The ethics of climate change and health-care delivery: a national survey of US-based physicians

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Health harms from climate change are partly driven by health-care emissions. Physician perspectives on the related ethical dilemmas of professional responsibilities, health equity, and trade-offs between individual health choices and the environmental impact of health care are not well described in current literature. We performed a cross-sectional survey of US-based physicians between July 18, 2023, and May 28, 2024 to assess related perspectives, and we analysed the results by the respondents' perceived impact of climate change on their patients' health (moderate–high impact *vs* no–to–low impact). 529 surveys were delivered, of which 304 (57·5%) were returned. 113 (37·4%) of 302 respondents reported that climate change had a moderate–high impact on their patients' health, whereas 249 (82·5%) respondents viewed climate change as having greater health impacts on patients with less access to health care. 105 (35·0%) of 300 respondents reported that the environmental impact of health care should be reduced even if it requires limiting treatment options of similar effectiveness. In response to hypothetical scenarios, the patients in the moderate-high impact group was more willing to place such limits (adjusted predicted probability=50%) than the no–to–low impact group (adjusted predicted probability=25%, difference=25% [95% CI 13–38]). In addition, the patients in the moderate-high impact group (adjusted predicted probability=86%) was more willing to initially trial a less effective but less environmentally toxic antihypertensive medicine than the no–to–low impact group (adjusted predicted probability=69%, difference=17% [95% CI 6–27]). A sample of US-based physicians accepted their health care-related responsibilities towards climate change and viewed its health impacts as inequitable. Perceptions of the health impact of climate change influenced willingness to accept limited treatment options for environmental reasons.

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Introduction

Climate change poses an existential threat to human health.[1] Between 2030 and 2050, the WHO conservatively estimates at least 250 000 additional deaths per year from undernutrition, malaria, diarrhoea, and heat stress due to climate change.[2] The USA produces 25% of global, health care-related greenhouse gas emissions at a per capita rate that is at least double that of other high-income countries.[3–5] These emissions (388 000 disability-adjusted life-years) lead to similar annual losses of life as those due to pancreatic cancer or colorectal cancer (470 000 and 284 000 disability-adjusted life-years, respectively).[6] To date, most climate mitigation, adaptation, and resilience efforts in US health care have focused on policy-level and system-level changes.[7] Growing evidence now suggests that clinical practices directly impact greenhouse gas emissions from care delivery and indirectly affect such emissions throughout the supply chain.[8–12] These effects generate a "harm, treat, harm cycle" whereby health care contributes to the upstream generation of health harms through emissions and climate change, propagating the very problems the system seeks to treat.[13,14] Health harms include increased incidence of respiratory and cardiovascular diseases mediated by air pollution, malnutrition mediated by food supply disruption from storms and weather pattern changes, and heat-related illness and death.[1] These harms impact some groups disproportionately, such as those who are less affluent; those from some physical geographies and cultures, including those from small island nations and indigenous people; individuals with chronic conditions; and those with less access to health care.[1] This issue raises a core set of unresolved ethical dilemmas: what (if any) professional responsibilities do physicians have towards the environment; how should alignment or misalignment of individual health and environmental interests be ethically approached; and how do these responsibilities and interests relate to health equity?

Interdisciplinary ethical systems such as environmental bioethics,[15] green bioethics,[16] and climate-informed clinical ethics[14] bring together human and environmental interests. These approaches all support the ongoing provision of life-saving and life-sustaining health care. These approaches are also broadly in agreement that climate commitments exist for professionals whose charge is human health, and that health-care delivery must be grounded in efficiency and stewardship of planetary resources.[14,16] Although these moral positions have been reasonably well defined by bioethicists, the perspectives of stakeholders who are asked to assume these responsibilities remain unclear, as do their views on ethical dilemmas such as limiting treatment choices for the purposes of greenhouse gas emissions reduction. Surveys have assessed health professionals' understanding of climate and health, in addition to their preferences and engagement with related activities. These surveys, however, have focused on non-physician professionals, were performed outside the USA, did not explicitly address clinical ethics, or had low response rates.[17–20] In this context, we conducted a

national survey of US-based physicians to characterise these issues with the goal of informing ethical clinical practice in the era of climate change.

Methods

Study design, objectives, and endpoints

We performed a cross-sectional survey of US-based practicing physicians to understand their views on professional responsibilities for sustainable health care, interactions between individual and environmental health, and the impact of climate change on health equity. The primary endpoint was to identify differences in reported willingness to limit individual treatment options on the basis of environmental impact, based on their perceived impact of climate change on their patients. Secondary endpoints were to understand their views on the responsibility of physicians towards health care sustainability overall and related to other health care stakeholders, acceptable trade-offs between treatment effectiveness and environmental impact, and current practices related to climate and health care decision making.

Participants and recruitment

Random samples of practicing physicians were identified using the National Plan & Provider Enumeration System (NPPES) and verified through a manual review until a prespecified sample size was reached. Sampling was stratified by primary practice area, as indicated by the taxonomy codes available in the NPPES. Records indicating family medicine, internal medicine, or paediatrics as their primary and only practice area were categorised as primary care and those indicating other practices as their primary area were categorised as specialty care. After excluding non-physician records or records with missing key contact information, a set of physician records were randomly selected using the slice_sample() function in the R package *dplyr*. Research staff then verified contact information by contacting the physician practice until a sample size of 550 was reached. Additional details of the NPPES sampling methods are described in the appendix (pp 2–3).

