

Pediatric Resident and Program Director Views on Climate Change and Health Curricula: A Multi-Institution Study

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Abstract

Purpose

The American Academy of Pediatrics emphasized in a 2007 policy statement the importance of educating trainees on the impacts of climate change on children's health, yet few studies have evaluated trainee knowledge and attitudes about climate change-related health effects in children. This multi-institution study assessed pediatric resident and program director (1) knowledge/attitudes on climate change and health, (2) perspectives on the importance of incorporating climate and health content into pediatric graduate medical education, and (3) preferred topics/activities to include in climate and health curricula.

Method

This mixed-methods study employed an anonymous cross-sectional survey of pediatric residents and residency program

directors from Association of Pediatric Program Directors (APPD) Longitudinal Educational Assessment Research Network (LEARN)-affiliated programs. Multivariable regression models and factor analyses were used to examine associations among resident demographics and resident knowledge, attitudes, and interest in a climate change curriculum. A conventional content analysis was conducted for the open-ended responses.

Results

Eighteen programs participated in the study with all program directors (100% response rate) and 663 residents (average response rate per program, 53%; overall response rate, 42%) completing respective surveys. Of the program directors, only 3 (17%) felt very or moderately knowledgeable about the association between climate change and

health impacts. The majority of residents (n=423, 64%) agreed/strongly agreed that physicians should discuss global warming/climate change and its health effects with patients/families, while only 138 residents (21%) agreed/strongly agreed that they were comfortable talking with patients and families about these issues. Most residents (n=498, 76%) and program directors (n=15, 83%) agreed/strongly agreed that a climate change curriculum should be incorporated into their pediatrics training program.

Conclusions

Pediatric residents and program directors support curricula that prepare future pediatricians to address the impact of climate change on children's health; however, few programs currently offer specific training, despite identified needs.

Climate change has dramatically impacted human health, with threats to ecosystems worsening human health as global temperatures rise.¹⁻⁸ The World Health Organization estimates that already over 150,000 deaths annually are

caused by climate change,⁹ with the majority occurring in children < 5 years¹⁰; these estimates are likely only a portion of the global burden of disease on children from climate change.¹¹ Climate change directly affects physical and mental health through events that cause injury, illness, or death (e.g., heat waves, storms, flooding) or indirectly through consequences of environmental changes (e.g., air pollution from fossil fuel extraction, precipitation changes contributing to food- or water-borne illnesses, and food and water insecurity).¹² Children are uniquely vulnerable to the many health risks associated with climate change. They spend more time outdoors than adults, are physiologically immature,¹⁰ and are dependent on caregivers to respond to

and protect them from climate change-related threats.¹³

The threats climate change poses to children were highlighted in an American Academy of Pediatrics (AAP) 2015 policy statement¹³ emphasizing that "pediatricians have a uniquely valuable role to play in the societal response" to climate change. Incorporating training on the health impacts of climate change can help prepare trainees to deliver anticipatory guidance, manage specific climate change-related health effects, and advocate for climate change policies benefiting children and their families.¹⁴ In 2019, the American Medical Association issued a statement supporting climate change teaching in undergraduate, graduate, and continuing medical

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education curricula.¹⁵ While there have been attempts to describe and evaluate climate change curricula for medical students,^{16–19} to our knowledge, no studies have evaluated the extent to which pediatric residency programs are teaching residents about climate change and health or what types of training or climate change–related activities residents want prioritized.

This multi-institution U.S. study aimed to evaluate 3 traits of pediatric residents and program directors: (1) knowledge/attitudes about climate change and health, (2) perspectives on the importance of incorporating climate and health content into medical training, and (3) preferred topics or activities to include in climate and health curricula. We hypothesized that although few training programs would have formal climate and health curricula, most pediatric residents and program directors would be interested in incorporating climate and health curricula into their training programs.

Method

Study design

We conducted a mixed-methods study using an anonymous cross-sectional survey of residents and residency program directors from Association of Pediatric Program Directors (APPD) Longitudinal Educational Assessment Research Network (LEARN)–associated

programs.²⁰ APPD LEARN has 165 programs in the United States, with slight overrepresentation of larger and academic programs relative to smaller and community programs. We sent invitations to participate electronically to all APPD LEARN training programs. Interested programs responded to the email indicating their willingness to participate in the study. We then identified site leads (e.g., pediatric residents, program directors) at each participating program who were made responsible for obtaining local institutional review board (IRB) approval. Once IRB approval was obtained, participating site leads disseminated the survey to all residents at their program and encouraged survey completion. Residents at each program who joined the study between July 2021 and June 2022 were eligible to participate. A program director or associate program director from each participating program was also asked to complete a program director-specific survey. The University of Washington was the lead site. To incentivize participation, residents in states and programs permitting raffles for research compensation could provide their email address via a separate response to enter into a raffle for one of twenty \$25 Amazon gift cards.

