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Article

Gender differences in knowledge and practice of eco-friendly dentistry among dental students and doctors: A study at Ajman University

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Abstract: This study investigates the awareness of environmentally friendly (green) dentistry practices among dental students and faculty at Ajman University in the United Arab Emirates. The primary objective is to assess their understanding and application of eco-friendly dental practices, including waste management, energy conservation, and sustainable material usage. Using a descriptive cross-sectional design, an online survey was administered to 231 randomly selected participants. The results show that although awareness of green dentistry has increased, its practical implementation remains limited. Specialists displayed the highest levels of knowledge and practice, while general practitioners demonstrated the least. Male participants showed greater experience and expertise compared to females, and the age group of 30–39 exhibited the highest levels of knowledge and practice, although age was not found to significantly affect awareness or usage. The findings highlight the need for enhanced education and encouragement of green dentistry to protect the environment and promote sustainable dental practices.

Keywords: eco-friendly; dentistry; green dentistry; awareness; sustainability; dental practices

1. Introduction

Since its inception, dentistry has advanced significantly, transitioning from a profession focused solely on treating patients to one that now acknowledges the wider environmental impacts of its operations. Prior to the 20th century, dentists were primarily concerned with patient care, often unaware of the potential environmental harm their methods or materials could cause (Varshney et al., 2020). However, with growing environmental concerns across various industries, dentistry has shifted toward more sustainable practices.

The term “green” has gained prominence in many fields, including dentistry, education, health, and engineering. Specifically, in dentistry, a movement known as “green dentistry” or “eco-friendly dentistry” has emerged, emphasizing resource conservation and environmental preservation alongside patient benefits. This trend aims to foster an environmentally conscious dental sector that prioritizes patient care while minimizing waste, pollution, and energy consumption. By adopting innovative technologies and methods, green dentistry also seeks to provide financial advantages (Spaveras and Antoniadou, 2023).

While dental practices are essential for oral healthcare, they contribute significantly to environmental pollution, producing biological, chemical, and heavy metal waste. Therefore, it is crucial to assess the environmental impact of materials

used in dentistry and explore biocompatible, non-toxic alternatives with lower carbon footprints (Varshney et al., 2020).

Although the dental industry is increasingly adopting eco-friendly practices, dental education institutions have yet to fully integrate these principles. It is essential for dental professionals and students to understand and apply the fundamentals of eco-friendly dentistry. This essay aims to explore the concept of green dentistry, including aspects like waste management, energy conservation, and material selection, and assess the awareness and adoption of green dentistry principles among dental students and professors at Ajman University, UAE (Varshney et al., 2020). By addressing these topics, we aim to highlight the importance of incorporating environmental considerations into dental practice for both patient and environmental health.

2. Literature review

Green dentistry, often known as eco-friendly dentistry, is a rapidly growing concept that strives to lessen the negative impacts of dental operations on the environment while still giving patients' and dental professionals' health top priority. Prior to the 20th century, dental offices focused exclusively on treating patients and gave little consideration to how the materials and procedures they used might have an impact on the environment (Linstadt, 2023). However, the dentistry industry also underwent a shift to fit with eco-friendly methods as environmental concerns gained popularity.

The tenets of "The Four R's"—rethink, reduce, reuse, and recycle—form the basis of green dentistry. These guidelines provide a foundation for resource conservation and waste reduction in dental clinics (Linstadt, 2023). The first phase, "rethink," calls for a mental change away from prioritizing only one's own interests and toward the welfare of the environment and future generations. Dental teams are urged to evaluate their procedures and practices objectively in order to find chances for waste reduction and eco-friendly substitutes.

The second concept, "reduce," underlines how critical it is to responsibly cut back on resource usage. This may be accomplished by utilizing dental care methods and materials that use fewer resources while still being effective (Linstadt, 2023). For instance, dentists can use biocompatible substitutes like glass ionomer cement (GIC) and composite resins in place of conventional dental amalgam, which contains mercury and causes environmental problems when disposed.

The third concept, "Reuse" encourages prolonging the life of dental supplies and equipment to reduce waste. Resources and energy are saved by reusing products rather of throwing them away after a single use, making dental procedures more sustainable (Kamran et al., 2022). Dental practitioners can employ sterilizable stainless steel instruments, reducing reliance on disposable materials, and using biodegradable or recyclable alternatives when necessary.

The final principle, "recycle," emphasizes the importance of recycling and repurposing materials to reduce waste accumulation. Amalgam separators, for example, help detect and segregate amalgam particles from wastewater, significantly reducing the environmental impact of dental amalgam waste (Kamran et al., 2022). Recycling also extends to other materials used in dental practices, such as silver from

X-ray fixers.

