Appendix D: Supplemental Information for Analyses in the Changing Seasons Chapter

This appendix describes methods, data sources, and assumptions for the changing seasons analyses presented in Chapter 5 of the main report. First is the information for the detailed analysis of pollen exposure and children's health. Second is information required for the discussion of emerging literature related to the impacts of changing seasonality on several forms of outdoor recreation.

Detailed Analysis of Pollen and Children's Health

This section includes analytic details of the pollen and children's health analysis: a summary of studies used in the analysis, analysis steps, detailed results, and limitations of the approach.

SUMMARY OF STUDIES USED IN THIS ANALYSIS

NEUMANN ET AL. (2019)[1]

Neumann et al. studied the association between emergency department (ED) visits associated with asthma, pollen exposure, and climate change in the United States (U.S.). The authors examined season-length pollen counts from 1994 to 2010, and then forecasted changes in pollen season length using established relationships between temperature, precipitation, growing degree days, and pollen for several sources from Zhang et al.[2], including oak, birch, and grass. Using the change in pollen season length and epidemiological functions from Iko et al.[3], the authors project future ED visits from asthma that are attributable to increased pollen exposure.

Under a high emissions scenario (RCP8.5) and across all three pollen types, changes in pollen season duration associated with climate change result in an additional 3,700 ED visits per year in 2030 (6% increase, 95% CI 1,200 to 6,800) to over 10,000 additional ED visits per year in 2090 (95% CI 4,000 to 20,000). Under a lower emission scenario (RCP4.5), the case numbers are roughly comparable in 2030, but approach only 6,100 ED visits per year by 2090 (95% CI 2,200 to 11,000). Children make up a majority of the cases, both now and in the future, for oak and birch pollen exposure specifically.

SAHA ET AL. (2021)[4]

Saha et al. investigated less severe and more commonly occurring outcomes associated with a broader set of pollen exposure sources; specifically, physician visits and prescriptions filled to treat allergy symptoms. Using a daily pollen data from 28 metropolitan statistical areas (MSAs) in the United States (U.S.) and health insurance claims data covering approximately 40 million Americans, the authors calculated location-specific relative risk (RR) between three pollen concentrations (tree, grass, and weeds) from within a given day, and two allergy outcomes (allergic rhinitis physician visits and prescriptions filled for allergies). The authors found varied relationships across MSAs. Overall, the RR of allergic rhinitis visits increased as concentrations increased for all pollen types, while the RR of prescriptions filled for allergies increased for tree and weed pollen only. The authors of Saha et al. do not report results specifically for children but include children in their overall assessment.

ANALYSIS STEPS

Chapter 5 of this report examines the effects of pollen exposures linked to climate change on children's health. It relies on estimates of ED visits related to asthma from Neumann et al. specific to children and presents the results in an impacts-by-degree format. Then, given findings from Saha et al., projections are provided for how increases in pollen season length may affect asthma-related physicians visits and prescriptions filled for allergies for children.

While this analysis does not forecast changes in the number of days at each level of pollen concentration—the environmental variable used in Saha et al.—it is assumed that pollen season length and pollen concentrations are well-correlated, as suggested by Zhang and Steiner.[5] More importantly, this analysis assumes that less severe physician visits and prescriptions filled for allergies are well-correlated with more severe health outcomes, as reflected by the ED visits for asthma. Relating the findings from Saha et al. and Neumann et al. also assumes that the pollen types explored in each analysis are relatively comparable. Table 1 details the analytic steps, data sources, and assumptions used to project these health effects on children resulting from increasing pollen exposure due to climate change.

This analysis considers all of the contiguous U.S. and is performed at the county level, but results are also interpreted at the census tract level (with identical incidence rates for all tracts within a county) for the social vulnerability analysis.

Table 1: Analytic Steps in Climate Change Impacts on Pollen Exposure and Children's Health Analysis

