

The Climate Impact of Medical Residency Interview Travel in the United States and Canada: A Scoping Review

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ABSTRACT

Background The change from in-person to virtual interviews for graduate medical education (GME) provides the opportunity to compare the potential environmental effects.

Objective To explore and summarize the existing literature on the potential climate impact of medical residency interview travel through a scoping review.

Methods The search was conducted in October 2022 using 5 research databases. Results were screened for inclusion by 2 reviewers in a 2-tiered process. Inclusion criteria were limited to English language articles from the United States and Canada, with no limitations on the type of study, type of applicant (allopathic, osteopathic, or international medical graduate), or type of residency. A thematic analysis focusing on the objectives and main findings of identified studies was conducted and an iteratively created standardized data extraction worksheet was used such that all studies were explicitly assessed for the presence of the same themes.

Results The search identified 1480 unique articles, of which 16 passed title and abstract screening and 13 were ultimately included following full-text review. There were 3 main themes identified: the carbon footprint of residency travel, stakeholders' perspectives on virtual interviews, and advocacy for virtual interviews. All 13 articles employed persuasive language on interview reform, ranging from neutral to strongly in favor of virtual interviews based wholly or in part on environmental concerns.

Conclusions Two main findings were identified: (1) Though carbon footprint estimates for in-person interviews vary, in-person interviews create considerable carbon emissions and (2) those working in GME are concerned about the climate effects of GME practices and describe them as a compelling reason to permanently adopt virtual interviewing.

Introduction

Until 2020, the standard process of applying to residency positions in the United States and Canada revolved around the in-person interview. Travel and safety limitations imposed by the COVID-19 pandemic disrupted this process, necessitating the change to a virtual interview format that has persisted through the 2022-2023 application cycle. In doing so, the pandemic created new opportunities to re-evaluate how residency interviews are conducted and consider future changes to this aspect of graduate medical education (GME). At its core, the functional question of in-person versus virtual interviews is one of location: where should these interviews occur? Interviews hosted at residency-sponsoring institutions necessitate the travel of a massive number of applicants to various destinations. In recent years, the average number of residency applications

has been increasing. Of the 48 distinct specialty programs recognized by the Electronic Residency Application Service (ERAS) who reported data for the years 2018 to 2022, 36 of those specialties saw an increase in the number of applications per applicant in that time period, with increases ranging from 2.5% to 332%.¹ In that time, the average length of the rank list has also increased, indicating an associated increase in interviews attended per applicant.² If this trend of increased applications and interviews continues, so does the potential travel burden on each applicant.

The contribution of transportation to carbon emissions is well documented, with passenger air travel resulting in the greatest impact.³ The considerable threat to human health posed by climate change is also well documented, with the worst health harms experienced by vulnerable populations.⁴ As such, the medical field has a professional responsibility to consider how our educational practices contribute to this growing health hazard and how such contributions can be mitigated. While there have been studies on the financial cost of interview travel⁵ and the carbon

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Editor's Note: The online supplementary data contains the search terms used in the study.

emissions produced by other forms of academic travel,⁶ the climate implications of in-person versus virtual residency interviews were less studied.

This scoping review aims to summarize the available literature on the climate impact of residency interview travel in North America as a potential return to in-person interviews is considered.

Methods

To generate a summary of articles relevant to the environmental impact of residency interview travel, a scoping review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR) protocol.⁷ The review format was selected with the anticipation that the available body of literature concerning this subject matter would be limited and diverse, as inferred from preliminary investigations.

Inclusion Criteria

Articles were selected based on a broad set of criteria to ensure the inclusion of all relevant literature. To be included, articles discussed and connected 3 premises: travel, medical residency interviews or application process, and environmental impact. Articles including only 2 of the defining premises—including but not limited to financial costs of residency travel, environmental costs of other forms of academic travel, nonenvironmental benefits of virtual interviewing, and subjective experiences of virtual interviewing—were excluded from the review. Additionally, the inclusion criteria were limited to English-language articles on the medical residency application process in the United States and Canada. These 2 countries use a similar interviewing and matching format, though the number of applicants and participating programs is larger in the United States. There were no limitations on the types of applicants (whether US or international medical graduates, allopathic or osteopathic graduates), specialty or number of programs applied to, or type of assessment (qualitative vs quantitative) of environmental impact. Any peer-reviewed article or commentary in a scholarly journal, including research of any study design, prepublished research, and perspective pieces were included. The date range was from inception to October 2022.