Despite its mechanical benefits, dental amalgam contains a large amount of mercury, which poses a serious environmental concern. Due to incorrect removal and replacement techniques, it can produce mercury vapor, amalgam scrap, and amalgam sludge, all of which are harmful to the environment. The use of chemical fixers and lead foils in conventional radiography contributes to the contamination of chemical waste, and inappropriate disposal can have a long-term negative impact on the environment (Ammar, 2021). Even though infection control measures are crucial for security, dental vacuum systems can cause hazardous waste to be produced and use up enormous quantities of water. Increasing knowledge of such environmental effects is essential for motivating dental professionals to use eco-friendly alternatives.

Numerous studies have assessed the adoption of eco-friendly dentistry among dental professionals around the globe. The ethical responsibility of the Western world to take the lead in implementing sustainable waste management solutions in dentistry was highlighted in a 2007 University of Waterloo research (Linstadt, 2023). While dentists were knowledgeable about eco-friendly dental office management systems, according to research conducted in Jordan, their adoption rates were low. According to a survey conducted in Thailand, dentists were informed about energy management but unaware of waste management procedures. Studies conducted in Saudi Arabia and India similarly showed the need of giving dental practitioners more in-depth instruction in eco-friendly dentistry. These results imply that although there is a rising interest in eco-friendly dentistry, its complete integration into dental offices calls for coordinated efforts and focused instructional programs.

3. The dental impact on the environment

3.1. Dental amalgam

Because of its longevity, affordability, and mechanical strength, dental amalgam has been utilized extensively for many years. It might be hazardous to the environment since it includes mercury and other heavy metals. Dental amalgam waste that is not properly disposed of can cause pollution of the air, water, and land by releasing mercury vapor, amalgam scrap, and amalgam sludge. In order to lessen the impact to the environment, it is crucial to handle dental amalgam waste management and disposal (Varshney et al., 2022).

3.2. Radiograph

Conventional X-rays, which are frequently utilized in dental offices, emit a variety of waste materials and chemical byproducts that harm the environment. Particularly alarming are the chemical fixers and lead foils employed in the X-ray development process. Chemicals included in X-ray fixers, such ammonium thiocyanate and boric anhydride, can irritate the skin, eyes, and respiratory system and be dangerous if consumed or breathed. Upon continuous contact, they can also damage the thyroid, kidneys, and liver in addition to causing blood poisoning. Additionally, these compounds' breakdown byproducts may be just as dangerous. Another consequence of traditional X-rays, lead foils, also poses a serious concern. Lead trash

may linger in the soil for up to 2000 years after being disposed of in the environment, making its way into the food chain through plants and posing major health risks (Pratheebha et al., 2022). Dental offices could switch to digital X-ray equipment, which greatly decreases waste and does away with the need for lead foils and chemical fixers, to lessen these negative environmental effects.

3.3. Waste and water

Waste produced by dental facilities includes disposable barriers, sterilizing supplies, and potentially harmful disinfectants needed to prevent infection. Such trash should be disposed of properly to protect worker health, improve workplace air quality, and protect the community's water supply. Toxic-free options for sterilization and infection control must be found in order to safeguard the environment, dental workers, and patients. Effective suction requires dental vacuum equipment, which are also a large water user. It is estimated that an average dental office uses up to 57,000 gallons of water yearly (Pratheebha et al., 2022). These water-intensive techniques are not sustainable in a world when there is a water shortage. An ecologically beneficial alternative is to use high-tech dry vacuum systems, which accomplish the same goals without the use of water.

Adopting environmentally friendly products and procedures that decrease waste, preserve resources, and minimize pollution is essential to reducing the negative effects dental practices have on the environment. A sustainable strategy is to use heavy metal-free alternative dental materials such glass ionomer cement and composite resin. In order to prevent mercury pollution, amalgam separators must be used to find and remove amalgam particles from wastewater (Spaveras and Antoniadou, 2023). Dental practitioners may also cut waste by using biodegradable materials for some applications and swapping out disposable barriers for reusable ones. Adopting renewable energy sources, such as solar and wind power, may help make dental practices much greener and less dependent on traditional energy sources.

3.4. Rethink

Amalgam management: To avoid the needless use of dental amalgam, choose heavy metal-free alternatives such as GIC and Composite resin, ceramic, or any metal alloy where appropriate.

Radiographic management: using a digital X-ray rather of a traditional one. The drawback of the current technology, the use of chemical waste and paper, plastic, and lead foil, will be lessened by employing the digital X-ray.

Waste management: Dental equipment should no longer be sterilized in plastic pouches; instead, metal boxes or reusable clothes should be used instead. To identify the areas that require improvement and correction, statistics on the volume and kind of recycled waste, as well as the annual use of water and energy, should be kept track of.

Energy management: The usage of the renewable energy sources, such as solar energy and wind energy, to supply the entire dental clinic is a good way to enhance the green dentistry.

3.5. Reduce

Amalgam management:

Using Pre-capsulated amalgam in order to decrease the disposed liquid mercury can decrease the amount of damage to the environment.