Step		Data	Methods, Assumptions, and Notes
Baseline Risks	1. Identify baseline incidence of health and well-being impacts under baseline pollen exposure and population	**Asthma-related ED visits:** County-level incidence obtained from BenMAP and derived from the Health Care Utilization Project's (HCUP) Nationwide Emergency Department Sample Database and State Emergency Department Database **Physicians visits and prescriptions filled:** based on information presented in Saha et al.	**Asthma-related ED visits:** As described in Neumann et al. Table S-4, the baseline annual number of ED visits is 34,110 across CONUS. **Physicians visits and prescriptions filled:** Because Saha et al. does not provide a baseline estimate for all children in CONUS, the analysis estimates this number using the following method: 1. Calculate the total annual prescription fills and first- time physician visits due to allergic rhinitis incidence among children across the 28 MSAs in Table ST3 of Saha et al. 2. The MarketScan data used in the study covers 40 million Americans of all ages, which is about 13.1% of the total population of the contiguous U.S. in 2010. The totals from Step 1 are divided by 13.1% to "inflate" to CONUS numbers. Table 2 presents the process and findings.
Future Climate Stressor	2. Calculate future season length by pollen source (oak, birch, grass) as a function of temperature, precipitation, and growing degree days	**Future climate:** LOCA future climate data at the census tract-level **Environmental function:** Neumann et al. (2019) use the relationships between climate variables and pollen season lengths from Zhang et al. (2015)	This analysis relies on the analysis completed in Neumann et al. Changes in pollen season length are adjusted for future climate using reduced form relationships found in Zhang et al. (2015). See both papers for details.
Future Effects on Children	3. Estimate the incidence of health impacts among children associated with each degree-C increase in global mean temperatures	Health impact functions are derived from Neumann et al. (2019), who use multiple pollen-specific model relationships between asthma ED visits and pollen exposure. See paper for details. See Chapter 2 of the main report and Appendix A for details on population methods and data sources used throughout the analysis.	**Asthma-related ED visits:** This assessment relies on the analysis completed in Neumann et al. (2019). See that paper for details. **Physicians visits and prescriptions filled:** Using findings related to ED visits from, the analysis estimates the percent increases between each degree of global warming and baseline. Then, those percent increases are applied to the baseline number of prescriptions filled and physician's visits estimated in Step 1 above to calculate the future effects on children.

BASELINE HEALTH EFFECTS

Table 2 below provides details on the implementation of Step 1 in our analytic steps described in Table 1. Specifically, it demonstrates how the baseline annual number of prescriptions filled for allergies and allergic-rhinitis first doctor visits were calculated using information from Saha et al. and other data sources.

Table 2: Construction of Baseline Health Impacts for Children (Aged 0-17) in the Contiguous U.S.

Location (MSA)	Prescriptions Filled for Allergies[1]	Allergic Rhinitis - First Doctor Visit[1]	2010 Population[2]
Atlanta, GA	136,002	38,607	1,393,056
Austin, TX	48,698	14,621	440,327
Baltimore, MD	25,008	12,415	624,701
Chicago, IL	105,013	31,977	2,365,597
College Station, TX	5,952	1,432	56,017
Colorado Springs, CO	4,392	2,646	167,915
Dayton, OH	8,222	5,381	185,051
Erie, PA	3,167	1,634	65,219
Eugene, OR	1,476	656	72,608
Houston, TX	79,114	23,353	1,646,476
Kansas City, MO	29,828	5,014	509,943
Louisville, KY	25,822	12,541	293,076
Madison, WI	2,059	301	136,316
Minneapolis, MN	14,532	2,682	831,800
Oklahoma City, OK	29,150	10,834	194,128
Omaha, NE	7,288	1,691	315,893
Rochester, NY	4,564	1,384	226,647
Saint Louis, MO	51,267	16,404	247,418
Salt Lake City, UT	4,381	2,825	662,309
San Antonio, TX	30,504	12,821	319,968
San Jose, CA	21,145	5,494	27,479
Seattle, WA	23,706	5,008	444,536

Location (MSA)	Prescriptions Filled for Allergies[1]	Allergic Rhinitis - First Doctor Visit[1]	2010 Population[2]
Springfield, MO	2,502	494	785,623
Tulsa, OK	18,572	7,384	103,282
Waco, TX	8,306	6,471	238,805
Washington, DC	45,451	25,122	65,637
Waterbury, CT	7,250	3,525	1,340,278
York, PA	4,037	3,488	101,385
Total in sample (2008-2015)	**747,408**	**256,205**	**13,861,491**
Annual in sample[3]	**93,426**	**32,026**	
Annual CONUS[4]	**714,709**	**244,996**	

