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Medical conferences in the era of environmental conscientiousness and a global health crisis: The carbon footprint of presenter flights to pre-COVID pediatric urology conferences and a consideration of future options☆,☆☆

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A B S T R A C T

Introduction: Medical conferences are integral to academic medicine, with academic posters being a well-established medium for presenting research. However, conferences carry an ecological footprint due to greenhouse gas emissions. Furthermore, traditional conference formats have recently not been possible due to the COVID-19 pandemic. Herein we examine the carbon footprint associated with travel by presenting delegates to the Fall SPU conferences from 2013 to 2019, and the 2015 ESPU conference.
Methods: Online programs for the targeted SPU Fall meetings and the 2015 ESPU Annual Meeting were retrospectively reviewed. Variables collected included meeting location and presenter home base. Distance traveled by the presenter, and likely CO_2e of this return trip were estimated using online calculators. Analysis was performed using the Kruskal-Wallis-H test with pairwise comparisons to detect differences in round trip distances and CO_2e between meeting locations.
Results: Six Fall SPU conferences and one ESPU conference were reviewed. The majority of presenters were from the region (North America and Europe, respectively), for both SPU and ESPU. The median round trip distance was 2596.34 miles (IQR 1420.96–4438.30), and the median CO_2e 0.61 metric tons (IQR 0.36–1.02). We found that the distances traveled to conferences in the Western USA and Europe were slightly further than those to conferences in Central Canada and the Southern US. The difference in CO_2e between these locations did not achieve statistical significance.
Conclusion: Presenter travel to and from pediatric urological conferences generates an important carbon footprint and may not be possible in the medium-term future due to a global pandemic. We should explore strategies to allow meetings and knowledge exchange to continue whilst reducing the need for travel and the ecological burden of conferences.
Level of Evidence: Level III: Most comparative level of evidence.

Contents

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Medical conferences are integral to academic medicine, offering attendees the opportunity to share knowledge, network and collaborate. Before the current COVID-19 pandemic, annual meetings of the Societies for Pediatric Urology (SPU) in North America and the European Society of Pediatric Urology (ESPU) in Europe attracted hundreds of local and international delegates, the vast majority of whom will travel to the conference venue by airplane. The practice of attending these conferences may contribute to global warming, and during the current COVID-19 crisis, international travel and mass gatherings are strongly discouraged.

Scientists around the globe have recognized the contribution of conference travel to carbon emissions and the need to seek strategies to address this [1]. These emissions are generated by ground and air travel to conference venues, the utilization of the hospitality and food service industry, the use of single-use items such as name badges, water bottles and coffee cups, the use of audiovisual equipment, and the manufacture of conference items such as posters, programs, tote bags and other merchandise. Of these, air travel is probably the greatest contributor to carbon dioxide emissions.

As local and national governments endeavor to slow the spread of the novel coronavirus, drastic measures have been taken to enforce 'physical distancing' and curb human mobility, interventions which have been shown to decrease spread [2]. In addition to travel bans, which are still in effect to varying degrees throughout the world at the time of writing, these measures include the closure of schools, offices, sit-down restaurants, malls and other sites that traditionally bring large numbers of people into close physical contact. Countless festivals, music shows, sporting events and academic conferences have been canceled. The cancellation of numerous medical conferences this year has forced health care workers to look critically at the traditional methods of fostering academic engagement and knowledge translation and to become flexible, innovative and technologically literate in order to harness tools that allow ongoing interaction. Such tools include the use of platforms and software that allow for the broadcasting of live and recorded video 'webinars', virtual conferences and podcasts.

It is unclear when a COVID-19 vaccine will be available [3], when the pandemic will subside and when travel will once again become unrestricted. Furthermore, as a result of economic hardship experienced in the wake of the pandemic, it is likely that even once it is possible to travel freely it will not be an option for many, and also that individuals who are at high-risk of suffering serious morbidity or even dying due to infection with a viral disease may be reluctant to attend mass gatherings. It is possible that medical conferences as we know them – large gatherings of diverse groups of physicians, nurses and allied health professionals, which present significant opportunities for travel, mingling, socializing and networking – may take many years to return. The situation we find ourselves in has given us the opportunity to reevaluate the need and impact of attending these gatherings, including the environmental consequences. To that effect, in this study we aimed to estimate the carbon footprint of poster and podium presenters traveling to SPU Fall conferences between 2013 and 2019, as well as the 2015 ESPU conference.