Waste management:

converting all patient information and records to digital format, which will cut down on the use of paper. Reducing the number of disposable materials used in dentistry would help protect the environment. Use paper bags wherever they are available instead than plastic ones.

Energy management:

Using highly effective lights such as LED as it can reduce the energy used, as the halogen bulbs, despite their cheap price) consume more energy (Singh and Khurshid, 2020). It is preferable to switch off the lights when not in use since it saves electricity. To save energy, shut off computers at night. Even when they are in sleep mode, computers still use electricity. Devices linked to a surge protector consume a little amount of electricity continuously; turn them off to conserve energy.

Water management:

Using detergents that don't require high volume of water and highly effective, and routinely checking all water taps, and advising the patients to close the water tap while brushing their teeth (Singh and Khurshid, 2020). Use hand sanitizer instead of simple hand washing when necessary and follow the CDC's hand hygiene recommendations. When lathering, turn off the water if you need to wash your hands. Use a dry dental vacuum pump in place of a wet one. Use only full loads when using sterilizing equipment or practice laundry machines. Low-flow aerators may be added to any sink faucet. Additionally, inspect the entire workplace for leaks every six months.

3.6. Reuse

Amalgam management

Using high-copper amalgam rather than low-copper amalgam will lengthen the life and durability of the amalgam filling and, at the same time, reduce the likelihood of replacement, reducing amalgam waste.

Radiographic management

The radiographic sensor (digital receptor) may be used more than once by just replacing the barrier after each use, allowing for many uses of the sensor.

Waste management

employing stainless steel tools that can be disinfected after use and can be recycled when they have fulfilled their function, or only using disposable medical equipment when it is absolutely required and non-disposable materials cannot be utilized owing to safety concerns. Materials that degrade naturally can be produced, for instance, from maize.

3.7. Recycle

Amalgam management

use an amalgam separator, a tool that looks for amalgam in the dental office's

water waste. The quantity of garbage projected to the environment will be greatly reduced after installing this device (Linstadt, 2023). The dental amalgam particles are separated from wastewater using sedimentation, filtration, or centrifugation technologies. In addition to ion exchange, some devices use a mix of these mechanisms. Because not all amalgam separation units can perform efficiently in every physical layout, it's important to choose the right one.

Radiographic management

The fixer used in the conventional X-Ray technique has a quantity of silver that can be recycled easily.

Waste management

Less should be consumed of non-hazardous trash like tissue, papers, and plastics, and PVC-containing material should be avoided wherever feasible because it is difficult to recycle (Srinivasan, 2018). Even though most dental waste is disposed of in the trash, the majority of it may be processed again and recycled into products like plastic, paper, metals, aluminum, and glass.

Several studies have examined dental professionals' knowledge and attitudes toward eco-friendly practices. For example, Anjum et al. (2019) conducted a study in India to assess the awareness of green dentistry among dental professionals and found that while there was a general understanding of sustainable practices, their application in clinics was limited. Similarly, Al-Mashhadani et al. (2020) studied eco-friendly dental practices in Saudi Arabia and identified a knowledge gap among dental practitioners regarding the use of energy-efficient equipment and waste reduction techniques.

A more recent study by Kamran et al. (2022) assessed the sustainability practices among dental students and practitioners in Malaysia. This study revealed that while the awareness of green practices was increasing, there was still a significant gap in the actual implementation of these practices in clinical settings. Many respondents cited a lack of institutional support and insufficient training on sustainable practices as key barriers.

While these studies provide valuable insights into the global trends in green dentistry, they primarily focus on professional dentists rather than dental students or interns, who represent the future workforce in dentistry. Additionally, most existing research has focused on countries in Asia, Europe, or North America, with little attention given to Middle Eastern countries like the United Arab Emirates (UAE). Ajman University, in particular, has not been the subject of extensive research on this topic.

3.8. Methodology

This descriptive cross-sectional study was conducted at Ajman University in Ajman, United Arab Emirates, between 1 December and 1 March 2022. The purpose of this study was to assess the knowledge and practices of environmentally friendly dentistry among dental students and professionals at the university.

Prior to the commencement of the study, ethical approval was obtained from the University's Research and Ethical Committee (Reference No. D-H-S-2021-Nove-24-17). All participants were informed about the study's purpose and provided written

informed consent.

The study included participants from various dental-related categories at Ajman University, including specialists, general practitioners (GPs), master's students, interns, and undergraduates in their fourth and fifth years. Participants were randomly selected, and a total of 231 individuals were included in the study. Students in their first, second, and third years were excluded as they had not yet started working in dental clinics, ensuring the participants had practical clinical experience. Additionally, medical professionals and students from institutions outside Ajman University were excluded.

The data was collected using an English-language online survey specifically developed for this study. The questionnaire consisted of three sections:

Demographic Data: This section gathered information such as age, gender, education level, and professional status.

