# Environmental Impact and Sustainability Associated with the Practice of Dermatology

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**OBJECTIVE:** The environmental impact of the practice of medicine, including dermatology, can be significant, driven by a growing and aging population that increasingly demands medical resources. This review explores the environmental effects of the practice of dermatology and identifies actionable solutions to reduce negative environmental impacts. **METHODS:** A PubMed search was conducted using the terms ("environmental impact" OR "sustainability") AND "dermatology." Results were screened to include English-only articles between 2018 to 2024 and excluded duplicates. Further exploration of dermatology's environmental effects was enhanced through citation tracking and additional PubMed searches. **RESULTS:** A total of 25 articles were included based on relevance and search terms and an additional 21 were added. Results were categorized into six categories for data representation. Patient travel was the largest contributor to negatively impact the environment, followed by waste management practices, journal publication and written patient material, and traveling to medical conferences. The environmental impact of pharmaceuticals, including topicals, is also notable. Potential sustainable alternatives include teledermatology, more appropriate waste production and segregation, and electronic versus printed formats and more virtual conferences. Additionally, dermatologic disease evolves in response to a changing environment, with new data indicating epidemiological shifts due to climate change. More sustainable practices within dermatology also have the potential to cut total overhead expenses. **CONCLUSION:** Clinical and surgical subspecialties, specifically dermatology, can contribute significantly to environmental pollution, leading to environmental and financial impacts, but implementing simple, documented methods can reduce their ecological footprint and provide potential financial benefits. **KEYWORDS:** Environment, sustainability, dermatology, climate change, medical waste, emissions

The practice of medicine, while crucial for maintaining health and well-being, can potentially have a substantial environmental impact, contributing to the growing concern of climate change. Healthcare is remarkably carbon-intensive, accounting for 10 percent of total greenhouse gas emissions in the United States, whose healthcare sector accounts for 25 percent of the total global healthcare-related emissions.[1] As global populations and medical demands increase, the healthcare sector's resource consumption rises accordingly. This surge not only fuels direct emissions of greenhouse gases but may also have broader ecological consequences. Over half of known human pathogenic diseases can be exacerbated by climate change.[2]

Sustainability in dermatology is growing in importance as the field addresses its environmental impact amidst a global push for ecological responsibility. Dermatologists believe that climate change should be a priority for the specialty.[3,4] As the practice of dermatology relies on significant numbers of in-person patient visits, a range of products from topical treatments to surgical supplies, and resource utilization and waste associated with medical education in the form of journals and continuing medical education (CME) meetings, it contributes to significant resource use and waste. In turn, the changing environment may play a role in the pathogenesis and epidemiology of many dermatological conditions.[5] This review aims to explore the environmental impacts associated with the practice of dermatology and discuss impacts that a changing environment potentially has on the dermatologic disease. By examining these factors alongside the broader effects of pharmaceuticals and personal care products on ecosystems, this review seeks to identify areas for change in dermatology to mitigate its ecological impact. Ultimately, the goal is to contribute to a dialogue within the medical community about reducing environmental harm while maintaining high standards of patient care.

## METHODS

A literature review was conducted on PubMed to examine the impact of dermatological care on the environment. This review was based on articles sourced through a targeted search, between the years of 2018

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to 2024, using: ("environmental impact" OR "sustainability") AND "dermatology". The review excluded non-English articles. Further investigation into dermatology's environmental effects were enhanced through citation tracking and additional PubMed searches.

## RESULTS

Our search criteria yielded 162 articles, which were subsequently reviewed for content and data quality. Duplicates were excluded, then titles and abstracts were reviewed for relevance and excluded or included accordingly. A total of 25 articles were included in this narrative literature review terms and an additional 21 were added from other sources. To streamline data organization and communication, the findings were categorized into distinct areas of environmental concern: patient travel associated emissions, ecological presence of pharmaceuticals, medical waste production, medical journals and patient education materials, medical conferences and the environment and dermatologic disease. Any additional, relevant data that did not fit within these categories was included to ensure comprehensive reporting and transparency in our results.

