YALE JOURNAL OF BIOLOGY AND MEDICINE 96 (2023), pp.185-188.

ORIGINAL CONTRIBUTION

YALE JOURNAL OF BIOLOGY AND MEDICINE
YJBM
CELEBRATING 95 YEARS 1928–2023

The Planetary Benefit of Suspending USMLE Step 2 CS: Estimating Carbon Emissions Associated with US Medical Students' Travel to Testing Centers

James R. Sherpa[a,*], Laura Donahue[b], Jennifer Tsai[c], and Max Jordan Nguemeni Tiako[d]

[a]Department of Surgery, University of Arizona-Phoenix, Phoenix, AZ, USA; [b]Department of Internal Medicine, Feinberg School of Medicine at Northwestern University, Chicago, IL, USA; [c]Department of Emergency Medicine, Yale School of Medicine, New Haven, CT, USA; [d]Department of Medicine, Brigham and Women's Hospital, Boston, MA, USA

Background: The discontinuation of the Step 2 Clinical Skills Exam (CS) by the United States Medical Licensing Examination (USMLE) eliminated the need for personal travel to testing centers. The carbon emissions associated with CS have not been previously quantified. **Objective**: To estimate the annual carbon emissions generated by travel to CS Testing Centers (CSTCs) and to explore differences across geographic regions. **Methods**: We conducted a cross-sectional, observational study by geocoding medical schools and CSTCs to calculate the distance between them. We obtained data from the 2017 matriculant databases of the Association of American Medical Colleges (AAMC) and the American Association of Colleges of Osteopathic Medicine (AACOM). The independent variable was the location as defined by USMLE geographic regions. The dependent variables were distance traveled to CSTCs and estimated carbon emissions in metric tons CO_2 (mtCO2) calculated using three models. In model 1 all students used single occupancy vehicles; in model 2, all carpooled; and in model 3, half traveled by train and half by single occupancy vehicle. **Results**: Our analysis included 197 medical schools. The mean out-of-town travel distance was 280.67 miles (IQR: 97.49-383.42). The mtCO2 associated with travel was 2,807.46 for model 1; 3,135.55 for model 2; and 635.34 for model 3. The Western region traveled the farthest, while the Northeast traveled significantly less than other regions. **Conclusion**: The annual estimated carbon emissions from travel to CSTCs was approximately 3,000 mtCO2. Northeastern students traveled the shortest distances; the average US medical student expended 0.13 mtCO2. Medical leaders must consider the environmental impact of medical curricula and pursue accordant reforms.

*To whom all correspondence should be addressed: James R. Sherpa, MD, University of Arizona Medical College-Phoenix, Phoenix, AZ; Email: jsherpa@arizona.edu.

Abbreviations: USMLE, United States Medical Licensing Examination; CS, Step 2 Clinical Skills Exam; CSTC, Clinical Skills Testing Center; CO_2, Carbon Dioxide; mtCO2, metric tons CO_2; MD, Medical Doctor; DO, Doctor of Osteopathy.

Keywords: climate change, medical education, USMLE, travel, carbon footprint

Author Contributions: JRS drafted the manuscript and conceived of the original research idea. LD assisted in data collection and manuscript editing. JT contributed to the manuscript editing. MJNT performed primary data analysis and contributed to manuscript writing and editing.

INTRODUCTION

Before the COVID-19 pandemic, medical students in the United States and international medical graduates completed a required in-person US Medical Licensing (USMLE) Step 2 Clinical Skills Exam (CS), which was only offered in five locations, necessitating extensive travel for most prospective physicians. The exam's value was questioned due to its high registration fee ($1,580, excluding travel and preparation expenses). Moreover, in the context of global warming, the pre-2020 travel requirements associated with the CS imposed high environmental costs and thus constituted a risk to public health.

Numerous studies have assessed the carbon footprint of the healthcare industry [1-4], revealing that the US healthcare system is responsible for 8.5% of the country's total carbon emissions [5,6]. The carbon emissions associated with travel related to scientific conferences [7] and medical education have also been scrutinized. Given that the CS was initially suspended due to the pandemic and has since been replaced by an online equivalent, we aimed to estimate the amount of carbon emission saved in 2020 by eliminating this requirement for nearly 30,000 US medical students.

METHODS

We utilized publicly available data from the American Association of Medical Colleges (AAMC) and the American Association of Colleges of Osteopathic Medicine (AACOM) for the 2017 medical school matriculants scheduled to graduate in 2021. We excluded international medical graduates from the analysis due to limited data on the location of departure for examination. We matched each medical school with its corresponding location, including city and state.

