Cardiology in the Young

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Webinars reduce the environmental footprint of pediatric cardiology conferences

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Original Article

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Abstract

Background: Webinars have recently replaced in-person medical conferences, including paediatric cardiology conferences, given the COVID-19 pandemic. *Methods:* With increasing environmental concerns, we analysed the differences between the environmental footprint of a paediatric cardiology webinar with a hypothetical conference. Travel data was collected, with assumptions made on the amount of computer use, internet use and accordingly the overall use of electricity for both forms of conference. Life Cycle Assessment methodology was used (OpenLCA and Ecovinvent v 3.7). *Results:* We showed that the theoretical environmental impact of a virtual conference is significantly less (4 tons CO2 equivalent) than the traditional international face-to-face conference (192 tons CO2 equivalent). The life cycle assessment methodology showed that resource use for a face-to-face conference lasting 2.5 days for 1374 attendees is equivalent to 400 times what an average person would use in one year, the climate change and photochemical ozone formation approximately 250 times and the eutrophication terrestrial equivalent to 225 times. However, using carbon equivalent emissions to measure environmental harm from flying is an under estimate of the potential damage, when one considers the additional production of airplane contrails. Notwithstanding this, there is a 98% reduction in climate change impact when meetings are held virtually. *Conclusions:* While the virtual conference may never completely replace the traditional in-person paediatric cardiology conference, due to networking benefits, the significant theoretical benefits to the environment highlighted in this study, warrants consideration for the virtual conference taking a more common place in sustainable academia.

There is overwhelming evidence to support the increasing concerns regarding the health of our planet. Wildlife habitat and biodiversity is reducing, air quality is deteriorating, disease patterns are changing, oceans are warming and acidifying; all of which have significant health effects for mankind.[1–4] Although widely debated, one could argue that the most pressing threat for humanity is climate change, resulting from the release of "greenhouse gases" by farming, deforestation, and the burning of fossil fuels to support industry and travel. Consequently, global average sea levels are expected to rise up to 82 cm by 2100.[5] Climate change is already displacing small indigenous communities around the world,[6] with many countries with low level populations considering their approach.[7] Climate change is harming human health, and needs a broad range of strategies to reduce this harm.[8,9]

There is a growing relationship between environmental harm and planetary health, defined as the "health of human civilisation and the state of the natural systems on which it depends".[10] In causing planetary harm, in this report we examine the hypothesis that widespread travel to conferences is harming human health.

Academics attend conferences to keep abreast of relevant research trends, to network, to be educated, and to present their own research. Traditionally the only way of accomplishing these goals was to travel locally, or as flights became cheaper and more available, internationally. With increased access to international conferences, year on year conference attendance has been growing,[11] with the global conference market having an important economic, and environmental, impact. Internationally the economic spend on industry meetings, conference and events is significant. Annually, the UK, Canada, Denmark, and Australia spend a respective $21.24 billion, $19.8 billion,[12] $2.75 billion,[13] and $17.6 billion[14] on these types of events. Conferences generate money for the host city, in terms of hotel accommodations, use of conference facilities and expenditure for local businesses.

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According to eventbrite, in the UK, on average 258 people attend each conference a year with 10,000 venues, and over 1.3 million business events held every year. Larger conferences attract many more people.[15] In 2018, the congress of the European Society of Cardiology had 32,858 participants and the congress of the European Society of Medical Oncology had 27,700 participants.

As conferences have increased, so has the environmental impact. A major concern with the amount of conferences is the effect that the required air travel has on planetary health. One source states that the air travel contributes 5% of the carbon equivalent emissions.[16] The interesting fact about planes is their environmental impact does not just relate to their carbon emissions. Planes also create contrails, with the soot from a plane allowing water vapor to condense and form cirrus clouds lasting for some hours. These clouds trap ice which in turn trap heat, and in turn warm the climate.[17,18] Whereas the carbon dioxide emissions from aviation is predicted to be 84 mW/m^2 by 2050, the warming effect from the effects of contrails will be almost twice as high, at 160 mW/m^2.[19] It is suspected that face-to-face conferences also causes other environmental impacts.

It could be argued that traditional paediatric cardiology conferences with in-person meetings can now be replaced by web based e-learning platforms, forums, and meetings. In the last few years, e-learning has become part of the mainstream in medical education.[20] With the COVID-19 pandemic, e-learning has become the new normal, with many primary, secondary and tertiary institutions turning to online platforms such as Zoom, Teams, and a variety of educational software to educate, and interact with their students. The academic conference industry has been slow to follow similar trends prior to the Covid pandemic. Some conferences started to allow online attendance prior to the current COVID-19 pandemic (e.g., the AMEE conference).[20] However since the Covid pandemic there has been a dramatic transition to a virtual framework. Several organisations have been producing excellent webinars in paediatric and congenital cardiology including "Heart University", "Congenital Heart Academy" and the "World University for Pediatric and Congenital Heart Surgery".

