Can J Anesth/J Can Anesth (2023) 70:327–334
https://doi.org/10.1007/s12630-022-02388-w

REPORTS OF ORIGINAL INVESTIGATIONS

An audit of the carbon footprint of travel for the Canadian Anesthesiologists' Society International Education Foundation partnerships

Un audit de l'empreinte carbone des voyages dans le cadre des partenariats de la Fondation d'éducation internationale de la Société canadienne des anesthésiologistes

Sarah Chibane, MD · Talia Ryan, MD · Francoise Nizeyimana, MD · Onica Gill, MD · Ananya Abate, MD · Joel Hamstra, MD · Ana Crawford, MD · Julian Barnbrook, MBChB · M. Dylan Bould, MBChB, MEd

Received: 31 March 2022 / Revised: 23 September 2022 / Accepted: 26 September 2022 / Published online: 20 January 2023

Abstract

Purpose *International partnerships have an important role in capacity building in global health, but frequently involve travel and its associated carbon footprint. The environmental impact of global health partnerships has not previously been quantified.*

Methods *We conducted a retrospective internal audit of the environmental impact of air travel for the international education programs of the Canadian Anesthesiology Society's International Education Fund (CASIEF). We compiled a comprehensive list of volunteer travel routes and used the International Civil Aviation Organization Carbon Emissions Calculator, which considers travel distance, passenger numbers, and average operational data for optimized estimates. Comparisons were made with average Canadian household emissions and disability adjusted life years (DALYs) lost from climate change consequences.*

Results *The total carbon dioxide emitted (CO_2-e) for the Rwanda, Ethiopia, and Guyana CASIEF partnerships were 268.2, 60.7, and 52.0 tons, respectively. The DALYs cost of these programs combined is estimated to be as high as 1.1 years of life lost due to the effects of CO_2-e. The mean daily carbon cost of the average Rwanda partnership was equivalent to daily emissions of 2.2 Canadians (or 383 Rwandans), for the Guyana partnership was equivalent to*

S. Chibane, MD
Faculty of Medicine and Health Sciences, McGill University, Montreal, QC, Canada

T. Ryan, MD
Foothills Medical Centre, University of Calgary, Calgary, AB, Canada

F. Nizeyimana, MD
Department of Anesthesiology and Critical Care, University Teaching Hospital of Kigali, University of Rwanda, Kigali, Rwanda

O. Gill, MD
Department of Anaesthesia and Intensive Care, Georgetown Public Hospital Corporation, Georgetown, Guyana

A. Abate, MD
Department of Anesthesiology, Addis Ababa University, Addis Ababa, Ethiopia

J. Hamstra, MD
Department of Anesthesia, McMaster University, Hamilton, ON, Canada

A. Crawford, MD
Department of Anesthesiology, Perioperative and Pain Medicine, Stanford University, Stanford, CA, USA

J. Barnbrook, MBChB
Department of Anesthesiology, University Hospital of Northern British Columbia, Prince George, BC, Canada

M. D. Bould, MBChB, MEd (✉)
Department of Anesthesiology and Pain Medicine, The Children's Hospital of Eastern Ontario, University of Ottawa, Ottawa, ON, Canada
e-mail: dbould@cheo.on.ca

1.6 Canadians (or 7.6 Guyanese people), and for the Ethiopia partnership was equivalent to 2.4 Canadians (or 252 Ethiopian people).
Conclusions *Air travel from these CASIEF partnerships resulted in 380.9 tons CO_2-e but also enabled 5,601 volunteer days-in-country since 2014. The estimated environmental cost needs to be balanced against the impact of the programs. Regardless, carbon-reduction remains a priority, whether by discouraging premium class travel, organizing longer trips to reduce daily emissions, prioritizing remote support and virtual education, or developing partnerships closer to home.*

