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Paper Accepted*

ISSN Online 2406-0895

Original Article / Оригинални рад

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Concept of Green Dentistry in Serbia

Концепт зелене стоматологије у Србији

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Received: December 11, 2023

Accepted: August 31, 2024

Online First: September 3, 2024

DOI: <https://doi.org/10.2298/SARH231211072Z>

* **Accepted papers** are articles in press that have gone through due peer review process and have been accepted for publication by the Editorial Board of the *Serbian Archives of Medicine*. They have not yet been copy-edited and/or formatted in the publication house style, and the text may be changed before the final publication.

Although accepted papers do not yet have all the accompanying bibliographic details available, they can already be cited using the year of online publication and the DOI, as follows: the author's last name and initial of the first name, article title, journal title, online first publication month and year, and the DOI; e.g.: Petrović P, Jovanović J. The title of the article. *Srp Arh Celok Lek*. Online First, February 2017.

When the final article is assigned to volumes/issues of the journal, the Article in Press version will be removed and the final version will appear in the associated published volumes/issues of the journal. The date the article was made available online first will be carried over.

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SUMMARY

Introduction/Objective Green dentistry as a term has been introduced into dental practice in Serbia in recent years. Minimal amount of research on the topic of medical waste disposal in health care institutions are available at the moment.

The aim of this research is to determine how familiar the professional public as well as dental students are with this term and whether they apply the recommended environmental protection measures in their daily clinical work.

Methods The study was conducted in the form of a survey that referred to the attitude of the professional public regarding environmentally friendly dental practice, in the period from June 1, 2022 until November 1, 2022. The survey includes demographic information, as well as 21 questions related to awareness and application of green dentistry in daily clinical practice.

Results Results indicate a very low level of information among the professional public regarding the mentioned concept, where even 36% of the total number of respondents do not have any information about Green Dentistry ($n = 45$) and only 6% ($n = 8$) fully informed about the given concept.

Conclusion On the basis of the obtained results, it can be concluded that the professional public's attitude towards Green Dentistry is such that its application is expected to reduce the consumption of available resources, as well as to improve the environment.

Keywords: green dentistry; sustainability in dentistry, ecological dentistry; medical waste

САЖЕТАК

Увод/Циљ Зелена стоматологија као појам је последњих година уведена у стоматолошку праксу у Србији. Овај концепт се у еколошки освешћеним државама систематски примењује кроз законе које прописује надлежна институција или држава, а усмерени су ка здравственим установама које спроводе мере здравствене заштите. У Србији постоји минималан број истраживања на тему одлагања медицинског отпада у државним и приватним клиникама.

Циљ овог истраживања јесте да се утврди колико је стручна јавност као и студенти стоматологије упознати са овим појмом и да ли примењују препоручене мере заштите животне средине у свакодневном клиничком раду.

Метод Студија је спроведена у виду анкете која се односила на став професионалне јавности у вези са еколошки прихватљивом стоматолошком праксом, у периоду од 1. 6. 2022. до 1. 11. 2022. године. Анкета обухвата демографске информације о учесницима анкете, као и 21 питање у вези са информисаношћу и примени зелене стоматологије у свакодневној клиничкој пракси.

Резултати Резултати истраживања који се односе на концепт зелене стоматологије указују на веома малу информисаност професионалне јавности у вези са поменути концептом, где од укупног броја испитаника чак 36% нема никаквих информација о зеленој стоматологији ($n = 45$) а да је само 6% ($n = 8$) потпуно информисано о датом концепту.

Закључак На основу добијених резултата може се закључити да је став професионалне јавности о зеленој стоматологији такав да се њеном применом очекује смањена потрошња расположивих ресурса, као и побољшање животне средине.

Кључне речи: зелена стоматологија; одрживост у стоматологији, еколошка стоматологија; медицински отпад

INTRODUCTION

Reflections on a healthy environment, cost-effective long-term life resources, and ecological aspects of human progress are the topics to which today's population pays significant attention, most often with the idea of reducing general pollution and the present global warming [1]. The greatest influence on the occurrence of global warming is human activity. In recent years, in Serbia, we have witnessed substantial air pollution in both urban and rural areas [2]. In addition to air pollution, other environmental factors, such as water and soil pollution are significant concerns [3].

