SUSTAINABILITY IN DENTAL PRACTICE : KNOWLEDGE, ATTITUDE, AND PRACTICES OF DENTISTS ABOUT GREEN DENTISTRY CONCEPT

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ABSTRACT

Green Dentistry involves providing oral health care using environmentally friendly technologies, procedures, and materials, as well as employing innovative technologies that enhance performance and reduce negative environmental impacts. Dentists are expected to integrate environmentally friendly dental care principles with the 4R principles: Reduce, Reuse, Rethink, and Recycle. Dentists should have a thorough understanding of how to apply the Green Dentistry concept. This study aims to evaluate the implementation of Green Dentistry principles among dentists in practice in the Province of Lampung. Using a descriptive design, the study focused on dentists who are members of the PDGI (Indonesian Dental Association) in the Province of Lampung. The sampling technique used is non-probability sampling with purposive sampling. Non-probability purposive sampling is utilized for data collection via a questionnaire distributed through Google Forms and subsequently analyzed using computer-based statistical software. The findings indicate that 69.7% of dentists in the Province of Lampung demonstrate a moderate level of behaviors in relation to Green Dentistry principles in their practice, reflecting a moderate degree of integration of environmentally friendly dental care practices.

Keywords: green dentistry, environment, dental practices, behaviors

INTRODUCTION

Global warming, as highlighted by the World Health Organization (WHO), stands as one of the most pressing concerns confronting the world today. The impact of climate change extends to human health, exacerbating environmental degradation and giving rise to various diseases. The adverse effects of climate change include heightened air pollution, increased prevalence of diseases transmitted through food and water, and more frequent occurrences of extreme weather events. These environmental challenges significantly affect the healthcare industry, including dentistry, which also contributes to carbon emissions and exacerbates global warming (WHO). In response to the growing environmental awareness, the healthcare sector, including dentists, has begun adopting "go green" initiatives to mitigate environmental damage. (Farahani & Suchhak)

Green Dentistry, introduced by Farahani and Suchhak in Canada in 2007, is characterized by the implementation of advanced technology to reduce the environmental impact of dental procedures. This concept emphasizes the importance of promoting and maintaining environmental well-being through eco-friendly practices. However, a study conducted by Agrasuta (2013) in Thailand indicated that a mere 16.5% of dentists were acquainted with Green Dentistry, with 83.5% lacking prior knowledge of it. A survey conducted in India by Prathima (2017) also revealed that 59.4% of dentists possessed limited understanding of the concept. Furthermore, findings by Bhargava (2017) indicated that 34% of dentists had no familiarity with Green Dentistry. In Bandung, a study conducted by Khairani (2020) revealed that 43.2% of dentists were unaware of Green Dentistry, signifying that the concept remains relatively unknown among dental practitioners.

Effective waste management plays a pivotal role in the practice of Green Dentistry due to the presence of hazardous and infectious materials in dental waste, such as mercury from dental fillings and other chemicals. These substances pose potential risks to both human health and the environment. (Farahani & Suchhak)
implement changes in their practices. For instance, they can consider using reusable items like cloth for patient chest pads and reducing paper use by transitioning to more efficient electronic medical record systems. A study by Pawar (2016) in India demonstrated that a significant number of dentists lack sufficient understanding of biomedical waste management. In fact, 52.4% of the surveyed dentists were unaware of the categories of biomedical waste regulated under the Indian Biomedical Waste Management Act of 2016.

A study conducted by Febrian (2020) revealed that 51.4% of dentists fail to effectively manage waste in their clinics, underscoring the imperative for enhanced education and implementation of best practices in waste management within

the dental industry. Additionally, study carried out by Nagarale et al. (2022) in Pune, India, revealed that 71.8% of dentists in the region lack awareness of the substantial quantity of dental sterilization pouches being deposited in landfills annually. This lack of awareness underscores the critical need for comprehensive education and training in Green Dentistry to cultivate environmental consciousness among dental practitioners.

Green Dentistry practices have been established in various countries for a significant period; however, the concept is still relatively nascent in Indonesia. There is a pressing need for further investigation and wider implementation of eco-friendly practices among dental professionals. Green Dentistry has the potential to increase environmental consciousness and mitigate the adverse environmental effects of dental care. These changes require a combination of knowledge, positive dispositions, and practical competencies to effectively execute the principles of Green Dentistry in routine practice.

This study aims to examine the knowledge, attitudes, and practices related to Green Dentistry among dentists in the Province of Lampung. To date, no study has been conducted on this subject in the region. This study aims to narrow the knowledge gap and promote the adoption of eco-friendly dental practices.