On Wednesday, 6 May, 2020, one of the first webinars in congenital heart disease was hosted by the Heart University, a free online educational platform, hosted by Cincinnati Children's Hospital, for providers of both congenital and paediatric acquired heart disease.[21] The webinar series is entitled Contemporary Questions in Congenital Heart Disease Webinar Series. The first webinar in this series was entitled "Tetralogy of Fallot: How can we avoid poor outcomes late after repair?", and represented the largest gathering at that time of congenital heart disease providers, outside the Quadrennial World Congress of Pediatric Cardiology and Cardiac Surgery, with 1374 participants from 100 countries across 6 different continents.

For the purposes of this study, we calculated what the environmental impact would be if all 1374 attendees at the paediatric cardiology Webinar attended the conference in-person in Cincinnati (typically lasting 2.5 days for the biannual conference). The city of residence for the attendee was used to calculate their travel distances as part of a Life Cycle Analysis calculation. Unlike other papers in this area we were also keen to present the results both as impact factors but also as normative results; showing the impact compared to a person equivalent impact (the impact on the environment a person would have in a usual life year).[23,24]

Materials and methods

Ethical approval for the Webinar study was obtained from the University of Alberta (JW) from which data was extracted regarding attendee participation and city of origin.

Definitions for all terms are provided in the Appendix 1.

Disability adjusted life year: The disability-adjusted life year is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability, or early death.

Comparative life cycle assessment: A specific life cycle assessment where two or more products are compared using life cycle assessment methodology.

Life cycle assessment: Life cycle assessment (LCA) is a methodology that strives for the assessment of environmental burdens along an entire (product) value chain.

Life cycle inventory: Life cycle inventory (LCI) involves making an inventory of input and output flows for a product system. Such flows could include inputs of raw materials, and output releases of products to air, land, and water.

A comparative life cycle assessment of a traditional (face-to-face) and a virtual medical conference was undertaken at Trinity College Dublin, Ireland in conjunction with Eastman Dental Hospital, London.

The software OpenLCA v1.10.2 was used for the Life Cycle Assessment, alongside the reference database Ecoinvent v3.7. The Life Cycle Assessment methodology was applied in line with ISO standards and across the 16 environmental impact categories recommended by the Product Environmental Footprint Category 2 Rules Guidance guidelines.[22]

The functional unit was defined as 1374 delegates attending a 2.5 day congenital heart disease conference. Assumptions and exclusions are described in Table 1.

The system boundaries are shown in Figure 1. The entire product system, including geographical location, was compared, in order to account for travel to Cincinnati from worldwide for the traditional conference. A life cycle inventory was created for each type of conference based on these assumptions.

Data from the life cycle inventory was modelled in OpenLCA v1.10 for the Life Cycle Impact Assessment (LCIA). The Life Cycle Impact Assessment method for each impact category was selected based on the PEF Category Rules Guidance and is described in Table 1.

Disability Adjusted Life Years (DALYs) were also calculated for the following human health impact categories: water consumption, ionising radiation, global warming, ozone formation and depletion, particulate matter formation, human carcinogenic and non-carcinogenic toxicity.

The life cycle inventory is shown in Table 2.

Results

The life cycle impact assessment results are shown in Figure 2. The virtual conference performed better than the traditional conference in all 16 environmental sustainability impact categories.

Figure 2 also illustrates which parts of the life cycle inventory contributed to the overall impact. For the traditional conference, air transport (long haul passenger flights) was the biggest contributing factor across 15 out of 16 impact categories (ranging from 37%–98%). Water scarcity was the only impact category where

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Table 1. List of assumptions made in this life cycle analysis