Environmental pollution on a global level has far-reaching consequences that pose a threat to the survival of the entire living population. Therefore, it is important to emphasize that professional dental practice, when using different materials without proper application and training, represents a significant potential risk to the survival of a healthy ecosystem [4, 5, 6]. The term "Green Dentistry" (GD) or "Eco Dentistry" has been introduced into dental practice in recent years [7]. The goal of incorporating "green" programs into dental reality is to inform and train dentists to use conventional energy (electricity, water) rationally, minimize the amount of waste and properly dispose of that waste, and make their practices more economical and less risky [8]. This concept has been present for some time in dental practice in environmentally conscious countries, where the GD principle is systematically applied through laws issued by competent institutions or the state and is aimed at health institutions that implement health protection measures [9, 10, 11]. In Serbia, there is a lack of extensive research on the topic of medical waste disposal in both public and private clinics [12].

The strategic postulates promoted by GD are represented by the four R letters (English transcription) which illustrate the initial letters of nouns that support the concept of environmentally friendly and sustainable dentistry (Eco-Friendly Dentistry): "R - Rethink, Reduce, Reuse, Recycle" [13].

Rethink

Environmental awareness and healthy sustainability of civilizational laws are considered a state of mind. Changing the way we think about the way dental offices are operated is the first step in trying to significantly modernize the practice. Thus, by implementing simple changes, it is possible to reduce energy and water consumption in the daily work of dental services.

Reduce

To decrease the consumption of natural resources, it is necessary to modify established habits and reduce the consumption of available resources to a reasonable extent. For instance, reducing paper consumption and properly managing paper waste can help prevent deforestation and mitigate global warming.

Reuse

This strategy encourages the prolonged use of various items. Certain objects can be repurposed after their primary use, thereby extending their use value. Reusing products also reduces the amount of energy required for producing new products.

Recycle

A significant amount of waste found in landfills can be reprocessed and recycled into new products. Intentional, purposeful use of products would reduce the waste of raw materials and energy required for the production of new materials [13, 14].

In addition to the mentioned 4R principles, for the purpose of easier application and modernization of GD, it is proposed to use protocols represented by 4 A letters (Eng.-Four A'S). [15] In practice, the issue of dental waste disposal would be addressed through the following four suggested settings:

1. Ask – (questionnaires): collecting basic data about the habits of a dental clinic
2. Assess - (estimation, assessment): evaluating possible modifications and improvements of daily dental practice towards ecologically sustainable dentistry.
3. Advice - (recommendation): clear guidelines and instructions for implementing the principles of GD
4. Assist - (help, aid): assistance in implementing all environmental procedures and their specific application. The introduction of the 4A principle ("Four A'S") requires forming teams that would be ready to carry out training through continuous medical education, as well as ensure its implementation in daily practice.

Considering the topicality of the stated views, this research objective is to determine how familiar Serbian dentists, dental nurses, dental technicians, and dental students are with the term GD, whether they apply it, and which recommended environmental protection measures they utilize in their daily clinical work.

METHODS

This study was designed as a cross-sectional study and included all employees in the dental profession (public and private sector) who perform part of their specialist training or internship at the Department of Dentistry, Faculty of Medical Sciences, University of Kragujevac.

The study was conducted in the form of a survey to assess the attitude of the professional public towards environmentally friendly dental practices from June 1, 2022, until November 1, 2022. Prior to filling out the survey, respondents were informed that all obtained data would be used exclusively for research purposes, personal data would not be used, and complete anonymity would be guaranteed. After completing the survey by circling one of the offered answers for each question, they return the survey to the researcher, and the researcher in charge of conducting the survey (M.J.) must pack it in an envelope, seal it, and forward it to the main researcher (D.Z.) for data processing. The survey includes demographic information about survey participants, but in addition to this data, it also contains 21 questions related to the awareness and application of GD in daily clinical practice (Figure 1).