Résumé
Objectif *Les partenariats internationaux jouent un rôle important dans le renforcement des capacités en santé mondiale, mais impliquent souvent des voyages et une empreinte carbone qui y est associée. L'impact environnemental des partenariats pour la santé mondiale n'a pas encore été quantifié.*
Méthode *Nous avons réalisé un audit interne rétrospectif de l'impact environnemental du transport aérien pour les programmes de formation internationale du Fonds d'éducation internationale de la Société canadienne des anesthésiologistes (FÉI SCA). Nous avons compilé une liste complète des itinéraires de voyage des bénévoles et utilisé le Calculateur d'émissions de carbone de l'Organisation de l'aviation civile internationale, qui prend en compte la distance parcourue, le nombre de passagers et les données opérationnelles moyennes pour des estimations optimisées. Des comparaisons ont été faites avec les émissions moyennes des ménages canadiens et les années de vie corrigées de l'incapacité (AVCI) perdues en raison des conséquences des changements climatiques.*
Résultats *Le dioxyde de carbone total émis (CO_2-e) dans le cadre des partenariats de la FÉI SCA avec le Rwanda, l'Éthiopie et le Guyana, étaient de 268,2, 60,7 et 52,0 tonnes, respectivement. Le coût combiné des AVCI de ces programmes est estimé à 1,1 année de vie perdue en raison des effets du CO_2-e. Le coût quotidien moyen du carbone du partenariat moyen avec le Rwanda équivalait aux émissions quotidiennes de 2,2 Canadiens (ou 383 Rwandais); pour le partenariat avec le Guyana, cela équivalait à 1,6 Canadien (ou 7,6 Guyanais) et pour le partenariat avec l'Éthiopie, à 2,4 Canadiens (ou 252 Éthiopiens).*
Conclusion *Les voyages aériens des partenariats de la FÉI SCA ont entraîné la production de 380,9 tonnes de CO_2-e mais ils ont également permis 5601 journées de bénévolat dans les pays partenaires depuis 2014. Le coût environnemental estimé doit être mis en perspective avec l'impact des programmes. Quoi qu'il en soit, la réduction des émissions de carbone reste une priorité, que ce soit en décourageant les voyages en première classe, en organisant des voyages plus longs pour réduire les émissions quotidiennes, en donnant la priorité à l'assistance à distance et à l'éducation virtuelle, ou en développant des partenariats plus près de chez soi.*

Keywords carbon emissions · carbon footprint · climate change · environment · global health

The 2019 *Lancet Countdown on Health and Climate Change* anticipated the forthcoming consequences of climate change. Predictive models describe hundreds of millions of lives affected by reduced crop yields, increased air pollution resulting from fossil fuel consumption and extreme weather, all expected to hit vulnerable populations in low-resource areas first. Not only will natural disasters accentuate current inequalities in access to healthcare but also an exacerbation of poverty and violent conflict will end up affecting "people of all ages and all nationalities."[1]

Since 2014, the Canadian Anesthesiology Society's International Education Fund (CASIEF) has organized over 250 international trips with its partner organizations. Of note, an equal partner in the Guyana and Rwanda programs is the American Society of Anesthesiologists Global Humanitarian Outreach committee (ASAGHO), also represented in the authorship of this paper (A. C.). ASAGHO volunteers are considered together with CASIEF volunteers for the purposes of this audit. The CASIEF mission is to "collaborate with partners to build capacity for safe, sustainable anesthesia and perioperative care globally through education, knowledge translation, and advocacy."[2] The organization's long-term capacity building efforts involve collaborating with local stakeholders in low- and middle-income countries as they build self-sustaining programs appropriate for their own needs. Relationship building and understanding the nuances of local culture and practice are key aspects of successful global health partnerships, and require time in-country by volunteers, even if much ongoing support can be provided remotely.

The Canadian Anesthesiology Society's International Education Fund's volunteers include physicians, residents, and fellows as well as nurses and researchers, among others. Most are from Canada and the USA, but some travel from Europe, Australasia, or Africa. All volunteers travel by air. In recent years, it has been shown that aviation fossil fuel emissions are a growing component of anthropogenic changes to the atmosphere, making up about 2% of identified atmospheric disturbances.[3] As such, it becomes important to recognize that international collaborations have a potentially damaging impact on the environment and thus on the progression of climate change.[4] Indeed, healthcare professionals, in global health and beyond, are developing an environmental conscience as we learn from evidence-based data including the sobering *Lancet* report.[1]

The anticipated consequences of climate change have resulted in leading global health organizations such as Médecins Sans Frontières to quote "reducing the environmental impact" of their activities as a top mandate priority.[5] The Canadian Anesthesiology Society's International Education Fund also values prioritizing environmentally conscientious decisions in global outreach efforts. Currently, we are unaware of any data that quantify the "environmental impact" of global health partnerships.

Environmental impact can be measured through a carbon footprint. A carbon footprint is defined as "the quantity of GHGs [greenhouse gases] expressed in terms of carbon dioxide emitted (CO_2-e) into the atmosphere by an individual, organization, process, product or event."[6] To better outline future steps toward change, a baseline understanding of CASIEF's own environmental impact is necessary. Therefore, we sought to conducted an audit to assess the environmental impact by measuring the carbon footprint of CASIEF's international education initiatives in Rwanda, Ethiopia, and Guyana from 2014 to 2020. This internal audit aimed to further improve the sustainability, both economic and environmental, of CASIEF initiatives.