Aspect of life cycle	Traditional (face-to-face) conference
Pre-conference organisation	• It was assumed the same amount of time was required for organisation, assumed as the equivalent of 1 person working full time for 7 months (based on discussions with industry experts). • It was assumed the organiser took responsibility for booking flights and accommodation for event managers and speakers. • It was assumed that each delegate spent 60 minutes online booking a traditional conference (register, book travel, and accommodation), and 15 minutes booking the virtual conference (e.g., register online)
Number of attendees	• For both conferences, it was assumed that there would be 1374 delegates, 32 speakers, and 5 event mangers.
Pre-conference exclusions	• Organisation and resources from sponsors and showcasing companies were excluded. • Delegates producing and printing poster and oral presentations were also excluded.
Travel to and from conference	• Travel was only applicable to the traditional conference, as it was assumed all attendees stayed at their residence for the virtual conference. • Travel was calculated using the city of residence for the 1374 attendees, collected by the author CJM. • It was assumed delegates lived in the exact city centre, and travelled separately, via passenger car, to the nearest commercial airport, calculated using GoogleMaps. • It was assumed delegates travelled via a long-haul direct flight to Cincinnati Northern Kentucky International Airport, and the flight distance was calculated using the website Great Circle Mapper (https://www.greatcirclemapper.net/). • It was assumed all delegates travelled 20.1 km, via passenger car, from the airport to the conference hotel. It was assumed travel from the conference was the same journey in reverse for each delegate. • It was assumed that the 32 speakers and 5 event managers travelled via car and flight, and average figures from the 1374 delegates was used as their travel distances.
Hotel operations	• It was assumed all attendees stayed at the hotel/conference venue, a 4* hotel, and they stayed for three nights. • Hotel accommodation was not applicable to the virtual conference, but the impact of attendees using their own residential heating and electricity resource while staying at home for 3 days was excluded.
Conference/virtual(home) facilities	• It was assumed that the conference presentations were in session for 7.5 hours/day, for 2.5 days. • Social, networking and industry showcase events were excluded. • For the virtual conference, it was assumed all attendees were using their computers or laptops to stream live video feed of the conference. For the virtual conference a day's energy was calculated for each individual to account for domestic use of energy. For the traditional conference, it was assumed 25% of delegates were using their laptops during the conference presentations. • Food and drink, paper programmes, goody bags, and prizes were all excluded, along with their waste.
Post-conference organisation	• It was assumed that delegates spent 10 minutes each completing feedback and downloading CPD certificates on their personal computers. • It was assumed that organisers spent 10 minutes per delegate collecting feedback and sending out CPD certificates.

building operations was the biggest contributor (64%). For the virtual conference, it was the residential energy use that was the biggest contributing factor, responsible for 91% of the climate change impact.

Figure 3 illustrates the normative results for a conference. The climate change impact for a 2.5 day, face-to-face conference for these 1374 people was equivalent to 245 times what an average person would use in 1 year, and the fossil fuel resource use 400 times.

For a virtual conference the results are much smaller; the climate change impact for the same conference for 1374 people would use less than 3 times what an average person would use in one year.

There are a number of reasons that the impact categories for the face-to-face conference are so high. The majority of the climate change burden of the face-to-face conference was due to the fossil carbon dioxide air emission from air travel. Similarly the resource use, energy carrier's burden of the conference was mainly due to ground crude oil use for petroleum and gas production, used in air travel. The non-cancer human health burdens of the face-to-face conference were mainly due to the lead and zinc emissions to air from passenger air travel. The terrestrial eutrophication burdens of the face-to-face conference were mainly due to the nitrogen oxides emissions to air from passenger air travel. In contrast the climate change burden of the virtual conference was mainly due to methane and carbon dioxide air emissions from hard coal plants for electricity production for attendees to use residential energy, remaining at home rather than travelling.

The traditional face-to-face conference resulted in a loss of 2.7 DALYs, and the virtual conference just 0.5 DALYs. Water scarcity was the biggest contributing factor to both DALY results (48% and 91% of the total DALYs respectively) followed by fine particulate matter formation (45% and 7% respectively).

Discussion

This is the first paper to use life cycle assessment to model the environmental effects of a cohort of people attending a virtual compared with a face-to-face conference. The life cycle assessment process is a comprehensive and widely accepted method to calculate an environmental impact of this type. It does not just measure carbon, but captures the total life cycle emissions of a process from