The inclusion criteria for the study involved respondents from the dental profession with varying years of service who agreed to participate, while the exclusion criteria included individuals who were not interested in participating in the study as well as those who incorrectly or inadequately filled out surveys.

After data collection, further processing was carried out by the main researcher using the commercial, standard software package SPSS v20.0.

The sample size was determined based on studies of similar designs [16]. The study sample was determined taking into account the following initial parameters: a study power of 80%, as well as a type 1 error probability (α) of 0.05. The sample size was calculated using the G Power v3.1 program for the t-test. The minimum required sample (number of respondents) in the research is 120 respondents.

The research was approved by the Ethics Committee of the Faculty of Medical Sciences of the University of Kragujevac (number 01-6013 on May 20, 2022).

RESULTS

The results of the research are presented in table and graph form (Table 1, Figure 2). The research included a total of 124 respondents ($n = 124$), with the majority being students enrolled in integrated academic studies in dentistry ($n = 68$). The next largest group of respondents in terms of sample size were dentists ($n = 42$) who were either employed at the Faculty of Medical Sciences of the University of Kragujevac or were completing part of their specialist internship in various fields of dentistry at this institution. Considering the size of the clinic and the staffing needs of the Faculty of Medical Sciences for dental nurses and dental technicians, a reasonably smaller number of respondents included these two groups (dental nurses: $n = 6$; dental technicians: $n = 8$). Regarding the two largest groups of respondents (students: $n = 68$; dentists: $n = 42$), among students, the gender distribution was in favor of the female gender with 78% ($n = 53$), while among dentists, the percentage of females was slightly higher at 83% ($n = 35$). Overall, this indicated, that, of the total number of respondents, a significant majority of respondents were female, with 81% ($n = 100$). The age of respondents was categorized into 5 age groups, with the largest number of respondents falling into the 20–29 age group (71%), which was directly influenced by the numerically largest group of respondents - students. The work experience of the respondents was divided into 5 groups, excluding the group of students. Among dentists, the years of work experience were almost equally distributed in the first two groups, with a total percentage of 38% for the group with 0–5 years of work experience while the group with 6–10 years of work experience accounted for a total percentage of 36%.

The research findings related to the concept of green dentistry indicate a very low level of awareness among dental professionals, in fact, 36% of the total number of respondents had no information about GD ($n=45$) and only 6% ($n=8$) had a comprehensive understanding of the concept. Despite the low level of knowledge, it can be inferred that the professional public holds a positive attitude towards GD, expecting its application to reduce resource consumption and improve the overall "healthy environment".

However, it is noteworthy that respondents also anticipate an increase in the overall costs of daily work associated with the implementation of GD principles. It is also important to note that respondents have a positive opinion about material recycling, while also demonstrating a high level of awareness regarding the harmful effects of amalgam and mercury on the environment as well as on therapists and patients. The encouraging data obtained from this survey is

that a significant portion of the student group supports the idea of including GD concepts in the curriculum of integrated academic studies of dentistry.

Using the Mann-Whitney test for independent samples to compare the different groups, statistically significant results were obtained, indicating a strong association between certain survey questions and the gender of the respondents (Table 1).

Furthermore, significant statistical results were also observed when analyzing the age groups and their responses to the survey questions using the Kruskal-Wallis test. The most prominent statistical result was found when comparing the survey questions related to the relationship between GD and education level as well as years of service (Table 1).

Regarding the comparison of the years of study among students and the survey questions, two questions showed statistically significant results based on the Kruskal-Wallis test. Question 11 illustrated the application of digital radiography, and question 17 was related to the respondents' awareness of the harmful effects of mercury on patients, therapists, and the environment. These findings highlight the students' knowledge and awareness about the positive impact of digital radiography, and potential mercury side effect. These findings highlight the students' knowledge and awareness in these areas, demonstrating their understanding of the benefits of digital radiography and the potential risks associated with mercury.