1. Materials and methods

Online programs for the SPU Fall Congress from 2013 to 2019, as well as the 2015 ESPU Annual Meeting were reviewed. Variables collected included meeting location and the home bases of all delegates with a poster or podium presentation. These years were selected due to program availability. We did not collect data on guest speakers or session moderators as this was not consistently available. The distance traveled by each presenter was then estimated by determining the direct flight distance between the international airport nearest to their home institution, and the airport nearest to the conference venue. The likely carbon footprint (CO_2e) of this round trip was then calculated using an online carbon calculator (Carbon Footprint Ltd., Hampshire, UK), which is rated as a 'strong' carbon calculator by the *International Journal of Greenhouse Gas Control*, and which makes carbon footprint calculations based on up-to-date country and region-specific emissions factors where available [4].

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 25.0. A descriptive summary of the data was presented as median and interquartile range (IQR) for the distances traveled and CO_2e. The continuous variable of miles traveled as well as CO_2e per flight were not normally distributed, thus the Kruskal-Wallis-H test was appropriately used to perform the non-parametric multigroup comparison. Pairwise comparisons were performed to identify significant differences between groups such as conference host region and for each meeting. The generated p-values were adjusted for multiple comparisons using the Bonferroni method.

2. Results

A total of 6 Fall SPU meetings were held between 2013 and 2019. In 2015 there was no Fall SPU. Two of these meetings were held in the Western USA (Las Vegas, NV; Scottsdale, AZ), 3 in the Southern USA (Miami Beach, FL; Dallas, TX; Atlanta, GA), and one in Southeastern Canada (Montréal, QC). The 2015 ESPU Meeting was held in Prague, in the Czech Republic.

A total of 983 unique presenters were included: 739 of these represented presenters at the Fall SPU conferences, and 244 were presenters at the 2015 SPU. For the Fall SPU meetings, the majority of the presenters were from the USA ($n = 587$, 79%): of these, 33% came from the Mid-West ($n = 193$), 32% from the North-Eastern USA ($n = 190$), 20% from the South ($n = 120$) and 14% from Western USA ($n = 84$). Twelve percent ($n = 90$) of presenters came from outside North America, and 8% ($n = 62$) were from Canada. For the 2015 ESPU, the majority of presenters were from Europe ($n = 104$, 43%) and 28% ($n = 69$) were from the USA. A summary of presenter origin by geographical region can be found in Table 1.

For all conferences included, the total round-trip miles traveled is 4,034,964, and the estimated CO_2e is 912.47 metric tons. Overall, the median round trip distance is 2596.34 miles (IQR 1420.96–4438.30), and the median CO_2e 0.61 metric tons (IQR 0.36–1.02). Breakdown of distances traveled and CO_2e for each meeting can be found in Table 2.

A box plot was generated to visualize the summarized round trip miles traveled and estimated CO_2e by each presenter in the meetings hosted by geographical region (Western USA, Southern USA, Southeastern Canada and Europe). We found that meetings held in Southeastern Canada (Montréal) and Southern USA (Atlanta, Dallas and Miami Beach) had a slightly shorter round trip than meetings held in Western USA (Scottsdale and Nevada) and Europe (Prague) (See Fig. 1). Similar difference was detected for CO_2e between these regions (see Fig. 2).

Comparative analysis between the host regions for the assessment of differences in round trip travel miles and estimated CO_2e per presenter noted a significant between group difference ($p < 0.0001$, $p < 0.0001$; respectively). Using the Kruskal-Wallis-H test with pairwise analysis with Bonferroni adjustment function, we identified that all pairs of host regions showed significant differences except for Europe and Western USA (adjusted $p = 1.0$); which is likely due to the fact that both these host regions had similar high round trip miles traveled by their presenters (Supplementary Fig. 1). While for the estimated CO_2e, all pairwise comparisons showed significant differences except for Southern USA- Canada (adjusted $p = 1.00$) and Europe- Western USA (adjusted $p = 1.00$) (Fig. 1B).

Using the equation that the emission of one metric ton of CO_2 results in the melting of 3 square meters of Arctic summer ice [5], these meetings combined would have resulted in the melting of around 2737.41 m^2 of summer ice.

3. Discussion

Climate change, caused by the large-scale combustion of fossil fuels and the increase in atmospheric greenhouse gases (GHG), has been

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Table 1
Summary of presenter origins by geographical region.