METHODS

This study employs a descriptive design to evaluate the dentists' behaviors towards Green Dentistry practices in the Province of Lampung. The study focuses on PDGI (Indonesian Dental Association) member dentists in the Province of Lampung who meet specific inclusion criteria and express willingness to participate. A sample of 89 respondents was selected using a non-probability purposive sampling technique. Data collection was performed through an online questionnaire, adapted from a study by Nagarale et al. (2022) , designed to assess dentists' knowledge, attitudes, and practices related to Green Dentistry. Prior to distribution, the questionnaire underwent validity and reliability testing. Validity was evaluated using the product moment test, with all questions deemed valid, and the reliability was assessed using Cronbach's Alpha, indicating the instrument's reliability with a value >0.6. Data analysis was conducted using computer-based statistical software to generate univariate analyses, presenting the frequency distribution of dentists' behaviors towards the concept of Green Dentistry across knowledge, attitudes, and practices categories.

RESULTS AND DISCUSSION

This study aims to assess the dentists' behaviors in the Province of Lampung regarding the concept of Green Dentistry. The study findings show that dentists generally have moderate levels of knowledge, attitudes, and actual practices in their workplaces. Subsequently, detailed explanations pertaining to each table are presented hereafter.

Table 1. The characteristic by gender and age of PDGI Lampung Member (n=89)

	Number (n)	Percentage (%)
Gender		
Male	11	12.4
Female	78	87.6
Age		
25-35 years	25	28.1
36-45 years	38	42.7
46-55 years	20	22.5
56-65 years	6	6.7

The study findings reveal a notable predominance of female respondents. Out of the total 89 respondents, 78 (87.6%) are female, while 11 (12.4%) are male, indicating a strong inclination towards female participation in the study. The study results reveal that the most prevalent age group among respondents is 36-45 years, comprising 38 respondents (42.7%). Additionally, the age brackets of 25-35 years, 46-55 years, and 56-65 years encompass 25 respondents (28.1%), 20 respondents (22.5%), and 6 respondents (6.7%) respectively. This suggests that the majority of respondents are in their productive years.(Table 1)

Table 2. Questions assessing knowledge of green dentistry concept in dental practice (n=89)

No.	Questions	Number (n)	Percentage (%)
1.	**Which of the following is an environmentally friendly practice for managing dental amalgam?**		
	Storing unused amalgam in loosely sealed containers	6	6.7%
	Utilizing amalgam separators	52	**58.4%**
	All of the above	14	15.7%
	None of the above	17	19.1%
2.	**Which of the following is a sustainable (reusable and durable) dental hygiene instrument that does not harm the environment?**		
	Bamboo toothbrush	66	**74.2%**
	Nylon dental floss	8	9.0%
	Tongue cleaner	2	2.2%
	All of the above	9	10.1%
	None of the above	4	4.5%
3.	**What type of flooring is considered environmentally friendly for clinical rooms?**		
	Bamboo	56	**62.9%**
	Vinyl	11	12.4%
	Marble	12	13.5%
	All of the above	4	4.5%
	None of the above	6	6.7%
4.	**Which of the following infection control measures are environmentally friendly in clinical settings?**		
	Use of non-biodegradable disinfectants	3	3.5%
	Use of HDPE (heat-resistant plastic) plastic spray bottles for disinfectants	14	15.7%
	The use of washable fabric scrubs or lab coats instead of disposable ones	49	**55.1%**
	All of the above	12	13.5%
	None of the above	11	12.4%
5.	**Which of the following dental innovations are considered environmentally friendly?**		
	Digital patient records, scheduling, billing, and recording.	16	18.0%
	Management of clinical practice using computerized systems (CAD/CAM)	8	9.0%
	Steam sterilization	7	7.9%
	All of the above	53	**59.6%**
	None of the above	5	5.6%
6.	**Which of the following methods would be effective in reducing the carbon footprint of the dental industry?**		
	Reducing face-to-face consultations frequency based on patient risk	7	7.9%
	Implementing telemedicine and teleconferencing for patients	13	14.6%
	Combining visits for family members	2	2.2%
	Encouraging staff to utilize public transportation for commuting to and from the clinical practice	19	21.3%
	All of the above	47	**52.8%**
	None of the above	1	1.1%

The study results reveal that the majority of the respondents possess a moderate level of understanding regarding Green Dentistry. Among the 89 respondents, 36 (40.4%) demonstrated moderate knowledge, 24 (27%) indicated good knowledge, and 29 (32.6%) displayed poor knowledge. These results underscore the necessity for dentists to enhance their environmental knowledge. The study results reveal that the majority of respondents (40.4) fall into the moderate knowledge category. Additionally, 27% of respondents demonstrate good knowledge, while 32.6% have poor knowledge of the Green Dentistry concept. These findings indicate a notable disparity in understanding the concept among dentists.(Table 3)