**Emissions associated with patient travel.** Traveling associated with clinical visits and procedures has a notable environmental influence. For instance, 75.1 percent of Americans live an average of 12.5 miles of a radiation treatment center, and 1.8 percent live over 50 miles from a radiation center.[6] A cross-sectional study was conducted at a dermatology department to evaluate the impact of travel for surgical visits on $CO_2$ emission rates over the span of one year. A total of 2,184 patients had 2,358 procedural visits. Collectively, these patients traveled over 68,000 miles, averaging 31.24 miles per patient. This travel was estimated to result in 20,650kg of $CO_2$ emissions annually, or 8.76kg per visit.[7] In 2016, the Center for Disease Control (CDC) reported 44,000,000 dermatology visits.[8] This means that there is more than 385,000,000kg $CO_2$ emissions annually from travel for dermatology visits alone.

**Ecological presence of pharmaceuticals.** Medications given to patients in any form, including topically, may find their way into the environment. Multiple studies have shown the ecotoxicology of antidepressants, specifically selective serotonin reuptake inhibitors (SSRIs), noting that they have been found in both wastewater and municipal water supplies at varying concentrations.[9] The presence of these antidepressants and their metabolites in different water samples is attributed to human metabolism and excretion, as many pharmaceuticals reach environments while still in the active metabolite phase.[9] Subsequent studies based on these data have commented on the effects of this pharmaceutical pollution on aquatic ecosystems, reporting effects including circadian disruption and predation risk increases.[9,10] Another study sought to quantify the amount of five non-steroidal anti-inflammatory drugs in surface water, wastewater, and drinking water and found that all five had measurable concentrations in all categories of water tested.[11] Specific to dermatology, a study analyzed groundwater at a popular tourist destination in Mexico and found significantly higher levels of both antibiotics and sunscreen ingredients, namely oxybenzone, in the water supply. These higher levels were present both with and without significant tourists present, although when tourists were present, a broader diversity of antibiotics and sunscreen products were found within the groundwater.[12] Previous studies have also demonstrated a potential link between chemical-based sunscreens and coral bleaching.[13]

**Medical waste production.** Surgical associated specialties like dermatology are not only resource-intensive but also generate large amounts of regulated medical waste, often referred to as infectious or "red bag" waste in addition to non-medical waste materials. Medical waste is typically managed through incineration, which leads to environmental damage via harmful byproducts and $CO_2$ emissions generated from waste transport. These byproducts can include potent toxins (ie, dioxins and furans) and particulate matter.[14]

Surgical subspecialists may decide to use disposable or reusable surgical instruments. This decision is influenced by several factors, including the availability of space for internal management (ie, sterilization) and the frequency of procedures. Studies have shown that recycling single-use instruments is currently both energy-intensive and economically unfeasible.[15] The field of dermatology ranks second in plug-and-process load (ie, electrical loads in buildings that are not related to lighting, heating, ventilation, cooling, and water heating) in addition to generating a large amount of procedural waste.[16] Studies have also examined the environmental impact of supervised surgical training, reporting increased resource use and waste production.[17,18] Another study found that carbon emissions from material waste alone were 644kg $CO_2$ equivalents ($CO_2e$, the equivalent amount of waste produced if it were only in the form of carbon dioxide) from just 25 Mohs treatment centers.[19] This data can be used to estimate the total amount of waste produced by the 12,040 non-self-employed dermatologists in the United States, which totals 136,031kg of $CO_2e$.