For more on **NPPES**, see https://npiregistry.cms.hhs.gov/search

See **Online** for appendix

Paper surveys were mailed to potential participants through a private courier service (FedEx). The climate impact of a paper versus electronic survey was also considered; paper was chosen because the research team concluded that the usual low response rates of electronic surveys[21] would preclude an effective study and downstream environmental benefits. Following best practices for maximising response,[22] surveys included a prepaid return envelope and a modest incentive (US$20 gift cards); a follow-up letter with an electronic response option was sent after 2 weeks, and a follow-up telephone call for non-responders was made 2 weeks after that. Surveys were mailed between July 18, 2023, and May 28, 2024. Ethics approval for the study was obtained from the Institutional Review Board of the Dana-Farber/Harvard Cancer Center (approval number 22–616) before data collection.

Survey development

The ethical systems of environmental bioethics,[15] green bioethics,[16] and climate-informed clinical ethics[14] served as the theoretical basis for the survey. A draft survey instrument was developed by an interdisciplinary research team of clinicians, climate scientists, bioethicists, and survey methodologists. This draft instrument included demographic questions adapted from the American Community Survey and US Decennial Census,[23] climate change belief questions adapted from the Medical Consortium on Climate Change and Health physician surveys,[18,20] and instrument-specific questions that covered the domains of climate-related professional responsibilities, climate and health-decision interactions, and climate and health equity. The draft survey was iteratively revised to improve question relevance, comprehension, clarity, and survey structure through formal cognitive testing with 19 physicians across three focus groups.[24] This draft was then pretested asynchronously by five physicians and a survey methodologist, with written feedback provided and incorporated. The final instrument included 26 questions in seven sections (demographics, views on climate change, health impact of climate change, environment and health discussions, responsibilities, limitations, and education).

Statistical analysis

Transformations of NPPES variables and survey response options for analysis are outlined in the appendix (pp 2–3, 6–7). To assess response associations with practicing in more vulnerable communities, practice location was linked to the county-level climate vulnerability index (CVI),[25] a validated measure that reflects baseline vulnerability and reduced resilience to climate change risks that impact health. CVI scores are normalised risk indices that range from 1 to 100, with 100 being areas most vulnerable to climate change; scores were analysed by grouping into quartiles. Due to aggregation at the county level, CVI scores in the reference dataset ranged from 21 to 71. Non-responder bias was assessed by comparing gender, taxonomy code type (primary *vs* specialty), CVI scores, and region between responders and non-responders, using Pearson's Chi-squared test and Wilcoxon rank sum test, with effect sizes calculated using Cramer's V for categorical variables and Cohen's f for continuous variables. Non-responder bias adjustment was considered when significant differences (two-sided $p<0{\cdot}05$) were observed using the Pearson's Chi-squared test and Wilcoxon rank sum test and when Cramer's V or Cohen's f effect sizes were greater than 0·10, as an effect size of 0·10 or lower is commonly interpreted as a small effect size.

The survey was powered to detect an approximately 15% difference in respondent willingness to limit individual treatment options (yes or no) on the basis of environmental impact, among two groups defined by their perception of the extent to which climate change has had an observable impact on their patients' health (no–to–low impact *vs*

moderate–high impact). These primary comparator groups were based on responses of "I don't know", "not at all", or "a little" (no–to–low impact) and "a moderate amount" or "a great deal" (moderate–high impact) to survey question 11 (appendix p 4). Based on responses during survey development, we assumed unbalanced groups (0·60 no-to-low, 0·40 moderate-high) and response proportions (0·75 no, 0·25 yes), two-sided α value of 0·05, and 80% power, which led to a minimum requirement of 282 respondents. Assuming a response rate of 55% and 5% undeliverable, we mailed 550 surveys.

Descriptive statistics, including means, standardised deviations, medians, IQR, and frequencies and proportions were calculated for continuous and categorical variables. Standardised mean differences with 95% CIs were calculated to assess the extent to which the various demographic characteristics differed between physicians who reported their patients experiencing no–to–low impact versus moderate–high impact. For primary and secondary endpoints, multivariable logistic regression models were used to assess differences in question responses between physicians who reported their patients experiencing no–to–low impact versus moderate–high impact from climate change. Regression models were adjusted for covariates of gender, race or ethnicity, practice type, years in practice, any environmental health education, and practice location CVI; these covariates were included because of known associations with general views on climate change[26] or because of an a priori concern for confounding, or both. Models with disaggregated and aggregated race or ethnicity were used. Respondent age was not included due to collinearity with years in practice; covariate interactions were not assessed. Adjusted predicted probabilities for the primary and secondary outcomes were calculated from the models for each level of each independent variable, in addition to differences in relation to the referent level. Bootstrapping using the percentile method (B=10 000) was carried out to estimate the 95% CI for these adjusted predicted probabilities. Analyses were of complete cases as item response missingness was less than 2%. All analyses were conducted using RStudio with R version 4.3.2, and manuscript reporting was performed according to the CROSS reporting standards (appendix pp 9–11).