Knowledge of Environmentally Friendly Dentistry: This section included 10 questions aimed at assessing participants' understanding of eco-friendly dentistry practices. Questions covered topics like sustainable materials, waste management, and energy-efficient practices in dental clinics.

Eco-Friendly Practices: The final section consisted of 9 questions focused on gauging participants' clinical practices in relation to environmentally sustainable dentistry.

The questionnaire was adapted from previously validated tools in similar studies (Ammar, 2021). Prior to data collection, the survey underwent content validation by a panel of experts in dental public health and environmental sustainability, ensuring the questions were clear, relevant, and comprehensive. A pilot study was conducted with 20 participants to test the reliability of the questionnaire. Cronbach's alpha was calculated to assess internal consistency, with a value of 0.745 indicating acceptable reliability. Feedback from the pilot study was used to refine the questions for clarity and coherence.

Furthermore, the questionnaire was distributed through various channels to ensure broad participation. Participants were approached directly during clinic visits, lectures, and doctor's offices, where they were given the self-administered survey. Additionally, the survey was made available digitally via email and social media platforms like WhatsApp, Telegram, and Instagram, to accommodate those unable to complete it in person.

The collected data from the survey were tabulated and entered then the statistical analyses were performed using SPSS 28.0 (SPSS, Inc, Chicago, Illinois, United States).

The present survey involved mainly a close-ended questionnaire, which validated using factor analysis (Cronbach's alpha).

Assumption of normality was established to check the validity of the parametric test using Shapiro-Wilk test. significance in Shapiro-Wilk test revealed $P < 0.05$, as a result we reject the null hypothesis and the data were not normally distributed for the total knowledge scoring. Therefore, non-parametric tests were used to estimate the difference between the selected variables (gender, age and academic level) in relation to different parameters (Knowledge and Practice).

Collected data were organized and tabulated as descriptive results, and they included the participant's gender, age and academic level; then the data were analysed

and tabulated as frequency and percentage distribution. Chi-square test (X2) was applied to know the association between study variables and different study questions.

Non-parametric Independent-Samples Mann-Whitney U Test and Kruskal Wallis Test was used to determine significant difference of the distribution of all study parameters across study categories: Gender, Age and Academic Level.

The mean of total score and standard deviation were tabulated for each of the measures under the current research. Statistical analysis was done after dividing the questionnaire into 2 categories: 8 knowledge related items and 9 items for practice.

In order to ascertain the relation between the variables, Spearman's correlation was calculated to compares the strength of the effect of each independent variable to the dependent one.

The statistical significance (*p*-value) was set in this study at < 0.05 with 95% confidence level.

4. Results

In our study, 61.5% of participants were undergraduate students, 13.4% were postgraduate students, 14.7%.

were general practitioners, and specialists made up 10.4%, the smallest group in this category. Regarding gender, females represented 55.8%, while males accounted for 44.2%. The age distribution revealed that the largest group, at 88.3%, was aged 20–29 years. This was followed by the 30–39-year age group at 7.8%. The 40–49-year age group constituted 1.7%, those aged 50–59 made up 1.3%, and individuals aged 60 and above were 0.9%, the smallest group by age. Concerning awareness of the term "green dentistry," 59.7% of participants reported hearing it for the first time, while 40.3% had encountered the term before. Finally, three factors influence the adoption of green dentistry: the lack of sufficient knowledge, cited by 59.3% of respondents, cost, which was a concern for 31.6%, and insufficient time, noted by 9.1% (**Table 1**).

Table 1. Sociodemographic characteristics of dental students and doctors in Ajman university (*N* = 231 students).

	Variable	**Frequency**	**Percentage**
Academic level	Under-graduates student	142	61.5%
	Post-graduates student	31	13.4%
	General practitioner	34	14.7%
	Specialist	24	10.4%
Gender	Male	102	44.2%
	Female	129	55.8%
Age Group	20–29 years old	204	88.3%
	30–39 years old	18	7.8%
	40–49 years old	4	1.7%
	50–59 years old	3	1.3%
	≥60 years old	2	0.9%
Are you aware of the term green dentistry?	Heard before	93	40.3%
	Heard for first time	138	59.7%

Table 1. (*Continued*).

	Variable	Frequency	Percentage
What are the factors that are influencing the adoption of green dentistry?	Cost	73	31.6%
	Not enough knowledge to proceed	137	59.3%
	Not enough time	21	9.1%

Table 2. Nonparametric correlations between academic level, age, gender, knowledge and practice of eco-friendly dentistry.