**Medical journals and patient education materials.** Beyond the clinical setting, printed dermatology journals can significantly contribute to waste production and therefore a larger carbon footprint. One study analyzed the environmental impact of printed journals. The study concluded that receiving printed paper journals annually contributes about 2,470 to 2,830kg of $CO_2e$, at their specific institution. *The Journal of the American Academy of Dermatology* (JAAD) alone has a circulation of nearly 17,000 as an example of a journal's involvement in global waste production.[20]

**Medical conferences.** Physicians often travel to attend conferences and the environmental footprint of the travel is significant, as transportation is the largest source of greenhouse gasses in the United States.[21] A national gastroenterology conference found an individual contribution of 540kg of $CO_2$ emissions per participant. Furthermore, a study was published that implemented a theoretical in-person dermatology event and estimated $CO_2$ emissions based on the attendance of 576 individuals from all over the world, including the United States. The unadjusted estimated carbon emissions for attendees was estimated based on the tendency to fly or drive by distance from the conference and were found to be around 408,000kg and 4,000kg, respectively. This equates to burning over 400,000 pounds of coal and requires an entire year for a 450-acre forest to sequester that amount of $CO_2$.[22,23]

Table 1 illustrates the annual waste production across various categories of potential dermatology aspects mentioned, highlighting the significant environmental impact of each category.

**TABLE 1.** Annual waste production across various dermatologic outlets, extrapolated and standardized to kg $CO_2e$/year.

| CATEGORY | WASTE PRODUCTION KG/$CO_2E$/YEAR | SUSTAINABLE ALTERNATIVE |
|---|---|---|
| Procedural visits and patient travel[7,19] | 385,440,000 | Teledermatology |
| Waste management[19] | 136,031** | Proper segregation, recycling, autoclave |
| Academic printed literature[20,22] | 29,885–34,240*** | Electronic format |
| Dermatology conference*[23,41] | 408,000 | Virtual setting |

*Estimated waste produced from a theoretical, in-person dermatology conference
**Waste production was calculated using data from 25 Mohs treatment centers. This data was used to determine the waste produced per surgeon, which was then extrapolated to estimate the waste production for the 12,040 non-self-employed dermatologists in the United States
***Includes all printed *JAAD* copies between 2021-2022, and waste production was extrapolated from one dermatology clinic with printed *JAAD* journals over one year

**The environment and dermatologic disease.** On the reverse side of this, the field of dermatology also sees clinical changes in our patients in response to environmental change. The changes observed in the global climate have resulted in a shift in the epidemiology of dermatologic conditions. For instance, air pollutants can potentiate skin damage via direct binding of the pollutant to the aryl hydrocarbon receptor, triggering an intracellular cascade that leads to inflammatory pathway activation and keratinocyte damage.[24] Dermatologists in the San Francisco Bay area have seen a growing number of flares in pediatric patients with atopic dermatitis. These flares have also been noted to be more severe than the typical outbreaks, for each respective patient.[25] Many other dermatologic conditions, such as psoriasis, pemphigus, acne vulgaris, and photoaging among others have all been associated with rising levels of air pollution.[26–28] There is also an increasing, additive effect of exposure to ultraviolet (UV) radiation secondary to both a depleted protective ozone layer of the atmosphere and from increasing global temperatures.[29] The increase in exposure intensity and duration to UV radiation has increased the rate of cutaneous carcinogenesis.[30] This increase in global temperatures has also changed the geographic distribution of vector-borne diseases, with new data suggesting a shift form the typical tropical distribution to increased latitudes in both the north and south directions.[31] Furthermore, the increase in global temperatures and extreme weather events as a consequence of climate change are associated with increased cutaneous injury rates, skin infections, worsening of inflammatory skin disorders, and disruption of the skin's natural microbiome.[26]

## DISCUSSION

The practice of medicine contributes significantly to environmental change, and in turn these changes have lasting effects on our patients and our practices. Our findings demonstrate the environmental impact of specialties like dermatology as well as its potential to cause a shift in the epidemiology of dermatologic conditions. These effects are both created and experienced in a multitude of ways by both the environment and the field of dermatology.