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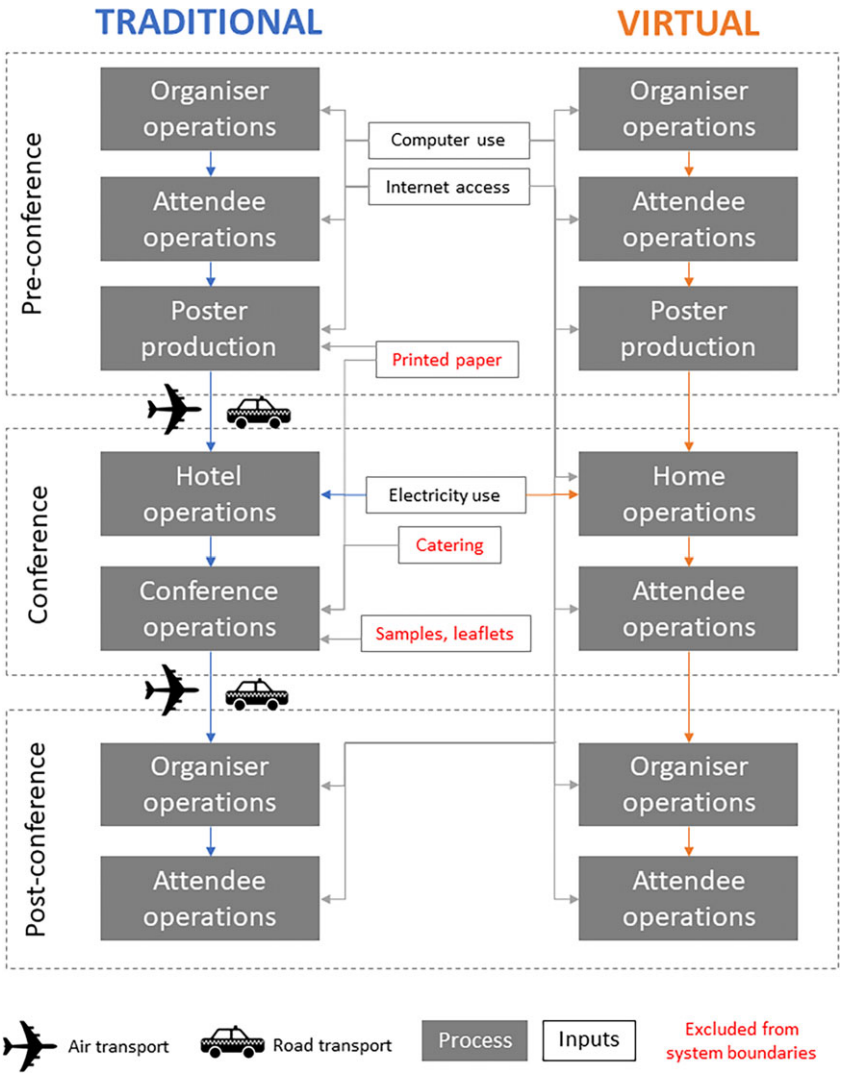

Figure 1. System boundaries.

cradle to grave and can estimate emissions from road travel, air travel, laptop use, and internet use. In this study the Life Cycle Assessment demonstrates the potential significant environmental harm of a traditional conference compared with a virtual conference, with more than a 98% reduction in climate change impact when meetings are held virtually.

The results of our Life Cycle Assessment were based on 1374 delegates, with our calculations showing that each delegate would have contributed almost 1.4 tons of carbon equivalent emissions. This is in similar agreement to that calculated by Zotova[23] (1.83 tons), but differs from the figure published recently by Klöwer.[24] Both authors consider only carbon emissions, not the overall environmental footprint of conferences including the 16 environmental impact categories recommended by PEF. Of more concern is that both papers fail to mention the "elephant in the room"; that flying is not just about carbon emissions but the other elements of flying which impact significantly on global warming (e.g., the air contrails mentioned above). By just looking at carbon emissions environmental consequences can be understated.

With the current mode of travel conferences are clearly "unsustainable" from an environmental impact viewpoint. In order to be sustainable, it has been suggested that a person should not be responsible for producing more than 3 tons of carbon equivalent emissions per year.[25] Zotova argues that a conference can be handled in a responsible and sustainable way, recommending low carbon travel, sustainable catering and carbon offsetting. However, like Klöwer we believe while some of these solutions may be a practical measure towards reducing carbon emissions, bigger changes are needed.[24] Our theoretical data, however, strengthens the argument that webinars may be both a practical and sustainable solution towards providing high quality medical education and a means for contemporary knowledge-sharing in a fashion that results in minimal carbon emission.

Participants attending industry events and conferences would argue that there is significant benefit to traditional, face-to-face attendance. New research trends are identified and explored. Collaborations are started and networking is enhanced. While this is indisputable, such characteristics are not unique to in-person meetings. Indeed, it could be argued that by enhancing the capacity of individuals from many different countries and financial backgrounds to attend such events, virtually, the richness of interaction and the potential for linkages between delegates is enhanced, albeit

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Table 2. Ecoinvent processes, and unit quantities used in the life cycle assessment