Results

The process of cohort identification and attrition is given in figure 1. 529 surveys were delivered, of which 304 (overall response rate=57·5%) were returned. The prespecified thresholds for non-responder bias adjustment were not met, and therefore, adjustment was not performed (appendix p 12); standardised mean differences between these groups were less than 0·15 for all variables; 127 (42·5%) of 299 respondents were identified as female, and 93 (30·7%) of 303 respondents were from a minoritised racial or ethnic group (table 1).

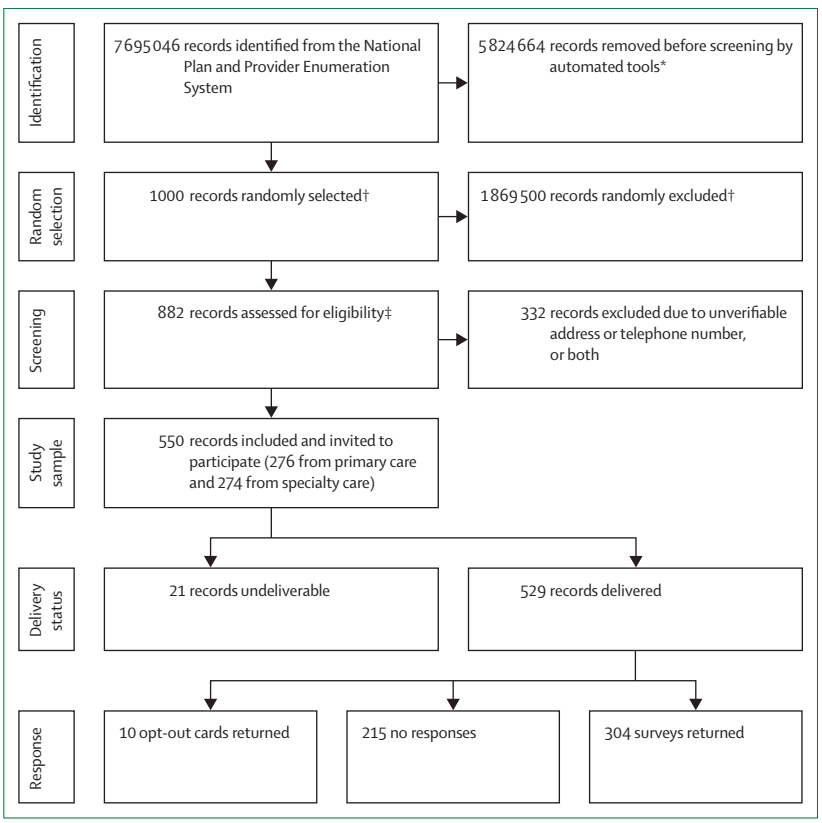

Figure 1: **Cohort identification and attrition**
*Removed based on criteria described in the appendix (pp 2–3). †Randomly selected using the slice_sample() function in *dplyr*'. ‡The sample size was reached after screening 882 records, 118 of the 1000 records did not need to be screened.

Using a definition adapted from the UN,[27] 288 (95·4%) of 302 respondents agreed that climate change is occurring, whereas 9 (3·0%) respondents were unsure and 5 (1·7%) disagreed. Among respondents who thought climate change was happening (n=286), 219 (76·6%) responded that climate change was caused entirely or mostly by human activities. 113 (37·4%) of 302 respondents reported a moderate or great deal of observable impact from climate change on their patients, which constituted the moderate–high group, and 189 (62·6%) respondents were unsure or reported no or a little impact, which constituted the no–to–low comparator group. More respondents in the moderate–high impact group were from minority racial or ethnic groups, had previous environmental health education, practiced primary care, had practiced for fewer years, and practiced in western USA (table 2). Detailed responses to survey questions about the impact of climate change on patients are given in the appendix (p 13), including the 249 (82·5%) of 302 respondents who reported that climate change will have a greater health impact on people with less access to health care.

Across the entire cohort, 268 (88·7%) of 302 respondents said that the environment was a risk factor for their patients' medical conditions, and 38 (12·6%) of