Literature Search and Article Selection

A literature search was conducted in 5 databases: PubMed, Embase, CINAHL, MEDLINE, and Google Scholar. The following basic search strategy was used, with appropriate mesh terms and Boolean operators for each database: (Residency OR “medical student” OR

resident OR internship OR “residency application” OR “residency interview” OR “specialty application” OR “residency match” OR “residency position”) AND (Travel OR flight OR car OR train OR gas OR distance OR miles OR virtual) AND

(Environment OR climate OR “climate change” OR “carbon emissions” OR “greenhouse gas” OR emissions OR “carbon footprint” OR “greenhouse effect” OR warming OR “global warming OR “environmental impact”) (see online supplementary data). The reference management software Covidence (Veritas Health Innovation Ltd) was used to manage and review the identified articles and to automatically screen out duplicates. A 2-tiered review process was utilized. To identify articles meeting inclusion criteria, 2 reviewers independently screened all articles based on title and/or abstract.

The reviewers then independently reviewed the full text of the screened articles to determine final inclusion. Any discrepancies were resolved by a third reviewer.

Data Extraction

Data extraction was performed utilizing the Covidence platform and a standardized worksheet that included general study information, study characteristics, study aims/objectives, and main findings. Because the sample was heterogeneous, we conducted a thematic analysis focusing on the study aims or objectives and main findings, instead of making a detailed comparison of research characteristics. The worksheet was developed iteratively as themes emerged so that the topics present in the sample were highlighted. If a new theme emerged it was added to the worksheet, and each article was rereviewed for that content so that each was explicitly assessed for the same themes. Articles were also assessed during data extraction for the overall level of recommendation and level of persuasive language, which was recorded on a 5-item Likert scale (1 strongly against residency interview reform, 3, neutral, 5, strongly in favor of residency interview reform). Representative persuasive language for each category was iteratively extracted from the articles into the worksheet to guide the assessment of the level of support. This language guide assisted in standardizing the assessments of the reviewers, regardless of individual stances on virtual interviews, which were generally favorable.

Results

The database searches returned a total of 2744 articles with 1480 remaining after the removal of duplicates. Of those remaining, 1464 were excluded based on title and abstract screening. The remaining

16 articles were assessed by full-text review, and of these, 13 were determined to be eligible for inclusion (FIGURE 1). The 3 excluded studies touched on only 2 of the 3 core premises: 2 dealt with the environmental impact of travel not related to the medical residency interview process (wrong population), and one with nonenvironmental aspects of virtual versus in-person residency interviews (wrong outcome).

Characteristics of Included Articles

The characteristics of the 13 included articles are summarized in TABLE 1. The 13 articles were published from 2020^{8,9} to 2022,¹⁰⁻¹³ with the majority falling in 2021,¹⁴⁻²⁰ and all articles were published after the onset of the COVID-19 pandemic. Three of the 13 articles focused on Canadian^{12,17,19} and the remainder on US residency interviews. Seven articles used qualitative survey-based methods^{10,11,16-20}; 3 were perspective pieces^{9,12,15}; and 3 included some form of retrospective numerical analysis of carbon emissions in

the context of a perspective piece.^{8,13,14} Eight studies focused on environmental concerns as the main topic of the article^{8,12-14,16-19} while in another 5, environmental concerns were present to varying degrees amid discussion of the general pros and cons of virtual interviewing.^{9-11,15,20} The study populations for the survey-based research varied in size and parameters, from 2580 (a cohort of matched allopathic US dermatology applicants over the last 15 years)¹³ to 24 (attendees of a radiology program second look event in 2021).¹¹ The study aims fell into 3 main thematic categories: quantification or estimation of the carbon footprint of interview travel based on survey research or available match data,^{8,13,14,16-19} assessment of the perspectives of stakeholders on virtual interviews, including but not limited to environmental impact,^{10,11,15,20} and commentary advocating for the continuation of virtual interviews based at least in part on environmental effects.^{9,12} While many articles included several of these themes, they are listed in TABLE 2 by their primary theme.