Flow	Process (Ecoinvent v3.6)	Unit	Amount	
			Traditional conference	Virtual conference
Pre-event organisation	Market for operation, computer, laptop, 68% active work with internet access 0.2Mbit/s, label-certified electricity CUT-OFF, U GLO	Hours	2511.5	1481
Travel to event	Market for transport, passenger car CUT-OFF, U GLO	Km	76,118	0
	Market for transport, passengers, air passengers, passenger aircraft, long haul CUT-OFF, U GLO	Km	9,243,991.92	0
Run event	Market group for electricity, low voltage, APOS U GLO	Kwhr	0	27889.21096
	Market for building operation, upmarket hotel, 4 star CUT-OFF, U GLO	Guest nights	4233	0
	Market for operation, computer, laptop, 68% active work with internet access 0.2Mbit/s, label-certified electricity CUT-OFF, U GLO	Hours	6680	0
	Market for operation, computer, laptop, videoconference CUT-OFF, U GLO	Hours	18.75	0
	Market for operation, computer, laptop, video mode CUT-OFF, U GLO	Hours	0	21,165
	Market for internet access, videoconference, 0.7Mbit/s CUT-OFF, U GLO	Hours	0	21,165
Travel from event	Market for transport, passenger car CUT-OFF, U GLO	Km	76,118	0
	Market for transport, passengers, air passengers, passenger aircraft, long haul CUT-OFF, U GLO	Km	9,243,991.92	0
Post-event organisation	Market for operation, computer, laptop, 68% active work with internet access 0.2Mbit/s, label-certified electricity CUT-OFF, U GLO	Min	27,480	27,480

in non-traditional ways (e.g., through subsequent virtual interactions rather than within the conference setting. Similarly, while virtual lectures perhaps lack the immediacy and interactiveness of one given in a meeting hall there is enhanced opportunity for virtual delegates to message/chat during a video conference in real time, asking questions, discussing the presentation but also to identify similar people in the audience who face similar issues. Indeed, some people may prefer the less socially awkward ability to connect with people initially online. Furthermore, providing instant lists of attendees may facilitate collaboration. Speakers can answer questions after presentations, with no time limits associated with face-to-face conferences. So while the virtual alternative may fall short in some regards to the face-to-face networking, there are also potential benefits to this format.

One of the features apparent to the organisers of the first Heart University webinar was the access it provided to low- and middle-income countries, with over half of attendees hailing from such geographical locations. This fulfilled a priority objective for the Heart University editorial board, to cater to lower resource settings.[26,27] A conference held virtually is a lot more accessible to delegates from such lower resource settings. A number of countries simply do not have the funding to provide access to their employees to attend international conferences, along with other barriers such as a heavy workload related to a critical shortage of specialists.[28] Virtual conferences provide access to low resource settings around the globe, to both increase content-specific knowledge as well as provide for networking opportunities in these countries.

Limitations

A complete analysis of the entire footprint of an in-person conference requires factoring in food and drink consumption, paper programs, goody bags, prizes and their waste. Each of these (e.g., a goody bag) is outside the scope of this paper and indeed would require a full manuscript. This manuscript analysed one in-person conference and this analysis could be applied to other congenital cardiology conferences including the American Heart Association, American College of Cardiology, American Society of Echocardiography, Society for Cardiovascular Angiography and Intervention to name a few. This data could also be collated for other specialist medical conferences outside paediatric cardiology. Although recent studies have evaluated the benefit of e-learning conferences in facilitating learning, further studies are warranted to evaluate the overall benefits of e-learning webinars compared to in-person conferencing.[29]

Conclusion

The theoretical environmental impact of a virtual paediatric cardiology conference (4 tons CO2 equivalent) is significantly less than the traditional international face-to-face conference (192 tons CO2 equivalent). However, using carbon equivalent emissions to measure environmental harm from flying is an under estimate of the potential damage, when one considers the additional production of contrails. This paper also highlights other significant environmental impacts of the face-to-face conference, including photochemical ozone formation of approximately 250 times the impact of an average person and the eutrophication terrestrial equivalent to 225 times an average person's impact. There are clear benefits to the traditional conference, such as in-person networking, however the virtual conference may offer appealing and competing advantages. While the virtual conference may never completely replace the traditional in-person conference, the significant theoretical benefits to the environment highlighted in this study warrants consideration for the virtual conference taking a more common place in academia.