Survey design

The resident and program director web-based survey instruments (with 32

and 30 questions, respectively) were developed by a multidisciplinary team, including pediatric trainees, pediatric resident and fellowship program directors, climate justice leaders, and general and subspecialty pediatricians with expertise in pediatric environmental health and climate change. The survey questions were informed by prior studies of medical student and physician knowledge and attitudes toward climate change and its health effects.^{21–24} Questions were grouped into 4 domains: (1) climate change–related knowledge, (2) attitudes toward global warming and climate change, (3) interest in incorporating climate change education into pediatric training programs, and (4) respondent demographic characteristics. Participants could also respond to an open-ended question asking for any other ideas/comments about addressing climate change in pediatric training. We pilot tested surveys for clarity and length with residents at the University of Washington. Surveys were fielded using the LimeSurvey platform (LimeSurvey GmbH, Hamburg, Germany).

Data analysis

Quantitative. Resident and program director demographic characteristics and responses were described using counts and proportions. We utilized an ordinal mixed-effects regression model to determine whether any demographic variables were associated with residents'



Figure 1 Map illustrating participating pediatric residency programs, from a multi-institutional study of pediatric residents' and program directors' views of climate change and health curricula.

interest in incorporating climate change education into their training program, with a random intercept to adjust for clustering within programs. To determine associations among trainee knowledge, attitudes, and climate change curricular interest, we computed Spearman’s correlations after adjusting for effects of program on each variable. Finally, we performed an exploratory factor analysis to examine relationships between individual attitude questions about climate change. We used maximum likelihood methods for factor extraction with an oblique factor rotation. We selected the number of factors to extract by comparing 2–4 factor solutions for parsimony and interpretability. We computed program-adjusted correlations between extracted factor scores and curricular interest. Statistical analyses were performed with R 4.2 (R Core Team, Vienna, Austria).

Qualitative. We conducted a conventional content analysis for the open-ended responses. A qualitative expert (K.S.B.) inductively categorized responses and organized them into clusters. These categories were shared with the larger research team and triangulated with existing quantitative findings to refine the definitions and categorizations. We examined open-ended responses by category, gender identity, and postgraduate year (PGY) level.

Results

Eighteen residency programs (of 165 APPD LEARN–affiliated programs, 10.9%) participated in the study and contributed survey data (Figure 1). The 18 APPD LEARN–affiliated programs that participated were statistically significantly larger (median of 72 residents; interquartile range [IQR], 47–84) than nonparticipating APPD LEARN–affiliated programs (median of 36 residents; IQR, 24–61), $P < .001$. No differences were seen between APPD LEARN–affiliated participating and nonparticipating programs in regional distribution (chi-square $P = .93$ across the 9 regions) or program type (academic, community, or military), chi-square $P = .30$. Among the 18 participating programs, 663 residents (average response rate per program, 53%; overall response rate, 42%) and 18 program directors (100%) completed the survey. Two programs had 100% resident participation, and 10

programs (56%) had > 50% resident participation. Among all participating residents, 485 (73%) were 25–30 years,

447 (67%) were first- or second-year residents, and 450 (68%) identified as female (Table 1). Complete results for all

Table 1
Demographic Characteristics of 663 Residents, From a Multi-Institutional Study of Pediatric Residents’ and Program Directors’ Views of Climate Change and Health Curricula