DISCUSSION

The implementation of ecological principles has been receiving increasing attention in recent years [17]. While our country may not be densely populated, air pollution remains a significant issue, adversely affecting the quality of life for residents. The development of environmental awareness and the pursuit of a sustainable, healthy environment are global concerns [18, 19, 20]. Therefore, it is necessary to apply ecological principles to all aspects of life [21]. This led to the establishment of the "Eco-Dentistry Association" in 2008, based in Berkeley, USA.

Today, the scientific literature contains an increasing number of scientific papers addressing this problem.

A study conducted by Sabha M. Al Shatrat et al. focused on the implementation of GD principles specifically related to the proper management of amalgam fillings and the associated waste

[22]. The problem of amalgam waste was also addressed by Margot H., who discussed potential pollution directly stemming from the material itself. The study highlighted the evaporation of mercury from the amalgam alloy, the residual amalgam during material preparation, excess amalgam created in modeling fillings, and the presence of amalgam particles in drainage systems, filters, and dental chair components [23].

In this pioneering study, the first of its kind and scope within the Serbian dental community, there was a high level of awareness among respondents regarding the harmful effects of amalgam and mercury on the environment, therapists, and patients. These findings coincide with the results of the aforementioned study by Sabha M. Al Shatrat et al., which also indicated high awareness about the harmfulness of mercury and amalgam [22].

Apart from these findings, the conducted study demonstrates that the dental profession supports the adoption of modern digital radiography as the preferred method in daily practice.

J. Richardson have conducted interesting research on the presence of various types of waste in dental clinical practice. Their findings reveal that paper waste constitutes the highest percentage of infectious waste at 33%, followed by gloves at 26%, and sterile packaging for instruments at 11%. When considering the types of materials used in dental practice, plastic waste was found to be the most common at 34%, while paper waste accounted for the largest mass [24].

Hancocks O.S. explored the materials used in dental and oral hygiene products. The author emphasizes the importance of the trend toward using natural materials for toothbrushes and toothpaste. This is recommended to reduce the amount of plastic waste, which takes a long time to decompose [25].

Sidhi Passi and his co-authors provide a definition of GD as defined by the Eco Dentistry Association, which consists of 15 clear guidelines for dentists on how to apply GD principles in their daily practice and minimize the harmful impact on the environment [14].

While previous authors have mainly focused on the problem of waste management in dental practice, few authors have addressed the root of the problem, which is the education of dental students and dental staff. A study conducted in Brazil at two dental schools and a healthcare institution revealed that the private school had the highest amount of non-infectious waste due to incorrect sorting, while the public school had the highest percentage of infectious and

potentially infectious waste. The healthcare institution had the lowest amount of waste compared to school institutions [26].

In addition, a study conducted at Hacettepe University in Turkey by Ozbek M. and colleagues revealed that the largest amount of waste, measured in grams, was generated by the prosthetics clinic, totaling 13,403 grams over a period of two months [27]. The results presented in this research support the adoption of modern principles in dental practice, particularly the utilization of digital technologies in the manufacturing process of dental restorations.

During a conference in Berlin in August 2019, the topic of GD was discussed, and a short questionnaire was used to assess dentists' understanding of sustainability in dental practice. To address this, a graph was created to illustrate the concept of GD in a more accessible manner, aiming to educate and facilitate the implementation of sustainable dentistry for all dental professionals [28, 29].

CONCLUSION

This research highlights that the protocols of ecological dentistry are largely unknown among dental professionals in Serbia and that fundamental changes are needed within the field. However, there is promising interest among young individuals, particularly dental students, regarding the concept of GD and the potential inclusion of this eco-friendly and rational approach in the curriculum of higher education institutions in Serbia. Given that this study is the first of its kind in the field of dentistry in Serbia, it is recommended that further research on this topic is supported by various entities (faculties, ministries, and medical chambers) with the aim of protecting the dental profession and the community as a whole.

Conflict of interest: None declared.