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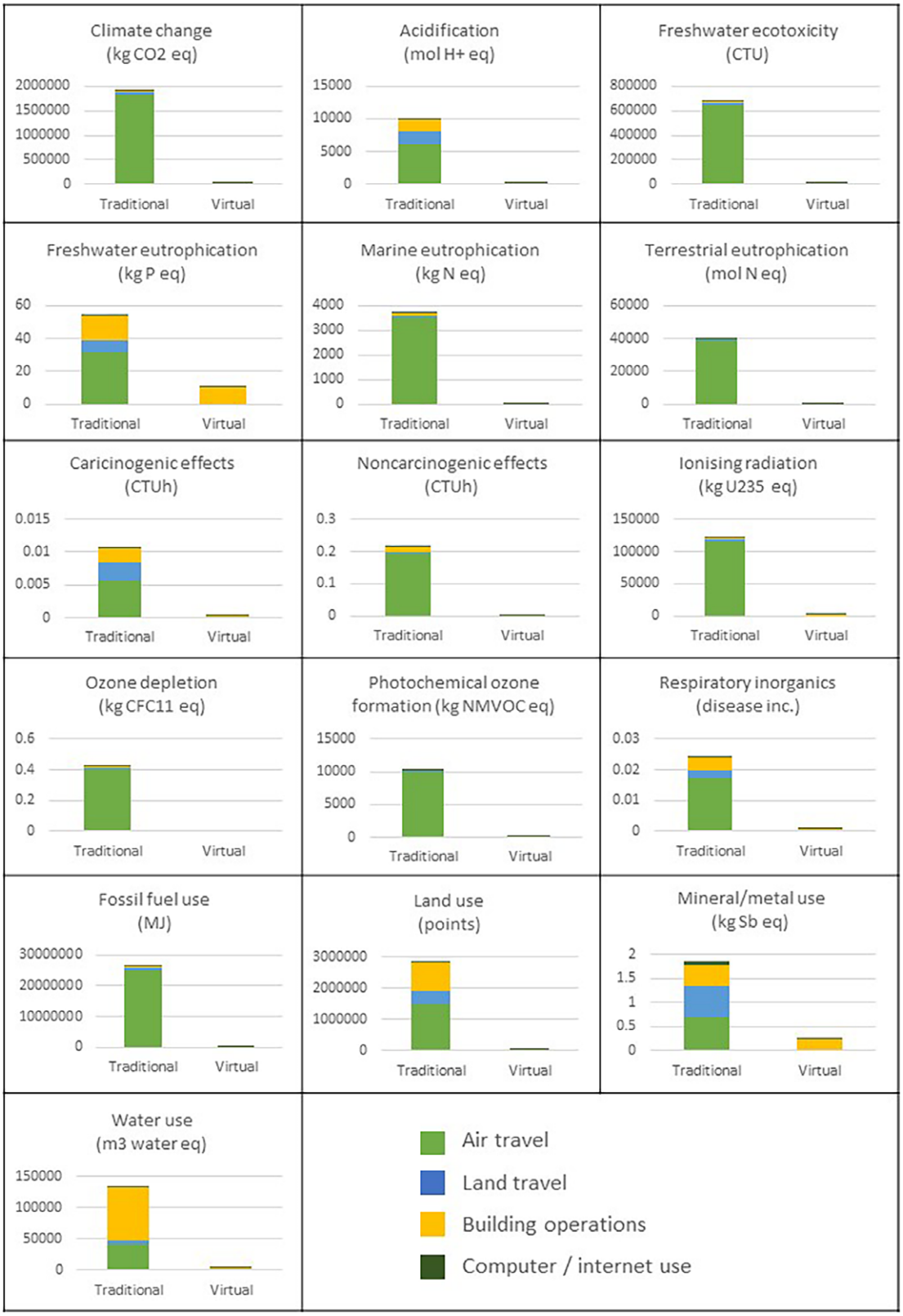

Figure 2. Life cycle impact assessment results.