| Demographic characteristic | No. (%) |
|--|----------|
| Training type | |
| Categorical | 553 (83) |
| Medicine/pediatrics | 50 (8) |
| Other (includes combined and preliminary programs) | 60 (9) |
| PGY-training year | |
| PGY-1 | 227 (34) |
| PGY-2 | 220 (33) |
| PGY-3 | 192 (29) |
| PGY-4+ | 24 (4) |
| Age | |
| 25–30 years | 485 (73) |
| 31–35 years | 125 (19) |
| 36–40 years | 22 (3) |
| 41+ years | 2 (< 1) |
| No response | 27 (4) |
| Current gender identity | |
| Female | 450 (68) |
| Male | 196 (30) |
| Trans female/trans woman | 0 (0) |
| Trans male/trans man | 1 (< 1) |
| Nonbinary | 3 (1) |
| Genderqueer/gender nonconforming | 4 (1) |
| Prefer not to answer | 10 (2) |
| Different identity | 1 (< 1) |
| Race/ethnicity | |
| American Indian or Alaska Native | 4 (1) |
| Asian | 136 (21) |
| Black or African American | 41 (6) |
| Hispanic, Latino, or Spanish origin | 49 (7) |
| White | 430 (65) |
| Prefer not to answer | 27 (4) |
| Different identity | 10 (2) |
| Parental status | |
| Have children | 87 (13) |
| Pregnant/expecting child | 12 (2) |
| Do not have children | 561 (85) |
| USMG/IMG status | |
| USMG | 618 (93) |
| IMG | 45 (7) |
| Expected career path (n = 603) | |
| General pediatrician | 158 (26) |
| Hospitalist | 61 (10) |
| Subspecialty/fellowship | 306 (51) |
| Undecided | 78 (13) |

Abbreviations: PGY, postgraduate year; USMG, U.S. medical graduate; IMG, international medical graduate.

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Table 2

Factors Associated With Resident Interest,^a From a Multi-Institutional Study of Pediatric Residents' and Program Directors' Views of Climate Change and Health Curricula

| Factor | % Residents expressing interest | P value ^b | Odds ratio (95% CI) | P value ^c |
|-----------------------------|---------------------------------|----------------------|--------------------------|----------------------|
| Age | | | 1.02 (0.95, 1.10) | .52 |
| Gender | | .009 | | |
| Female (reference) | 78 | | – | – |
| Male | 68 | | 0.49 (0.34, 0.69) | < .001 |
| Gender other | 54 | | 0.41 (0.11, 1.61) | .20 |
| PGY | | .68 | | |
| PGY-1 (reference) | 77 | | – | – |
| PGY-2 | 75 | | 0.93 (0.63, 1.36) | .70 |
| PGY-3 | 72 | | 0.66 (0.44, 1.00) | .049 |
| PGY-4+ | 70 | | 0.72 (0.29, 1.79) | .48 |
| Parental status | | .18 | | |
| Not parent (reference) | 76 | | – | – |
| Parent yes/expecting | 69 | | 0.68 (0.42, 1.11) | .12 |
| USMG/IMG status | | .33 | | |
| USMG (reference) | 74 | | – | – |
| IMG | 81 | | 0.37 (0.19, 0.74) | .005 |
| Race | | n/a | | |
| White (vs non-White) | 73 | | 1.41 (0.79, 2.53) | .25 |
| Black (vs non-Black) | 76 | | 0.82 (0.37, 1.83) | .63 |
| Hispanic (vs non-Hispanic) | 79 | | 1.47 (0.75, 2.89) | .26 |
| Asian (vs non-Asian) | 84 | | 2.15 (1.13, 4.08) | .020 |
| Region | | .02 | | |
| Mid-America (reference) | 63 | | – | – |
| Mid-Atlantic | 77 | | 2.71 (0.74, 9.96) | .13 |
| Midwest | 68 | | 1.43 (0.68, 3.01) | .35 |
| New England | 75 | | 1.05 (0.31, 3.62) | .94 |
| New York | 81 | | 1.70 (0.73, –3.95) | .22 |
| Southeast | 79 | | 1.87 (0.83, 4.21) | .13 |
| Southwest | 73 | | 1.86 (0.64, 5.41) | .25 |
| Western | 82 | | 2.39 (1.17, 4.88) | .017 |

Abbreviations: CI, confidence interval; PGY, postgraduate year; IMG, international medical graduate; USMG, U.S. medical graduate.

^aBolded text represents statistically significant findings.

^bResidents agreeing or strongly agreeing they were interested are counted as showing interest. For each categorical variable (e.g., gender, PGY, etc.), the P value reported is from a univariate omnibus chi-square test of those proportions by the variable categories.