Presenter Origin	SPU 2019 Scottsdale, AZ n = 170 (%)	SPU 2018 Atlanta, GA n = 120 (%)	SPU 2017 Montréal, QC n = 123 (%)	SPU 2016 Dallas, TX n = 114 (%)	ESPU 2015 Prague, Czech Republic n = 244 (%)	SPU 2014 Miami, FL n = 104 (%)	SPU 2013 Las Vegas, NV N = 108 (%)	Total n = 983 (%)
Canada	15 (9)	7 (6)	13 (10)	12 (11)	10 (4)	7 (7)	8 (0.7)	72 (7.3)
South America	4 (2)	2 (1.7)	0	2 (1.8)	7 (3)	4 (4)	2 (2)	21 (2.1)
Scandinavia	1 (0.6)	0	1 (0.8)	0	7 (3)	0	0	9 (0.9)
Europe	2 (1.2)	2 (1.7)	8 (7)	4 (3.5)	104 (43)	11 (11)	9 (8.3)	140 (14)
North Africa	0	2 (1.7)	0	1 (0.9)	5 (2)	0	3 (2.8)	11 (1.1)
East Africa	1 (0.6)	0	0	0	0	0	0	1 (0.1)
Russia	1 (0.6)	1 (0.8)	0	1 (0.9)	2 (0.8)	1 (1)	1 (0.9)	7 (0.7)
West Asia	1 (0.6)	3 (2.5)	3 (2.4)	1 (0.9)	10 (4)	2 (2)	1 (0.9)	21 (2.1)
South Asia	0	0	2 (1.6)	0	6 (2.5)	0	0	8 (0.8)
Southeast Asia	1 (0.6)	0	0	0	2 (0.8)	0	0	3 (0.3)
East Asia	0	1 (0.8)	3 (2.4)	1 (0.9)	16 (6.6)	2 (2)	1 (0.9)	24 (2.4)
Oceana	0	0	1 (0.8)	1 (0.9)	6 (2.5)	1 (1)	1 (0.9)	10 (1)
Western USA	25 (15)	20 (17)	11 (9)	6 (5.3)	9 (3.7)	13 (13)	9 (8.3)	93 (9.5)
Midwestern USA	56 (33)	25 (21)	27 (22)	34 (30)	21 (8.6)	24 (23)	27 (25)	214 (22)
Southern USA	23 (14)	29 (24)	15 (12)	22 (19)	13 (5.3)	12 (12)	19 (18)	133 (14)
North-Eastern USA	40 (24)	28 (23)	39 (32)	29 (25)	26 (11)	27 (26)	27 (25)	216 (22)

described as the biggest health threat of the 21st century [6]. If left unchecked, the Earth's surface temperature is expected to rise more than 2 °C above pre-industrial averages this century, and direct effects of this include increased heat stress, floods, droughts, and increased frequency of intense storms. Subsequent health effects include increased disease due to rising air pollution and the spread of disease vectors, malnutrition due to food insecurity, displacement of populations as habitats are lost, and mental illness [7].

Human industry is responsible for the vast majority of GHG emissions, and the carbon emissions of a particular industry or process is often referred to as its ‘carbon footprint’. The health sector is responsible for considerable emissions: in the US, the healthcare system generates 8–10% of all GHG, and in the United Kingdom the National Health Service is responsible for 25% of public-sector emissions [8]. Hospitals, which are large buildings that are always active, and require extensive lighting, sophisticated ventilation and temperature-control systems, depend on technology including laboratory and medical equipment, and must provide laundry and food service, are the second-most energy-intensive commercial buildings, after food-service facilities [9]. On the clinical side, operating theaters in particular are significantly more energy-intense than hospitals as a whole due to heating, ventilation and air-conditioning requirements, and the use of anesthetic gases [8].

Apart from clinical work, the academic work of medical research and development and conference attendance has its own environmental impact. Medical conferences attract hundreds and even thousands of local and international delegates, who essentially become tourists at the conference destination. Ground and air transport to and from conference venues, utilization of the hospitality and food service industry, the manufacture and transport of conference posters and the utilization of audiovisual equipment all contribute to carbon emissions [10]. Air travel is probably the biggest source of conference-related emissions: aircraft burn fuel and release GHG, particles and condensation trails (contrails), which all have climate effects [11]. Total GHG emissions from aviation probably amount to 4–5% of global emissions annually [12].

There is a precedent for investigating the contribution of healthcare-related activities to global emissions as concern around these increases. A recent position paper from the American College of Physicians called for ‘the broader health care community throughout the world [to] engage in environmentally sustainable practices that reduce carbon emissions’ [13], and in 2018 the British Medical Journal published an editorial calling on medical organizations to divest from fossil fuels [14]. Multiple papers interrogate the environmental impact of laparoscopic surgery, otorhinolaryngology, endoscopic urological procedures, anesthetic equipment, acute care, outpatient care and the operating room and hospitals in general, and discuss techniques to mitigate these effects [8,9,15–24]. The broader scientific community has discussed the environmental implications of conferences [1,25,26], and concern regarding the same issue has been raised within the medical community [27].

