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Sustainability Integration in Global Dental Education and Policy Advancing Sustainable Dentistry: Eco-Dentistry Education, Carbon Literacy, and Global Sustainability Indexing

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ABSTRACT: Sustainable practices in dentistry are crucial as the field addresses climate change and environmental issues. In the context of sustainability, this review discusses three main themes: Incorporating eco-dentistry in dental curricula, providing carbon literacy training for students and dental practitioners; and further creating a global sustainability index to evaluate dental practices. Methods included reviewing peer-reviewed articles published in last ten years (2015–2025) and reports from organizations including the World Health Organization (WHO) and World Dental Federation, to gather global perspectives, initiatives, gaps, barriers, and best practices. Findings reveal inconsistencies in incorporating sustainability into dental education; while over 80% of students recognize its importance, fewer than 5% have formal exposure in certain areas. Barriers include busy curricula, a lack of faculty expertise, and limited institutional mandates; however, emerging drivers, such as new competency frameworks and student advocacy, are fostering change. Carbon literacy training, such as the Carbon Literacy Toolkit for Healthcare, is becoming increasingly vital, enabling practitioners to measure and reduce their carbon footprint. There is a consensus on the need for standardized metrics to evaluate sustainable practices. Currently, no global index exists, and initiatives are voluntary. A proposed “Global Dental Sustainability Index” could evaluate practices based on carbon emissions, waste reduction, energy efficiency, and procurement, aligning with international environmental targets. This emphasizes the need for dental education and policy to integrate sustainability through collaborations that embed eco-dentistry, improve carbon literacy, and develop standards, such as a global index. These efforts aim to close gaps, promote sustainable practice, contribute to global health and climate goals.

1. INTRODUCTION

Environmental sustainability (ES) is now recognized as a critical component of healthcare delivery, including oral health care. The healthcare sector is a significant contributor to global greenhouse gas emissions, accounting for an estimated 4.4% of total emissions. This underscores an ethical imperative for the health professions to mitigate their environmental impact.(1,2,3). Dentistry, in particular, has a notable environmental footprint due to energy-intensive clinics, extensive use of water and biomaterials, electrical equipment, and generation of plastic, biohazardous and chemical waste. Recent analyses have quantified this impact: for example, in England's National Health Service (NHS) dental services, annual emissions were ~675 kilotonnes CO₂, with approximately 64.5% of emissions arising from travel (patients and staff), 19% from procurement of dental materials and services, and 15.3% from energy use in dental clinics. (Figure) (4). These findings highlight that “business-as-usual” in dentistry is environmentally unsustainable and that concerted efforts are needed to reduce resource consumption and waste without compromising patient care. (5) (Figure)

1.1. Policy frameworks

Globally, there is growing recognition at the highest policy levels that oral health must align with sustainable development. The World Health Organization's Global Oral Health Status Report (2022) and the recent 2024 Bangkok Declaration on Oral Health emphasize integrating oral health into the broader environmental sustainability and climate resilience agenda for health systems.(6). These policy frameworks emphasize that oral health strategies should not only aim for universal health coverage and disease prevention, but also reduce environmental harm and enhance the climate preparedness of oral healthcare delivery. For dentistry, this translates into adopting “green” practices in clinics and laboratories, promoting disease prevention (to reduce resource-intensive treatments), and building a workforce educated in sustainability principles.

1.2. Sustainability in Dental Education

Despite these imperatives, sustainability remains a relatively nascent focus within mainstream dental education and practice globally. Many dental schools and institutions have only recently begun to consider how to teach and implement eco-friendly dentistry.(5). There is substantial variability across regions: some European and Antipodean dental programs have piloted modules on environmental stewardship, whereas surveys in North America, the Middle East, and Asia report little to no formal integration of sustainability in dental curricula. (6) Likewise, while individual dental practices and organizations (e.g., “eco-dentistry” clinics) have voluntarily adopted greener protocols, there is a lack of comprehensive standards or benchmarks to guide and evaluate sustainability in routine dental practice.(7). In most countries, progress toward environmentally sustainable dentistry has been driven by grassroots enthusiasm or isolated institutional initiatives, rather than coordinated policy mandates.(4). Training in sustainability dentistry and evaluating the environmental impact of dental choices can surely facilitate a paradigm shift by empowering oral health educators and leaders in promoting sustainable oral healthcare practices.