Methods

Data collection

We audited three current CASIEF partnerships: Rwanda, Guyana, and Ethiopia. As mentioned above, because of the existing collaborative partnership, CASIEF and ASAGHO volunteers were considered together. According to the Children's Hospital of Eastern Ontario Research Institute Research Ethics Board, neither ethics approval nor a formal waiver is required for an audit (program evaluation). These partnerships were selected according to availability of volunteer and travel information. Travel dates ranged from 2014 to 2020 for the Rwanda partnership (since records of travel and reimbursement were kept electronically) and from 2016 to 2020 for the Guyana partnership (the inception of the program).

Travel data were made available by CASIEF administration from routine records of reimbursement and program management; access to CASIEF administrative documents was granted, and complete volunteer lists were provided. Volunteers were assigned an anonymized audit ID number. Specific travel dates and departing cities for each trip were routinely detailed in volunteer lists for the Guyana, Rwanda, and Ethiopia global outreach partnerships. Data for the exact travel routes were determined through the following steps:

1. From travel receipts for reimbursement, when available
2. From e-mail communication with volunteers
3. Estimated from an average of other CASIEF volunteers' routes departing from the same city for the same destination
4. If there was no available route information for a volunteer trip, Google Flights was used to determine the most common route traveled for the volunteer's starting and end points. Google Flights data may vary over time, and routes were estimated from March to June 2020 for Rwanda and Guyana routes and in February 2022 for Ethiopia routes.

Some volunteers chose to travel using a business class fare. If no cabin class information was available, volunteers were assumed to be traveling economy.

Calculation of airplane travel-related CO_2 emissions

We used the International Civil Aviation Organization (ICAO) calculator to calculate carbon emissions. The ICAO calculator is a free, web-based application which applies the best publicly available industry data to offer the most accurate carbon emissions estimates.[7] The ICAO has developed average values for each factor in their estimates. Their data are sourced from aircraft manufacturers, American passenger and cargo airline reports, charter companies, the US Department of the Interior, the ICAO database, and literature searches. A given flight's passenger load factors (number of passengers, average operational data for the flight, number of economy seats) and its average cargo load were initially calculated. The "portion" of a given flight reserved for freight-type travel was considered and deducted in each calculation. Then, the amount of fuel attributable to carried passengers was determined. Trip distances, which are calculated alongside carbon consumption estimates, were determined according to ICAO location indicators, based on airport coordinates. The final equation considered trip distance, equivalent aircraft fuel consumption, passenger load factors, passenger-to-freight ratio, and the factor 3.16, which represents the number of tons of CO_2 produced by burning a ton of aviation fuel, where "number of y seats" refers to the number of economy class seats. This equation was as follows: CO_2-e per passenger = 3.16 $\times$ (total fuel $\times$ passenger-to-freight factor)/(number of y-seats to passenger load factor).

Cabin class was only considered in routes over 3,000 km, using a simplified approach that allocates double the emissions to any "premium class passenger."

To make meaningful comparisons for our programs' carbon emission estimates, comparator variables were identified as the numerical value of carbon consumption may not be meaningful to most healthcare professionals. The selected variables were the average carbon consumption by a Canadian, Rwandan, Guyanese, or Ethiopian individual obtained from 2018 World Bank data.[8–11] As per the World Bank, the average Canadian individual produces 15.49 tons per year of carbon through all activities combined or 41.4 kg of carbon per day.[8] The average Rwandan individual would be responsible for about 0.088 tons of carbon per year or 0.24 kg per day.[9] The average Ethiopian individual would be responsible for about 0.149 tons of carbon per year or 0.4 kg per day.[10] Finally, the average Guyanese individual would be responsible for about 3.09 tons per year of carbon per year or 8.5 kg of carbon per day.[8]