The COVID-19 pandemic accelerated the shift to virtual formatting in the medical field, notably reducing reliance on fossil fuel transportation (ie, fossil fuel-burning cars, planes, and public transit). The shift to virtual formats and telemedicine offers another promising avenue for reducing environmental impact. As our results indicate, patient travel for medical visits contributes significantly to carbon emissions. Substantial reductions in carbon emissions by minimizing travel, which can be largely accomplished by increasing the use of teledermatology. The use of teledermatology has the potential to reduce hospital referrals by up to 72 percent.[19] One dermatology center found that 20 to 30 percent of their visits could be performed virtually, creating the potential to cut down on patient travel for visits.[32] This can result in a difference of up to 77 million kg of $CO_2$ if 20 percent of visits were switched to the virtual setting nationwide, using the total visits figure from the CDC.[8] A teledermatology program in the Catalan region was able to reduce face-to-face consultations by 69 percent. This same study reported economic savings in addition to an estimated reduction in carbon emissions by 21,000kg over a period of 18 months.[19] A recent study looking at the environmental impact of three months of teledermatology visits during the early COVID-19 pandemic found that 1,476 teledermatology appointments saved 55,737 miles of car travel, equivalent to 15,370kg of $CO_2$.[33] An estimated 4,983kg of $CO_2$ were prevented by managing select patients' isotretinoin via virtual follow-ups during a nine-month study period. When extrapolated, this would result in 49,400kg of greenhouse gas emissions in $CO_2e$ being eliminated annually across all isotretinoin patients at the study center.[34] This is the emission load released when 24,690kg of coal are burned.[35] Virtual follow-ups for treatments like isotretinoin therefore results in notable reductions in greenhouse gas emissions, further proving an effective strategy for environmental responsibility. Teledermatology is therefore effective in reducing face-to-face consultations, thereby decreasing transportation-related emissions. The environmental benefits of teledermatology were particularly evident during the early months of the COVID-19 pandemic. However, it is important to consider that while consultation visits may be performed in a virtual setting, procedural visits do not offer this solution.

The volume of current studies delineating pharmaceutical ecotoxicology are of concern. Dermatology is a field that inherently deals with a large volume of topical medications, both prescribed and over the counter. The increased concentrations of sunscreens found to be a groundwater pollutant at tourist destinations has been proven to be statistically significant. Thus, the extent to which other dermatologic topical medications (ie, topical steroids, etc.) can enter the water supply has the potential to be and likely is significant based on the current data. The runoff from cleansing skin after application can disrupt ecosystems and aquatic species that experience the water runoff firsthand. However, a study in 2022 found that wiping hands (ie, with a towel) after the application of topical diclofenac resulted in a 66 percent reduction of medication runoff into the wastewater from hand washing.[36] Topical sunscreen is currently irreplaceable and serves as a necessary protectant against harmful UV radiation, especially as the radiation exposure increases as a result of climate change.[29] A sound balance between proper application volume and time spent swimming in bodies of water that supply groundwater reserves can help to mitigate both the harmful effects of the sun's rays and environmental pollution. Sun protective clothing (ie, swim shirts) can also offer a no-chemical solution.[37] These data not only communicate the problem, but also offer a simple, time-efficient solution to a potentially substantial environmental impact.