In this context, our review adopts a global perspective on integrating sustainability into dental education and policy, focusing on three interrelated themes: the integration of eco-dentistry into the curriculum, carbon literacy training, and the development of a global sustainability index for dental practices. We examine the current state of each area, highlighting existing initiatives, gaps, and challenges, and discuss strategies and recommendations to advance sustainability in dentistry. By doing so, we aim to provide dental educators and policymakers with a consolidated understanding of how to prepare the future dental workforce for sustainable practice and how to incentivize and measure progress towards an eco-friendlier profession. Ultimately, integrating sustainability is not only about environmental responsibility; it also offers an opportunity to innovate dental education, improve the efficiency of care, and contribute to the broader public health goals of mitigating the impacts of climate change.

2. METHODOLOGY

Following database (PubMed, Scopus, Web of Science) and grey literature searches, 112 records were initially identified. After removing duplicates and screening titles and abstracts, 48 full-texts were assessed. Of these, 32 met the inclusion criteria for the final narrative synthesis. The dataset included 14 original research articles, eight reviews, six policy reports, and four commentaries. Inclusion criteria: (i) publications from 2015-2025; (ii) relevant to sustainability in dental education (eco-dentistry), carbon literacy, or sustainability assessment in dental practice; and (iii) peer-reviewed or authoritative publications. Exclusion: non-English, unrelated to dentistry, or lacking a sustainability discussion. Due to study heterogeneity, a narrative thematic synthesis was used, systematically reviewing and coding documents under three domains.

This study was a structured narrative review with scoping features, aiming to map key concepts, educational frameworks, policies, and sustainability assessment in dentistry. It involved a search in PubMed, Scopus, Web of Science, and grey literature from WHO, FDI, and ADEE, limited to English publications (2015–2025). Articles were screened by relevance to three themes: sustainability in dental education, policy frameworks, and global indicators, with specific inclusion/exclusion criteria. Due to evidence heterogeneity and conceptual focus, findings were synthesized narratively without critical appraisal, aligning with scoping review goals.

A structured literature search and review were undertaken to gather relevant information on sustainability in dental education and practice. We searched major databases (PubMed, Scopus, Web of Science) for peer-reviewed articles published between 2015 and 2025 using combinations of keywords such as “sustainable dentistry,” “dental curriculum,” “environmental sustainability,” “eco-dentistry education,” “carbon footprint dentistry,” “carbon literacy healthcare,” and “sustainability index dental practice.” Additional sources were identified by screening the reference lists of key articles and by targeted searches for institutional reports and policy documents (including WHO oral health reports, FDI World Dental Federation publications, and dental regulatory body guidelines). Given the emerging nature of this field, the authors included commentaries, consensus statements, scoping reviews, and research studies to capture a broad range of insights and proposals.

Literature selection was guided by relevance to the three core themes: (1) integration of sustainability content into dental curricula; (2) training interventions or educational needs for carbon literacy and environmental stewardship among dental students or professionals; and (3) frameworks or proposals for assessing sustainability in dental clinics/practices (including any mentions of indices, metrics, or benchmarking schemes). Priority was given to sources that took a global or multi-country perspective, or those that offered transferable models and recommendations.

2.1. Data Extraction and synthesis

Data were extracted on current practices, identified barriers and challenges, described benefits or outcomes of interventions, and any recommended best practices or standards. Given the heterogeneity of available literature (ranging from quantitative surveys to qualitative reports and opinion pieces), a narrative synthesis approach was used. We thematically organized the findings under the three core areas. To ensure accuracy and topicality, particular attention was paid to recent consensus statements (e.g., FDI and ADEE reports), and policy statements by reputable organizations.

2.2. Curriculum Integration of Eco-Dentistry in Dental Education

Embedding environmental sustainability into the dental curriculum is increasingly recognized as essential for training “future-ready” oral health professionals. Eco-dentistry (or sustainable dentistry) in education refers to teaching the knowledge, skills, and values that enable dentists to minimize the environmental impact of their practice. (5,6) This can include topics such as healthcare pollution and climate change, sustainable clinic practices (including waste segregation, energy conservation, and water conservation), the environmental impacts of dental materials, and the role of prevention and public health in sustainability. A growing body of literature maps the current landscape of such integration – revealing both notable efforts and significant gaps worldwide.(4–7).

