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ORIGINAL RESEARCH

Virtual Learning Decreases the Carbon Footprint of Medical Education

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ABSTRACT

Introduction: The environmental impact of holding in-person academic conferences and continuing medical education (CME) programs can be significant. In-person conferences provide a unique social and professional platform to engage in networking and foster professional development; however, there is an opportunity for hybrid and virtual platforms to provide CME for broader audiences looking to improve their clinical skills and strengthen their knowledge base. This study seeks to describe the reduction in carbon emissions associated with a webinar hosted by an online dermatology-focused medical education platform.

Methods: This cross-sectional study used the location of deidentified virtual attendees of a webinar to predict the carbon emissions produced if attendees had instead traveled to the location of the most recent Integrative Dermatology Symposium (Sacramento, CA). Following

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collection of each virtual attendee's location, the mode of transportation was predicted on the basis of each participant's distance to the conference.
Results: The estimated carbon emissions were calculated for 576 participants. The total estimated, unadjusted carbon emissions for both attendees predicted to fly or drive was 370,100 kg CO_2. The emissions produced per participant from those expected to fly to an in-person CME after adjusting for all additional passengers on every flight were 4.5 kg CO_2. The emissions produced per participant from those expected to drive were 42.7 kg CO_2.
Conclusion: The use of a virtual CME webinar led to a significant reduction in travel-related carbon dioxide emissions when compared to running the same program in-person event. When accounting for all passengers traveling via plane on any flight, driving to an event produced more emissions per participant than flying.

Keywords: Conference; Emissions; Carbon dioxide emissions; Greenhouse gas; Travel; Virtual learning; In-person conferences

Key Summary Points

There is a considerable environmental impact from travel to in-person academic medical conferences.

This study seeks to determine the reduction in carbon emissions from virtual attendance of an online continuing medical education event when compared with a theoretical in-person academic medical conference.

Virtual attendance rather than theoretical in-person attendance in this study was found to prevent the emission of 370 metric tons of carbon dioxide.

These findings suggest options for holding conferences virtually or using hybrid in-person and virtual models may be important steps in reducing the environmental impact of academic medical conferences.

INTRODUCTION

In 2020, virtual learning opportunities became more commonplace due to the coronavirus disease 2019 (COVID-19) pandemic. From medical school lectures to national academic conferences, the entire field of medicine adapted swiftly. One rapid change was decreased use of fossil-fuel intensive transportation modalities such as cars, airplanes, and public transportation. The transportation sector generates more greenhouse gas emissions than any other source in the USA, putting into perspective how beneficial this adaptation may be to the environment [1]. A recent study estimating the carbon footprint associated with the 2018 and 2019 American Psychiatric Association annual meeting found that 19,819 and 21,456 metric tons of CO_2 emissions were used for attendee transport, respectively. The same study concluded that holding the 2020 meeting virtually saved the equivalent of the burning of 500 acres of dense forest. [2]

Thus, the environmental impact of holding in-person academic medical conferences is considerable. Although in-person meetings provide a unique social and professional platform, there is an opportunity for a hybrid model involving both virtual and in-person options. In this study, we aim to better characterize the environmental impact of in-person conferences as well as describe the reduction in carbon emissions associated with virtual conference attendance.

METHODS

This cross-sectional study used the location of deidentified virtual attendees of a webinar to predict the carbon emissions produced if attendees had instead traveled to the location of the most recent annual meeting hosted by the same dermatology-focused medical education platform (Integrative Dermatology Symposium, Sacramento, CA). All attendees were identified through virtual registration records. Following collection of each virtual attendee's location, the mode of transportation was predicted on the basis of each participant's distance to the conference. Attendees < 150 miles from the location of the conference were predicted to drive and attendees > 150 miles were predicted to fly. To estimate the carbon emissions from each individual predicted to drive, the US Environmental Protection Agency (EPA) "Greenhouse Gas Emissions from a Typical Passenger Vehicle" reference was used [3]. To estimate the emissions from each individual predicted to fly, the United Nations International Civil Aviation Organization Carbon Emissions Calculator was used [4]. Furthermore, to account for the additional individuals on any commercial plane flight who would not be attending the webinar, the total emissions calculated for individuals predicted to fly was divided by an estimate of the average number of seats occupied on a plane flight (150). Additionally, we estimated each individual's distance to an airport at 15 miles and calculated the emissions of travel to and from an airport using the EPA reference mentioned above. A separate analysis of only attendees within the country of the webinar (USA) was performed. This study was a cross-sectional analysis of users of a virtual platform and did not involve any protected health information. Thus, the study was deemed minimal risk and did not require institutional review board (IRB) approval.