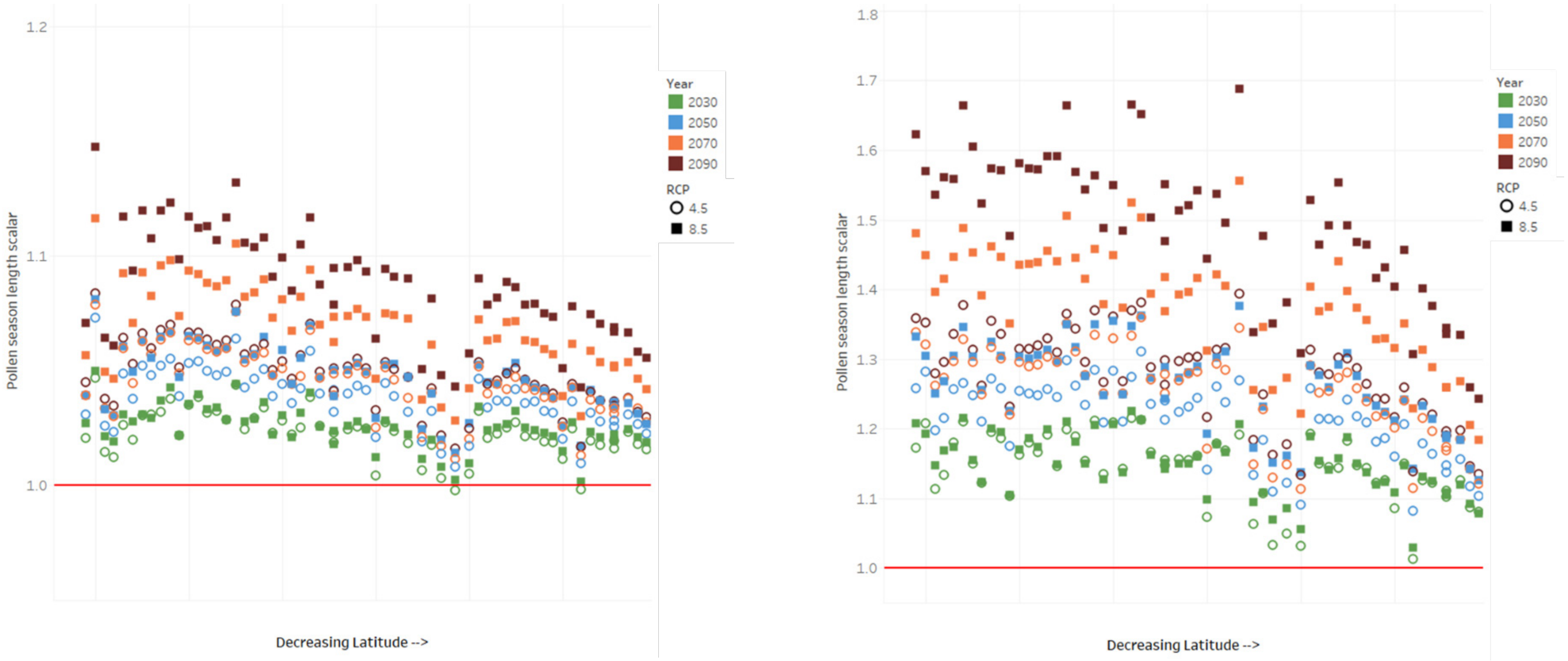
Sources and notes:

1. *From Table ST3 of Saha et al. supplemental materials.*
2. *2010 U.S. Census data.*
3. *Saha et al. MarketScan data covers 8 years (2008-2015).*
4. *Saha et al. MarketScan data covers 40 million individuals of all ages per year, which is 13.1% of individuals in the contiguous U.S. based on 2010 population. In the analysis, the sample is scaled to a CONUS number using this percentage. Saha et al. does not document the portion of individuals in their dataset that are children, so the analysis inflates based on a multiplier that considers all ages.*

FUTURE LENGTH OF POLLEN SEASON

Figure 1 presents how birch and grass pollen season lengths are expected to increase throughout the 21st century. As shown, , the pollen season length scalar, indexed to baseline season length, increases between 2030 and 2090 (see color legend) at all included pollen monitor sites across a broad range of latitudes (with higher, more northern latitudes to the left). Similarly, the lengths are greater under a higher emission scenario (RCP8.5, filled boxes) than the lower emission scenario (RCP4.5, open circles).

Figure 1: Estimates of Change in Pollen Season Length by Monitor Location for Birch (Left) and Grass (Right)



***Source:** Neumann et al. (2019), reprinted with permission of the author. **Notes:** Pollen monitors along x-axis are arranged by decreasing latitude, indicating that effects on season length are more pronounced in the north (left side of graphic). Estimates are averaged across five climate models, for each era and RCP assessed. The y-axis represents pollen season length scalar, with baseline (current climate) season length equal to 1.*

EFFECTS ON CHILDREN RESULTS

Table 3 describes the results of the analyses assuming population growth (see Chapter 2 and Appendix A). The analysis estimates additional health impacts attributable to climate change relative to the baseline period and sums the impacts across the three pollen sources (oak, birch, grass). Table 4 provides the same estimates but assumes population remains constant at 2010 levels, isolating the influence of climate change specifically. With population growth (Table 3), the increase in annual ED visits relative to baseline levels applied to the other two health impacts were 7%, 17%, 24%, and 30% at 1°C, 2°C, 3°C, and 4°C of global warming, respectively. For the analysis that holds population constant at 2010 levels (Table 4), the analogous increases were 6%, 14%, 19%, and 23% at 1°C, 2°C, 3°C, and 4°C of global warming, respectively.