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Survey (survey is voluntary and anonymous)					
Demographic information of survey participants					
Gender	M		W		
Age	20–29	30–39	40–49	50–59	60–69
Education	Dentist	Dental assistant	Dental technician		Student
Work experience	0–5 years	5–10 years	10–15 years	15–20 years	Over 20 years
If you answered "Student" to the question about education, complete the year of study.		1. Third year of study 2. Fourth year of study 3. Fifth year of study			
1. I am familiar with the term "green dentistry" or "ecological dentistry"					
1) I totally disagree					
2) I partially disagree					
3) Thread I agree nor disagree					
4) I partially agree					
5) I totally agree					
2. Do you agree that dental practice improves the overall "healthy environment"					
1) I totally disagree					
2) I partially disagree					
3) Thread I agree nor disagree					
4) I partially agree					
5) I totally agree					
3. Do you agree that eco-dentistry protocols can contribute to energy savings and reduced water consumption					
1) I totally disagree					
2) I partially disagree					
3) Thread I agree nor disagree					
4) I partially agree					
5) I totally agree					
4. Do you agree that changing the existing dental practice to "green" is feasible in the near future					
1) I totally disagree					
2) I partially disagree					
3) Thread I agree nor disagree					
4) I partially agree					
5) I totally agree					
5. Do you agree that changing the existing dental practice to "green" will be an additional financial burden					
1) I totally disagree					
2) I partially disagree					
3) Thread I agree nor disagree					
4) I partially agree					
5) I totally agree					
6. Do you agree that dental products that are the result of environmental practice are readily available on the market					
1) I totally disagree					
2) I partially disagree					
3) Thread I agree nor disagree					
4) I partially agree					
5) I totally agree					
7. Do you agree that waste recycling is an additional financial burden for conducting dental practices					
1) I totally disagree					
2) I partially disagree					
3) Thread I agree nor disagree					
4) I partially agree					
5) I totally agree					
8. Do you agree that a recycled instrument or accessories for work is not as "clean" as conventional instruments or accessories that are sterilized by standard procedures?					
1) I totally disagree					
2) I partially disagree					
3) Thread I agree nor disagree					
4) I partially agree					
5) I totally agree					

9. Do you agree that energy consumption is increased by using recycled materials
1) I totally disagree
2) I partially disagree
3) Thread I agree nor disagree
4) I partially agree
5) I totally agree
10. Do you agree that water consumption increases using recycled materials
1) I totally disagree
2) I partially disagree
3) Thread I agree nor disagree
4) I partially agree
5) I totally agree
11. Do you agree that the application of digitized radiography is environmentally friendly
1) I totally disagree
2) I partially disagree
3) Thread I agree nor disagree
4) I partially agree
5) I totally agree
12. Do you agree that the radiography material should be disposed of as municipal waste
1) I totally disagree
2) I partially disagree
3) Thread I agree nor disagree
4) I partially agree
5) I totally agree
13. Do you agree that the application of composite materials is more environmentally friendly than the application of amalgam for fillings
1) I totally disagree
2) I partially disagree
3) Thread I agree nor disagree
4) I partially agree
5) I totally agree
14. Do you agree that amalgam for fillings should be disposed of as medical waste according to the set protocols
1) I totally disagree
2) I partially disagree
3) Thread I agree nor disagree
4) I partially agree
5) I totally agree
15. Do you agree that the separation of medical from municipal waste in everyday practice contributes to environmental protection
1) I totally disagree
2) I partially disagree
3) Thread I agree nor disagree
4) I partially agree
5) I totally agree
16. Do you agree that the separation of medical waste into infectious and non-infectious in everyday practice contributes to the protection of the environment
1) I totally disagree
2) I partially disagree
3) Thread I agree nor disagree
4) I partially agree
5) I totally agree
17. Do you agree that mercury has a detrimental effect on the patient, therapist and the environment
1) I totally disagree
2) I partially disagree
3) Thread I agree nor disagree
4) I partially agree
5) I totally agree
18. Do you agree that your current knowledge of the concept of green dentistry is satisfactory
1) I totally disagree
2) I partially disagree