Recent literature indicated that the current integration of sustainability into dental curricula is patchy and non-standardized globally. A 2025 scoping review by Bamedhaf et al. mapped sustainability content in dental education across multiple countries and found that, while awareness of environmental issues in dentistry is increasing, formal curriculum content lags.(5). Many dental programs still lack structured learning objectives or courses on sustainability, and the incorporation that does exist is often informal and dependent on individual faculty members' interests. For instance, one study reported that over 80% of dental students in the United States considered environmental sustainability important, yet only 5% had encountered any sustainability-related topics during their training. (7)Similarly, a cross-sectional survey of 26 dental schools in Saudi Arabia found that *none* had formally integrated environmental sustainability into their curricula, despite a high proportion of faculty and students expressing support for its inclusion.(8). These findings echo the situation in many regions, suggesting that sustainability remains a peripheral topic, if addressed at all, in most dental schools.(7,8).

At the same time, there are encouraging developments in the developed countries. In the UK and Europe, the integration of sustainability is poised for significant advancement. A 2024 survey of all dental schools in the UK and the Republic of Ireland, conducted by Dixon et al., reported that 56% of schools were not yet incorporating environmental sustainability into their dental curriculum. (4) Still, most indicated plans to introduce the topic following recent changes in educational frameworks.

Indeed, the General Dental Council (GDC) in the UK updated its competencies (the Safe Practitioner framework) in 2023 to include learning outcomes related to sustainable dentistry, which will be mandated for all graduating dentists by 2030. This move, influenced by a European consensus, essentially requires dental schools in the UK to incorporate and assess sustainability topics in their curricula from 2025 onward(4). Likewise, the Association for Dental Education in Europe (ADEE) convened a special interest group on “Sustainability in Dentistry,” which published consensus reports (2021–2022) outlining recommended curriculum content and specific learning outcomes for environmental sustainability in undergraduate dental education. (5) These consensus outcomes encompass not only theoretical knowledge (e.g., understanding carbon footprints and pollution from dental materials) but also practical competencies (such as waste management in clinics, energy-saving practices, and advocacy for prevention-oriented oral healthcare). The ADEE’s work has been influential; as noted, regulators such as the GDC have begun adopting these outcomes, and universities are using them to design new modules. (6)

Outside Europe, similar momentum is building, albeit slowly. As of 2025, no accreditation standards in North America explicitly require climate or sustainability education in dentistry, and dental curricula are often densely packed with biomedical content. Nonetheless, calls have been made to integrate climate change and health topics. For example, the Commission on Dental Accreditation (CODA) in the U.S. had *no requirement* to teach about climate change or sustainability, urging that standards be updated to prepare dentists for emerging health challenges. Some individual North American schools have begun offering elective lectures or projects on eco-dentistry, often driven by student interest or as part of public health coursework, but these remain exceptions. In the Western Pacific region and Australasia, there are reports of pioneering efforts, such as the inclusion of “minimal intervention dentistry” and public health sustainability in dental programs in Australia and New Zealand. However, comprehensive integration is not yet widespread(8,9). The WHO Global Oral Health Action Plan (2023–2030) encourages member states to incorporate environmental sustainability into oral health professional training, potentially leading to curricular reforms in low- and middle-income countries in the coming years.