Characteristic*	n (%)
Age in years	
Mean (SD)	49 (13)
Median (IQR)	49 (39–59)
Unknown	8
Minoritised racial–ethnic group	
Minoritised group	93 (30·7%)
Non-Hispanic White	198 (65·3%)
I choose not to answer	12 (4·0%)
Unknown	1
Ethnicity	
Hispanic or Latino	20 (6·7%)
Not Hispanic or Latino	273 (91·0%)
I choose not to answer	7 (2·3%)
Unknown	4
Race†	
American Indian or Native American	1 (0·3%)
Asian Indian	25 (8·2%)
Black or African-American	11 (3·6%)
Eastern Asian or Pacific Islander	28 (9·2%)
White	219 (72·0%)
A race not listed	9 (3·0%)
I choose not to answer	12 (3·9%)
Sex	
Female	127 (42·5%)
Male	172 (57·5%)
Unknown	5
Years in practice	
Less than 10	87 (28·9%)
11–20	79 (26·2%)
21–30	77 (25·6%)
More than 30	58 (19·3%)
Unknown	3
Primary care physician	
Specialty care	142 (46·7%)
Primary care	162 (53·3%)
Practice setting†	
Outpatient	261 (85·9%)
Acute care	130 (42·8%)
Specialty care facility	18 (5·9%)
Rehab or long-term care facility	9 (3·0%)
Other setting	6 (2·0%)
Unknown	2
Practice location CVI quartile‡	
Lowest vulnerability	90 (29·7%)
Low–moderate	98 (32·3%)
Moderate–high	82 (27·1%)
Highest vulnerability	33 (10·9%)
N missing	1
Environmental health education	
No previous education	135 (44·9%)
Formal or informal education	150 (49·8%)
Formal education	16 (5·3%)
Unknown	3
Region	
North central	79 (26·1%)
Northeast	54 (17·8%)
South	101 (33·3%)
West	69 (22·8%)
Unknown	1
Do you think climate change is happening at this time?	
Yes	288 (95·4%)
No	5 (1·7%)
I don't know	9 (3·0%)
N missing	2
To the best of your knowledge, climate change is··.	
Caused entirely or mostly by human activities	219 (76·6%)
Caused equally by human activities and natural changes	53 (18·5%)
Caused entirely or mostly by natural changes	14 (4·9%)
N missing	18
Climate change is having an observable effect on the health of my patients.	
Moderate or A great deal	113 (37·4%)
Not at all or A little	154 (51·0%)
I don't know or I do not think climate change is occurring	35 (11·6%)
N missing	2
In the next 10 years, climate change will have an observable effect on the health of my patients.	
Moderate or A great deal	189 (62·6%)
Not at all or A little	79 (26·2%)
I don't know or I do not think climate change is occurring	34 (11·3%)
N missing	2
In the next 10 years, climate change will have a greater health impact on people with less access to health care.	
Agree or Strongly Agree	249 (82·5%)
Disagree or Strongly Disagree	17 (5·6%)
I don't know or I do not think climate change is occurring	36 (11·9%)
N missing	2

*Transformations from original response categories are shown in the appendix (pp 2–3, 6–7). †Non-mutually exclusive response categories. ‡CVI scores are normalised risk indices that range from 1 to 100, with 100 being areas most vulnerable to climate change; scores were analysed by grouping into quartiles. CVI=climate vulnerability index.

Table 1: **Respondent characteristics (n=304)**

302 respondents said that they discussed the interaction between patients' health care and the environment at least a moderate amount. Although 221 (74·9%) of 295 respondents said that they wanted to reduce the environmental impact of the health care they provided, only 35 (11·7%) of 299 respondents said that they knew how to do so. Additional views on the intersection among the environment, health, and health-care delivery are given in the appendix (p 14).

Overall, 269 (89·7%) of 300 respondents said that physicians should help to make health care sustainable. The extent to which respondents viewed different actions as ones that physicians should take part in to fulfil that responsibility is shown in the appendix (p 15). The most commonly reported actions participants thought physicians

should undertake were joining a hospital sustainability committee (219 [72·1%] of 304) and changing clinical practices (215 [70·7%] of 304). The health-care stakeholders who the respondents viewed as having more or less responsibility for reducing the environmental impact of the health-care system is shown in the appendix (p 20). Participants reported that the government, hospital administration, and pharmaceutical companies were more responsible than physicians, who were in turn more responsible than patient advocacy groups. The complete findings related to the responsibilities for health-care sustainability are shown in the appendix (p 16).

When presented with a choice of two similar medicines (by patient benefit, risks, and costs) with different environmental impacts, 223 (74·3%) of 300 respondents reported that they would recommend the less environmentally impactful medicine while informing the patient about the other, whereas 37 (12·3%) respondents said that they would not offer the patient the other medicine; 40 (13·3%) respondents would let the patient choose given that the medicines were otherwise equivalent (appendix [p 17]). For the same scenario, 173 (57·5%) of 301 respondents said that the more environmentally impactful medicine should stay on the market with an alert for patients and physicians; 80 (26·6%) said with an alert for physicians only; 26 (8·6%) said they would not favour an alert; and 22 (7·3%) said they would want the medicine removed from the market.

105 (35·0%) of 300 respondents reported that the environmental impact of the health-care system should be reduced even if it requires limiting treatment options of similar effectiveness (figure 2). Respondents in the moderate–high impact category (adjusted predicted probability=50% [95% CI 40–60]) were more willing than those in the no–to–low impact category (adjusted predicted probability=25% [95% CI 19–32], difference: 25% [95% CI 13–38]) to limit individual treatment options because of their environmental effects (table 3). When presented with a clinical scenario that asked how much of a reduction in expected treatment response was allowable for respondents to initially prescribe a less environmentally toxic antihypertensive medicine (figure 2), only 75 (24·9%) of 301 respondents did not allow any reduction in effectiveness, whereas 133 (44·2%) respondents allowed a 1–10% reduction in effectiveness and 93 (30·9%) respondents allowed a greater than 10% reduction. Respondents in the moderate–high impact category (adjusted predicted probability=86% [95% CI 78–93]) were more willing to initially attempt treatment with a medicine of lower effectiveness than those in the no–to–low impact category (adjusted predicted probability=69% [95% CI 62–76], difference=17% [95% CI 6–27]). Results of the full model and the complete results of perspectives on environmentally related limitations of care are given in the appendix (pp 18–19).