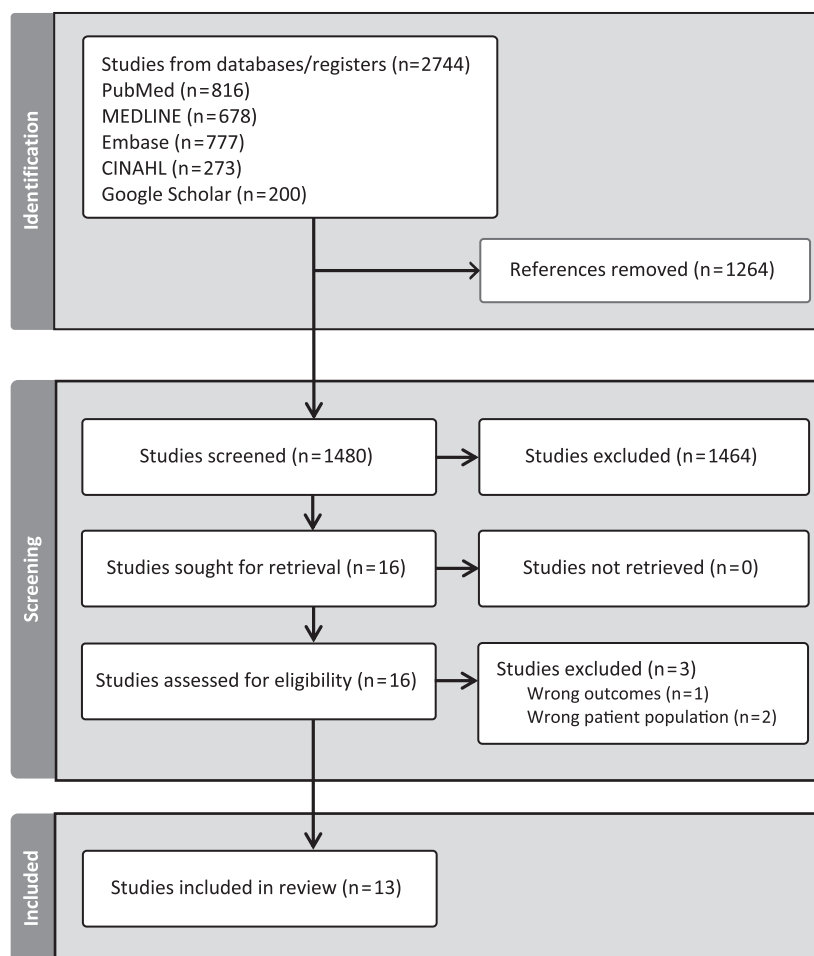


FIGURE 1
PRISMA Flow Diagram of Study Identification and Inclusion in the Scoping Review

TABLE 1
Summary of Key Article Characteristics by Percentage of Articles

Characteristics	n (%)
Publication year	
2020	2 (15)
2021	4 (31)
2022	7 (54)
Publication country	
USA	10 (77)
Canada	3 (23)
Study design	
Qualitative survey-based research	7 (54)
Perspective pieces	3 (23)
Retrospective numerical analysis of carbon emissions in the context of a perspective piece	3 (23)
Environmental concerns as main topic	
Yes	8 (62)
No	5 (38)
Study aims by theme	
Quantitative estimation of carbon footprint based on survey research or available match data	7 (54)
Assessment of the perspectives of stakeholders on virtual interviews	4 (31)
Advocacy for the change to the interview process	2 (15)

Themes of Carbon Emissions Quantification

Of the 7 studies estimating the carbon footprint of residency interview travel or the carbon emissions savings associated with virtual interviews, 3 provided a per-interview estimation,^{13,16,18} 6 a per-applicant estimation,^{8,13,14,16-18} and 6 an extrapolation to other specialties or time periods^{13,14,16-19} (TABLE 2).

