training as key obstacles.

Statistical Analysis: The chi-square test revealed statistically significant associations between the adoption of eco-friendly practices and specific demographic factors, including the level of professional experience ($p < 0.05$). Practitioners with more than 10 years of experience were more likely to adopt digital radiography and electronic documentation, whereas younger practitioners were less reliant on disposable materials. Table: 2 further shows the participant's responses in regard to each question from the questionnaire.

Table No.2: Overall display of the participants response to the questionnaire

Questions	Answer	Qualification						Total	
		BDS/DDS		MASTERS		PHD			
1.Are you aware of the concept green dentistry	No	9	(6.43%)	2	(1.43%)	0	(0.00%)	11	(7.86%)
	Yes	118	(84.28%)	9	(6.43%)	2	(1.43%)	129	(92.14%)
Total		127	(90.71%)	11	(7.86%)	2	(1.43%)	140	(100.00%)
2.What type of light are you using in your clinic	Incandescent	45	(32.14%)	0	(0.00%)	0	(0.00%)	45	(32.14%)
	LED	82	(58.57%)	11	(7.86%)	2	(1.43%)	95	(67.86%)
Total		127	(90.71%)	11	(7.86%)	2	(1.43%)	140	(100.00%)
3.Are you using motion sensors to save electricity in your clinic	No	65	(46.43%)	5	(3.57%)	0	(0.00%)	70	(50.00%)
	Yes	62	(44.29%)	6	(4.29%)	2	(1.43%)	70	(50.00%)
Total		127	(90.71%)	11	(7.86%)	2	(1.43%)	140	(100.00%)
4.Are you using water faucet sensors in your clinic	No	66	(47.14%)	9	(6.43%)	1	(0.71%)	76	(54.29%)
	Yes	61	(43.57%)	2	(1.43%)	1	(0.71%)	64	(45.71%)
Total		127	(90.71%)	11	(7.86%)	2	(1.43%)	140	(100.00%)
5.To increase oxygenation are you growing plants in your clinic	No	91	(65.00%)	10	(7.14%)	2	(1.43%)	103	(73.57%)
	Yes	36	(24.71%)	1	(0.71%)	0	(0.00%)	37	(26.43%)
Total		127	(90.71%)	11	(7.86%)	2	(1.43%)	140	(100.00%)
6.What type radiographic technique are you using	Conventional radiographs	28	(20.00%)	1	(0.71%)	0	(0.00%)	29	(20.71%)
	Digital radiographs	99	(70.71%)	10	(7.14%)	2	(1.43%)	111	(79.29%)
Total		127	(90.71%)	11	(7.86%)	2	(1.43%)	140	(100.00%)
7.Are you aware that the solutions used in conventional X-ray film will cause environmental hazards	No	29	(20.71%)	2	(1.43%)	0	(0.00%)	31	(22.14%)
	Yes	98	(70.00%)	9	(6.43%)	2	(1.43%)	109	(77.86%)
Total		127	(90.71%)	11	(7.86%)	2	(1.43%)	140	(100.00%)
8.Are you aware about the side effects of	No	5	(3.57%)	1	(0.71%)	0	(0.00%)	6	(4.29%)
	Yes	122	(87.14%)	10	(7.14%)	2	(1.43%)	134	(95.71%)

mercury on patients									
Total		127	(90.71%)	11	(7.86%)	2	(1.43%)	140	(100.00%)
9.How do you document patient details	Computer documentation only	108	(77.14%)	11	(7.86%)	2	(1.43%)	121	(86.43%)
	Paper documentation only	19	(13.57%)	0	(0.00%)	0	(0.00%)	19	(13.57%)
Total		127	(90.71%)	11	(7.86%)	2	(1.43%)	140	(100.00%)
10.What type of drapes are you using in your clinic	Disposable	105	(75.00%)	9	(6.43%)	2	(1.43%)	116	(82.86%)
	Reusable	22	(15.71%)	2	(1.43%)	0	(0.00%)	24	(17.14%)
Total		127	(90.71%)	11	(7.86%)	2	(1.43%)	140	(100.00%)
11.What Type of suction tips are you using in your clinic	Disposable	119	(85%)	11	(7.86%)	2	(1.43%)	132	(94.29%)
	Reusable	8	(5.71%)	0	(0.00%)	0	(0.00%)	8	(5.71%)
Total		127	(90.71%)	11	(7.86%)	2	(1.43%)	140	(100.00%)
12.What types of cups are you using for patients in your clinic	Disposable	118	(84.29%)	11	(7.86%)	2	(1.43%)	131	(93.57%)
	Reusable	9	(6.43%)	0	(0.00%)	0	(0.00%)	9	(6.43%)
Total		127	(90.71%)	11	(7.86%)	2	(1.43%)	140	(100.00%)
13.What is the most common type of restorative material are you using	Amalgam	1	(0.71%)	0	(0.00%)	0	(0.00%)	1	(0.71%)
	Composite	122	(87.14%)	10	(7.14%)	2	(1.43%)	134	(95.71%)
	GIC	4	(2.86%)	1	(0.71%)	0	(0.00%)	5	(3.57%)
Total		127	(90.71%)	11	(7.86%)	2	(1.43%)	140	(100.00%)

DISCUSSION

The dental profession is intricately linked to significant environmental challenges, primarily due to the materials consumed, the waste generated, and the substantial consumption of energy and water. Dental waste, which includes lead foils, radiographic chemicals, plastic coverings, amalgam remnants, and disinfectant mixtures, frequently ends up in landfills and waterways, exacerbating environmental degradation[8,9]. Addressing this issue requires implementing sustainable practices to minimize hazardous waste. Proper use of materials, efficient resource management, and adherence to waste disposal protocols enable dental practitioners to mitigate their environmental footprint, aligning with broader goals of ecological conservation[3,6,7].