Discussion

In this cross-sectional survey of US-based physicians, most respondents considered the impact of climate change on

	No–to–low impact* n=189 n (%)	Moderate–high impact* n=113 n (%)	Difference†	95% CI†
Age			0·24	0·01 to 0·48
Mean (SD)	51 (13)	47 (12)		
Median (IQR)	51 (39–60)	46 (37–57)		
Unknown	4	4		
Minoritised racial–ethnic group			0·32	0·08 to 0·55
Minoritised group	49 (26·1%)	44 (38·9%)		
Non-Hispanic White	133 (70·7%)	63 (55·8%)		
I choose not to answer	6 (3·2%)	6 (5·3%)		
Unknown	1	0		
Ethnicity			0·25	0·02 to 0·49
Hispanic or Latino	8 (4·3%)	12 (10·8%)		
Not Hispanic or Latino	175 (93·6%)	96 (86·5%)		
I choose not to answer	4 (2·1%)	3 (2·7%)		
Unknown	2	2		
Race‡				
American Indian or Native American	0 (0·0%)	1 (0·9%)	−0·13	−0·37 to 0·10
Asian Indian	17 (9·0%)	8 (7·1%)	0·07	−0·16 to 0·30
Black or African American	4 (2·1%)	7 (6·2%)	−0·21	−0·44 to 0·03
Eastern Asian or Pacific Islander	17 (9·0%)	11 (9·7%)	−0·03	−0·26 to 0·21
White	142 (75·1%)	75 (66·4%)	0·19	−0·04 to 0·43
A race not listed	4 (2·1%)	5 (4·4%)	−0·13	−0·36 to 0·10
I choose not to answer	6 (3·2%)	6 (5·3%)	−0·11	−0·34 to 0·13
Sex			0·16	−0·07 to 0·40
Female	74 (39·8%)	53 (47·7%)		
Male	112 (60·2%)	58 (52·3%)		
Unknown	3	2		
Years in practice			0·3	0·11 to 0·53
Less than 10	48 (25·7%)	39 (34·8%)		
11–20	49 (26·2%)	30 (26·8%)		
21–30	50 (26·7%)	26 (23·2%)		
More than 30	40 (21·4%)	17 (15·2%)		
Unknown	2	1		
Primary practice			0·28	0·05 to 0·51
Specialty care	98 (51·9%)	43 (38·1%)		
Primary care	91 (48·1%)	70 (61·9%)		
Practice location‡				
Outpatient	163 (86·2%)	96 (85·0%)	0·04	−0·20 to 0·27
Acute care	90 (47·6%)	40 (35·4%)	0·25	0·02 to 0·48
Specialty care facility	14 (7·4%)	4 (3·5%)	0·17	−0·06 to 0·40
Rehab or long-term care facility	6 (3·2%)	3 (2·7%)	0·03	−0·20 to 0·26
Other setting	4 (2·1%)	2 (1·8%)	0·03	−0·21 to 0·26
Environmental health education			0·59	0·35 to 0·82
No previous education	102 (54·5%)	32 (28·3%)		
Any education	80 (42·8%)	70 (61·9%)		
Formal education	5 (2·7%)	11 (9·7%)		
Unknown	2	0		
Practice location CVI quartile§			0·11	−0·13 to 0·34
Lowest vulnerability	50 (26·6%)	25 (22·1%)		
Low–moderate	47 (25·0%)	29 (25·7%)		
Moderate–high	46 (24·5%)	30 (26·5%)		
Highest vulnerability	45 (23·9%)	29 (25·7%)		
N missing	1	0		

(Table 2 continues on next page)

	No–to–low impact* n=189 n (%)	Moderate–high impact* n=113 n (%)	Difference†	95% CI†
(Continued from previous page)				
Region			0·32	0·08 to 0·55
North central	55 (29·3%)	24 (21·2%)		
Northeast	37 (19·7%)	17 (15·0%)		
South	62 (33·0%)	38 (33·6%)		
West	34 (18·1%)	34 (30·1%)		
Unknown	1	0		
Do you think climate change is happening at this time?			0·40	0·16 to 0·64
No	5 (2·6%)	0 (0·0%)		
Yes	175 (92·6%)	113 (100·0%)		
I don't know	9 (4·8%)	0 (0·0%)		
To the best of your knowledge, climate change is…			0·53	0·28 to 0·77
Caused entirely or mostly by human activities	121 (69·5%)	98 (87·5%)		
Caused equally by human activities and natural changes	39 (22·4%)	14 (12·5%)		
Caused entirely or mostly by natural changes	14 (8·0%)	0 (0·0%)		
N missing	15	1		
In the next 10 years, climate change will have an observable effect on the health of my patients.			1·5	1·3 to 1·8
Not at all or A little	79 (41·8%)	0 (0·0%)		
Moderate or A great deal	79 (41·8%)	110 (97·3%)		
I don't know or I do not think climate change is occurring	31 (16·4%)	3 (2·7%)		
In the next 10 years, climate change will have a greater health impact on people with less access to health care.			0·83	0·58 to 1·1
Disagree or Strongly Disagree	17 (9·0%)	0 (0·0%)		
Agree or Strongly Agree	137 (72·5%)	112 (99·1%)		
I don't know or I do not think climate change is occurring	35 (18·5%)	1 (0·9%)		