The harmful byproducts created by the incineration of medical waste contribute to environmental degradation. Ensuring that only materials with infectious potential, as defined by each state's Environmental Protection Agency, are disposed of in regulated medical waste containers can dramatically reduce the harmful effects of incineration via volume reduction. Carbon emissions from this incineration process can pollute the air and water, leading to environmental harm. The high cost of this regulated medical waste disposal also adds to the economic burden of a medical practice and has more significant financial consequences for dermatology practices in addition to the environmental impact. Additionally, studies have commented on how limiting regulated medical waste can be remarkably cost-effective, as its disposal is 5 to 10 times more expensive than that of typical medical waste.[14] Effective waste segregation offers a simple and feasible solution. Appropriate waste segregation has been found to have environmental and economic advantages; improving recycling not only reduces carbon emissions from incineration of waste but can reduce truck travel through working with more local waste companies.[19] A recent study found that proper waste management and segregation can result in an approximately 13-percent reduction in the amount of bulk waste that is created by dermatology visits over the course of one year.[38] Effective waste management and segregation can therefore substantially mitigate environmental effects, and the expected burden reduction is exhibited by current data which indicate a decrease in both carbon emissions and transportation-related environmental impacts. The results also draw attention to the environmental challenges of using disposable surgical instruments. Factors influencing the obstacles to reducing the volume of procedure-related waste include trainees' (ie, students', residents', and fellows') initial experience with minor surgeries, the acquisition of new techniques, and the complexity of procedures such as biopsies and Mohs micrographic surgery (MMS). These elements often necessitate heightened supervision, which in turn increases resource use and waste production during training. Indeed, MMS often generates more waste than other skin surgeries.[18] An alternative solution offered by autoclaving reusable instruments can reduce waste volume, but would come with autoclave operational costs, including water, electricity, and additional supplies. Current data indicates that recycling single-use instruments requires significant energy and incurs high costs but presents an avenue for potential future initiatives helping the environment with the added benefit of cost reduction.

**TABLE 2.** Annual waste prevention across various source categories, extrapolated and standardized to kg $CO_2$e/year.

| CATEGORY | WASTE PRODUCTION KG/$CO_2$E/YEAR | SUSTAINABLE ALTERNATIVE |
|---|---|---|
| Procedural visits and patient travel[32] | 77,088,000–115,632,000† | Teledermatology |
| Waste management[38] | 17,684* | Proper segregation, recycling, autoclave |
| Academic printed literature[20,22] | 29,876–34,231 | Electronic format |
| Dermatology conference[7,19,40] | 20,400 | Virtual setting |

†Reflects current data on waste prevention due to existing solution of teledermatology visits in the United States
*Waste reduction was calculated using the percentage of clinical waste that can be prevented using sustainable practices data

The production and distribution of pharmaceutical-related patient education materials and printed dermatology journals add to the carbon footprint associated with the practice of dermatology. Although no data currently exist on the volume of product-related materials that are created and used each year, and therefore the amount of waste produced, the number is likely substantial based on the current volume of inserts received with product shipments. This number includes the educational materials given to patients in the office, often in the form of "frequently asked questions" and other procedure, treatment, and product-information. The solution to the high volume of both pharmaceutical and patient educational material lie in electronic formatting. In a constantly advancing technology era, this can be accomplished via placement of a quick response code (QR code) or link to important pharmaceutical data that is mandated to be included with products.

Electronic formats of medical journals can potentially mitigate waste volume. To promote the accessibility of electronic formats and thereby reduce environmental harm, costs must be reduced on both sides. Proposed methods such as advertising have been discussed in recent literature, providing a potential solution.[39] Access to electronic educational materials significantly reduces $CO_2$ emissions, offering an appealing and environmentally responsible strategy for everyone involved. For instance, in contrast to the emissions associated with paper circulation mentioned in the results section, visiting the JAAD website generates only about 0.34 grams of $CO_2$e per click.[20,22]

Virtual formats for professional meetings have avoided hundreds of thousands of kilograms of $CO_2$ emissions, providing an avenue for sustainable practices in both patient care and medical education. One study estimated that the virtual format of the 2020 American Psychiatric Association meeting avoided around 20,000,000kg of $CO_2$ emissions.[7,40] Similarly, a survey of the South West Wales Cancer Network showed that a reduction of 2,590kg $CO_2$ was made by over 90 people using videoconferencing to attend 30 meetings.[19,41] In the future, it is clear that a significant number of conferences can be held virtually.

Table 2 displays the total potential waste prevention by category and provides examples of sustainable practices that can be implemented.