RESULTS

The webinar studied included 583 participants from 47 different countries and 39 different states within the USA (Table 1). Seven of the 583 participants were excluded from the analysis since they lived in the city of the theoretical in-person medical education event or had incomplete data, thus a total of 576 participants were included in the analysis. Of the total 576 participants, 146 (25%) were viewing from a country outside of the USA, 36 were predicted to drive, and 540 were predicted to fly. The total unadjusted estimated carbon emissions for both attendees predicted to fly or drive was 376,645 kg CO_2 (370 metric tons CO_2) and 4037 kg CO_2 (4 metric tons CO_2), following adjustment for all passengers on any flight (150). The adjusted emissions produced from all participants predicted to fly to an in-person CME event were 2501 kg CO_2 (2.5 metric tons CO_2). This value consisted of 62% of all emissions in our study and would amount to 4.6 kg CO_2 per participant (540 participants total) expected to fly. The estimated emissions from participants predicted to drive were 1536 kg CO_2 (1.5 metric tons CO_2), amounting to 38% of the total, adjusted estimated emissions resulting from travel to an in-person CME event. A total of 42.7 kg CO_2 was estimated to be emitted per participant (36 participants total) predicted to drive.

An analysis of only virtual attendees in the USA showed that 36 participants were still predicted to drive and 400 were predicted to fly. The total, unadjusted estimated carbon emissions from US participants were 192,247 kg CO_2 (192 metric tons CO_2) and 2818 kg CO_2, following adjustment for all participants on any flight (150). The adjusted emissions produced from all US participants predicted to fly were 1282 kg CO_2, amounting to 3.2 kg CO_2 per participant. Additionally, the emissions per participant in the USA for those predicted to drive remained unchanged at 42.7 kg CO_2. A summary of the emissions per each group analyzed can be seen in Table 2.

DISCUSSION

Prior studies have found the environmental impact of traveling to in-person medical education events and conferences to be significant [1, 5–7]. For instance, an analysis of the Annual Meeting of the Canadian Association of Gastroenterology found each participant's travel resulted in emissions equal to 0.540 metric tons of carbon dioxide [5]. The study measuring the environmental impact of the American Psychiatric Association annual meeting mentioned earlier also found each participant's travel to the conference would result in 1.19 metric tons of carbon dioxide emissions [2]. These results are supported by our study; however, our study differs in that additional considerations were made for additional passengers on each flight. The results of this study suggest the estimated, unadjusted carbon emissions from traveling to a

Table 1 Countries in which participants viewed the virtual webinar

Location	Number of Attendees	Distance (Km)
North America	481	3977 (average)
USA	436	4057
Mexico	4	3022
Canada	38	3525
Bahamas	1	4384
Jamaica	2	4896
South America	10	6937 (average)
Brazil	2	10,396
Colombia	4	6075
Guatemala	2	4050
Guyana	2	7226
Africa	11	14,006 (average)
Kenya	1	15,052
Malawi	1	16,586
Nigeria	4	12,411
Somalia	1	15,290
Tanzania	1	15,511
Trinidad and Tobago	2	6708
Zimbabwe	1	16,485
Europe	27	9114 (average)
Albania	1	10,297
Denmark	1	8635
Germany	1	8758
Greece	1	10,782
Ireland	1	8031
Lithuania	2	9165
Norway	1	7898
Poland	1	9446
Romania	1	9994
Sweden	1	8635
Switzerland	1	9233
United Kingdom	15	8492
Asia	41	12,186 (average)
Azerbaijan	1	11,181
Bangladesh	2	12,315
Cambodia	2	12,642
India	5	12,083
Indonesia	2	12,786
Kuwait	1	12,382
Libya	1	10,786
Malaysia	1	12,291
Mongolia	1	9267
Myanmar	1	12,219
Oman	1	13,130
Pakistan	7	12,897
Philippines	8	11,223
Saudi Arabia	1	12,862
Singapore	1	13,594
United Arab Emirates	4	12,906
Vietnam	2	12,590
Oceania	12	11,693 (average)
Australia	10	12,765
New Zealand	2	10,621

The number of attendees from each country who viewed the virtual webinar is displayed. The distance from each country to the location of the theoretical in-person event is also provided with averages displayed per continent

Table 2 Emissions by participant's mode of travel

Analysis group	Emissions per analysis group (kg CO_2)		
All participants	**Total emissions**	**Predicted to fly**	**Predicted to drive**
Unadjusted	376,645	375,109	1536
Adjusted	4037	2501	1536
USA			
Unadjusted	192,247	190,711	1536
Adjusted	2818	1282	1536

The total adjusted and unadjusted number of predicted emissions for all participants, as well as stratified by transportation type, can be seen. Additionally, the total adjusted and unadjusted emissions only from participants in the USA is provided

theoretical in-person medical education event would be equivalent to the burning of 409,482 lbs of coal [8]. Moreover, to sequester the carbon dioxide estimated to be produced via travel to this event, it would require the work of 438 acres of forests in the USA capturing and transforming carbon dioxide for 1 year [8].