Health burden of airplane travel-related CO_2 emissions

As a further comparator, we calculated the estimated CO_2 emission-attributable health damage using a framework recently developed by Tang *et al*.[11,12] for estimating health damage in accordance with the Special Report on Emission Scenarios (SRES) developed by the Intergovernmental Panel on Climate Change.[13] In this framework, health damage factors are expressed as disability adjusted life years (DALYs) per kg of additional CO_2 emission. Disability adjusted life years represent the years of life lost because of premature mortality, poor health, or disability.[14] The framework uses SRES scenarios, which evaluate the impact of emissions, demographics, and economic driving forces on climate change over the coming century. The health damage factors (DALYs per kg CO_2-e) were applied to three socioeconomic scenarios (SSP1, high growth; SS2, base; SSP3, low growth) to give a range of values for different rates of global socioeconomic growth. The health damage factors for SSP1, SSP2, and SSP3 scenarios are 1.3 x 10^{-6} DALY·kg^{-1} CO_2-e (90% confidence interval [CI], 0.7 × 10^{-6} to 1.9 × 10^{-6}), 1.5 × 10^{-6} DALY·kg^{-1} CO_2-e (90% CI, 0.8 × 10^{-6} to 2.2 × 10^{-6}), and 2.0 × 10^{-6} DALY·kg^{-1} CO_2-e (90% CI, 1.0 × 10^{-6} to 2.8 × 10^{-6}).[11,12] We applied the same health damage factors for the three scenarios to our study. We multiplied the total annual CO_2-e equivalent for each country by each of the health damage factors to determine the DALYs in each socioeconomic scenario.

Results

From January 2014 to March 2020, exact travel routes and classes of fare were obtained for 55 Rwanda trips with 104 estimated routes of travel (65% of routes). We included data from 159 volunteers for the Rwanda partnership: 79 anesthesiologists, 17 fellows, 53 residents, five nurses, one pharmacist, one project manager, one surgeon, one medical student, and one researcher. For the Guyana program, detailed route data were available from September 2016 to March 2020 for 32 trips and 33 estimated routes of travel (51% of routes). We included data from 65 volunteers for the Guyana partnership: 50 anesthesiologists, one fellow, and 14 residents. We included 58 volunteers for the Ethiopia partnership, all of which had exact travel route data available: 41 anesthesiologists, six fellows, nine residents, one nurse, and one simulation technician. Time spent in each country is detailed in Table 1.

Table 1 Volunteer information

	2014	2015	2016	2017	2018	2019	2020
Guyana							
Volunteers			3	13	23	19	7
Time in-country (days), mean (total)			12 (35)	13 (168)	16 (373)	13 (248)	16 (116)
Rwanda							
Volunteers	21	25	13	30	36	27	7
Time in-country (days), mean (total)	23 (481)	24 (597)	25 (323)	18 (544)	22 (796)	23 (610)	30 (208)
Ethiopia							
Volunteers				5	7	33	13
Time in-country (days), mean (total)				14 (70)	12 (82)	23 (750)	15 (200)
All Partnerships							
Volunteers	21	25	16	48	66	79	27
Time in-country (days), mean (total)	23 (481)	24 (597)	22 (358)	16 (782)	19 (1,251)	20 (1,608)	19 (524)

Table 2 Carbon footprint by country partnership

	Guyana	Rwanda	Ethiopia
Time in-country (days)	13 [12–14 (4–34)]	25 [15–25 (4–89)]	11 [7–16 (4–175)]
Distance traveled (km)	9,856 [8,922–13,700]	26,066 [25,202–29,365]	22,988 [11,832–25,800]
CO_2-e per volunteer (kg)	712 [662–964]	1,636 [1,466–1,789]	1,175 [563–1,398]
CO_2-e per volunteer day in-country ($kg \cdot day^{-1}$)	56 [46–78 (21–210)]	68 [60–103 (18–481)]	82 [44–133 (3–331)]

Values are median [interquartile range] or median [interquartile range (range)].

The total carbon footprint for travel supporting the Rwanda partnership (2014–2020) was 268.2 tons CO_2-e, a mean of 1,687 kg CO_2-e per volunteer. The total carbon footprint for travel supporting the Guyana partnership (2016–2020) was 52.0 tCO_2-e, a mean of 801 kg CO_2-e per volunteer. The total carbon footprint for travel supporting the Ethiopia partnership (2017–2020) was 60.7 tCO_2-e, a mean of 1,046-kg CO_2-e per volunteer. The CO_2-e per volunteer day in-country is detailed in Table 2, and the mean carbon footprint per day in-country differed, with 92 $kg \cdot day^{-1}$ for the Rwanda program, 101 $kg \cdot day^{-1}$ for the Ethiopia program, and 65 $kg \cdot day^{-1}$ for the Guyana program. Figure 1 illustrates the relationship between distance traveled and CO_2-e per volunteer for both economy fare and business class travel. Figure 2 illustrates the relationship between time in-country and CO_2-e per volunteer day for the three partnerships.

The per capita carbon emission values described by the World Bank show that one volunteer day in the Rwanda program was comparable to the daily emissions of 2.2 Canadians or 383 Rwandan people. One volunteer day in the Guyana program amounted to the daily emissions of approximately 1.6 Canadians or 7.6 Guyanese people. One volunteer day in the Ethiopia program amounted to the daily emissions of approximately 2.4 Canadian people or 252 Ethiopian people.