This study revealed that 78.6% of participants were male, a demographic pattern consistent with the findings of Al-Qarni et al[10] and Ammar A et al[12]. Regarding knowledge of green dentistry, 92.14% of participants demonstrated awareness, a figure substantially higher than previous studies, such as Versa et al. (74.49%)[15], Al-Qarni et al. (73.3% before an educational intervention)[10], Thakar S (48.2%)[11], Shivangi V (60.8%)[16], and Chandrasekhar P (64.4%)[17]. These findings align closely with Renuka N's study, where 90.47% of participants were aware of eco-friendly dentistry[14]. The higher awareness levels in this study may reflect increased educational efforts, accessibility to information, and rising concerns regarding environmental sustainability.

Electricity usage in dental practices contributes significantly to energy consumption, making energy conservation a critical component of green dentistry. The transition to energy-efficient LED lighting systems is a practical step in this direction, as LEDs consume less electricity than incandescent or halogen lights while being environmentally friendly. In this study, 67.86% of participants reported using LED lights, surpassing the rates observed in Versa et al. (59.18%)[15] and Ammar A et al. (62.1%)[12], though falling short of Nafiya A (76.9%)[18] and Chandrasekhar P (83.9%)[17]. Additionally, only 50% of participants utilized motion sensors to reduce electricity wastage, underscoring the need for greater adoption of advanced energy-saving technologies.

Water conservation is another pillar of green dentistry, given its extensive use in sterilization, preparation of restorative materials, and daily clinical operations. Approximately 45.71% of participants in this study employed water faucet sensors to prevent wastage, a figure consistent with Ammar A et al. (42.64%)[12] but significantly higher than Chandrasekhar P (21.8%)[17]. The integration of green spaces within clinics is also noteworthy, as 26.42% of participants reported growing

plants to improve air quality and oxygenation. This finding aligns with Ammar A et al. (22.22%)[12] but is lower than Chandrasekhar P (37.9%)[17]. Such measures not only enhance the environmental aesthetics of dental clinics but also contribute to the broader goals of sustainability.

The advent of digital radiography represents a transformative shift in dental imaging, eliminating the need for environmentally hazardous chemicals such as developers and fixers. In this study, 79.3% of participants reported using digital radiography, a rate comparable to Ammar A et al. (76.7%)[12] but significantly higher than Thakar S (48.6%)[11], Chandrasekhar P (51.7%)[17], and Nafiya A (41.3%)[18]. This trend underscores the increasing recognition of the environmental and operational benefits associated with digital technology in dental practice.

Awareness regarding the adverse effects of mercury, a key component of dental amalgam, was notably high, with 95.7% of participants acknowledging its hazards, consistent with Chandrasekhar P (94.3%)[17]. Mercury is recognized as one of the most toxic pollutants, and its use in dentistry is being progressively restricted or banned in many countries. In a study performed by Al-Nahedh HN et al, the study concludes that amalgam is widely accepted by dentists and patients in Saudi Arabia. Most dentists perceive amalgam as safe for both practitioners and patients, with its superior longevity being a key reason for preference over other materials. However, patient awareness regarding the controversies surrounding amalgam use is notably low, with many expressing neutrality or acceptance of its application in their oral health care[19]. In this study, 95.71% of participants used composite materials, 3.57% used glass ionomer cement (GIC), and only 0.71% reported using amalgam, closely aligning with Ammar A et al. (3.70%)[12]. By contrast, Versa et al. reported a significantly higher prevalence of amalgam usage (95.51%)[15]. These findings highlight the need for continued education and advocacy for the adoption of mercury-free restorative materials.

Digital patient record-keeping, another cornerstone of green dentistry, was reported by 86.43% of participants, exceeding the rates observed in Ammar A et al. (74.2%)[12], Thakar S (40.91%)[11], and Shivangi V (44.5%)[16]. This practice not only reduces paper consumption but also enhances record management, facilitating the integration of digital and tele-dentistry systems.

Infection control, a critical aspect of dental practice, saw heightened attention during the COVID-19 pandemic, with increased use of disposable items such as drapes, suction tips, and cups. In this study, 82.85% of participants used disposable drapes, 94.3% used disposable suction tips, and 93.57% used disposable cups, figures comparable to Ammar A et al. (81.76%, 75.15%, and 90.2%, respectively)[12] but higher than Chandrasekhar P (69%, 91%, and 37.9%, respectively)[17]. While disposable items contribute to infection control, their environmental impact underscores the need for balanced approaches, such as sterilizable and reusable alternatives.

CONCLUSION

Green dentistry represents a pivotal approach to minimizing environmental harm while promoting sustainable practices in the dental profession. Central to this concept is the adoption of recyclable and reusable materials, alongside the integration of digital technologies, to reduce ecological footprints. Currently, dental professionals primarily acquire knowledge of green dentistry through informal channels such as peer networks, social media, and seminars rather than structured academic training. Given the growing emphasis on environmental sustainability in the dental sector, it is imperative to incorporate green dentistry principles into the core curriculum of dental education. This will equip future practitioners with the knowledge and skills necessary to align their practices with global sustainability goals.

Author's Contribution:

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