Table 3: Projected Annual Risks to Children's Health Associated with Future Exposure to Oak, Birch, and Grass Pollens (with Population Growth)

Degree of Global Warming (°C)	(1) ED Visits for Asthma	(2) Allergic Rhinitis First Doctor Visit	(3) Prescriptions Filled for Allergies
1°C	2,380 *(1,920 to 2,730)*	17,100 *(13,800 to 19,600)*	49,800 *(40,200 to 57,200)*
2°C	5,760 *(4,800 to 7,990)*	41,400 *(34,500 to 57,400)*	121,000 *(101,000 to 167,000)*
3°C	8,130 *(6,950 to 10,600)*	58,400 *(49,900 to 76,100)*	170,000 *(146,000 to 222,000)*
4°C	10,100 *(9,460 to 10,700)*	72,300 *(68,000 to 76,700)*	211,000 *(198,000 to 224,000)*

Notes: All estimates presented in the table are incremental relative to baseline risk: (1) 34,100 ED visits, (2) 256,000 physicians visits, and (3) 747,000 prescriptions filled for allergies. Tables 1 and 2 of this appendix provide further details on baseline calculations. Data from Neumann et al. do not support extrapolation to 5°C. The table displays the average and range across climate models.

Table 4: Projected Annual Risks to Children's Health Associated with Future Exposure to Oak, Birch, and Grass Pollens (2010 Population)

Degree of Global Warming (°C)	(1) ED Visits for Asthma	(2) Allergic Rhinitis First Doctor Visit	(3) Prescriptions Filled for Allergies
1°C	2,170 *(1,750 to 2,490)*	15,600 *(12,600 to 17,900)*	45,500 *(36,600 to 52,200)*
2°C	4,830 *(4,160 to 6,600)*	34,700 *(29,900 to 47,400)*	101,000 *(87,200 to 138,000)*
3°C	6,540 *(5,520 to 8,390)*	47,000 *(39,700 to 60,300)*	137,000 *(116,000 to 176,000)*
4°C	7,900 *(7,430 to 8,380)*	56,800 *(53,300 to 60,200)*	166,000 *(156,000 to 176,000)*