When converted into DALYs, the Rwanda program was responsible for between 4.2 (90% CI, 2.3 to 6.1) and 6.4 (90% CI, 3.2 to 9.0) months of life lost because of disability or premature death, depending on the model used and the assumptions. We estimate that the Guyana program was responsible for between 0.8 (90% CI, 0.4 to 1.2) and 1.2 (90% CI, 0.6 to 1.7) months of life lost because of disability or premature death, and the Ethiopia program was responsible for between 0.9 (90% CI, 0.5 to 1.4) and 1.5 (90% CI, 0.7 to 2.0) months of life lost, depending on the model used and the assumptions.

Discussion

In this audit, from January 2014 to March 2020, CASIEF sent a total of 282 volunteers to Rwanda, Guyana, and Ethiopia partnerships. The carbon footprint for travel supporting the Rwanda, Guyana, and Ethiopia partnership was 268.2, 52.0, and 60.7 tons CO_2-e, respectively—around 380 tons of CO_2 in total. The CO_2-e per volunteer footprint per day in-country differed at 92 $kg \cdot day^{-1}$ for the Rwanda program, 101 $kg \cdot day^{-1}$ for the Ethiopia program, and 65 $kg \cdot day^{-1}$ for the Guyana program. The daily volunteer CO_2-e was equivalent to twice the average Canadian daily carbon footprint. This does not include the environmental impact of daily transportation and activities. For an alternative comparison, the carbon footprint per volunteer for the three CASIEF partnerships (1.7, 1.0, and 0.8 tCO_2-e) is in the same order of magnitude as the Canadian Resident Matching Service nationwide interview tour for a single medical student (1.4 tCO_2-e).[15]

A key concern of climate change is its effect on population health. Estimated years lost to premature death or disability due to carbon emissions from travel should be considered when planning global health partnerships and balanced against potential DALYs saved by the program outcomes. These three CASIEF partnerships primarily focus on anesthesia training and developing sustainable training programs in Rwanda, Ethiopia, and Guyana. Through the development of educational programs, clinical teaching in the workplace, interprofessional collaborations, quality improvement, research, mentorship, and leadership, all our volunteers support the development of anesthesia as an essential part of a healthcare system. Although speculative, even the high estimate of 9.0 months of life lost to premature death or disability for the Rwanda program in 2014–2020 would likely be outweighed by the benefit of training multiple specialist anesthesiologists and setting up an anesthesia residency program in a context of extreme shortage of human resources for health. The benefits of CASIEF partnerships have been described elsewhere.[16,17]

Some would claim an ideal goal of any program should be carbon neutrality; however, this may not even be truly possible.[18] It is important to recognize that there are inherent costs to any given societal activity. Key considerations include how to minimize costs for any given goal, and which carbon costs are most important and should be prioritized as a society. Ultimately, the best use