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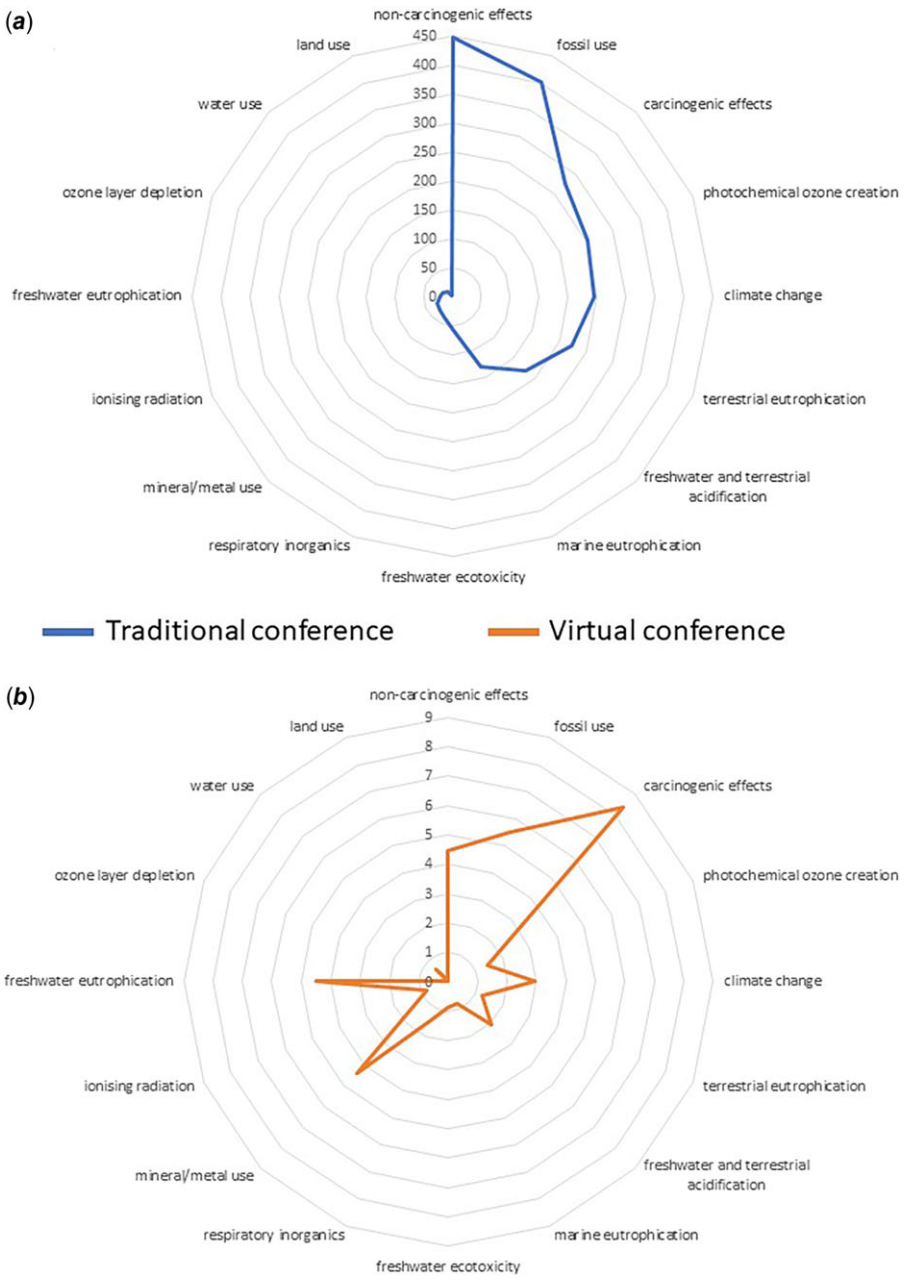

Figure 3. Life cycle assessment normative results.

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Conflict of interest. None.

Ethical approval. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national guidelines and with the Helsinki Declaration of 1975, as revised in 2008, and has been approved by the institutional committees (Ethics Committee University Edmonton, Alberta, Canada).

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/S1047951121000718

References

1. Trompiz G. Scientists warn a million species at risk of extinction. *Reuters*, 2019. Available at: https://www.reuters.com/article/us-un-environment-biodiversity/scientists-warn-a-million-species-at-risk-of-extinction-idUSKCN1SC0PJ.
2. Caminade C, Kovats S, Rocklov J, et al. Impact of climate change on global malaria distribution. Proc Natl Acad Sci USA 2014; 111: 3286–3291. doi: 10.1073/pnas.1302089111
3. World Health Organisation. Public health, environmental and social determinants of health (PHE), 2020. Retrieved July 22, 2020, from https://www.who.int/phe/health_topics/outdoorair/en/#:~:text=WHO%20leads%20Global%20Platform%20on%20Air%20Quality%20and%20Health&text=Air%20pollution%20is%20the%20largest,stroke%2C%20respiratory%20disease%20and%20cancer
4. The International Union for Conservation of Nature (IUCN). Issues brief. Ocean Warming, 2020. Retrieved July 22, 2020, from https://www.iucn.org/resources/issues-briefs/ocean-warming