This study also seeks to compare the carbon emissions from driving to an in-person medical education event as compared with flying. While the emissions produced from flying on an airplane are significantly greater than via driving, this study also considered other passengers traveling via plane who would not have attended the theoretical in-person CME event and were on the same flight as those who would. Dividing the total emissions produced via flying by a number representing the estimated average number of passengers on each theoretical flight, 150 used in this study, resulted in the share of carbon emissions attributed only to the virtual attendees who would have traveled via flight. Interestingly, after using these values to calculate the amount of carbon dioxide emitted per participant, those who were predicted to drive had a larger carbon footprint than those who were predicted to fly. Another limitation of this study is the fact that one cannot predict if virtual attendees of a webinar would travel in-person to a conference or medical education event. Thus, the calculation of carbon emissions in this study may be overestimated, especially for virtual attendees living in countries outside the USA who may be less likely to travel internationally. Future studies may better compare virtual and in-person experiences by calculating the environmental impact of attending an event virtually. An additional consideration that is relevant to this study is the development and increasing use of carbon offsets programs, which allow one to purchase an equivalent reduction in greenhouse gas emissions to one's travel-related emission, including medical conferences [9]. In this study, it is possible there were carbon offsets purchased by participants which were not accounted for in the results.

One unexpected finding from our analysis is that a local conference that may have the majority of the attendees driving in may actually lead to a higher carbon footprint per person compared with air-based travel. This suggests that if in-person meetings are pursued, having attendees come by air may be more environmentally mindful than having all the attendees drive in locally. However, it should be noted that as electric-powered vehicles become more commonplace, the carbon footprint of driving may decrease, and thus, driving may become less environmentally harmful when compared with flying. An additional point of consideration is that there may be alternative transport options in the future which would be more efficient than either flying or driving and allow transport to conferences, such as national development of a functional electric-powered high-speed rail.

Another limitation of this study is that we only focused on the carbon emission aspect of travel. However, in-person meetings offer significant benefit for community building and social connection that can make educational programs effective from a holistic perspective as well as help combat burnout syndrome. Nevertheless, our analysis is helpful to understand the environmental impact of just the travel portion of attending an in-person symposium.

CONCLUSIONS

The purpose of this study was not to discourage in-person conferences and CME events in the future but to shed light on how virtual learning options in medicine, and the field of dermatology in particular, may reduce carbon emissions. Our results lend further support for the use of hybrid approaches to conferences to balance the social benefit of in-person meeting, yet allow for distant learners to have an environmentally beneficial option. With prior studies highlighting the need for more climate-conscious initiatives in academia [5–7]. In-person events are crucial to communication, collaboration, and learning to advance the field of dermatology. However, as the impact of climate change on human health continues to grow, developing methods to reduce carbon emissions in any capacity is imperative. Opting for virtual learning options when appropriate may be a fundamental step in the healthcare transformation required to address the impending climate crisis.

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Declarations

Conflict of Interest. Dr. Divya Sharma, Julianne Rizzo, Yvonne Nong, Lilia C. Murase, Sydney Fong, and Kenny Lo have nothing to disclose. Dr. Jenny Murase has participated in advisory boards for Genzyme/Sanofi, Eli Lilly, AbbVie LeoPharma, and UCB, participated in disease statement management talks for Regeneron and UCB, and provided dermatologic consulting services for UpToDate. Dr. Raja Sivamani serves as a scientific advisor for LearnHealth, Codex Labs, and Arbonne and as a consultant to Burt's Bees, Novozymes, Nutrafol, Novartis, Bristol Myers Squibb, Abbvie, Leo, Biogena, UCB, Incyte, Sanofi, Sun, and Regeneron Pharmaceuticals. Dr. Misha Rosenbach serves as a consultant for: AbbVie, Merck, J&J, Processa, Xentria, CSL Behring, and receives research support from Processa. Dr. Misha Rosenbach is the cochair of the AAD's ERG on Climate Change; he is speaking on behalf of himself and not the academy.

Ethical Approval. This study is a cross-sectional analysis of users of a virtual platform and did not involve any protected health information. Thus, the study was deemed minimal risk and did not require IRB approval.

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