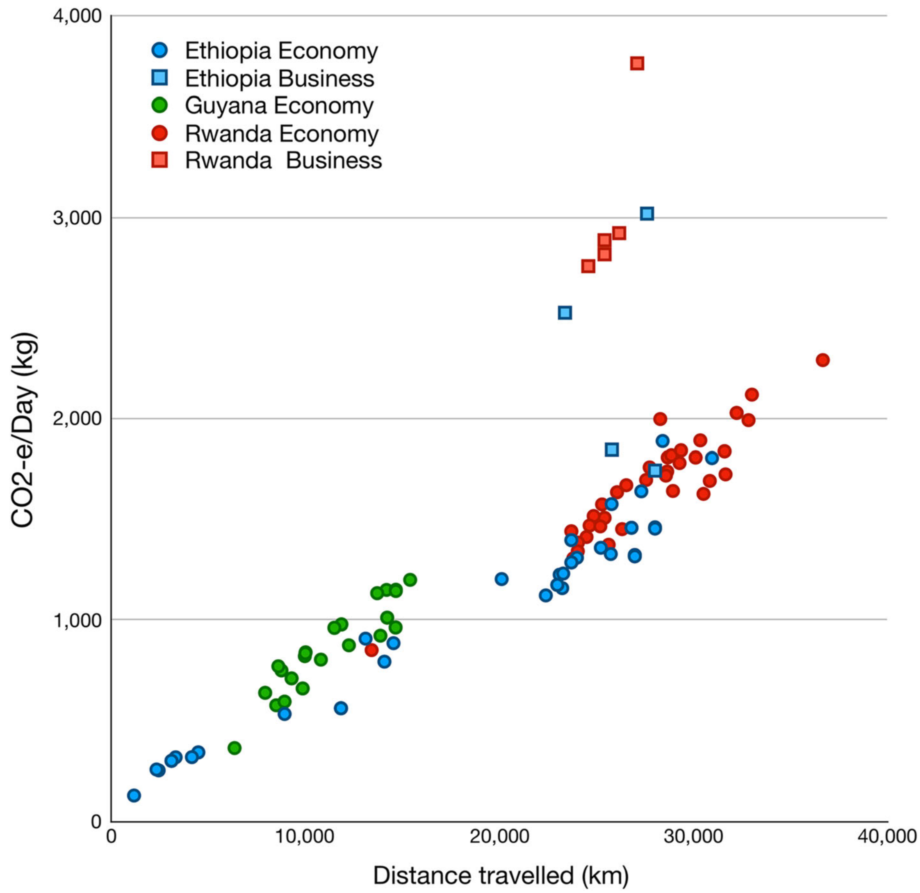

Fig. 1 Carbon footprint according to distance traveled. Red circles represent economy-fare travel to Rwanda, red squares represent business class-fare travel to Rwanda, green circles represent economy-fare travel to Guyana, blue circles represent economy-fare travel to Ethiopia, and blue squares represent flights to Ethiopia where some or all legs of travel were business class.

of our data is to encourage a discussion on how to reduce the carbon footprint of global health partnerships. Another key consideration is the economic cost to a carbon footprint, and recent research has suggested an ultimate social cost of carbon at around USD 3,000 per ton of CO_2-e,[19] which would add up to over a million USD for these partnerships, constituting a further negative externality. A potential solution for the environmental cost is carbon "offsetting." These programs aim to reduce the environmental impact of global partnerships by investing in activities such as reforestation.[20]Nevertheless, carbon offsetting is controversial and may not be effective, and some have argued that it may even contribute to harm, such as through "green-washing."[18]

The main factors influencing the carbon footprint for each CASIEF volunteer were their distance traveled and class of fare. Nevertheless, the daily carbon footprint may be more meaningful as it is balanced against the potential contribution to the program. When considering the daily carbon footprint of travel per volunteer, length of time in the country seems to have more impact than either distance traveled or fare class. A key concern from our data is the large variation in CO_2-e/volunteer day for different trips made: the least efficient trip (a return business class trip from Halifax-Kigali for six days in-country) resulted in 160 times more CO_2-e/volunteer day than the most efficient trip (a return economy class trip from London-Addis, with 175 days in-country). To reduce the carbon cost of partnerships, volunteers should be encouraged to have fewer, longer visits, and to travel economy class. There are clear environmental advantages in picking a partner that is geographically closer, but this is largely offset by the length of stay in-country. Very short trips are clearly not carbon efficient and the CASIEF trips under two weeks appear particularly poor value with respect to carbon cost. Nevertheless, after the two-week mark, longer visits begin to have diminishing returns in terms of an optimized carbon footprint (Fig. 2).

Many organizations (including CASIEF) have switched to remote support during COVID-19, utilizing technology that was often already accessible to project participants, which has almost eliminated the air travel carbon footprint of the organization's educational activities. These activities have their own carbon cost, and while it is reasonable to expect the environmental costs of electronic remote learning to be less than programs based on international travel, an evaluation of these costs is outside the scope of this audit. It is likely that continuing remote support in the