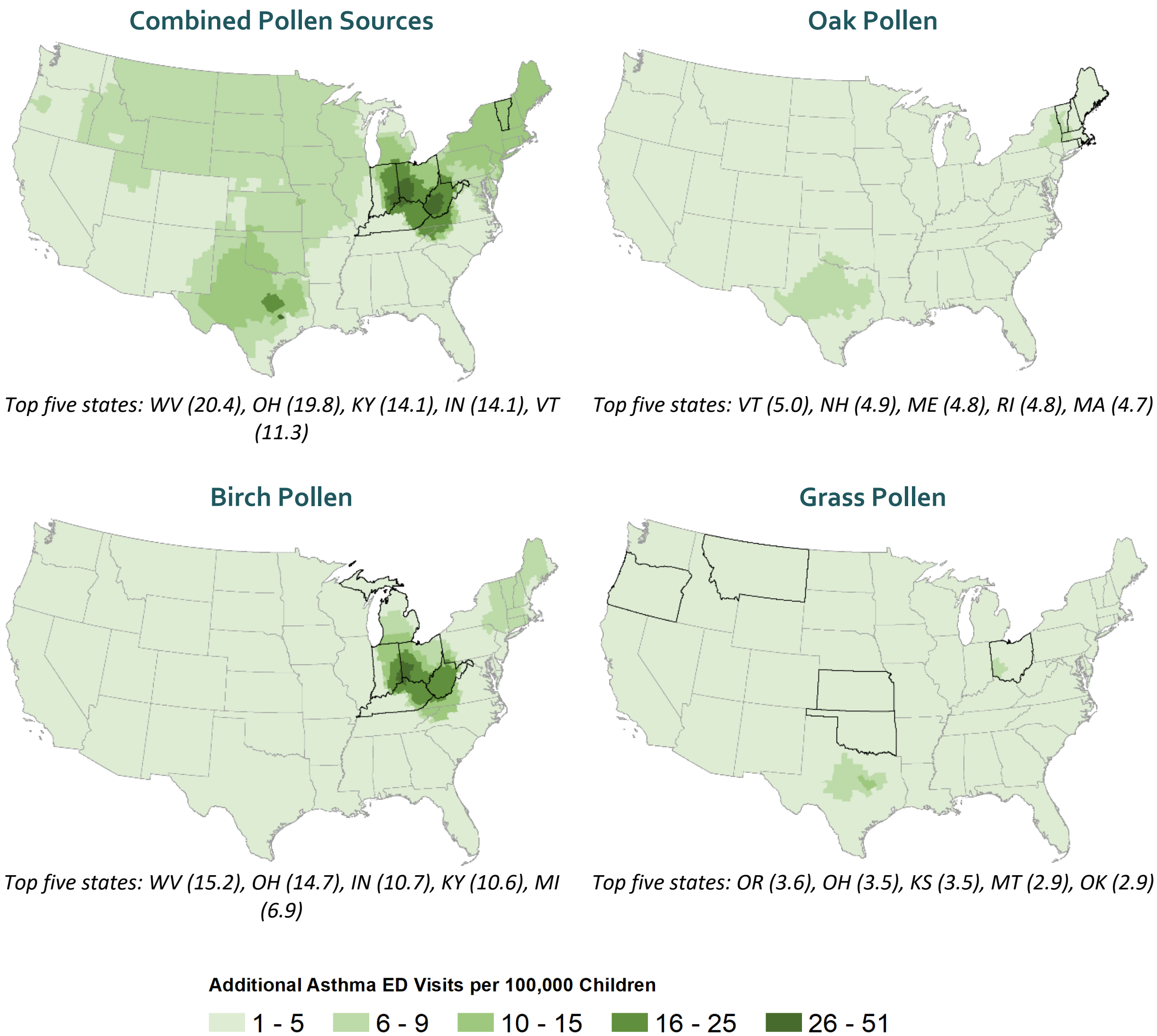
Notes: See Table 3.

Figures 2 and 3 shows the change in ED visits for asthma per 100,000 children aged 0-17 at 2°C and 4°C of global warming at the county level. For each figure, one panel shows the combined impacts across pollen sources, which are subsequently split out by source. The five states with largest impacts per 100,000 children are outlined in black for each pollen source and listed below each map.

Table s5 and 6 then follow with the average number of ED visits for asthma per 100,000 children for each state at 2°C and 4°C of global warming specifically to provide perspective on the range of impacts across states, although there can be considerable heterogeneity within states (see Figure 2 and Figure 3).

Figure 4 shows the change in total ED visits for asthma among children aged 0-17 at 2°C and 4°C of global warming at the county level. Impacts are generally highest in areas with large children's populations. The five states with largest total impacts are outlined in black and listed below each map. The relevant quantities or rates presented in each figure are provided in parentheses after the state name in the lists of top 5 states.

Figure 2: Estimated Changes in Annual ED Visits for Asthma Per 100,000 Children (Aged 0-17) at 2°C Global Warming (with Population Growth)



Note: These maps describe the projected change in new ED visits for asthma linked with climate-induced pollen exposure per 100,000 children at 2°C of global warming relative to the baseline (1986-2005). Darker shading conveys larger increases while lighter shading conveys small increases. The five states with the largest increases on average are outlined in black. The map at the top left provides impacts across all three included pollen sources; subsequent maps show the contributions of individual pollen sources.

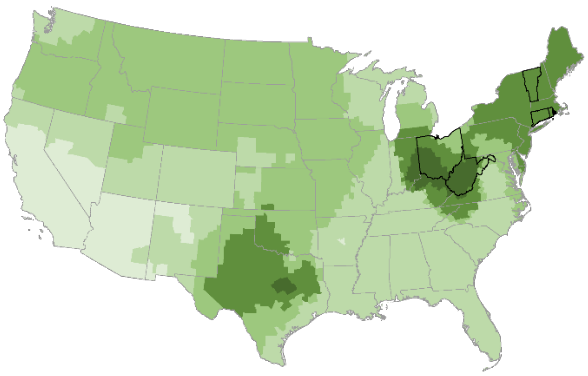
Table 5: Estimated Annual ED Visits for Asthma Per 100,000 Children by State with 2°C Global Warming (with Population Growth)