We found that the median round trip for northern hemisphere, Fall urology conferences is 2596.34 miles, with a median CO_2e of 0.61 metric tons. These conferences are relatively small: the number of unique presenting delegates ranges from 100 to 244, and the majority of these delegates are ‘local’. The carbon footprint of these conferences can be expected to be far lower than that of mega-conferences which attract thousands of delegates from all over the world. Nevertheless, attendees at these conferences are likely to travel to larger umbrella conferences, to smaller sectional meetings and workshops, to provide outreach care to remote or poorly resourced areas, to conduct visiting professorships, to attend interviews and board meetings, and to enjoy their own vacations. All of these trips provide value, and academic meetings in particular offer a unique opportunity for colleagues from highly varied settings to meet, share ideas, and form connections and networks that enable them to broaden their knowledge, access opportunities, and learn. However, in light of the climate crisis we currently face, perhaps it is time to start considering how the ecological impact of such conferences can be minimized.

This could be achieved through various strategies, several of which have recently been actively adopted by organizations as the COVID-19 pandemic has made travel impossible. First and foremost, the option

Table 2
Estimated presenter round trip flight distances and travel-related CO_2e.

Meeting	Median round trip in miles (IQR 25–75)	Median CO_2e in metric tons (IQR 25–75)
SPU 2019	3309.64	0.74
Scottsdale, AZ	(2538.50–3939.06)	(0.55–0.88)
SPU 2018	1401.70	0.31
Atlanta, GA	(1083.92–3797.58)	(0.24–0.85)
SPU 2017	1455.56	0.47
Montréal, QC	(692.70–3208.30)	(0.39–0.84)
SPU 2016	2113.30	0.48
Dallas, TX	(1506.10–2858.33)	(0.34–0.64)
ESPU 2015	4183.90	0.93
Prague, Czech Republic	(1340.58–9180.46)	(0.32–2.02)
SPU 2014	2481.04	0.56
Miami, FL	(2053.54–5182.52)	(0.46–1.2)
SPU 2013	3869.88	0.90
Las Vegas, NV	(3040.26–4466.12)	(0.68–1.06)

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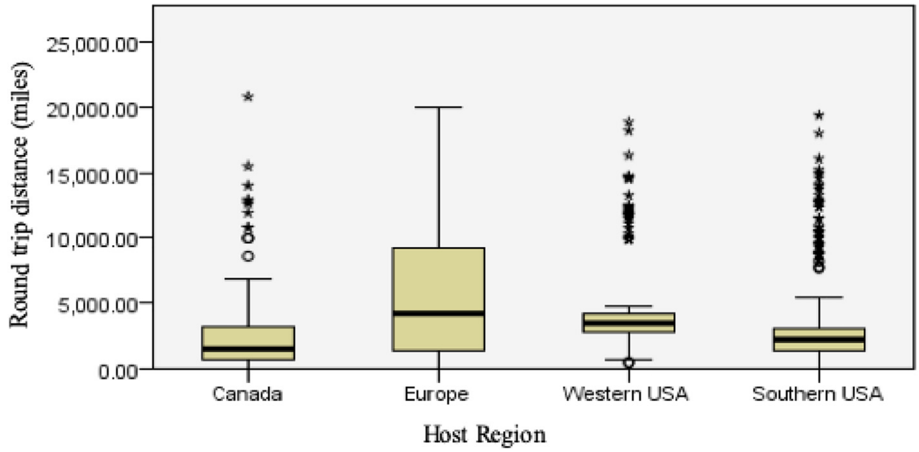

Fig. 1. Relative round-trip miles traveled by conference geographical region.

of forgoing certain physical conferences, opting instead for virtual conferences, webinars and lecture series needs to be seriously considered by organizations responsible for arranging medical meetings. Although the data regarding the carbon footprint of video streaming services is contentious, analysis finds that the emissions generated by video streaming are modest and are likely to become even more so as technologies improve and become more efficient [28]. Offering would-be conference attendees the option to watch presentations remotely via an audiovisual link-up, and offering speakers the option to give their talks using the same technology would significantly reduce the CO_2e associated with conference travel, lodging and dining. Additionally, the conference proceedings would become more accessible to individuals who are in remote locations, are time and resource-poor [29], or who simply cannot travel due to local or international restrictions. Such a conference has already been implemented by the SPU with great success, as it broadcast its 2020 meeting live over the course of several days. An added advantage of using these technologies is that sessions can be recorded and saved for posterity.