*These dichotomised primary comparator groups were based on responses of "moderate" or "a great deal" (moderate–high impact); or "I don't know" or "no", "a little" (no–to–low impact) to survey question 11. †Standardised mean difference. ‡Non-mutually exclusive response categories; comparisons and listed p-values are differences between low and high impact. §CVI scores are normalised risk indices that range from 1 to 100, with 100 being areas most vulnerable to climate change; scores were analysed by grouping into quartiles. CVI=climate vulnerability index.

Table 2: **Bivariate demographic differences between the no–to–low and moderate-high impact groups (n=302)**

For more information on the **contemporary movement**, see https://practicegreenhealth.org

health to be inequitable, accepted health-related responsibilities for climate change and were willing to make some trade-offs between individuals' treatment options and environmentally mediated public health. Despite broad acknowledgment of the impact of the changing climate on patient health and the impact of health-care delivery on climate change, only few respondents reported discussing these interactions with patients, which aligned with self-perceived inadequacy of climate and health education. The respondents' perceived impact of climate change on patient health was associated with their acceptance of professional responsibilities and limitations of treatment options to reduce the environmental impact. Together, these data highlight the need to address the interest of stakeholders in climate-informed medical practice through climate, health, and ethics education, in addition to developing the evidence and policy that can support informed discussions and decision making. The data also underscore increasing ethical tensions between a consumptive US health-care system that propagates climate change while managing the health of patients harmed by climate change.[3,28]

Until recently, allopathic physician education in the USA included little on the intersection of climate and health, and the US health-care system pursued research and patient care with sparse attention to its environmental (and downstream health) impact.[14] A contemporary movement spanning care delivery, health policy, medical ethics, health equity research, and climate science has sought to reintegrate health care with the environment in which patients live[29–32] Our current data highlight the unresolved ethical dilemmas involved in that reintegration. These dilemmas include the responsibilities of physicians towards climate and health, which can be broken into questions about the roles physicians should assume to further climate mitigation, adaptation, or resilience; what their responsibilities are; and how to manage their responsibilities for individual patients' treatment options and public health (through the mitigation of climate change), in case of conflict.

Our data align with and expand on findings of other surveys on climate and health in which physicians or other health-care professionals acknowledge some responsibilities for the mitigation of climate change.[17–20] Notably, our findings show that acceptance of such a responsibility was associated with perceiving a higher impact of climate change on their patients' health. However, there was no association between climate vulnerability and the practice locations of the respondents, which could reflect the degree to which climate impacts and their perception vary by age, specialty, individual physician interest, or their patients' characteristics. As climate impacts on health are expected to increase, these findings suggest that physicians might accept more responsibilities moving forward.

The inadequacy of physician education and institutional structures that allow these responsibilities to be addressed—alongside actionable data that can support evidence-based decision making—is most likely to give rise to substantial moral distress. Respondents also highlighted the responsibilities of other health-care actors in driving change at the organisational, supply chain, and policy levels, without which physician action alone would be insufficient.[33] Examples of pioneering initiatives that can meet physician needs include a quality incentive programme that has been shown to increase knowledge about practical strategies for understanding climate health impacts and health-care sustainability,[34] in addition to dedicated medical school curricula and continuing