3) I totally disagree
4) I partially disagree
5) I totally agree
19. Do you agree that green dentistry should be introduced into the study program of integrated academic studies of dentistry
1) I totally disagree
2) I partially disagree
3) I totally agree
4) I partially agree
5) I totally agree
20. Do you agree that your colleagues from other universities are more familiar with this term
1) I totally disagree
2) I partially disagree
3) I totally agree
4) I partially agree
5) I totally agree
21. Do you agree that the current handling of medical and non-medical waste while conducting practical classes is environmentally friendly
1) I totally disagree
2) I partially disagree
3) I totally agree
4) I partially agree
5) I totally agree

Figure 1. Survey parameters implemented in the study

Table 1. Overview of questions that showed great significance compared to gender, age, education and work experience

Question number	Gender Mann–Whitney	Age Kruskal–Wallis	Education Kruskal–Wallis	Work experience Kruskal–Wallis
1	0.434	0.018*	0.000*	0.004*
2	0.901	0.026*	0.000*	0.012*
3	0.216	0.794	0.393	0.049*
4	0.056	0.062	0.555	0.017*
5	0.612	0.358	0.388	0.086
6	0.979	0.051	0.417	0.006*
7	0.932	0.012	0.171	0.118
8	0.012*	0.068	0.001*	0.421
9	0.743	0.807	0.558	0.455
10	0.622	0.479	0.106	0.104
11	0.348	0.523	0.436	0.689
12	0.344	0.076	0.173	0.015*
13	0.958	0.095	0.015	0.050*
14	0.155	0.047*	0.092	0.173
15	0.582	0.054*	0.019*	0.006*
16	0.152	0.443	0.365	0.307
17	0.375	0.000*	0.004*	0.000*
18	0.664	0.683	0.014*	0.044*
19	0.016*	0.099	0.090	0.144
20	0.349	0.279	0.423	0.161
21	0.466	0.154	0.128	0.163

*p < 0.05 – Mann–Whitney test;

*p < 0.05 – Kruskal–Wallis test

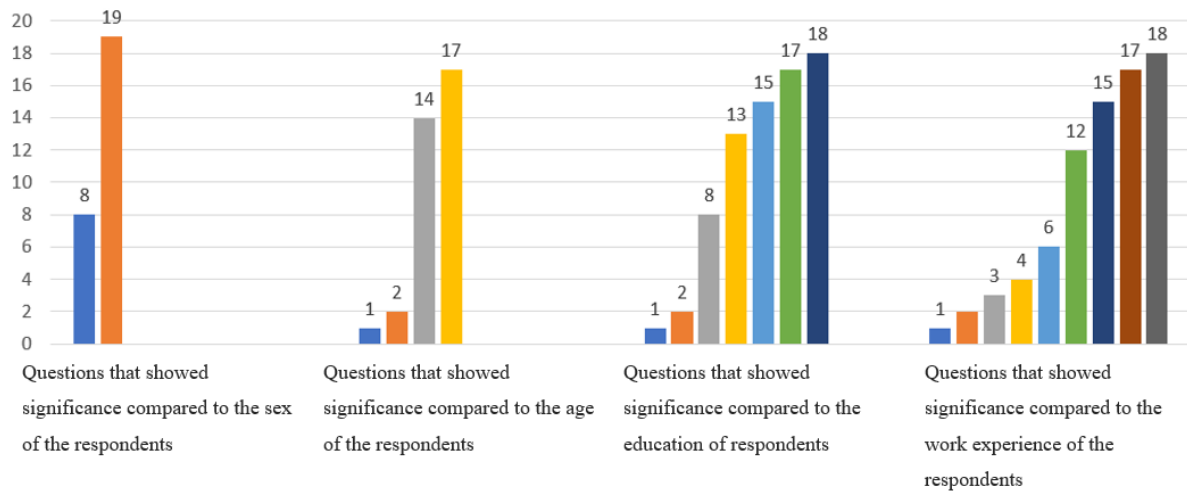


Figure 2. Questions that showed great significance compared to the demographic characteristics of the survey respondents

Paper accepted