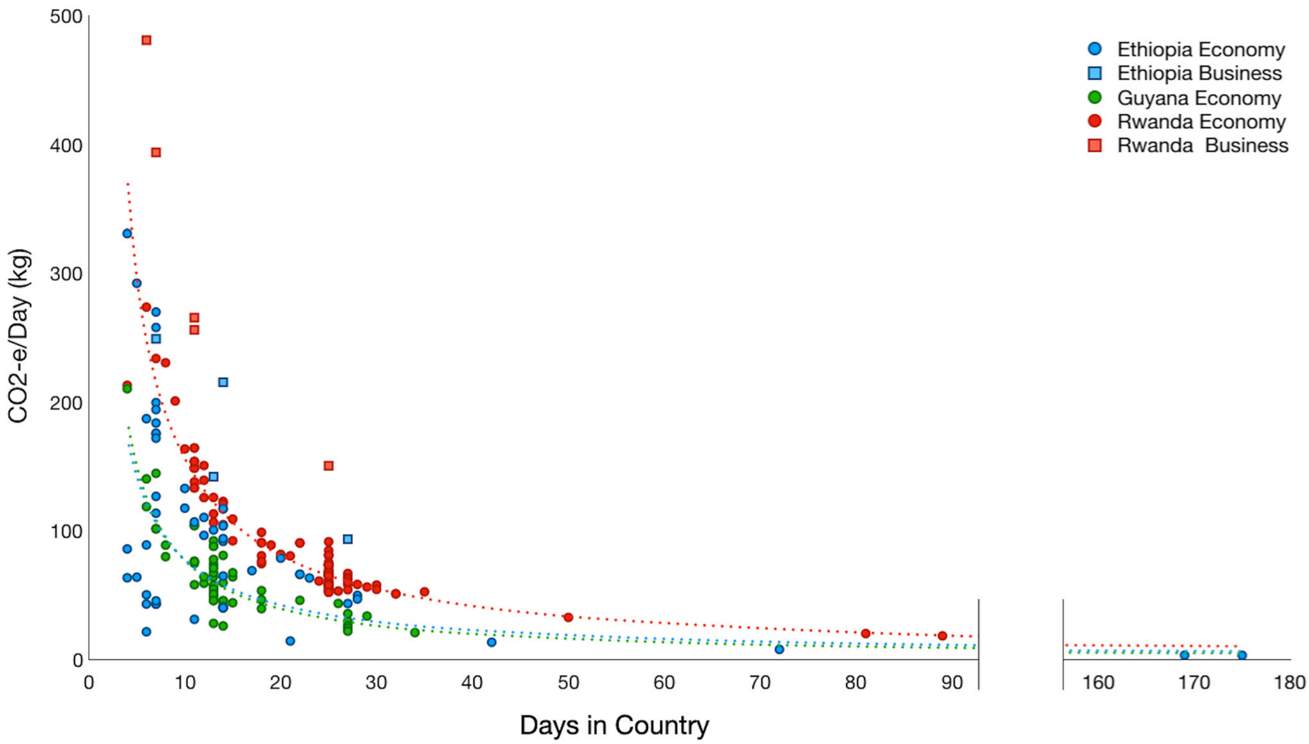

Fig. 2 Daily carbon footprint according to time in-country. Red circles represent economy-fare travel to Rwanda, red squares represent business class-fare travel to Rwanda, green circles represent economy-fare travel to Guyana, blue circles represent economy-fare travel to Ethiopia, and blue squares represent flights to Ethiopia where some or all legs of travel were business class.

future will allow reduction of the potential harm associated with the carbon footprint of travel. Nevertheless, some support is particularly challenging to provide from a distance, for example the clinical teaching of nuanced clinical decision-making in the operating room. Building strong relationships and understanding the local context is key to the success of global health partnerships and this may be challenging without an in-person element. Even when in-person support is possible and necessary, it seems likely that a hybrid model will be advantageous for both teaching and reducing the carbon cost of partnerships.

A strength of this audit is that it is, to our knowledge, the first attempt at quantifying the carbon cost for international global health partnerships. The estimates presented are also drawn from verifiable data as the ICAO calculator uses data drawn directly from international governmental reports, is transparent by using publicly available data, and is vetted by and used across the United Nations.[7] Nevertheless, this audit has important limitations. Although air travel is considered the major contributing factor, our carbon footprint estimates did not include in-country travel or any other activities involved in a CASIEF volunteer trip. Some travel routes were estimated when route information was unavailable. Although deemed industry standard, ICAO carbon footprint calculations remain estimates. Indeed, some assumptions involved in the calculations may not be completely reflective of true carbon footprint. The calculator uses model aircrafts since specifics can vary between different airlines' fleet configurations. The class-fare variable, limited to economy or business class as well as the use of average values for passenger load and passenger-to-cargo factors represent simplifications of the carbon emission implications of a given passenger's contribution to a flight's carbon cost. As such, the true carbon cost may be underestimated. Finally, the calculation of the comparators, and in particular, DALYs lost because of carbon emissions are estimates relying on multiple assumptions.

In conclusion, this audit showed that longer in-country volunteer stays, partnerships entailing shorter travel distances, and traveling economy would optimize the carbon footprint of travel of global health initiatives. As a result of this audit, we suggest that other global health partnerships and organizations audit their own carbon footprint to measure the efforts needed to minimize the potential harm of their environmental impact and ensure that work being done is both responsible and impactful. It is expected that the results of this audit will promote further discussion of future directions and remote education in a hybrid model as a solution in limiting emissions related to the practice of global anesthesia.

Author contributions *Sarah Chibane*, *Talia RyanSarah Chibane*, *Talia Ryan*, and *Dylan Bould* contributed to all aspects of this manuscript, including conception and design; acquisition, analysis, and interpretation of data; and drafting the article. *Francoise Nizeyimana*, *Onica Gill*, *Ananya Abate*, and *Ana Crawford* contributed to the conception and design of the study and drafting of the article. *Julian Barnbrook* contributed to acquisition of data, conception and design of the study, and drafting of the article.