2.3. Barriers in integration

Barriers to integrating eco-dentistry include an overloaded curriculum, lack of faculty expertise, limited teaching materials, institutional inertia, cost concerns, mindset barriers, and potential resistance from various stakeholders. Nearly 90% of UK/Irish dental schools cited curriculum time as a major obstacle, while few educators have formal environmental training. The scarcity of resources is easing with the introduction of new toolkits and online courses. However, institutional priorities and perceptions hinder progress, with some viewing sustainability as peripheral to clinical skills. Several drivers and opportunities facilitate the integration of sustainability into dental education. Student demand, with new generations expecting sustainability in their training, strongly influences this shift. In the UK, student advocacy played a role in incorporating sustainability into the GDC’s competency review. Growing faculty support, as many academics and clinicians recognize its importance and are willing to develop curricula with guidance, also drives change.(10–12). Resources like ADEE’s consensus learning outcomes lower the barriers to curriculum design. Institutional missions are increasingly aligning with sustainability goals, enhancing universities’ public image and fulfilling their commitments. Regulatory signals are crucial: when accreditation or exams require sustainability competence, schools comply quickly, as seen with the GDC’s mandates. The availability of resources is improving, with tools like the FDI’s “Sustainability in Dentistry” toolkit and AI based educational options. These materials support faculty and student learning worldwide, making curriculum reform more feasible and justified.

2.4. Carbon Literacy Training for Dental Students and Practitioners

A cornerstone of cultivating sustainable practice in dentistry is improving “carbon literacy” among both students and current practitioners. Carbon literacy in healthcare refers to an awareness of the carbon costs and environmental impacts of one’s activities, as well as the knowledge and motivation to reduce those impacts at both individual and organizational levels. In dentistry, carbon literacy training encompasses understanding the sources of greenhouse gas emissions in dental care (e.g., energy use, travel, and production of consumables), the principles of climate change and its health implications, and strategies for practicing dentistry in a low-carbon manner. Essentially, it is about empowering dental professionals with the competencies to contribute to climate mitigation while delivering oral healthcare.(7,8).

There is a compelling rationale for carbon literacy in dentistry. As outlined earlier, patient and staff travel, along with energy use and procurement, make dentistry a carbon-intensive field (9). If dentists are unaware of these facts, they are less likely to make the desired changes. Moreover, climate change is increasingly recognized as a public health issue that will impact dentistry – from influencing disease patterns to disrupting supply chains and clinic operations. Educating dental teams about climate

change connects their daily work to broader planetary health outcomes. Carbon-literate clinicians can play a role in advocacy (for example, advising patients on environmentally friendly oral health practices or supporting community water fluoridation as a preventive measure that reduces resource-intensive treatments)(13,14). They are also more likely to innovate and support institutional policies that reduce emissions, such as implementing tele-dentistry to reduce travel or investing in energy-efficient equipment.

In practice, carbon literacy training can take several forms. In undergraduate dental programs, it may start with integrating relevant content into lectures on public health or professionalism. For instance, students could learn about the carbon footprint of common dental procedures or calculate the emissions saved by a prevention-focused care plan compared to one with repeated interventions. Some schools have introduced seminar sessions where students audit their clinic's waste output or energy use and present findings on how to improve – exercises that inherently build carbon awareness. Outside the formal curriculum, co-curricular activities such as student-led “green dentistry” clubs or projects (e.g., campus sustainability challenges) have been effective in raising carbon literacy informally.(12,15,16)

For current practitioners, continuing professional development (CPD) courses are key. In the UK, Health Education England has developed online modules, “Environmentally Sustainable Healthcare” and a specific module, “Environmental Sustainability in Dentistry,” which are accessible to all NHS staff. These courses cover the basics of climate science, the NHS's Net Zero goals, and practical steps for dental teams to reduce their carbon footprint. Likewise, the Centre for Sustainable Healthcare (a UK-based organization) provides a Sustainable Dentistry “How-To” guide and workshops for dental professionals to learn about carbon reduction strategies in clinics. One notable initiative is the Carbon Literacy for Healthcare Toolkit, a free resource that any healthcare organization can utilize to conduct a one-day training workshop on carbon awareness and action, developed under the Carbon Literacy Project. This toolkit has been adapted for settings, including dental practices, where participants learn through exercises and pledge specific actions to reduce carbon emissions in their work. Early evaluations suggest such training can significantly increase self-reported knowledge and commitment to sustainable practices among dental staff. (17)

Importantly, carbon literacy is not solely about lectures or knowledge transfer; it strives to achieve behavior change. This is why interactive and applied learning is emphasized. For example, after learning that travel is the single largest emissions source in dentistry, staff might work on a plan to optimize appointment scheduling to minimize patient visits (thus cutting travel frequency)(12). After calculating energy usage, a clinic might pledge to switch to a renewable energy supplier or invest in LED lighting. Carbon literacy thus translates knowledge into concrete sustainability actions. Some training programs encourage participants to make formal pledges (such as reducing personal car use for work or initiating a recycling program in the office) and then follow up on these pledges, thereby embedding new habits. (18)