State	Incidence Per 100,000 Children	State	Incidence Per 100,000 Children
West Virginia	20.4	North Dakota	6.1
Ohio	19.8	Washington, DC	6.0
Kentucky	14.1	Utah	5.9
Indiana	14.1	Montana	5.9
Vermont	11.3	Wyoming	5.6
New Hampshire	11.0	Illinois	5.5
Maine	11.0	Wisconsin	5.4
Rhode Island	10.9	Tennessee	5.3
Connecticut	10.7	Idaho	5.3
Massachusetts	10.6	North Carolina	5.1
New York	10.0	Oregon	4.2
Pennsylvania	9.9	Arkansas	4.1
Michigan	9.8	Colorado	3.8
New Jersey	9.2	South Carolina	3.6
Delaware	8.8	Florida	3.4
Oklahoma	8.1	Louisiana	3.3
Kansas	7.9	New Mexico	3.3
Iowa	7.4	Washington	3.1
Maryland	7.2	Georgia	2.9
Texas	7.2	Mississippi	2.8
Virginia	6.8	Alabama	2.6
Missouri	6.7	Arizona	2.2
Minnesota	6.6	Nevada	1.7
South Dakota	6.3	California	0.9
Nebraska	6.2		

Notes: This table describes the projected new ED visits for asthma linked with climate-induced pollen exposure per 100,000 children at 2°C of global warming using the methods described in Table 1 averaged to the state level. States are listed from largest to smallest impacts.

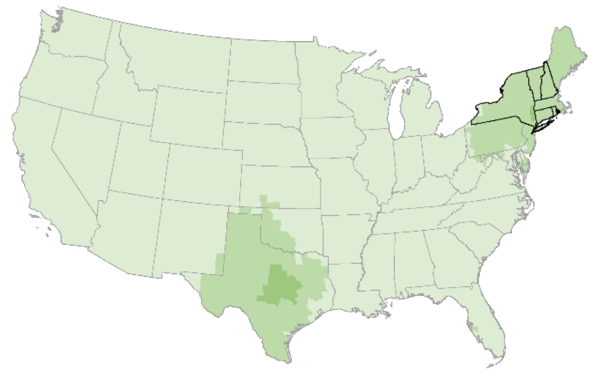
Figure 3: Estimated Changes in Annual ED Visits for Asthma Per 100,000 Children (Aged 0-17) at 4°C Global Warming (with Population Growth)

Combined Pollen Sources



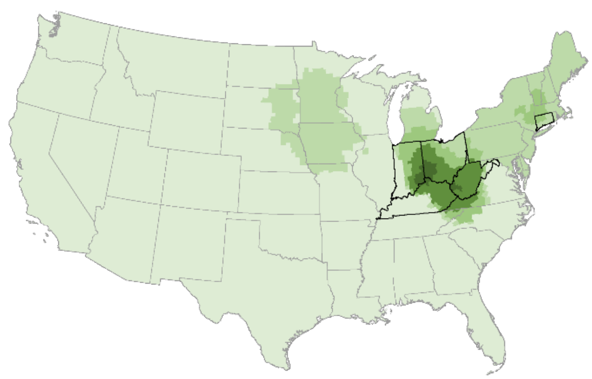
Top five states: WV (25.4), OH (23.7), CT (18.3), RI (18.2), VT (18.1)

Oak Pollen



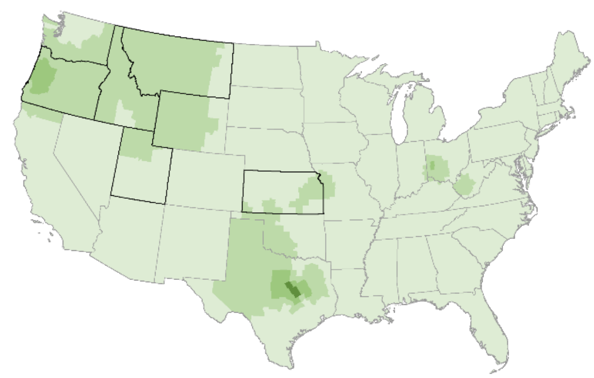
Top five states: CT (8.2), RI (8.0), NY (7.9), VT (7.6), NH (7.5)

Birch Pollen

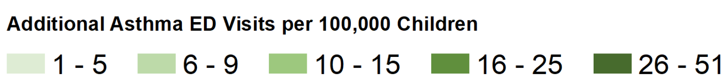


Top five states: WV (17.2), OH (16.4), IN (12.2), KY (11.8), CT (8.8)

Grass Pollen



Top five states: OR (8.7), MT (5.7), ID (5.6), UT (5.3), KS (5.2)



Note: These maps describe the projected change in new ED visits for asthma linked with climate-induced pollen exposure per 100,000 children at 4°C of global warming relative to the baseline (1986-2005). Darker shading conveys larger increases while lighter shading conveys small increases. The five states with the largest increases on average are outlined in black. The map at the top left provides impacts across all three included pollen sources; subsequent maps show the contributions of individual pollen sources.