Environmental change has resulted in the exacerbation of dermatologic conditions and increased flares of chronic conditions among patients. The increase in UV radiation exposure and therefore dose creates a major increase in risk for skin cancer. The effects of climate change are disproportionately burdening vulnerable and marginalized populations due to structural disparities.[26,42] This increase will undoubtedly lead to patient physical and psychological effects that come with a diagnosis of skin cancer, increased patient load for dermatologists, and increased demand for resources used to manage these conditions. Further, the increase in global temperature as a direct result of climate change has increased the frequency of atopic dermatitis flares and has even changed the geographic distribution of vector-borne diseases.[43] These changes will not be met without consequences, as a larger population may now be at risk for diseases that were not a concern previously thus leading to an increase in the patient load per dermatologist and increased carbon emissions for the patients to travel to dermatology visits, creating a multi-faceted increase in the amount of $CO_2e$ produced per year. As mentioned, these air pollutants can bind directly to the aryl hydrocarbon receptor, possibly causing inflammation and exacerbation of inflammatory dermatoses. Compounding this issue is the possibility that current infrastructure, which is likely not prepared to handle these diseases at a large scale, now has the potential to experience a major public health crisis.[44] Potential solutions to these dilemmas are discussed in the "The Centers for Medicare and Medicaid Services' Decarbonization and Resilience Initiative". This initiative is designed to address climate change-related threats to health and health systems through collection, monitoring, and assessment of hospital-based greenhouse gas emissions and their effects on healthcare costs, quality, and outcomes.[45] Additional solutions for sustainable healthcare were published in 2023 by the Joint Commission. They introduced the Sustainable Healthcare Certification, which provides a common decarbonization framework for hospitals and health systems to establish priorities, set baselines, and measure and record reductions in emissions.[46] These two initiatives can help practices achieve lower carbon emissions, thereby combatting the epidemiology changes seen with current climate changes.

Future climate strategies should prioritize innovative waste management using sustainable practices. Collaboration between dermatology practices and local waste services can optimize waste segregation and disposal. Staff education on medical waste handling is key to proper segregation. Research into recycling single-use surgical instruments, despite challenges, could yield environmental and financial benefits. Additionally, future studies should assess the long-term effects of telemedicine on patient outcomes and carbon emissions. Finally, research is needed to evaluate educational programs promoting sustainable waste management in healthcare.

## CONCLUSION

Specialties such as dermatology can significantly contribute to the environmental footprint from patient visits, medical waste, medications runoff, printed materials to medical conferences. Controlling environmental impact offers both environmental and financial benefits. Without changes in the way we live and practice the specialty of dermatology we risk perpetuating a vicious cycle of environmental damage and worsening disease epidemiology as well as clinical outcomes. Environmental consequences, including $CO_2$ emissions linked to treatment advancements, are all but unavoidable. However, implementing simple steps can reduce environmental impact leading to lasting environmental improvements and financial gains for the dermatology community.