Table 3. The category of Green Dentistry Knowledge Levels Among Dentists (n=89)

	Number (n)	Percentage (%)
Category		
Good (5-6)	24	27%
Moderate (2-4)	36	**40.4%**
Poor (0-2)	29	32.6%
Total	**89**	**100%**

Table 4. Questions assessing attitude of green dentistry concept in dental practice (n=89)

No.	Questions	Number (n)	Percentage (%)
1.	**Do you believe that environmentally friendly dental practices are a professional obligation, given the substantial evidence on global climate change?**		
	Strongly agree	23	25.8%
	Agree	63	**70.8%**
	Neutral	3	3.4%
	Disagree	-	-
	Strongly agree	-	-
2.	**In your opinion, do you believe that the adoption of eco-friendly practices would attract more patients to your clinic?**		
	Strongly agree	27	30.3%
	Agree	47	**52.8%**
	Neutral	10	11.2%
	Disagree	4	4.5%
	Strongly agree	1	1.1%
3.	**Do you believe that implementing environmentally sustainable practices could improve the efficiency of your clinical operations?**		
	Strongly agree	26	29.2%
	Agree	39	**43.8%**
	Neutral	16	18.0%
	Disagree	6	6.7%
	Strongly agree	2	2.2%
4.	**Do you believe that formal education on environmentally sustainable practices is essential for dentists?**		
	Strongly agree	20	22.5%
	Agree	58	**65.2%**
	Neutral	10	11.2%
	Disagree	-	-
	Strongly agree	1	1.1%
5.	**Do you believe that adopting environmentally sustainable practices would be more cost-effective for dentists, necessitating minimal resources and avoiding significant alterations to the practice's existing infrastructure?**		
	Strongly agree	11	12.4%

Agree	33	37.1%
Neutral	43	**48.3%**
Disagree	2	2.2%
Strongly agree	-	-

The study findings indicate that a significant majority of respondents exhibit a positive attitude toward Green Dentistry. Specifically, 70.8% of respondents believe that adopting environmentally friendly practices is an obligation, while 65.2% agree that formal education on Green Dentistry is essential for dentists. This favorable disposition suggests a potential for broader implementation of Green Dentistry principles. Nevertheless, concerns remain about the costs associated with implementing these changes. (Table 4)

Table 5. The Category of Green Dentistry Attitude Levels Among Dentists (n=89)

	Number (n)	Percentage (%)
Category		
Good (19-25)	35	39.3%
Moderate (12-18)	54	**60.7%**
Poor (5-11)	-	-
Total	**89**	**100%**

The study findings reveal that 60.7% of respondents fall into the moderate attitude category, while 39.3% demonstrate a good attitude. This underscores the need for increased efforts to improve both attitudes and practices related to Green Dentistry principles. (Table 5)

Table 6. Questions assessing practice of green dentistry concept in dental office (n=89)

No.	Questions	Number (n)	Percentage (%)
1.	**When washing your hands, do you turn off the water while lathering with soap?**		
	Yes	76	**85.4%**
	No	13	14.6%
2.	**Do you implement energy management practices in your clinic, such as utilizing LED lighting?**		
	Yes	53	**59.6%**
	No	36	40.4%
3.	**Do you use recycled paper products to manage paper waste in your clinic, such as recycled paper for prescription pads?**		
	Yes	12	13.5%
	No	77	**86.5%**
4.	**Do you prefer environmentally friendly alternatives to single-use products, such as choosing reusable glass or metal cups?**		
	Yes	57	**64.0%**
	No	32	36.0%
5.	**Do you use eco-friendly dental products, such as bamboo toothbrushes, and recommend them to your patients?**		
	Yes	33	37.1%
	No	56	**62.9%**
6.	**Do you prefer using electronic medical records for managing patient data?**		
	Yes	82	**92.1%**
	No	7	7.9%
7.	**Do you use reusable personal protective equipment, such as fabric scrubs?**		
	Yes	80	**89.9%**

No	9	10.1%

The study findings indicate that 89.9% of respondents fall into the moderate category regarding the use of reusable personal protective equipment, while 92.1% have adopted electronic medical records. (Table 6)

Table 7. The category of Green Dentistry Practice Levels Among Dentists (n=89)

	Number (n)	Percentage (%)
Category		
Good (6-7)	35	4.5%
Moderate (3-5)	50	**56.2%**
Poor (0-2)	4	39.3%
Total	**89**	**100%**

The study findings show that 56.2% of respondents exhibit moderate levels of action, 39.3% demonstrate poor practices, and only 4.5% display good practices. This suggests that, although there is awareness of environmentally friendly practices, broader implementation still needs significant improvement.(Table 7)