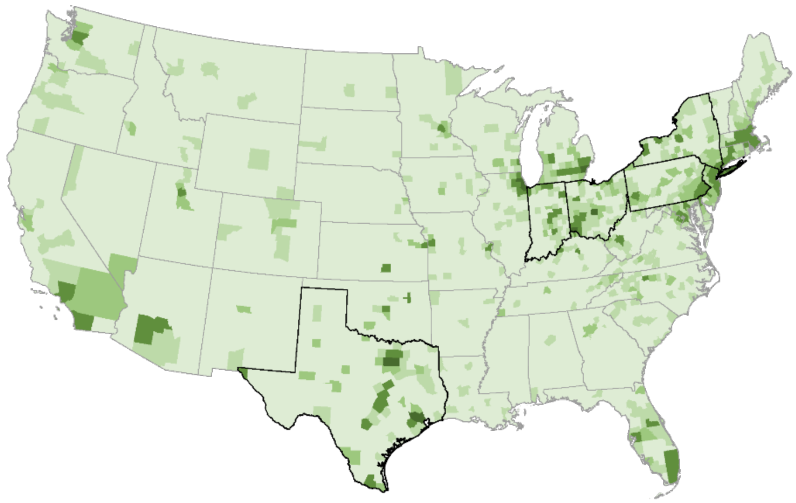
Table 6: Estimated Annual ED Visits for Asthma Per 100,000 Children by State with 4°C Global Warming (with Population Growth)

State	Incidence Per 100,000 Children	State	Incidence Per 100,000 Children
West Virginia	25.4	Minnesota	10.3
Ohio	23.7	North Dakota	10.3
Connecticut	18.3	South Dakota	10.3
Rhode Island	18.2	Wyoming	9.9
Vermont	18.1	Utah	9.8
New York	17.8	Idaho	9.7
Maine	17.6	Nebraska	9.4
New Hampshire	17.6	North Carolina	9.3
Indiana	17.4	Tennessee	9.1
Kentucky	17.3	Illinois	8.9
Massachusetts	17.2	Wisconsin	8.5
New Jersey	16.9	South Carolina	8.3
Pennsylvania	16.0	Florida	7.7
Delaware	15.6	Washington	7.7
Michigan	13.1	Georgia	7.6
Oklahoma	12.4	Arkansas	7.0
Maryland	12.2	Colorado	7.0
Kansas	11.9	Louisiana	6.7
Texas	11.9	Alabama	6.5
Iowa	11.2	Mississippi	6.4
Oregon	11.0	New Mexico	5.7
Montana	10.9	Arizona	3.6
Virginia	10.9	Nevada	3.1
Missouri	10.4	California	2.1
Washington, DC	10.3		

Notes: This table describes the projected new ED visits for asthma linked with climate-induced pollen exposure per 100,000 children at 4°C of global warming using the methods described in Table 1 averaged to the state level. States are listed from largest to smallest impacts.

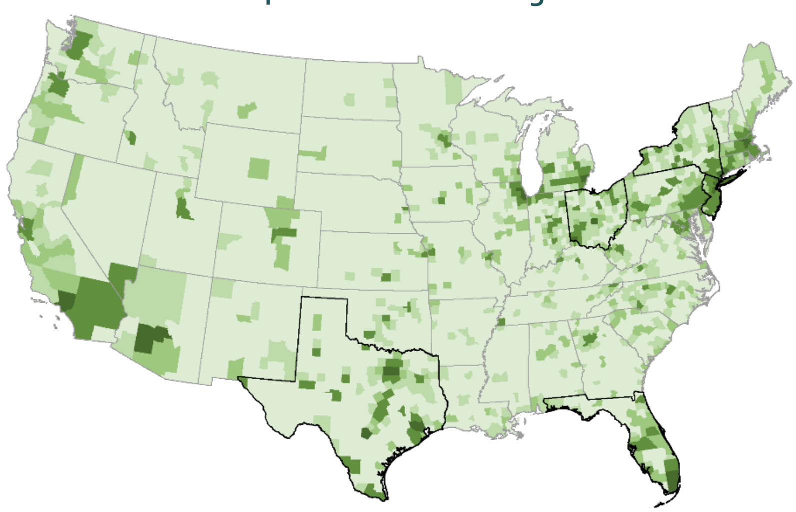
Figure 4: Estimated Changes in Total Annual ED Visits for Asthma Among Children (Aged 0-17) (with Population Growth)