## REFERENCES


1. Ways and Means - Democrats. Health care and the climate crisis: preparing America's health care infrastructure. Accessed 19 Aug 2024. https://democrats-waysandmeans.house.gov/health-care-and-climate-crisis-preparing-americas-health-care-infrastructure
2. Mora C, McKenzie T, Gaw IM, et al. Over half of known human pathogenic diseases can be aggravated by climate change. *Nat Clim Change*. 2022;12(9):869–875.
3. Andersen LK, Coates SJ, Enbiale W, et al. Climate change perception among dermatologists: an online survey of International Society of Dermatology members. *Int J Dermato*l. 2020;59(9):e322–e325
4. Mieczkowska K, Stringer T, Barbieri JS, et al. Surveying the attitudes of dermatologists regarding climate change. *Br J Dermatol*. 2022;186(4):748–750.
5. Heuer R, Gaskins M, Werner RN, et al. Planetary health in dermatology: towards a sustainable concept of health in clinical practice guidelines. *Br J Dermatol*. 2023;23;188(1):132–133.
6. Maroongroge S, Wallington DG, Taylor PA, et al. Geographic access to radiation therapy facilities in the United States. *Int J Radiat Oncol Biol Phys*. 2022;1;112(3):600–610.
7. Doyle C, McFeely O, Beatty P, et al. Same-day surgery promotes sustainability in dermatology. *Clin Exp Dermatol*. 2023;5;48(6):692–693.
8. Centers for Disease Control and Prevention. Dermatology fact sheet from the National Ambulatory Medical Care Survey. Updated 30 Aug 2024. Accessed 20 Nov 2024. https://archive.cdc.gov/www_cdc_gov/nchs/data/namcs/factsheets/NAMCS-2015-16-Dermatology-508.pdf
9. Melchor-Martínez EM, Jiménez-Rodríguez MG, Martínez-Ruiz M, et al. Antidepressants surveillance in wastewater: overview extraction and detection. *Case Stud Chem Environ Eng*. 2021;3:100074.
10. Chen Y, Wang J, Xu P, et al. Antidepressants as emerging contaminants: Occurrence in wastewater treatment plants and surface waters in Hangzhou, China. *Front Public Health*. 2022;11;10:963257.
11. Hejna M, Kapuścińska D, Aksmann A. Pharmaceuticals in the aquatic environment: a review on eco-toxicology and the remediation potential of algae. *Int J Environ Res Public Health*. 2022;23;19(13):7717.
12. Cooney J, Lenczewski M, Leal-Bautista RM, et al. Analysis of sunscreens and antibiotics in groundwater during the COVID-19 pandemic in the Riviera Maya, Mexico. *Sci Total Environ*. 2023;10;894:164820.
13. Raffa RB, Pergolizzi JV JR, Taylor R, et al. Sunscreen bans: coral reefs and skin cancer. *J Clin Pharm Ther*. 2019;44(1):134–139.
14. Sharma D, Murase LC, Murase JE, et al. Combatting Climate Change: 10 interventions for dermatologists to consider for sustainability. *Cutis*. 2022;110(2):59–62.
15. Niebel D, Herrmann A, Balzer S, et al. Sustainability of dermatological offices and clinics: challenges and potential solutions. *J Dtsch Dermatol Ges*. 2023;21(1):44–58.
16. Fathy R, Nelson CA, Barbieri JS. Combating climate change in the clinic: cost-effective strategies to decrease the carbon footprint of outpatient dermatologic practice. *Int J Womens Dermatol*. 2021;7(1):107–111.
17. Johnson-Ogbuneke J, Williamson T, Gamal N, et al. Sustainability in delivering skin surgery training: additional resources consumed and opportunities for environmental gain using the Healthcare Environmental Performance Tool. *Clin Exp Dermatol*. 2023;1;48(3):250–253.
18. Shearman H, Yap SM, Zhao A, et al. A UK-wide study to describe resource consumption and waste management practices in skin surgery including Mohs micrographic surgery. *Clin Exp Dermatol*. 2023;25;48(9):1024–1029.
19. Allwright E, Abbott RA. Environmentally