Correlations							
			Academic level	Gender	Age	Knowledge	Practice
Spearman's rho	Academic level	Correlation Coefficient	1.000	0.112	0.518**	0.052	0.005
		Sig. (2-tailed)	.	0.091	<0.001	0.434	0.935
		N	231	231	231	231	231
	Gender	Correlation Coefficient	0.112	1.000	0.034	−0.161*	−0.093
		Sig. (2-tailed)	0.091	.	0.607	0.014	0.157
		N	231	231	231	231	231
	Age Group	Correlation Coefficient	0.518**	0.034	1.000	0.005	0.000
		Sig. (2-tailed)	<0.001	0.607	.	0.934	0.996
		N	231	231	231	231	231
	Knowledge regarding eco-friendly dentistry among study participants	Correlation Coefficient	0.052	−0.161*	0.005	1.000	0.312**
		Sig. (2-tailed)	0.434	0.014	0.934	.	<0.001
		N	231	231	231	231	231
	Practice regarding eco-friendly dentistry among study participants	Correlation Coefficient	0.005	−0.093	0.000	0.312**	1.000
		Sig. (2-tailed)	0.935	0.157	0.996	<0.001	.
		N	231	231	231	231	231

There is no significant correlation between knowledge and practice in Academic level, Gender, age and Knowledge regarding eco-friendly dentistry while there is positive significant correlation in Practice regarding eco-friendly dentistry ($p < 0.001$) (**Table 2**).

4.1. Descriptive statistics

The average score for knowledge about eco-friendly dentistry was 4.49 ± 1.55 out of 8.00, while the average score for practice was 5.39 ± 1.65 out of 9.00.

Among different academic levels, specialists exhibited the highest knowledge of eco-friendly dentistry, whereas general practitioners had the lowest. The mean scores for specialists and general practitioners were 5.0 ± 1.41 and 4.24 ± 1.71, respectively, with no significant difference in knowledge between the academic levels ($p = 0.237$). In terms of practice, specialists also performed better, while postgraduate students had the lowest practice scores. The mean scores for specialists and general practitioners in practice were 6.04 ± 1.16 and 4.97 ± 1.74, respectively, with a significant difference in practice observed between academic levels ($p = 0.035$) (**Figure 1**).

Gender differences showed that males had a higher level of knowledge about eco-friendly dentistry compared to females. The mean scores for males and females were

4.71 ± 1.53 and 4.21 ± 1.53, respectively, with a significant difference in knowledge between genders (p = 0.015). However, there were no significant differences in practice scores between males and females, with mean scores of 5.57 ± 1.77 for males and 5.25 ±1.55 for females (p = 0.157).

Regarding age groups, those aged 30–39 had the highest levels of both knowledge and practice in eco-friendly dentistry, while individuals aged 60 and above had the lowest. However, no significant differences in knowledge (p = 0.893) or practice (p = 0.898) were observed across different age groups.

Regarding age groups, a study on environmentally friendly dentistry produced some intriguing results. In comparison to other age groups, the study found that those under 30 and those over 60 showed relatively less knowledge and skill on eco-friendly dentistry practices. The study did not discover any variations in practice (p = 0.898) or knowledge (p = 0.893) amongst different age groups (**Figure 2**).

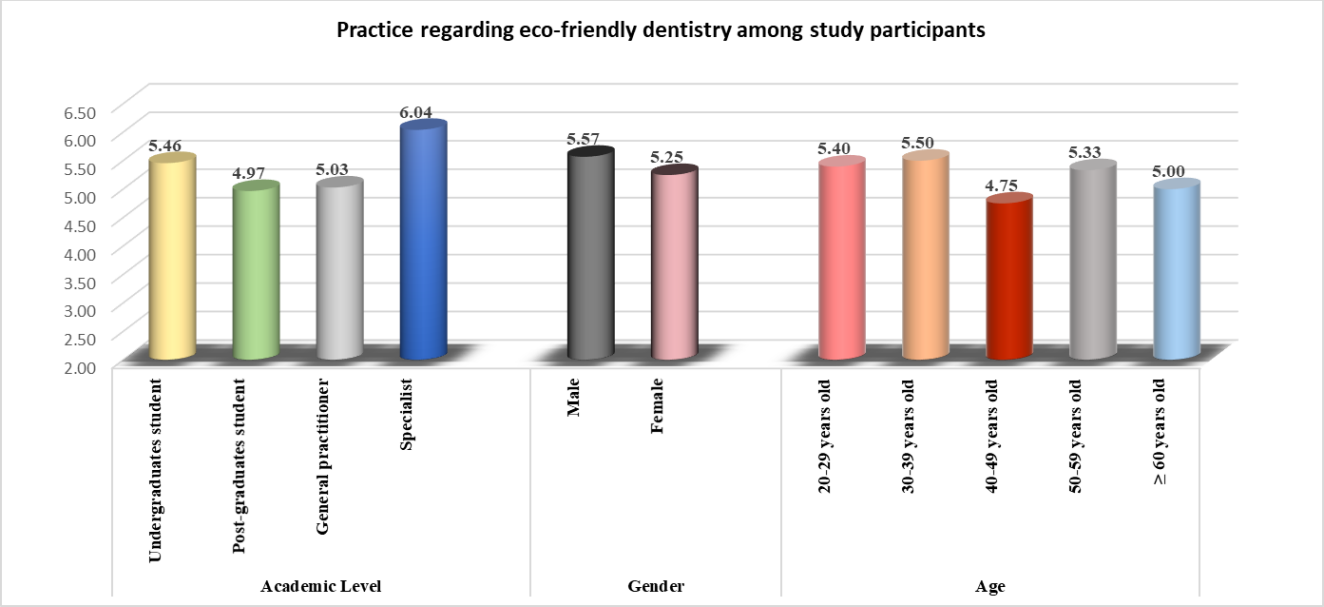

Figure 1. Average scores regarding the practice of eco- friendly dentistry.