Themes of Perspectives on Environmental Impact

Of the 4 articles identified that focused on the perceptions of various stakeholders on virtual interviews,^{10,11,15,20} all noted that the reduced environmental impact was perceived as a benefit. In both articles that were based on surveys of residency applicants and program directors, more than 70% of respondents identified reduced environmental impact as an advantage of virtual interviewing.^{10,20} When asked to rate the importance of various benefits of virtual interviewing in one of these surveys, nearly half of the respondents who selected environmental impact felt “very strongly” about this advantage.²⁰

Themes of Advocacy

All 13 papers articulated a clear call to action for change to the residency interview system, including general reform, the continuation of virtual interviews, advocating for centering the climate impact in reform decisions, or a combination thereof. Of these,

8 articles advocated for reform based solely or largely on the climate impact of in-person interviews.^{8,12-14,16-19} The language of the calls to action varied in the intensity of recommendation or persuasion, with 5 studies including language “strongly in favor of reform,”^{8,9,12,17,19} 5 “in favor of reform,”^{13-16,18} and 3 “neutral to reform”^{10,11,20} as determined by reviewers on a 5-item Likert scale (FIGURE 2). No articles fell into the “opposed to reform” or “strongly opposed to reform” categories. Two articles stated that the climate impact of the residency interview process was a “moral” issue^{12,17}; words such as “critical,” “imperative,” and “crisis” also appeared in the “strongly in favor” category of papers (FIGURE 2).

Discussion

This scoping review examining the potential environmental impact of travel associated with in-person residency interviews in the United States and Canada found 3 main themes in the current literature: efforts to quantify the carbon footprint of interview travel, assessment of stakeholders’ perspectives on virtual interviews, and advocacy for virtual interviews. Overall, the literature suggests a high level of interest and concern around the carbon emissions associated with in-person interviewing.

The quantitative estimates of carbon emissions associated with in-person interviews were varied but substantial. Yearly per-applicant estimates ranged from

TABLE 2
Quantitative Estimates of the Carbon Footprint of Residency Interview Travel by Study, Study Population, Time Period, and Travel Type

Study	Study Population	Time Period	Travel Type Accounted For	Per Interview Estimation	Per Applicant Estimation	Per Cohort Estimation	Notes
Green, 2020 ⁸	Single US MD internal medicine applicant, 2018	2018-2019 cycle	Air travel only		6049kg		Author's personal data
Bernstein, 2021 ¹⁴	89 members of Stanford MD class	2019-2020 cycle	Air travel only		5593.25kg	447 564kg/year	Cumulative Stanford MD, all specialties
Donahue, 2021 ¹⁶	103 members of University of Michigan MD class	2019-2020 cycle	Car, train, air travel	210kg	3070kg	51 665 000kg/year	Cumulative all US applicants, all specialties
Fung, 2021 ¹⁷	39 general surgery applicants to University of Ottawa program	2019-2020 cycle	Car, bus, train, air travel		1820kg	101 900kg/year	Cumulative University of Ottawa general surgery program applicants
Gallo, 2021 ¹⁸	73 applicants to US Urology Match	2020-2021 cycle	Car, air travel	490kg	6260kg	3 011 000/year	Total carbon emissions avoided in 2021 US Urology Match
Liang, 2021 ¹⁹	960 Canadian medical students applying to any specialty	2019-2020 cycle	Air travel only		1440kg	423 900kg/year	Cumulative Canadian residency applicants, all specialties
Narang, 2022 ¹³	Cohort of 2580 matched US MD dermatology applicants	Past 15 years	Car, air travel	101kg		530 000kg/year	One year's worth of US seniors applying to dermatology (15-year average)

Note: All units kg CO₂ or CO₂ equivalents (CO_{2(e)}). "Per cohort estimation" refers to the estimated carbon footprint of the entirety of the specific cohort studied, details of which can be found in the "notes" column.