Testing centers were located in five cities, namely: Philadelphia, PA, Chicago, IL, Los Angeles, CA, Atlanta, GA, and Houston, TX. The primary objective was to estimate the total carbon footprint generated from travel to these testing centers from medical schools in the US. Additionally, we analyzed regional differences in the minimum distance traveled as a secondary outcome. The geocoding of schools and testing centers was performed at the zip code level using ArcGIS Pro 2019 (Version 10.0. Redlands, CA: Environmental Systems Research Institute, Inc., 2010; Beyer, H. L. 2004. Hawth's Analysis Tools for ArcGIS.), and we used the "find nearest" function to calculate the distance to the nearest center for each school. In cases where schools were in the same city as a testing center, we assigned them a null distance.

We modeled multiple travel modality scenarios to estimate the total carbon emissions. Assuming that students at schools further than 250 miles away from a testing center would travel by plane, we estimated the total carbon footprint in three models. In model 1, all students at the remaining schools (<250 miles) used single-occupancy vehicles. In model 2, students carpooled using a fully occupied four-person vehicle. Finally, in model 3, 50% of students traveled by train, and the remaining 50% used single-occupancy vehicles. A 2015 Honda Accord was selected for all models. It represents a commonly used vehicle in the United States due to its relative affordability (15,000 USD, Kelly Blue Book) and fuel economy (47 MPG, fueleconomy.gov).

CARBON EMISSIONS CALCULATIONS

We determined the carbon emissions of flights and car trips using the Carbon Footprint Calculator for Individuals and Households [8]. We calculated the carbon footprint of intercity train trips using the Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) model. The Quality Insurance Standard audits the Carbon Footprint Calculator and complies with the methodology outlined by the British Government. The carbon footprint, expressed in metric tons CO_2 (mtCO2) for each school, was determined by multiplying individual carbon footprint by student population, then summed to estimate the total carbon footprint for each model.

STATISTICAL ANALYSES

We used linear regressions to estimate any regional disparities in distance traveled, and distance traveled was the dependent variable. The independent variables were region, as defined by the USMLE CS registration site (Northeast, Southeast, Midwest, Southwest, West), number of students by school, and MD (Medical Doctor) versus DO (Doctor of Osteopathy) designation.

RESULTS

In this study, we analyzed 182 schools with a matriculating class in 2017, with 143 being MD-designated and 39 being DO-designated. The total number of students included in the study was 28,138, with a mean (IQR) of 156 (114-183) matriculating students per school. The mean (IQR) out-of-town distance to the nearest testing center was 280.67 (97.5-383.4) miles or 451.70 (156.9-617.0) kilometers. Our results showed that the total carbon footprint associated with out-of-town travels for all students was 2,807.5 mtCO2 for model 1, 3,135.6 mtCO2 for model 2, and 635.3 mtCO2 for model 3 (Table 1).

Comparing schools in the Northeast to those in other regions, our analysis revealed that students from the West traveled significantly farther out-of-town distances to testing centers. After adjusting for the number of students

Table 1. Total Carbon Emissions

Number of students, IQR	(114-183)
Out of town distance to the nearest testing center, IQR (mi)	(97.49-383.42)
Model 1 (total carbon emissions in metric tons CO_2)	(2807.5)
Model 2 (total carbon emissions in metric tons CO_2)	(3135.6)
Model 3 (total carbon emissions in metric tons CO_2)	(3635.5)

Table 2. Additional Distance Traveled by Variables

Region		
Northeast	reference	P
Southeast	102.1 (28.9, 175.2)	0.007
Southwest	113.0 (19.1, 206.8)	0.019
Midwest	127.9 (53.8, 202.0)	0.001
West	242.4 (99.1, 385.7)	0.001
Designation (MD versus DO)		
MD	77.5 (-15.7, 170.8)	
DO	-0.5 (-1.1, 0.2)	

per school and MD versus DO designation, we found that students from the West traveled an average of 242.4 additional miles (95% CI [99.1, 385.7], P<0.001) compared to those from the Northeast. This was followed by students from the Midwest, who traveled an additional 127.9 miles (95% CI [53.8, 202.0], P<0.001), and students from the Southwest, who traveled an additional 113.0 miles (95% CI [19.1, 206.8], P=0.02). Students from the Southeast also traveled significantly farther than those from the Northeast, with an additional 102.1 miles (95% CI [28.9, 175.2], P=0.007) (Table 2).