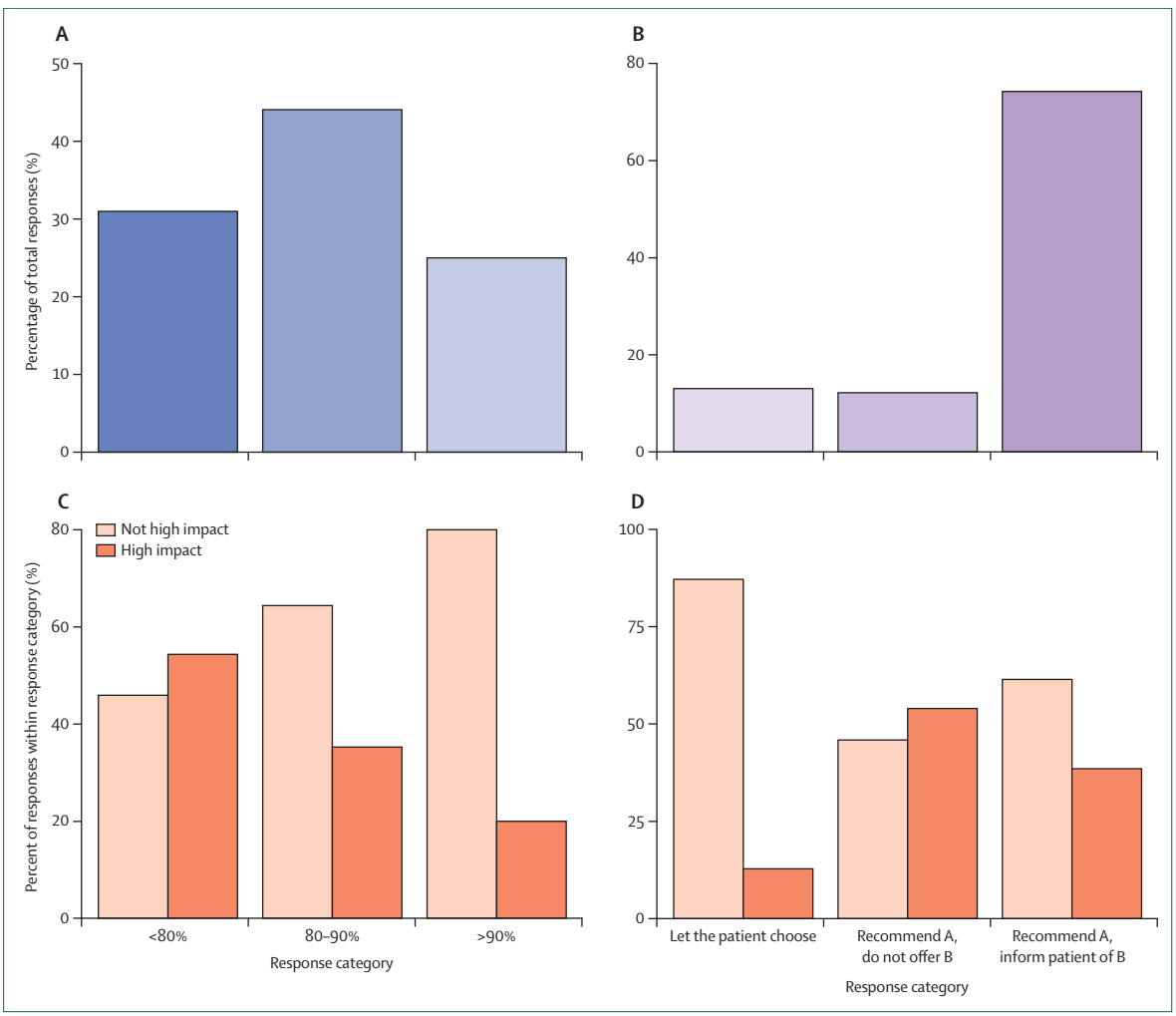

Figure 2: **Responses to questions in the survey, overall and stratified by moderate–high patient impact and no–to–low patient impact categories**
Responses in Panel A and C are to the survey question "A patient has hypertension and there are two approved medications to treat it. The medicines are equivalent except that one is environmentally toxic and effective 90% of the time, the other is environmentally non-toxic and effective __% of the time. How low can the blank value be for you to prescribe the environmentally non-toxic medicine"? Responses in Panel B and D are to the survey question "If Medicines *A* and *B* have similar benefits, side effects and costs, but Medicine *B* is worse for the environment, physicians should…".

medical education that connects clinical medicine to the environment.[29,35,36] Other forward-thinking ideas such as embedding climate and health into physician oaths, practice guidelines, peer support, and local practice advocacy can also be further considered[37] and were acceptable to many respondents. Together, these initiatives might also improve the understanding of climate change among US-based physicians, as 53 (18.5%) of 286 respondents incorrectly reported that climate change was caused equally or more from natural changes than from human activity, a percentage higher than that reported in previous surveys (especially those conducted outside the USA).[17–20]

We found that perceptions of how climate change impacts patient health are associated with a willingness to change medical practices—even those that limit individual treatment choices—to reduce the environmental impact of health care. However, at present, that willingness is low, as only 35% of respondents accepted a reduction in treatment options and only 31% accepted a reduction in initial treatment effectiveness. This observation aligns with qualitative findings that clinicians are indeed concerned about climate mitigation measures decreasing effective patient care.[24,38] US health-care delivery, however, can make many changes that are co-beneficial to individual patients and the environment or are health agnostic and environmentally beneficial. Some of these changes could involve trade-offs such as limiting individuals' choices, whereas other changes could involve true trade-offs between individual and public health via reductions in emissions. Actionable evidence from which such considerations can be approached remains scarce but is increasing through the use of lifecycle

	Adjusted predicted probability	95% CI	Difference in adjusted predicted probability	95% CI
Perceived impact of climate change on patients				
No–to–low impact	0·25	0·19 to 0·32	..	..
Moderate–high impact	0·50	0·40 to 0·60	0·25	0·13 to 0·38
Racial–ethnic group				
Non-Hispanic White	0·33	0·26 to 0·39	..	..
Minoritised group*	0·40	0·29 to 0·50	0·07	–0·05 to 0·19
Sex				
Male	0·32	0·25 to 0·40	..	..
Female	0·38	0·30 to 0·47	0·06	–0·05 to 0·17
Primary practice				
Specialty care	0·38	0·30 to 0·47	..	..
Primary care	0·32	0·25 to 0·40	–0·06	–0·17 to 0·05
Years in practice				
Less than 10	0·44	0·33 to 0·53	..	..
11–20	0·23	0·14 to 0·32	–0·21	–0·34 to –0·08
21–30	0·37	0·26 to 0·48	–0·07	–0·22 to 0·09
More than 30	0·35	0·23 to 0·48	–0·08	–0·24 to 0·08
Any environmental health education				
No previous education	0·22	0·15 to 0·29	..	..
Any previous education	0·45	0·37 to 0·53	0·23	0·12 to 0·35
Practice location CVI†				
Lowest vulnerability	0·39	0·29 to 0·48	..	..
Low–moderate	0·35	0·25 to 0·45	–0·04	–0·17 to 0·10
Moderate–high	0·33	0·23 to 0·43	–0·06	–0·20 to 0·08
Highest vulnerability	0·30	0·17 to 0·44	–0·08	–0·25 to 0·08