^cThe odds ratios and associated P values were obtained from a multivariate ordinal mixed-effects model in which planned contrasts of all covariates were simultaneously introduced as predictors of the 5-level Likert-scaled item and adjusted for clustering of residents within programs.

survey questions and answers (for residents and program directors) are available in Supplemental Digital Appendix 1, at <http://links.lww.com/ACADMED/B515>. While almost all (n = 653, 99%) residents agreed that global warming/climate change has occurred and is occurring, only 113 (17%) felt very or moderately knowledgeable about the association between climate change and health impacts. More than

half of residents (n = 423, 64%) agreed/strongly agreed that physicians should discuss global warming/climate change and its health effects with patients and families, yet only 138 (21%) agreed/strongly agreed that they were comfortable talking with patients and families about these issues.

Most residents (n = 498, 76%) agreed/strongly agreed that a climate change

curriculum should be incorporated into their training program, while only one-third indicated their training program currently had climate change-related educational activities. Residents more likely to express a climate change curricular interest identified as Asian (vs non-Asian) (adjusted odds ratio [AOR] = 2.15; 95% CI, 1.13, 4.09; P = .02) or came from a Western region program (vs mid-America AOR = 2.39; 95% CI,

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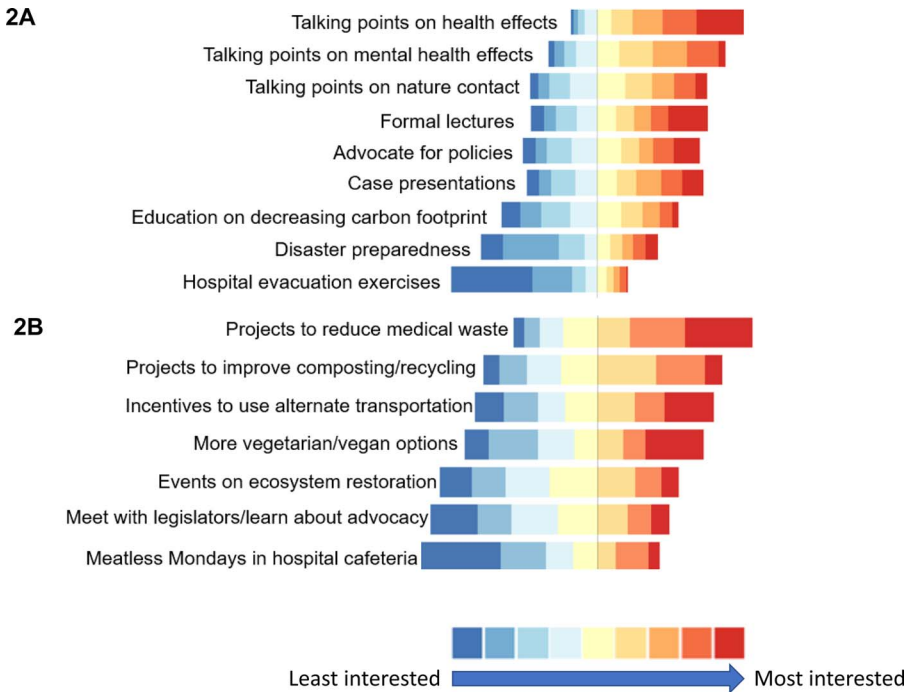


Figure 2 Resident preferences, from a multi-institutional study of pediatric residents’ and program directors’ views of climate change and health curricula. APPD Region: Western (Loma Linda, Stanford, Utah, University of Washington); Midwest (Medical College Wisconsin, UCI-Chicago, University of Wisconsin); Mid-Atlantic (University of Pennsylvania); Mid-America (Marshall, Michigan State, University of Michigan); Southwest (Baylor); Southeast (Emory, University of North Carolina); New York (Montefiore, NY Medical College, Buffalo); New England (Dartmouth). (Panel A) Preferences for types of training and content. (Panel B) Preferences for specific interventions to include.

1.17, 4.88; $P = .02$). In contrast, third-year residents (vs first years; AOR = 0.66; 95% CI, 0.44, 1.00; $P = .049$), international medical school graduates (IMGs) (vs U.S. medical school graduates [USMGs]; AOR = 0.37; 95% CI, 0.19, 0.74; $P = .005$), and residents who identified as male (vs female; OR = 0.49; 95% CI, 0.34, 0.69; $P < .001$) were less likely to express a climate change curricular interest (Table 2, Figure 2).