Another aspect of carbon literacy for clinicians is understanding the concept of climate resilience – preparing practices for the impacts of climate change. While this goes beyond mitigation (carbon reduction), it's often included in comprehensive sustainability training. Dentists learn about how extreme weather events could disrupt supply chains or patient attendance and discuss adaptive measures such as digital record-keeping and flexible scheduling. This broadens the conversation from just reducing emissions to also sustaining oral healthcare delivery in a changing climate. (19)

From a global perspective, the integration of carbon literacy into dental training varies. The NHS has been a frontrunner in linking sustainability to its healthcare quality agenda and offering accredited carbon literacy courses to staff. In other countries, organized carbon literacy training in dentistry is less common; however, interest is on the rise. For instance, the FDI's sustainability MOOC- (Massive open online course) includes a module on the carbon footprint of dentistry and was taken by thousands of participants worldwide in its first year. Some dental associations (e.g., in Canada and Scandinavia) have started to include climate change topics in annual conferences or webinars for their members, signaling a cultural shift. In contrast, in many low- and middle-income countries where dentistry's environmental impact has not been a primary concern, formal carbon literacy initiatives are scarce. However, these contexts also stand to benefit greatly – often, resource constraints mean that many carbon-reducing measures (like conserving materials or energy) align with cost savings and efficiency, which are universally relevant. (20)

Integrating carbon literacy into dental education presents challenges, including limited time and faculty knowledge gaps, which can be addressed through 'train-the-trainer' models and the engagement of guest experts. It offers tangible, motivating targets—such as carbon emissions, travel, and waste—turning sustainability into measurable actions. A carbon-literate workforce can reduce the profession's carbon footprint and better communicate environmental health to patients. Incorporating sustainability

into health advice, such as low-waste dental products, can amplify impact. Although still emerging, carbon literacy is essential for driving change, with potential inclusion in licensure and audits. Existing toolkits serve as valuable resources for dental institutions seeking to promote sustainability education. (21)

A Global sustainability index aims for a standardized, adaptable framework for benchmarking environmental efforts across countries. While challenging due to differing infrastructures, core principles like reducing energy and waste are universal. The index could be flexible, adjusting for context, similar to models like LEED for green buildings and EDA's GreenDOC™ for dental practices.(17). It could be managed by organizations like FDI or WHO, especially as future policies may require sustainability reporting for healthcare facilities. Benefits include setting measurable targets, encouraging competition, aiding public health tracking, and identifying areas for improvement. Developing a global index presents several challenges, including collecting data efficiently, making fair adjustments for practice size, and ensuring regular updates as technology advances. A practical approach involves piloting in selected regions, gaining support from associations, and potentially influencing regulations over time. This index provides a system-level approach to promoting sustainability in dentistry, complementing education and encouraging practices that align with broader sustainability goals.(18).

The proposed Global Dental Sustainability Index (GDSI) is a flexible benchmarking and educational framework, not a regulatory tool. As summarized in Table 2, it integrates seven core domains—energy efficiency, travel and transportation, waste management, procurement and materials, water use, chemicals and pollution control, and policy, training, and organizational culture—each represented by measurable indicators like energy consumption per dental chair, recycling rates, digital radiography adoption, and staff sustainability training. Domains may be scored using a standardized system (e.g., 0–3 or 0–5), with scores aggregated into an overall sustainability score; weighting can be tailored to local priorities, allowing for flexibility and incremental improvement. Beyond benchmarking, the GDSI is applicable in dental education, where it can be used in undergraduate and postgraduate training through sustainability audits, case exercises, and quality projects. Using the index in education promotes systems thinking, boosts carbon literacy, and helps learners understand how decisions affect environmental impact, fostering sustainability-oriented competencies and culture.