Table 8. The category of Green Dentistry Behaviour Levels Among Dentists (n=89)

	Number (n)	Percentage (%)
Category		
Good (28-38)	27	30.3%
Moderate (17-27)	62	**69.7%**
Poor (5-16)	-	1
Total	**89**	**100%**

The study findings reveal that the dentists' behaviors in applying Green Dentistry concepts is largely categorized as moderate. Specifically, 69.7% of respondents demonstrate moderate behaviors in this area. This indicates that, although most dentists in Lampung recognize the importance of Green Dentistry, its implementation is not yet fully optimized. (Table 8)

This study included respondents aged 20 to 65 years, with the 36-45 age group being the most prevalent at 42.7%. The majority of respondents are female, aligning with findings from a study by Agrasuta et al. in Thailand, which also identified a predominance of females (72.2%) in the dental profession (Agrasuta et al., 2013). Additionally, women are generally more active than men in adopting environmentally friendly dental practices.

The majority of respondents possess moderate knowledge of Green Dentistry, with 40.4% of the 89 participants falling into this category. This finding aligns with the study by Khairani et al. (2018) in Bukittinggi, which reported that 56.8% of respondents had limited knowledge of Green Dentistry (Khairani et al., 2018) . Additionally, most respondents demonstrate an understanding of amalgam waste management and the use of environmentally friendly dental hygiene tools.

In response to specific questions about environmentally friendly technologies, such as CAD/CAM and electronic medical record systems, 59.6% of dentists recognize that these technologies can help reduce the environmental impact of their practice. This understanding is supported by Nagarale et al. (2013), who found that technologies like CAD/CAM and digital record-keeping are essential for reducing the carbon footprint of dental practices (Nagarale et al., 2013).

Dentists demonstrate very positive attitudes toward Green Dentistry, with 70.8% of respondents believing that environmentally friendly practices are a duty. Furthermore, 65.2% agree that formal education on this concept is essential. These attitudes align with the findings of Zia et al. (2024), which demonstrated that the majority of dentists hold a positive view of Green Dentistry implementation and recognize the crucial role of formal education in enhancing understanding. (Zia et al., 2024).

The study findings also indicate that 56.2% of dentists in Lampung demonstrate moderate behaviors in implementing Green Dentistry. Additionally, 85.4% of dentists practice water conservation by turning off the water while washing

their hands, which is a critical step in reducing water waste and aligns with Green Dentistry principles (Saxena et al., 2023). Furthermore, 59.6% of respondents use energy-saving technologies, such as LED lighting, consistent with study in India that highlights LED lights as highly energy-efficient and effective in reducing carbon emissions (Alshamrani & Alzahrani, 2024).

Challenges persist in paper waste management, with 86.5% of respondents not yet using recycled paper in their practices. This issue is also noted in the study by Nagarale et al. (2021), which found that many dentists have not fully adopted recycling practices (Nagarale et al., 2013). Additionally, the use of single-use products remains problematic, as 46% of dentists in the Province of Lampung continue to use plastic cups. In contrast, study in Modinagar indicates that many dentists have transitioned to reusable metal cups (Rafia & Singla, 2023).

Dentists in the Province of Lampung have not widely promoted Green Dentistry to their patients, with only 37.1% recommending eco-friendly products such as bamboo toothbrushes. This highlights a need for improvement, given the importance of engaging patients in Green Dentistry practices (Alshamrani & Alzahrani, 2024). On a positive note, the majority of dentists, 92.1%, are already using electronic medical records. This aligns with the Indonesian Ministry of Health's regulations requiring the implementation of Electronic Medical Records by the end of 2023, which also contributes to reducing paper waste (Thakar et al., 2023).

Overall, the behaviors of dentists in the Province of Lampung regarding Green Dentistry is categorized as moderate. While their knowledge and attitudes are relatively strong, there is a need to intensify efforts to enhance actual practices, especially in waste management and the use of eco-friendly products in daily operations (Nagarale et al., 2021; Saxena et al., 2023).

CONCLUSION

This study concludes that the dentists' behaviors in the Province of Lampung regarding the implementation of Green Dentistry is generally categorized as moderate. Despite having positive knowledge and attitudes toward environmentally friendly dental practices, actual implementation in daily operations still requires improvement, particularly in waste management, the use of single-use items, and the adoption of eco-friendly technologies. Although the majority of dentists recognize the value of technologies such as electronic medical records and energy-efficient lighting, many have yet to adopt paper recycling or promote eco-friendly products to their patients. Therefore, there is a need for enhanced formal education and increased awareness about Green Dentistry to ensure these environmentally friendly practices are more broadly and effectively integrated within the dental profession.

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