There was a moderate correlation between the proportion of knowledge-based questions answered correctly and a climate change curricular interest (Spearman’s $\rho = 0.21$, adjusted for program), along with a moderate correlation between residents who indicated they were affected by climate change and interest in a climate change curriculum (Spearman’s $\rho = 0.30$). Three correlated factors explained 59.2% of the program-adjusted variance among the data. The first factor included attitudes related to advocacy and the importance of action and accounted for 24.4% of the variance. The second factor linked together attitudes related to being directly affected by climate change and

explained an additional 20.1% of the variance. The third factor included attitudes regarding feeling knowledgeable about climate change and explained 14.7% of the variance. Higher scores on the advocacy and knowledge factors were statistically significantly positively associated with interest in a curriculum (Spearman’s $\rho = 0.48$, $P < .001$, and Spearman’s $\rho = 0.09$, $P = .03$, respectively).

Figure 2A and B illustrates resident preferences for types of training and specific interventions to include in climate change curricula, respectively. The most common types of preferred training included learning talking points about the health effects (particularly mental health effects) of climate change and the relationship between nature contact and health, and learning how to advocate for climate-friendly policies. With respect to specific interventions, resident preference included projects on reducing medical waste, efforts to improve hospital composting and recycling, and interventions incentivizing the use of alternative transportation (e.g., biking, public transit) for commuting to work.

Among all participating residents, 55 (8.3%) provided open-ended comments. Our qualitative analysis identified several themes; many related to areas identified by our factor analysis (see Table 3 for a subset of resident representative comments). A full list of all provided comments (including program director responses) is available in Supplemental Digital Appendix 2, at <http://links.lww.com/ACADMED/B515>. Several participants commented on the importance of waste and recycling programs, vegetarianism, and transportation concerns, all of which relate to attitudes on advocacy and the importance of action (the first factor identified). Similarly, many residents commented on the importance of climate change-related education for physicians and families, ideas that align with the third factor in our factor analysis (attitudes regarding feeling knowledgeable about climate change). A few residents wrote that climate change-related topics are either a poor use of time or an inappropriate topic to discuss in a primary care clinic in which other health maintenance concerns might take priority.

Among the 18 participating program directors, 14 (78%) identified as female and 16 (89%) as White. Program director cohort characteristics are illustrated in Supplemental Digital Appendix 3, at <http://links.lww.com/ACADMED/B515>. Supplemental Digital Appendix 4, at <http://links.lww.com/ACADMED/B515>, illustrates program director preferences for types of training, content, and specific interventions to include in a climate change curriculum. Only 3 (17%) felt very or moderately knowledgeable about the association between climate change and health impacts, while all but one indicated that climate change is relevant to direct patient care a moderate amount or a great deal. Fifteen (83%) agreed or strongly agreed that a climate change curriculum should be incorporated into their training program. Like residents, program directors were most interested in climate change curricula focusing on talking points about the health effects of climate change, as well as formal lectures, case presentations, and advocacy training for policies that address climate change. In terms of specific interventions, priority was given to projects targeting alternative transportation, reducing medical

Table 3
Exemplary Quotes From Residents, From a Multi-Institutional Study of Pediatric Residents' and Program Directors' Views of Climate Change and Health Curricula