sustainable dermatology. *Clin Exp Dermatol*. 2021;46(5):807–813.
20. Li C, Pagani K, Eberhart Z, et al. The environmental impact of printed journals in dermatology. *J Am Acad Dermatol*. 2023;11;S0190-9622(23)03207-03203.
21. United States Environmental Protection Agency. Fast Facts on Transportation Greenhouse Gas Emissions. Updated 18 Jun 2024. Accessed 12 Aug 2024. https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions
22. Website Carbon. The original website carbon calculator. Accessed 12 Aug 2024. https://www.websitecarbon.com/
23. Sharma D, Rizzo J, Nong Y, et al. Virtual learning decreases the carbon footprint of medical education. *Dermatol Ther (Heidelb)*. 2024;14(4):853–859.
24. Parker ER, Mo J, Goodman RS. The dermatological manifestations of extreme weather events: a comprehensive review of skin disease and vulnerability. *J Clim Change Health*. 2022;8:100162.
25. Rosenbach M. Climate change, dermatology, and the time for real action. *Pediatr Dermatol*. 2019;36(4):567–568.
26. Belzer A, Parker ER. Climate Change, Skin Health, and Dermatologic Disease: A Guide for the Dermatologist. *Am J Clin Dermatol*. 2023;24(4):577–593.
27. Williams ML. Global warming, heat-related illnesses, and the dermatologist. *Int J Womens Dermatol*. 2020;9;7(1):70–84.
28. Kaffenberger BH, Shetlar D, Norton SA, et al. The effect of climate change on skin disease in North America. *J Am Acad Dermatol.* 2017;76(1):140–147.
29. Diffey B. Climate change, ozone depletion and the impact on ultraviolet exposure of human skin. *Phys Med Biol*. 2004;7;49(1):R1–11.
30. Parker ER. The influence of climate change on skin cancer incidence—a review of the evidence. *Int J Womens Dermatol*. 2020;17;7(1):17–27. Erratum in: *Int J Womens Dermatol*. 2021;28;7(5Part B):867.
31. Coates SJ, McCalmont TH, Williams ML. Adapting to the effects of climate change in the practice of dermatology—a call to action. *JAMA Dermatol*. 2019;1;155(4):415–416.
32. Kutner A, Love D, Markova A, et al. Supporting virtual dermatology consultation in the setting of COVID-19. *J Digit Imaging*. 2021;34(2):284–289.
33. O'Connell G, O'Connor C, Murphy M. Every cloud has a silver lining: the environmental benefit of teledermatology during the COVID-19 pandemic. *Clin Exp Dermatol*. 2021;46(8):1589–1590.
34. Lee J, Yousaf A, Jenkins S, et al. The positive environmental impact of virtual isotretinoin management. *Pediatr Dermatol*. 2021;38(3):613–616.
35. United States Environmental Protection Agency. Greenhouse Gas Equivalencies Calculator. Accessed 12 Aug 2024. https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator
36. Bielfeldt S, Urquhart D, Brandt M, et al. Reduction of residual topical diclofenac in waste water by a wiping procedure before hand washing. *Chemosphere*. 2022;292:133350.
37. Lu JT, Ilyas E. An overview of ultraviolet-protective clothing. *Cureus*. 2022;14(7):e27333.
38. Tso S. Dermatology sustainability: case study of potential efficiency savings and waste reduction in dermatology punch biopsies using the Healthcare Environmental Performance Tool. *Clin Exp Dermatol*. 2023;20;48(1):41–43.
39. Nestor MS, Fischer DL, Arnold D, et al. Rethinking the journal impact factor and publishing in the digital age. *J Clin Aesthetic Dermatol*. 2020;13(1):12–17.
40. Wortzel JR, Stashevsky A, Wortzel JD, et al. Estimation of the Carbon Footprint Associated With Attendees of the American Psychiatric Association Annual Meeting. *JAMA Netw Open*. 2021;4(1):e2035641.
41. Leddin D, Galts C, McRobert E, et al. The Carbon Cost of Travel to a Medical Conference: Modelling the Annual Meeting of the Canadian Association of Gastroenterology. *J Can Assoc Gastroenterol*. 2021;29;5(2):52–58.
42. Hoffman JS, Shandas V, Pendleton N. The effects of historical housing policies on resident exposure to intra-urban heat: a study of 108 US urban areas. *Climate*. 2020;8(1):12.
43. Silva GS, Rosenbach M. Climate change and dermatology: an introduction to a special topic, for this special issue. *Int J Womens Dermatol*. 2021;7(1):3–7.
44. Salas RN, Shultz JM, Solomon CG. The climate crisis and COVID-19—a major threat to the pandemic response. *N Engl J Med*. 2020;(11)383.
45. Centers for Medicare and Medicaid Services. TEAM Decarbonization and Resilience Initiative. Updated 1 Aug 2024. Accessed 19 Aug 2024. https://www.cms.gov/team-decarbonization-and-resilience-initiative
46. The Joint Commission. Sustainable Healthcare Certification. Accessed 19 Aug 2024. https://www.jointcommission.org/what-we-offer/certification/certifications-by-setting/hospital-certifications/sustainable-healthcare-certification/ JCAD