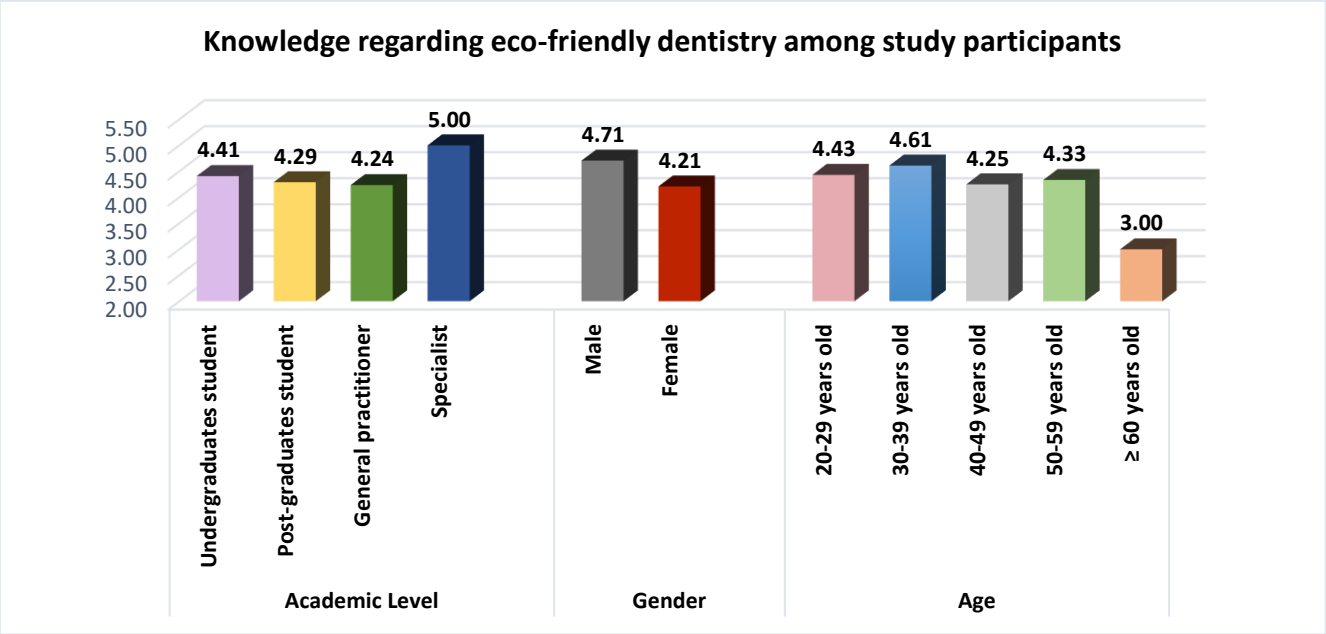

Figure 2. Average scores regarding the knowledge of eco-friendly dentistry.

4.2. Discussion

This study's main goal was to evaluate the proficiency and familiarity of Ajman University's dentistry faculty with environmentally friendly dental practices. Direct discussions with respondents helped to set the survey's sample size. 44.2% of the participants in our research were men, whereas 55.8% of them were women. ShIvangI Verma's 2020 study found a substantial difference in the gender distribution, which contrasts with Mohammed A. Al-Qarni's 2016 analysis, which found a distribution that was not similar. Particularly, ShIvangI Verma reported a much lower number of female participants (40% vs. 78.75%), showing a particularly low representation of female participants in that specific study (4.2%) (Pratheebha et al., 2022).

The phrase "green dentistry" was less known to survey participants than it was to those who said they had heard of it previously. This conclusion was supported by a survey of Thai dental professionals, which revealed that just 16.5% of the respondents were aware of it (Pratheebha et al., 2022). In contrast, a study done in 2017 by Sen N. and Bhat N. revealed that participants had a greater degree of knowledge of the phrase "green dentistry," with almost 60% of their sample giving this terminology a favorable response.

Most of the dental professionals at Ajman University agreed that a lack of knowledge was the biggest obstacle to incorporating green dentistry into their daily practices. Cost, which makes adopting green dentistry seem pricey, is the second barrier, and the time needed to apply the concepts of rethink, reduce, reuse, and recycle is the third. More than half of their sample responded that knowledge came first in deciding the adoption of green dentistry, followed by cost, in a recent survey conducted in 2020 that produced similar results (Kamran et al., 2022).