3.DISCUSSION

The themes explored in this review, including curriculum integration, carbon literacy, and sustainability indexing, are interrelated components of a cohesive strategy to embed sustainability in global dentistry. Taken together, the findings paint a picture of a profession in the early stages of a paradigm shift. Significant gaps and challenges remain, but there are clear opportunities and a mounting urgency to act.(19,20). One overarching observation is the lag between awareness and action. There is widespread acknowledgement, from global policy halls to dental school classrooms, that environmental sustainability is important. However, concrete actions – whether integrating a new lecture into a course or retrofitting a clinic with energy-efficient lighting – often lag behind this awareness. (21) This lag is due in part to structural barriers (curricular inertia, funding limitations) and in part to the novelty of operationalizing sustainability in a field that historically did not consider it. Bridging this gap will require deliberate efforts, guided by both top-down and bottom-up influences.(22).

From a top-down perspective, policy and accreditation are crucial. The GDC, UK plans to incorporate sustainability into educational outcomes by 2023–2025, demonstrating how quickly schools respond when requirements are established. Similarly, if health authorities or dental boards elsewhere incorporate environmental criteria into their quality standards, adoption will likely accelerate. (23) The WHO's inclusion of environmental sustainability in oral health strategies and FDI's advocacy offer international support that national bodies can turn into local policy. (24) Policymakers can also encourage change through funding, such as grants for curriculum development, staff professional development or subsidies for green technologies. (25) For example, some governments offer incentives for clinics to install solar panels or improve waste segregation; extending this to dentistry could speed up practice changes.(26).

Meanwhile, the bottom-up approach is equally important. Grassroots enthusiasm—especially from students and young dentists—is a powerful driver of this change management. As noted, students demand sustainability content, to own these values into their workplaces after graduation. Supporting student initiatives—such as environmental clubs or research on sustainable dentistry—enriches education and fosters a culture of sustainability. (18) The same applies to early-career professionals who bring fresh ideas; including sustainability in conferences or creating “young sustainability champion” awards can help them implement ideas in practice. A critical theme that runs throughout is the need for faculty and leadership development. Dental educators and practice managers did not traditionally receive sustainability training, and many are learning

alongside their students or staff. (27) Providing workshops, resources, and success case studies to these leaders can build confidence and expertise. For example, sharing a case study of how one dental school successfully embedded an ES module (and perhaps even showing that it did not detract from core competencies) can alleviate concerns elsewhere. Networks of educators (such as the ADEE special interest group) and online communities of practice can facilitate the exchange of teaching materials and tips, thereby reducing duplication of effort (28,29).

Our review highlights the synergy between sustainability and quality in dentistry. Many sustainable practices also improve the quality of care. Prevention, as a sustainability strategy, aligns with good clinical practice. (10) Efficient material use and waste reduction save costs, while telehealth and better scheduling enhance patient convenience and reduce emissions. Emphasizing these benefits reframes sustainability as a pathway to smarter, modern practice. Education should emphasize that “getting it right the first time” reduces repeat visits and emissions, and that durable restorations are both cost-effective and eco-friendly. (11) Despite progress, challenges remain. One is avoiding a one-size-fits-all approach; regions differ, and low-income countries may lack the capacity for advanced sustainability efforts. Global frameworks should allow staged, adaptable progress, starting with efficiency and awareness. (17) Another challenge is measuring impact. More research is needed on how education influences long-term behavior and emission reductions versus technological upgrades. Early evidence is promising, but long-term data and collaboration among researchers, professionals, and environmental scientists are essential for progress. (18).

The cultural change aspect should not be underestimated. Dentistry has strong traditions in how clinical training is delivered and how practices operate. Introducing sustainability involves instilling a new dimension to the professional ethos – that part of being a good dentist is being a steward of environmental resources. This echoes how ethics and humanism were integrated into medical/dental curricula in past decades; initially met with some resistance, they are now considered integral. We are likely witnessing a similar evolution with environmental ethics in dentistry. Champions and role models will play a key role in this cultural shift. Seeing dental faculty or successful practitioners prioritize sustainability can inspire others to do the same. In this review, the three identified themes were explicitly aligned with global sustainability frameworks. Sustainability in dental education supports SDG 4 (Quality Education) and SDG 13 (Climate Action) through workforce capacity building, while policy and practice-level reforms align with health-sector decarbonization and planetary health principles. The proposed Global Dental Sustainability Index reflects SDG 12 (Responsible Consumption and Production) by promoting measurable and accountable sustainability in dental practice; however, key gaps remain, including the absence of standardized metrics, limited longitudinal educational outcomes, and underrepresentation of low- and middle-income settings, highlighting priorities for future research and policy integration.