Disclosures No competing interests to declare.

Funding statement No sources of funding to disclose.

Editorial responsibility This submission was handled by Dr. Vishal Uppal, Associate Editor, *Canadian Journal of Anesthesia/Journal canadien d'anesthésie*.

References

1. *Watts N, Amann M, Arnell N, et al*. The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. Lancet 2019; 394: 1836–78. https://doi.org/10.1016/s0140-6736(19)32596-6
2. *CASIEF*. About. Available from URL: https://casief.ca/about/ (accessed October 2022).
3. *Gettelman A, Chen C*. The climate impact of aviation aerosols. Geophys Res Lett 2013; 40: 2785–9. https://doi.org/10.1002/grl.50520
4. *Durieux ME*. "Primum non nocere": global health and climate change. Anesth Analg 2020; 131: 981–3. https://doi.org/10.1213/ane.0000000000004815
5. *Médecins Sans Frontières/Doctors Without Borders*. Environmental impact toolkit, 2020. Available from URL: http://msf-transformation.org/news/environmentalimpacttoolkit/ (accessed October 2022).
6. *Pandey D, Agrawal M, Pandey JS*. Carbon footprints: current methods of estimation. Environ Monit Assess 2011; 178: 135–60. https://doi.org/10.1007/s10661-010-1678-y
7. *ICAO*. ICAO carbon emissions calculator methodology, 2017. Available from URL: https://www.icao.int/environmental-protection/CarbonOffset/Documents/Methodology%20ICAO%20Carbon%20Calculator_v10-2017.pdf (accessed October 2022).
8. *The World Bank*. CO2 emissions (metric tons per capita) – Canada, 2020. Available from URL: https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=CA (accessed October 2022).
9. *The World Bank*. CO2 emissions (metric tons per capita) – Rwanda, 2020. Available from URL: https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=RW (accessed October 2022).
10. *The World Bank*. CO2 emissions (metric tons per capita) – Ethiopia, 2020. Available from URL: https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=ET (accessed October 2022).
11. *Tang L, Ii R, Tokimatsu K, Itsubo N*. Development of human health damage factors related to CO_2 emissions by considering future socioeconomic scenarios. Int J LCA 2015; 23: 2288–99. https://doi.org/10.1007/s11367-015-0965-9
12. *Tang L, Furushima Y, Honda Y, Hasegawa T, Itsubo N*. Estimating human health damage factors related to CO_2 emissions by considering updated climate-related relative risks. Int J LCA 2019; 24: 1118–28. https://doi.org/10.1007/s11367-018-1561-6
13. *Nakićenović N, Alcamo J, Grubler A, et al*. Special Report on Emissions Scenarios: A Special Report of Working Group III of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press; 2000.
14. *Murray CJ*. Quantifying the burden of disease: the technical basis for disability adjusted life years. Bull World Health Organ 1994; 72: 429–45. http://www.ncbi.nlm.nih.gov/pmc/articles/pmc2486718/
15. *Liang KE, Dawson JQ, Stoian MD, Clark DG, Wynes S, Donner SD*. A carbon footprint study of the Canadian medical residency interview tour. Med Teach 2021; 43: 1302–8. https://doi.org/10.1080/0142159x.2021.1944612
16. *Shrestha BM, Rana NB*. Training and development of anesthesia in Nepal – 1985 to 2005. Can J Anesth 2006; 53: 339–43. https://doi.org/10.1007/bf03022496
17. *Twagirumugabe T, Carli F*. Rwandan anesthesia residency program: a model of north-south educational partnership. Int Anesthesiol Clin 2010; 48: 71–8. https://doi.org/10.1097/aia.0b013e3181dd4f65
18. *McAfee K*. Shall the American Association of Geographers endorse carbon offsets? Absolutely not! Prof Geogr 2021; 74 : 171–7. https://doi.org/10.1080/00330124.2021.1934879
19. *Kikstra JS, Waidelich P, Rising J, Yumashev D, Hope C, Brierley CM*. The social cost of carbon dioxide under climate-economy feedbacks and temperature variability. Environ Res Lett 2021; 16: 094037. https://doi.org/10.1088/1748-9326/ac1d0b
20. *Kim R, Pierce BC*. Carbon offsets: an overview for scientific societies, 2018. Available from URL: https://www.cis.upenn.edu/~bcpierce/papers/carbon-offsets.pdf (accessed October 2022).