For physical conferences, the geographic location of meetings should be taken into account. The concept of alternating meetings between venues that result in higher and lower CO_2e has been explored in other disciplines [1]. Our study found that for the SPU meeting, a conference predominantly attended by Americans, meetings on the Western side of the USA resulted in higher travel related CO_2e. The majority of presenters in the USA hail from the Mid-West and the North-Eastern USA, and although we appreciate that holding conferences in locations that offer attractive leisure and tourism opportunities is a significant draw-card, alternating conferences to places that do not require the majority of delegates to travel a large distance may reduce carbon emissions overall.

Then, the necessity of multiple single-use items should be reevaluated. Physical posters – which in addition to being single-use can often not be recycled – could be replaced with electronic posters, especially considering that at a conference such as the SPU, most poster-presenters are required to provide and present an electronic slide deck in addition to the printed poster. Electronic posters are an acceptable and effective tool for presenting research, and are already being used at various medical conferences [30,31]. The necessity of other single-use conference items such as booklets, lanyards, plastic water bottles and coffee cups could also be reevaluated, and more sustainable options for conference merchandise could be considered.

Finally, the option of carbon offsetting could be offered to delegates. Carbon offsetting schemes allow individuals and companies to invest in projects that aim to balance their carbon footprints, through investment in renewable energy projects or the planting of trees [32]. Certain airlines already offer passengers the option to offset their flights and delegates may already be utilizing such schemes. Conference organizers could also encourage offsetting by contributing a small portion of registration fees to a carbon offsetting scheme.

There are important methodological limitations to our study that are critical to acknowledge. Our study looked specifically at some of the likely emissions generated by delegates presenting research at six North American and one European pediatric urological conferences. It is likely that we underestimated emissions generated by transit, as we

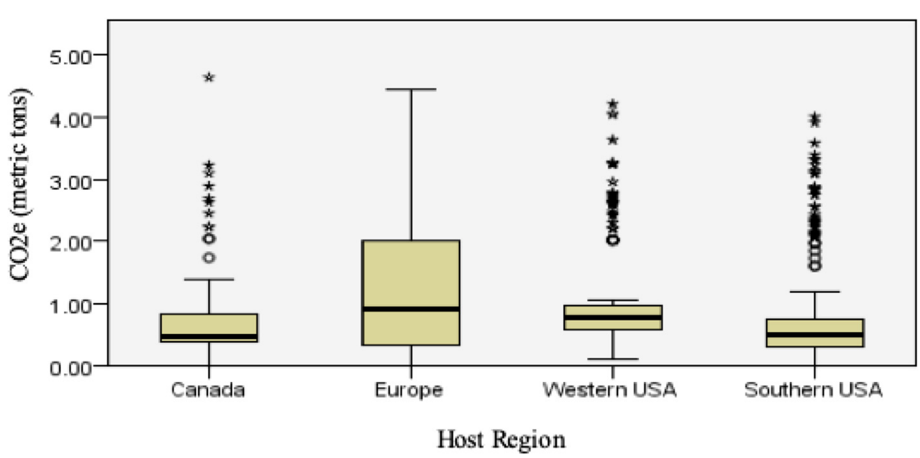

Fig. 2. Relative CO_2e by conference geographical region.

calculated carbon emissions based on the most direct flight between the delegate's home institution and the conference venue when it is likely that many delegates use more circuitous routes that are less expensive, and did not factor in the emissions generated by ground transport to and from airports and between venues. We did not attempt to quantify the emissions related to the utilization of the hospitality and food service industry at the conference venue, the utilization of audiovisual equipment, or the printing and manufacturing of items such as conference booklets, lanyards, tote bags and other complementary items. Furthermore, we attempted to calculate only the carbon emissions of flights: other gases and chemicals are released into the environment as a result of both of these processes.

4. Conclusion

Climate change caused by the emission of GHG by human industry poses a serious health concern this century, and the COVID-19 pandemic has thrown into sharp relief the necessity of seeking alternatives to large, physical academic medical conferences. These conferences are essential to the sharing of research and offer invaluable networking opportunities, but they also contribute to global emissions and are not possible at a time when long-distance travel and large gatherings are restricted. Delegate travel, accommodation and food requirements, as well as the use of audiovisual equipment and the printing and manufacturing of single-use items such as conference booklets, lanyards, posters and beverage containers all carry an ecological footprint. We suggest that there are strategies that could potentially decrease their carbon footprint whilst continuing to provide a satisfying academic experience for delegates who cannot be in close physical proximity to each other. These include the enthusiastic adoption of remote video streaming and teleconferencing options, rotating conference venues between different geographical regions, reducing the use of single-use items, and offering delegates options to offset their conference-related carbon footprint.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpedsurg.2020.07.013.

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