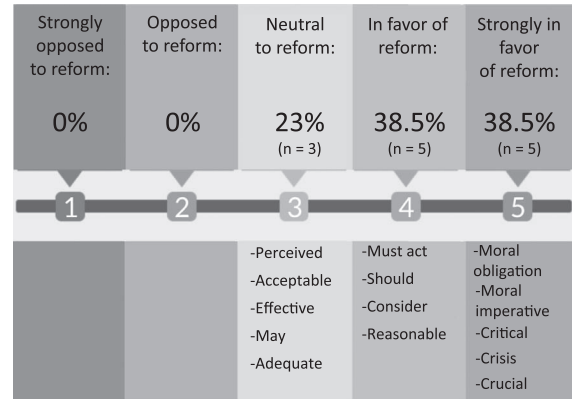


FIGURE 2
Articles by Position on Residency Interview Reform, Ranked on a 5-Item Likert Scale
Note: Top boxes show the numerical breakdown in each position category, bottom boxes show representative language found in articles of each category that was used to assess the articles' position.

1440 kgCO_{2(e)} to 6260 kgCO_{2(e)}. For reference, global average per-person emissions are estimated at 4000 kgCO_{2(e)} per year while the estimate in the Unites States is 16 000 kgCO_{2(e)}.²¹ Thus, the top per-applicant emissions estimate of 6260 kgCO_{2(e)} surpasses the global average and is roughly equivalent in terms of carbon emissions to 16 048 miles driven in a standard gasoline-powered car, the yearly electricity usage of 1.2 United States homes, and nearly 7000 pounds of coal burned.²² For an application season of in-person residency interviews, an average applicant could be responsible for emitting more carbon into the atmosphere than can be sequestered by 100 tree seedlings in 10 years.²²

The number of perspective and opinion pieces on this topic as well as the generated themes suggest a level of interest on the part of the profession regarding the environmental impact of in-person residency

interviews as they were previously conducted. The findings also suggest that many applicants and program directors consider the environmental impact of GME processes both personally and professionally important. The persuasive language and level of advocacy found in this review suggest there is support in the profession for continuing virtual interviews, partially or wholly based on the climate impact. Despite the variety of estimations arrived at and paths arrived by, this review provides evidence from multiple sources that the environmental costs of residency interview travel are substantial and of considerable interest to the medical profession.

Additionally, the field of medicine's approach to addressing its own carbon footprint can be considered a consequential health equity issue given that marginalized populations bear the brunt of the health-related costs of climate change.⁴ While the specific effects of climate change on vulnerable populations are outside the scope of this review, the relationship between the medical profession's social contract and the principle of nonmaleficence to the downstream effects of its internal educational practices warrants consideration.

This review is limited by the available literature, which is heterogeneous, including the studies with quantitative estimates of carbon emissions. These studies used various populations, types of travel, and emissions models for calculation. Several of the studies included only air travel emissions estimates. Furthermore, a majority of the quantitative estimation studies were based on survey feedback from applicants about their travel details, introducing potential recall bias, incomplete responses, and small sample sizes. Survey designs also varied between studies, and it is unclear how well international applicants were represented in the samples. As a result, it is likely that many of the final emissions estimates are underestimates. Additionally, the inclusion criterion to specifically reference the environmental impact of residency interview travel likely resulted in the exclusion of articles that were less favorable towards maintaining virtual interviewing and may have oversampled articles supportive of virtual interviewing. This review was also limited to studies on the interview process from the United States and Canada, which may differ from processes elsewhere.

Given the high carbon footprint of in-person interviews and the profession's concerns regarding climate and health, as evidenced in the sample, future study of new approaches to residency interviews is indicated. These studies might examine regional or national centralized specialty interviews and other models.

Conclusions

From this scoping review, the carbon footprint of travel associated with in-person US and Canada medical residency interviews appears large. The literature to date is limited in number and heterogeneous in nature but reveals a consistent theme of advocacy for the continuation of virtual interviews. Overall, the literature suggests a high level of interest and concern around the carbon emissions associated with in-person interviewing.

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