| Factor identified or theme | Exemplary quote |
|---|--|
| Attitudes related to advocacy/importance of action | |
| Waste | <ul style="list-style-type: none"> I feel so strongly about this topic. Every time I throw out a mask/gown/other PPE after just one use I feel so guilty yet ultimately know that is warranted in many clinical scenarios to keep infection rates low. Yet there are many ways we CAN reduce waste and lessen our carbon footprint in hospitals ... being more mindful with use of medical supplies so as not to waste, etc. (Female, PGY-2) |
| Recycling | <ul style="list-style-type: none"> I think working on at least creating a recycling program at our residency and possibly the hospital network would be something simple to start with and could work on other climate change policies from this point. (Did not answer gender question, PGY-1) |
| Meat, vegetarianism, and agriculture | <ul style="list-style-type: none"> Vegetarian options should have variety day to day and should be as filling as other options. Also, a focus on locally supplied meat/food can have more impact than simply making everything vegetarian. (Male, PGY-2) |
| Transportation | <ul style="list-style-type: none"> It would be helpful if there was more space for parking bikes as a way to help encourage using alternative transportation. Granted this would require secure monitoring as theft would undo confidence in an initiative like this. (Male, PGY-2) Continuing virtual interviews would tremendously reduce climate impact. Fewer flights to programs all over the country across all pediatric residency programs add up. (Male, PGY-2) |
| Advocacy/Education for residents | <ul style="list-style-type: none"> I think residents should be more educated on the health effects of climate change and taught how to speak to legislators to influence legislation. (Female, PGY-1) |
| Attitudes feeling knowledgeable about climate change | |
| Education for families/physicians (not for advocacy) | <ul style="list-style-type: none"> I would like further training on the systems level causes of climate change. Biking and being vegetarian is great, but there are greater forces at play which I think if often ignored by medical education. (Female, PGY-1) It would be useful to create a bulleted list of talking points for providers at well child checks. They could be relevant for specific ages and to our location and could potentially be added to the list of things we give families, like the bright futures handouts. (Female, PGY-1) I think often families believe that there are other basic needs that need to be met before considering their environment, but developing ways of demonstrating how much this matters particularly for BIPOC families would be really important. (Female, PGY-2) |
| Other supportive comments | <ul style="list-style-type: none"> I think the first step includes acknowledging the problem and the effects that it has on ourselves and our patients. There are many small things that can easily be implemented that would effect change. (Female, PGY-3+) |
| What is working/being done | <ul style="list-style-type: none"> Our program has a vegetarian cafeteria as well as incentives to bike or carpool to work. We also recently held Veganuary for our residency program to encourage others to live a healthier lifestyle and decrease their carbon footprint which we invited all of the children's hospital to participate in. (Did not answer gender question, PGY-2) |
| Not an issue for clinics or hospital | <ul style="list-style-type: none"> This is not an appropriate topic for patient visits when most patients struggle to afford medications or childcare. This is a policy issue that requires international cooperation on fixing industrial and transport pollution by corporations and infrastructure. (Did not answer gender question, PGY-2) Unless there are climate change questions on the pediatric boards, then a climate change curriculum should not be implemented. (Male, PGY-3+) I think there is too much crammed into a categorical pediatric residency training for this to be added on top of everything. Perhaps someone could create a nationally available curriculum/rotation that could be an elective for residents with a personal interest in this topic. (Did not answer gender question, PGY-2) |

Abbreviations: PPE, personal protective equipment; PGY, postgraduate year; BIPOC, Black, Indigenous, or people of color.

waste, and providing more vegetarian and vegan options.

Discussion

This study of more than 650 pediatric residents and their program directors from 18 U.S. pediatric residency training programs found that the large majority believe a climate change curriculum should be included in residency training. Nevertheless, only one-third of residents were aware of existing educational

activities on climate change and health in their program, and only one-sixth of program directors felt knowledgeable about the health impacts of climate change. These results indicate a persistent gap in implementing the 15-year-old recommendation to include climate change curricula in pediatric training posited by the AAP in 2007, echoed across professional societies and medical education in recent years.^{13,15,25} Despite the lack of climate and health education occurring in pediatric training programs to date, our

findings indicate future pediatricians and the leaders who train them generally embraced the AAP's call to action.

Our findings indicate that, when compared to White residents, a statistically higher proportion of Asian residents and a higher (though not statistically significant) proportion of other residents of color expressed interest in a climate change curricula. While these findings did not reach statistical significance across all minority groups,

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that residents of color may have higher interest in these curricula may reflect the inequitable effects of climate change on health in communities of color.²⁶

While most residents responded that pediatricians should discuss climate change and its health effects with patients, only about 1 in 5 felt comfortable leading such discussions. Given this incongruity, residents were most interested in education applicable to clinical encounters. This finding mirrors existing studies on medical student preferences for climate and health education,^{18,27} and suggests residents' readiness to embrace the role of physicians as trusted climate and health communicators often cited in the literature.^{28–30}

Talking points on the health benefits of nature contact (i.e., the health benefits of exposure to the natural world, including parks, wilderness, and other green spaces) ranked second among resident content preferences. A recent systematic review supports a positive relationship between nature contact and children's health,³¹ yet pediatricians lack resources and guidance on how to encourage time in, and access to, nature-rich environments.³² This topic relates to broader movements in planetary health education and the bio-psycho-social-ecological framework for medicine,^{33–35} underscoring a desire for attention to preventive medicine that is often underemphasized in busy clinical services. An approach to pediatric care that is "climate-informed" recognizes the power of individual actions (e.g., routine health promotion to promote healthy diet and physical activity)^{36,37} that both mitigate climate change and improve child health.³⁸ Educators can leverage this guidance to inform pediatric training resources that efficiently integrate climate change and health into existing clinical training and practice.