*Individual groups included in this category and a disaggregated model with individual racial groups and Hispanic ethnicity are shown in the appendix (pp 18–19). †CVI scores are normalised risk indices that range from 1 to 100, with 100 being areas most vulnerable to climate change; scores were analysed by grouping into quartiles. Due to aggregation at the county level, CVI scores in the reference dataset ranged from 21 to 71. CVI=climate vulnerability index.

Table 3: **Multivariable logistic regression of willingness to limit treatment options based on their environmental impact (n=280)**

assessments, which comprehensively assess the environmental impact of clinical products (eg, inhalers for asthma and anaesthetic gases for surgery) or processes (eg, telehealth *vs* in-person care), from extraction of the natural resources involved to their disposal or reuse.[39–43] Even when available, however, these data have economic and social barriers to practice integration, based on supplier contracts, hospital norms, politicisation, and paucity of defined implementation methodologies that could limit their uptake and be more impeding for changes that involve patient choice and trade-offs rather than co-benefits.

Patient-reported views on these trade-offs are not broadly understood, with available data from a gynaecological cohort in the Netherlands showing diverse opinions, with a tendency to choose environmentally friendly options.[44] Additional data on patient perspectives and any differences between patient and physician views are essential for guiding clinical practice, physician education, and public policy. Analogous limitations of choice due to cost and insurance coverage, which might be less normatively acceptable than trading personal health for public health, suggest that acceptability could be low. These dilemmas are confounded by concerns over health equity that physicians also find important, such as avoiding sharing the burden of environmental impact of health care with marginalised patients.[24]

Our study has limitations, which include the cross-sectional design, hypothetical nature of some of the questions that might not reflect future views or actual decisions, and analyses that were able to identify associations but not causality. Although we did not see non-response bias across the limited set of sociodemographic measures, the culturally and politically charged nature of the subject matter in the USA could have resulted in important differences between non-responders and responders that we were not able to identify and should be assessed in future research. Likewise, outcome differences among responders might have been biased by unmeasured confounders or effect modifiers that were not captured, such as political affiliation, or through changing opinions over the period of survey distribution. Instrument questions were not psychometrically validated; however, rigorous instrument design and cognitive testing was performed and the usefulness of psychometric validation outside of psychological or behavioural construct assessment is arguable.[45] Of note, insurers was removed as a response option from question 18 due to confusion during cognitive testing between the roles of insurers vis a vis health-care administrators, as they relate to climate and health; nonetheless, the removal of this option might diminish our understanding of insurers' role in climate and health responsibilities. Additionally, although climate change and environmental impacts are not synonymous, both terms were used based on cognitive testing; this conflation in the terms might have confused participants with high baseline knowledge. Finally, although we surveyed a random sample of US-based physicians, the sample was not representative of US-based physician demographics, and our findings are not generalisable to other countries with different health-care systems and potentially, different views on climate change and health.

As the evidence for links between climate change and health-care delivery grow, so should the consideration of the ethical dilemmas that stem from their intersection. A reasonable path forward is to supplement the current approach, which is reacting to the already present and intensifying changes to the climate and patients' health, with a preventive approach that anticipates and attempts to equip stakeholders for the additional challenges to come.[46] Our data suggest that US-based physicians are already thinking about the impact of climate change during clinical care and are open to interventions that integrate climate-informed practices. Key components of such an approach could include physician education, generating evidence that supports informed policy and decision making,

transparent discussions over trade-offs and health equity, and a continued realignment of health-care delivery with the environment in which it occurs.

Contributors

AH, CR, MS, and GAA conceptualised the study. AH, ES, CR, FJH, AR, BN-C, GAA, and AC were in charge of the methodology. AH, ES, FJH, TPW, HJ, ASD, AR, and BN-C collected the data. AH, TPW, and AC analysed the data. AH, TPW, and CR wrote the initial draft of the manuscript. ES, FJH, HJ, AC, ASD, AR, BN-C, MS, and GAA conducted the critical review of the manuscript. All authors contributed to the revision of the manuscript and gave the final approval for publication.

Declaration of interests

We declare no competing interests.

Data sharing statement

The institutional review board approval for this study does not allow for the individual participant data to be released publicly. The data, data dictionary, and analysis code supporting the findings could be made available to other investigators immediately after publication until 5 years after publication and are subject to approval by the institutional review boards that approved the study, data use agreements, and any other restrictions deemed necessary by the institutional review boards.

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