DISCUSSION

Our study aims to investigate the impact of the COVID-19 pandemic-induced discontinuation of CS on the carbon footprint of US medical education, as well as the geographic disparities in travel burden. Our analysis revealed two primary findings. Firstly, the discontinuation of CS in 2020 led to an estimated annual reduction of over 3,000 mtCO2 emissions. Secondly, students attending medical schools in the Northeast region travel shorter distances to testing centers than their peers in other regions. According to EPA carbon equivalencies, the estimated annual carbon footprint of USMLE CS was equivalent to the annual carbon output of 364 to 419 American households, and would necessitate 3,666 to 4,747 acres of US forests for comparable carbon sequestration. The average US medical student's carbon footprint for completing CS in person was 0.13 mtCO2, accounting for approximately 8% of the 1610 kg per annum individual carbon emission limit set by the 2016 Paris Agreement [9]. This finding adds to the growing evidence of the impact of medical education-related travel on carbon emissions, as demonstrated by a recent study on pre-COVID-19 travels for residency interviews [4]. Additionally, although using videoconferencing for travel yields lower carbon emissions, it is not carbon-neutral [10].

Furthermore, our study reveals the disproportionate burden of travel placed on students before the discontinuation of CS. While transitioning to a virtual format reduces these disparities, it is critical to consider the financial burden of the high cost of the assessment, which disproportionately affects students from lower-income backgrounds [11].

The COVID-19 pandemic has led to a 17% decrease in global carbon emissions compared to mean 2019 levels, with an estimated overall decrease of 4-7% in 2020 [12]. This reduction is comparable to the changes required to prevent global temperatures from rising 1.5°C, as the Paris Agreement outlines. Medical education leaders and policymakers must recognize the effects of effective policy changes on planetary health, as demonstrated in this study by the estimated annual carbon emissions reduction attributed to CS's discontinuation. Furthermore, medical education leaders must consider the carbon footprint of travel-based activities and the role of medicine in mitigating climate change [13-15].

LIMITATIONS

Our study has both strengths and limitations. While our findings are based on assumptions regarding travel behavior rather than survey data, we present a range of

estimates, and our calculations do not account for international medical graduates, who make up a substantial proportion of residency applicants. Nonetheless, our findings are likely to be a conservative estimate. Additionally, we recognize the regional inequalities in travel burden due to the geographic distribution of testing centers and medical schools.

CONCLUSIONS

In conclusion, the discontinuation of in-person CS due to the COVID-19 pandemic resulted in a significant reduction in the carbon footprint of US medical education in 2020. Permanent discontinuation of the exam will contribute to a considerable decrease in travel-related carbon emissions in medical education and address pre-existing geographic inequalities in travel burden. Leaders in medical education and policymakers must consider the role of medicine in mitigating climate change and incorporate planetary effects into decision-making.

Funding: none.

REFERENCES

1. Chung J, Meltzer D. Estimate of the Carbon Footprint of the US Health Care Sector. JAMA. 2011;308(18):3–5.
2. Govia I, Guell C, Unwin N, Wadende P. Air travel for global health: flying in the face of sustainable development? Lancet. 2019 Nov;394(10211):1786–8.
3. Eckelman MJ, Sherman JD. Estimated Global Disease Burden From US Health Care Sector Greenhouse Gas Emissions. Am J Public Health. 2018 Apr;108 S2:S120–2.
4. Donahue LM, Morgan HK, Peterson WJ, Williams JA. The Carbon Footprint of Residency Interview Travel. J Grad Med Educ. 2021 Feb;13(1):89–94.
5. Sherman JD, Lagasse R. How Healthy Is Health Care? JAMA Netw Open. 2018 Aug;1(4):e181000.
6. Eckelman MJ, Huang K, Lagasse R, Senay E, Dubrow R, Sherman JD. Health Care Pollution And Public Health Damage In The United States: an Update. Health Aff (Millwood). 2020 Dec;39(12):2071–9.
7. Callister ME, Griffiths MJ. The carbon footprint of the American Thoracic Society meeting. Am J Respir Crit Care Med. 2007 Feb;175(4):417.
8. Carbon Footprint Calculator: carbonfootprint.com.
9. Paris Agreement to the United Nations Framework Convention on Climate Change, Dec. 12, 2015, T.I.A.S. No. 16-1104.
10. Faber G. A framework to estimate emissions from virtual conferences. Int J Environ Stud. 2021;78(4):608–23.
11. Lehman EP 4th, Guercio JR. The Step 2 Clinical Skills exam—a poor value proposition. N Engl J Med. 2013 Mar;368(10):889–91.
12. Le Quéré C, Jackson RB, Jones MW, Smith AJ, Abernethy S, Andrew RM, et al. Temporary reduction in daily global CO2 emissions during the COVID-19 forced confinement. Nat Clim Chang. 2020;10(7):647–53.
13. Fraser H, Soanes K, Jones SA, Jones CS, Malishev M. The value of virtual conferencing for ecology and conservation. Conserv Biol. 2017 Jun;31(3):540–6.
14. Mian A, Khan S. Medical education-training toward a greener future. Nat Med. 2020 Feb;26(2):156.
15. Haines A, Ebi K. The imperative for climate action to protect health. N Engl J Med. 2019 Jan;380(3):263–73.