Third among resident-identified preferences for climate and health content was advocacy. While climate counseling in exam rooms can support patient health, broader societal change is crucial to safeguarding child health in the climate crisis.¹³ The 2019 Lancet Countdown notes, "It will take the work of the 7.5 billion people currently alive to ensure that the health of a child born today is not defined by a changing climate."³⁹ In our study, many residents indicated interested in advocating for

institutional change in their health care system, while others suggested a preference for advocacy in local and federal climate policy decisions. To support the former, educators have an opportunity to synergize residents' interests in environmental sustainability with quality improvement initiatives required during residency training.⁴⁰ To reach the latter, educators can enhance advocacy curricula, an Accreditation Council for Graduate Medical Education (ACGME) requirement,⁴¹ with climate-related topics.

In their qualitative responses, a handful of pediatric residents indicated that counseling on the health effects of climate change in clinical encounters is a poor use of time given more pressing issues (e.g., assessing developmental milestones, asking about healthy eating), or that solutions are best found at the population level (regional/national policies) rather than the individual level. That our study found a statistically significant (though moderate) correlation between pre-existing knowledge about climate change and health and interest in a climate change curriculum suggests that residents who do not see the value in climate and health counseling are least familiar with the health implications of climate change for their patients. Educational interventions that address lack of knowledge around climate change and child health may be an important first step in assuring skeptical trainees about the clinical relevance of the content. Future studies with pre- and posteducational intervention assessments of knowledge and attitudes could help evaluate this hypothesis.

Finally, in our study, residents overwhelmingly acknowledged ($n = 653$, $> 99\%$ of residents) that climate change is occurring, with 443 (65%) indicating that they had been directly affected by climate change. As medical students are increasingly learning about and driving the creation of curricula around climate change and health in medical schools (and earlier),⁴² program directors and educators will need to adjust content to an evolving baseline level of knowledge for future residents. Our findings support that residents are invested partners in cocreating and directing climate change and health curricula, and their insights and initiative can continue to inform design of materials.^{43,44} Many tools and content resources exist to support

residency educators in integrating climate and health topics into existing content for pediatric trainees. These tools include frameworks for climate and health education linked to ACGME requirements,¹⁴ repositories of materials that can be adapted to local (geographical/topical) needs,⁴⁵ and updated content or chapters of widely used pediatric training tools.⁴⁶

To the best of our knowledge, this multi-institution study is the first to assess pediatric trainee and program director knowledge and attitudes about climate change and climate change curricula in U.S. residency training. Nevertheless, this study has important limitations. Survey inclusion depended upon program directors' willingness to participate. Program directors more familiar with or interested in this topic may be more willing to join the study, which might be contributing to the overall low participation rate among all APPD LEARN-affiliated programs. Additionally, APPD LEARN programs (compared to nonaffiliated programs) are more likely to be large and academic, which might affect the study's generalizability. The APPD LEARN participating programs had a larger number of residents compared to APPD LEARN nonparticipating programs, which might also affect study generalizability. This study was United States based and thus might not reflect trainee or program director views in other countries. Pediatric trainee motivation to participate may have been driven by strong climate change opinions (in either direction), introducing the potential for selection bias and limiting the generalizability of our findings. Among our study's strengths are its diverse representation in geographic location, program size, and the total response rate of over 40% of eligible pediatric residents. Free response data yielded additional perspectives to help interpret quantitative results.

In conclusion, this study found nearly unanimous agreement among both pediatric residents and program directors that climate change is occurring, yet a great majority of residents and program directors indicated a lack of comfort in discussing climate-related topics and poor awareness of links to climate issues and pediatric health. Opportunities exist within pediatric residency programs for the implementation of climate change curricula that (1) emphasize training on

the health effects (including mental health-related effects) of climate change and (2) sponsor targeted interventions aimed at reducing climate change–related effects, including projects to reduce medical waste and increase composting and recycling. In addition to climate change curricular interventions for pediatric trainees, strategies prioritizing the inclusion of climate change–related content into more structured training for all physicians—such as developing board questions or continuing medical education efforts that focus on climate change—⁴⁸ are needed. AMEE⁴⁷ and other study groups⁴⁸ have published best practice recommendation for educating the healthcare workforce to deliver sustainable healthcare and promote planetary health, and undoubtedly, pediatricians and other physicians—⁴⁸ as scientists, educators, advocates, and clinicians—are crucial participants in the global climate crisis response.

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