In agreement with this survey, a 2017 study by Chopra and Raju revealed that "cost" and "lack of knowledge" were the most common barriers to the adoption of eco-friendly practices, according to the majority of respondents. The lack of environmentally friendly products or financial obstacles were also seen as obstacles

by Thai dentists. More specifically, experts ranked cost as the most important element influencing the idea of green dentistry (62.5%) and knowledge as the least important component (29.16%), indicating that they have the information necessary to undertake green dentistry in contrast to ordinary practitioners (Kamran et al., 2022).

Between the knowledge and practice of eco-friendly dentistry in our study, there was a substantial and positive association (*p* 0.001). This outcome makes sense since dentists are likely to use green dentistry more frequently as their understanding of the topic grows. The association between academic level, gender, age, and familiarity with eco-friendly dentistry was not, however, very strong.

According to Rogers, there are two separate components to a concept that can result in the field accepting a green dental invention: knowledge and practice. This study demonstrates that there is no knowledge or practice gap between dental professors and dental students about eco-friendly dentistry. In contrast to this conclusion, another research discovered that there is a gap between Thai dentists' understanding of green dentistry and their attitudes and activities.

In this study, specialists had the highest degree of knowledge about green dentistry, while general practitioners at Ajman University had the lowest levels of knowledge. varying academic levels demonstrate varying levels of both understanding and practice to the notion of green dentistry. However, another study conducted in 2020 by ShIvangI Verma discovered that postgraduates had greater knowledge than undergraduates because they had more years of experience in their specialized field. As a result, knowledge is essential in the practice of green dentistry, and it is crucial to start introducing such a subject (Kamran et al., 2022).

While in terms of practicing eco-friendly dentistry, also specialists had ahigher rate of practicing different methods of eco-friendly dentistry when compared to practice among post-graduate students, in which they rarely practice this concept.

Both males and females participated in this study, however men were more knowledgeable about and experienced with environmentally friendly dentistry than women were. Similar findings were found in two investigations; one conducted in 2013 found that men participants understood green dentistry better than female ones. The results of another study carried out by Ehrampoush and Moghadam were comparable. In some contexts, there might be sociocultural factors that influence how men and women engage with professional knowledge acquisition. For example, men might be more encouraged to participate in professional development or might have different networks that provide access to updated knowledge about sustainable practices.

In our study, the results showed that the majority of the participants that filled the survey were within the age group of 20 to 29. However, another surveyfound that the majority of respondents were between the ages of 41 and 50, which matches the demographics of a study that found that the majority of dentists were between the ages of 31 and 60 (Kamran et al., 2022).

When compared to other age groups, it was found that research participants in the 30 to 39 age range shown the highest degree of knowledge and involvement with eco-friendly dentistry. On the other hand, people over 60 showed the least amount of acquaintance with and use of environmentally friendly dental procedures. Given that

eco-friendly dentistry is a relatively new idea that first appeared in the 1970s, these findings were not surprising (Varsheny et al., 2022). The percentage of respondents who had heard of green dentistry, on the other hand, increased with respondents' ages, according to a 2013 research by Voramon Agrasuta, suggesting that older dentists were more educated about green practices (Varsheny et al., 2022). A recent survey of young people revealed that they did not prioritize environmental concerns, which is consistent with their general findings.

5. Limitations

Although eco-friendly dental procedures have many benefits, there are a number of obstacles that prevent their widespread use. The capacity of dental professionals to adapt to change, current rules, and financial concerns are all included in this list of barriers.

5.1. Cost considerations

The initial cost needed to switch from traditional dental procedures to more environmentally friendly options is one of the main drawbacks of green dentistry (Kamran et al., 2022). For instance, when buying equipment like digital X-ray machines or dental vacuum systems that utilize dry technology, dental clinics can have to pay more up front. Although these expenditures can result in long-term cost savings by using less water and energy, certain dental offices, particularly smaller ones or those in economically depressed areas, may find it difficult to make the changeover due to the associated costs. A further obstacle to the widespread use of eco-friendly dental materials is that some, such composite resins, may have greater material prices than conventional amalgam. Governments and dental associations might provide incentives, grants, or low-interest loans to dental clinics to assist in the transition to greener practices and cover the initial expenditures in order to get over this barrier.

5.2. Existing regulations

The dental industry is subject to numerous regulations and guidelines governing safety, waste management, and infection control. While the intention of these regulations is to protect public health and the environment, they can sometimes impede the implementation of green dentistry practices (Singh and Khurshid, 2020). For example, certain regulations may require the use of specific materials or disposal methods, even if eco-friendlier alternatives are available. To overcome this limitation, there is a need for collaborative efforts between dental associations, environmental agencies, and policymakers to update and adapt regulations to accommodate sustainable dental practices. By encouraging the development and approval of environmentally friendly dental materials and technologies, regulatory bodies can play a crucial role in facilitating the adoption of green dentistry principles.