3.1. Recommendations

Drawing on the findings of this review, we propose the following recommendations for dental educators, professional bodies, and policymakers to accelerate the integration of sustainability in dental education and practice: Integrate sustainability early in dental education by introducing concepts from the first year and reinforcing them through clinical training, making it a recurring theme similar to ethics or infection control. Utilize existing frameworks, such as ADEE’s outcomes, which are tailored to local contexts and include standards requiring competence in sustainability by 2030. Invest in faculty training through short courses, workshops, and the sharing of resources via repositories to enhance teaching and learning. Promote active learning with student-led audits, community projects, and involvement in university sustainability initiatives, emphasizing professional responsibility. Mandate carbon literacy training for all dental team members, utilizing courses such as the Carbon Literacy Project or FDI’s MOOC, to encourage practical changes. Develop sustainability policies for clinics, appointing green champions to monitor progress and organize activities, ensuring ongoing focus and momentum.

This review recommends piloting a dental sustainability index in collaboration with professional and health authorities, starting with practice testing, then scaling it up for national recognition and eventual integration into inspections. Policymakers should support greening efforts with incentives such as grants, loans, and updated regulations that promote the use of sustainable materials. (13) Meanwhile, dental institutions must align with broader health system sustainability initiatives, including international SDG goals. Monitoring progress through surveys, data collection, and research on sustainability practices is crucial, alongside sharing outcomes to inform and improve strategies. Embracing new technologies and updating educational content will ensure ongoing advancement in dental sustainability. (17) Interdisciplinarity is another point of discussion. Dental educators might seek partnerships with environmental engineering or public health departments to co-develop training material, ensuring scientific rigor in sustainability content. At the practice level, dental teams may work with waste management experts or

sustainability consultants to conduct audits and implement improvements. This openness to expertise outside traditional dentistry will strengthen initiatives and should be encouraged.(18).

Dentistry, a minor contributor to emissions, is part of the healthcare sector that ranks fifth globally in terms of emissions. Greening dentistry reduces its environmental impact and promotes public health behaviors related to sugar, nutrition, and sustainability. As the climate crisis worsens, dentists can advocate for healthier environments by collaborating with physicians on sustainability initiatives. Incorporating sustainability into dental education and practice requires changes in curriculum, mindset, and systems, which are urgent to prevent severe climate impacts. Dentistry must uphold the 'do not harm' principle to the planet and future generations, influencing its future resilience and relevance. These efforts should transform dental practice into a global movement, producing professionals who prioritize patient and environmental health, ensuring that dentistry benefits both populations and the planet amid climate change.(20).

4. CONCLUSION

Sustainability in dentistry is an important ethical responsibility that involves dental education, practice, and policy. While global awareness is growing, its systematic integration is inconsistent. Filling this gap with curriculum updates, carbon literacy training, and assessment tools is crucial for preparing a future-ready dental workforce that delivers quality care with less environmental impact.

A global sustainability index for dental practices, though ambitious, points to where the profession should head in the near future. It envisions evaluating clinics' environmental impact alongside clinical quality, requiring international collaboration and phased implementation. This positions dentistry among industries accountable for their role in planetary health. Sustainability aligns with dentists' advocacy for health. Climate change and pollution threaten public and oral health, underscoring the connection between health and environmental stewardship. Integrating sustainability reinforces the principle of 'first, not harm' to ecosystems and communities. The provided recommendations outline a proactive path toward normalizing eco-dentistry in education and practice. As climate indicators worsen, all sectors, including dentistry—driven by new members and leaders—must act urgently. Integrating sustainability into global dental policy is both a challenge and an opportunity. Success means a profession that heals mouths and the planet. This journey has begun; hopefully, by the mid-21st century, dentistry will be recognized for rising to this challenge—being as green as its intent, leaving a legacy of healthy smiles on a healthy planet.