5. Hemming D, Iowe J, Biginton M, Betts R, Ryall D. Impacts of Mean Sea Level Rise Based on Current State-of-the-Art Modelling. Hadley Centre for Climate Prediction and Research, Exeter, 2007.
6. World Economic Forum. Here's how rising sea levels could affect our health, 2020. Retrieved July 22, 2020, from https://www.weforum.org/agenda/2019/04/how-will-retreating-from-the-sea-affect-our-health/
7. World Economic Forum. The world's coastal cities are going under. Here's How Some Are Fighting Back, 2020. Retrieved July 22, 2020, from https://www.weforum.org/agenda/2019/01/the-world-s-coastal-cities-are-going-under-here-is-how-some-are-fighting-back/
8. Charlesworth A, Gray A, Pencheon D, Stern N. Assessing the health benefits of tackling climate change. BMJ 2011; 343: d6520. doi: 10.1136/bmj.d6520.
9. IOM Migration Research Series. Migration and Climate Change. 2020. Retrieved July 22, 2020, from https://www.ipcc.ch/apps/njlite/srex/njlite_download.php?id=5866
10. Whitmee S, Haines A, Beyrer C, et al. Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–Lancet Commission on planetary health. Lancet 2015. http://dx.doi.org/10.1016/S0140-6736(15)60901-1
11. International Congress and Conference Association. Statistics Report Country & City Rankings Public Abstract, 2020. Retrieved July 22, 2020, from http://www.iccaworld.org/dcps/doc.cfm?docid=2321
12. The Economic Contribution of Meetings Activity in Canada. 2020. Retrieved July 22, 2020, from http://www.iccaworld.com/dcps/doc.cfm?docid=1621
13. The Economic Contribution of Meetings Activity in Denmark. 2012. https://www.visitdenmark.dk/sites/default/files/vdk_images/PDF-and-other-files/Analyser/2012/the-economic-contribution-of-meeting-activity-in-denmark-2012.pdf
14. Business Events Council of Australia. The Value of Business Events to Australia Business Events Council of Australia, 2020. Retrieved July 22, 2020, from https://www.businesseventscouncil.org.au/files/View_Report.pdf
15. Eventbrite Pulse Report. 2020. Retrieved July 22, 2020, from https://www.eventbrite.co.uk/blog/academy/eventbrite-pulse-report-2018-fds00/
16. Sullivan A. DW. To fly or not to fly? The environmental cost of air travel, 2020. Retrieved July 22, 2020, from https://www.dw.com/en/to-fly-or-not-to-fly-the-environmental-cost-of-air-travel/a-42090155
17. Lee DS, Fahey D, Forster P, et al. Aviation and global climate change in the 21st century. Atmos Environ 2009; 43: 3520–3537.
18. ICAO: Environmental Report. Environmental Unit on the International Civil Aviation Organization. ICAO, Montreal, Canada, 2007.
19. LePage M. New Scientist. It turns out planes are even worse for the climate than we thought, 2020. Retrieved July 22, 2020, from https://www.newscientist.com/article/2207886-it-turns-out-planes-are-even-worse-for-the-climate-than-we-thought/#ixzz6RLtIpmBi
20. AMEE. An international Association for Medical Education. e-Learning in Medical Education, 2020. Retrieved July 22, 2020, from https://amee.org/getattachment/Covid-19/eG32_Electronic.pdf
21. Tretter JT, Windram J, Faulkner T, et al. Heart University: a new online educational forum in paediatric and adult congenital cardiac care. The future of virtual learning in a post-pandemic world? Cardiol Young 2020; 30: 560–567.
22. https://ec.europa.eu/environment/eussd/smgp/pdf/PEFCR_guidance_v6.3.pdf
23. Zotova O, Pétrin-Desrosiers C, Gopfert A, Van Hove M. Carbon-neutral medical conferences should be the norm. Lancet Planet Health 2020; 4: e48–e50. doi: 10.1016/S2542-5196(20)30,003-6.
24. Klöwer M, Hopkins D, Allen M, Higham J. An analysis of ways to decarbonize conference travel after COVID-19, 2020. Retrieved July 22, 2020, from https://www.nature.com/articles/d41586-020-02057-2
25. Ecocivilisation. Three tons of carbon dioxide per person per year, 2020. Retrieved July 22, 2020, from https://www.ecocivilization.info/three-tons-carbon-dioxide-per-person-per-year.html#:~:text=At%20the%20average%20individual%20rate,dioxide%20 in%20the%20 atmosphere%20level
26. Tretter JT, Windram J, Faulkner T, et al. Heart University: a new online educational forum in paediatric and adult congenital cardiac care. The future of virtual learning in a post-pandemic world? Cardiol Young 2020; 30: 560–567.
27. Tretter JT, Ramachandram P, Zhelevab B, et al. Reply to letter "Leveraging e-learning for medical education in low- and middle-income countries" Cardiol Young 2020: 30:905–906.
28. Musa NL, Hjortdal V, Zheleva B, et al. The global burden of paediatric heart disease. Cardiol Young 2017: 27: S3–S8.
29. McMahon CJ, Tretter JT, Faulkner T, Krishna Kumar R, Redington AN, Windram JD. Are e-learning webinars the future of medical education? An exploratory study of a disruptive innovation in the COVID-19 era. Cardiol Young 2020; 15: 1–10.

https://doi.org/10.1017/S1047951121000718 Published online by Cambridge University Press