5.3. Resistance to change

The slow adoption of green dentistry techniques might be significantly hampered by resistance to change within the dental profession. Dentists and dental staff could be reluctant to move to unproven eco-friendly options since they are used to using

conventional techniques and materials. This opposition can be linked to things like a lack of knowledge about how dentistry procedures affect the environment, concern over sacrificing patient care, or doubts about the efficacy of green options. To overcome this obstacle, educational campaigns and training programs should be created to spread the word about the significance of sustainable dentistry and provide dental practitioners the know-how and abilities they need to adopt greener procedures without compromising patient results.

5.4. Limited availability of green products and technologies

In comparison to traditional solutions, the selection of eco-friendly dental goods and technology currently on the market may be constrained. This restriction is caused in part by the green dentistry movement's relatively recent beginnings as well as the continuous research and development needed to provide efficient and economical substitutes. Manufacturers will certainly increase their product lines as demand for environmentally friendly dental items rises, but in the interim, dental professionals can have trouble locating adequate green options for every element of their practice. To overcome this obstacle and encourage broader adoption of sustainable practices, cooperation between dental associations, manufacturers, and research organizations can speed up the creation and distribution of green dental goods.

5.5. Recommendations for implementing environmentally friendly dentistry practices

In conclusion, this study highlights both the knowledge and practical application of environmentally friendly dentistry among dental students and professionals at Ajman University. While the findings demonstrate a moderate level of awareness about green dentistry, the adoption of sustainable practices in clinical settings remains limited. Based on these findings, several specific recommendations can be made to improve the implementation of eco-friendly practices within the dental community.

One important recommendation is to incorporate sustainability into the dental curriculum. The gaps in knowledge identified, particularly among students, suggest that eco-friendly dentistry should be integrated into the education process. This could involve adding modules on sustainable dental materials, energy-efficient equipment, waste management, and overall environmentally conscious clinical practices. By making these subjects a core part of the curriculum, students would be better prepared to adopt green practices in their future careers.

For practicing dental professionals, continuing education programs should be developed to focus on environmentally sustainable dentistry. These could be delivered through workshops, webinars, or seminars and would provide updated knowledge on eco-friendly technologies, materials, and techniques. Given the observed gender differences in knowledge and practice, such programs should ensure equitable access for all professionals to improve overall awareness and implementation.

The study also revealed that while awareness of green practices exists, actual implementation is often hindered by a lack of institutional support. To address this, dental clinics and educational institutions should promote and adopt green certifications or standards, such as those provided by organizations like the Eco-

Dentistry Association. Providing financial incentives or resources for clinics to switch to sustainable materials and energy-efficient technologies would encourage broader adoption of eco-friendly practices.

Additionally, awareness campaigns driven by universities could foster a culture of sustainability within the dental community. Organizing events, workshops, and awareness days that focus on the environmental impact of dentistry, as well as using social media and digital platforms to share best practices, could help engage both students and professionals in the movement toward more sustainable practices. This awareness could lead to more widespread implementation of green dentistry principles in daily practice.

Encouraging further research in the field of sustainable dentistry is also essential. Universities and research institutions should support studies exploring new eco-friendly materials, energy-saving techniques, and waste reduction strategies. Collaboration between dental schools, environmental organizations, and government agencies could lead to innovative solutions that reduce the ecological footprint of the dental industry.

Finally, it is important to establish mechanisms for monitoring and evaluating the effectiveness of implemented green practices. Dental clinics should regularly assess their environmental impact and look for areas of improvement. Introducing regular audits or reports on energy use, waste production, and sustainable material usage would ensure that practices remain environmentally conscious over time and continue to evolve.

6. Conclusion

In summary, implementing green dentistry principles has the potential to significantly lessen the environmental effect of dental offices and increase overall sustainability in the healthcare industry. Dental practitioners may drastically reduce their carbon footprint, save natural resources, and generate less hazardous waste by implementing eco-friendly technology, materials, and waste management techniques. Furthermore, green dentistry reduces exposure to dangerous compounds that are frequently present in traditional dental offices, improving the health of dental personnel and patients in addition to benefiting the environment.

This essay's study has highlighted a number of green dentistry-related topics, such as the usage of dental amalgam substitutes, digital radiography, ethical waste disposal, and water saving techniques. The research suggests that these environmentally friendly methods are not only practical but also successful in upholding standards for high-quality dental treatment.

But it's important to recognize the constraints and difficulties that come with switching to green dentistry. The broad adoption of sustainable practices may be hampered by cost concerns, current laws, opposition to change, and the scarcity of eco-friendly goods and technology. Collaboration between dental practitioners, decision-makers, manufacturers, and environmental organizations is essential to removing these obstacles. The advancement of green dentistry and its incorporation into dental offices throughout the world may be aided by financial incentives, modernized rules, educational programs, and research partnerships.

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