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Legends

Tables

Table 1: Barriers and Drivers for Embedding Environmental Sustainability (ES) in Dental Curricula

Table 2: Proposed Components of a Dental Practice Sustainability Index

Figure

Figure: Carbon footprint of dental services. Minimizing travel requirements, adopting greener procurement practices, and enhancing energy efficiency are key strategies for reducing the carbon footprint of the dental industry

Table 1: Barriers and Drivers for Embedding Environmental Sustainability (ES) in Dental Curricula

Barriers (Challenges to Integration)	Drivers (Facilitators of Integration)
Overloaded curriculum and time constraints – Difficulty adding new content to an already full schedule.	Student demand and interest – Strong support from students who view sustainability as essential to their future practice.
Lack of faculty expertise and resources – Few instructors are trained in sustainability; there have been limited teaching materials until recently.	Faculty and institutional support – Growing recognition among educators and universities that ES is part of modern professional training.
No formal requirement or mandate – Absence of accreditation or policy requirements, leading to low institutional priority.	Regulatory changes – Accreditation bodies beginning to include ES competencies (e.g., GDC mandating ES outcomes by 2030), creating pressure to comply.
Perceived costs or logistical issues – Concerns about implementing sustainable practices in teaching clinics (equipment, protocol changes).	Consensus frameworks and resources – Availability of published learning outcomes, toolkits, and Massive open online course-(MOOCs) that give clear guidance on <i>what and how</i> to teach.
Inertia or competing priorities – Other curricular topics and immediate accreditation needs overshadow sustainability content.	Global and institutional sustainability goals – Aligning with universities' sustainability strategies and the global Sustainable Development Goals (SDGs) encourages the inclusion of ES in curricula.
Limited awareness of relevance – Some educators are not convinced of the link between dentistry and environmental impact (diminishing as evidence grows).	Ethical and professional responsibility – Acknowledgement that dentists have a duty to practice in an environmentally responsible manner, as emphasized by professional bodies.

Table 2: Proposed Components of a Dental Practice Sustainability Index

Domain	Example Indicators (per practice or clinic)	Relevance
Energy Efficiency	– Annual energy use (kWh) per dental chair or per patient. Percentage of energy from renewable sources (solar, wind, etc.) used on-site or via green suppliers	Clinics are energy-intensive (lighting, sterilization, HVAC). Lowering energy usage and switching to renewable sources reduces the carbon footprint.
Travel & Transportation	– Patient and staff travel emissions (CO ₂ e) per month, % of patients using low-carbon transport (walking, cycling, public transit), Telemedicine/tele-dentistry utilization rate (to avoid travel)	Travel is the largest contributor to emissions in the dental industry. Tracking and reducing travel through scheduling, telehealth, and active transport can significantly cut emissions.
Waste Management	– Total waste generated per dental procedure or per patient % of waste recycled or safely segregated (recycling rate) Amount of hazardous/clinical waste reduced (kg)	Dental care generates plastic, chemical, and biomedical waste. Higher recycling rates and lower total waste indicate efficient and environmentally conscious practices.
Procurement & Materials	– % of dental supplies procured that are reusable or made of sustainable materials. Presence of an eco-friendly procurement policy (yes/no) and supplier sustainability credentials, Inventory of single-use plastics eliminated or replaced with reusables	Sustainable procurement minimizes upstream environmental impact. Favoring products with lower lifecycle footprints and reducing single-use items helps lower resource depletion and pollution.
Water Use	– Water consumption per month (or per patient), Water-saving measures in place (e.g., efficient autoclaves, plumbing fixtures)	Water is a vital resource; practices can implement conservation (important in regions facing water scarcity). Reducing water also often saves energy (hot water).
Chemicals & Pollution	– Amalgam separator present and functional (mercury control). Use of digital radiography % (reduces chemical use), Proper disposal protocols for x-ray fixers, solvents, etc. (compliance)	Ensures that hazardous chemicals (mercury, lead, etc.) are not polluting the environment. Digital workflows reduce the use of chemicals and materials.
Policy & Culture	– Practice has a written sustainability policy or “green team” (yes/no). Staff received sustainability training (% of staff carbon-literate), Patient education: presence of patient-facing info on green practices (yes/no)	Captures the organizational commitment. A sustainability-oriented culture (with trained staff and policies) is essential for continuous improvement and engages patients in the effort.