2°C of Global Warming



Top five states: TX (694), NY (578), OH (535), PA (286), IN (278)

4°C of Global Warming



Top five states: TX (1,270), NY (1,110), OH (631), NJ (550), FL (477)

Additional Asthma ED Visits

0 - 2 | 3 - 5 | 6 - 10 | 11 - 50 | 51 - 155

Note: These maps describe projected total change in ED visits for asthma linked with climate-induced pollen exposure at 2°C and 4°C of global warming relative to baseline (1986-2005). The five states with the highest impacts are outlined in black. See Table 1 for analytic details.

Figures 5 and 6 describe the results of the social vulnerability analysis at 2°C and 4°C of global warming, respectively (see Chapter 2 and Appendix A for methods, data sources, and assumptions). Within each figure, the results are presented separately for each pollen source and then combined. Figure 7 includes results by racial and ethnic group for oak pollen and combined pollen specifically. The estimated risks for each socially vulnerable group are presented relative to each group's reference population, defined as all individuals other than those in the group analyzed. Positive numbers indicate the group is disproportionately affected by the referenced impact. Negative numbers indicate the group is less likely to live in the areas with the highest projected impacts.

Figure 5: Social Vulnerability Analysis Results for Pollen and ED Visits for Asthma Among Children at 2°C Global Warming

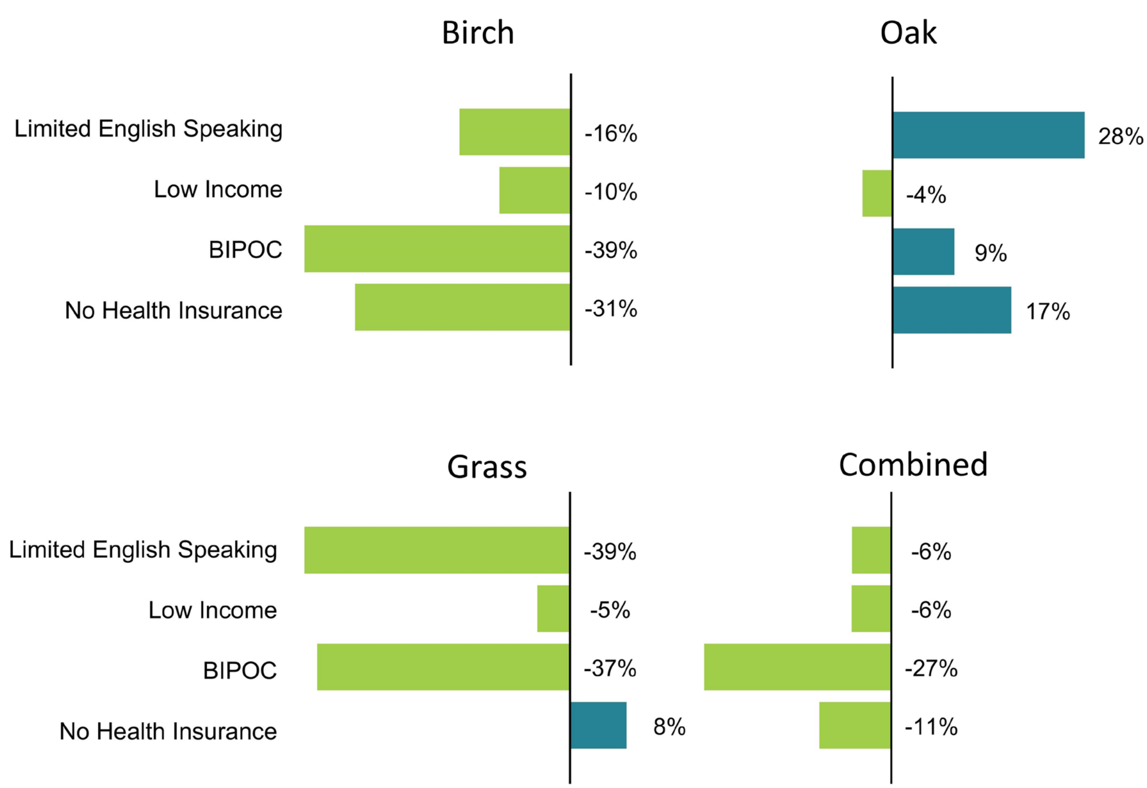


Figure 6: Social Vulnerability Analysis Results for Pollen and ED Visits for Asthma Among Children at 4°C Global Warming

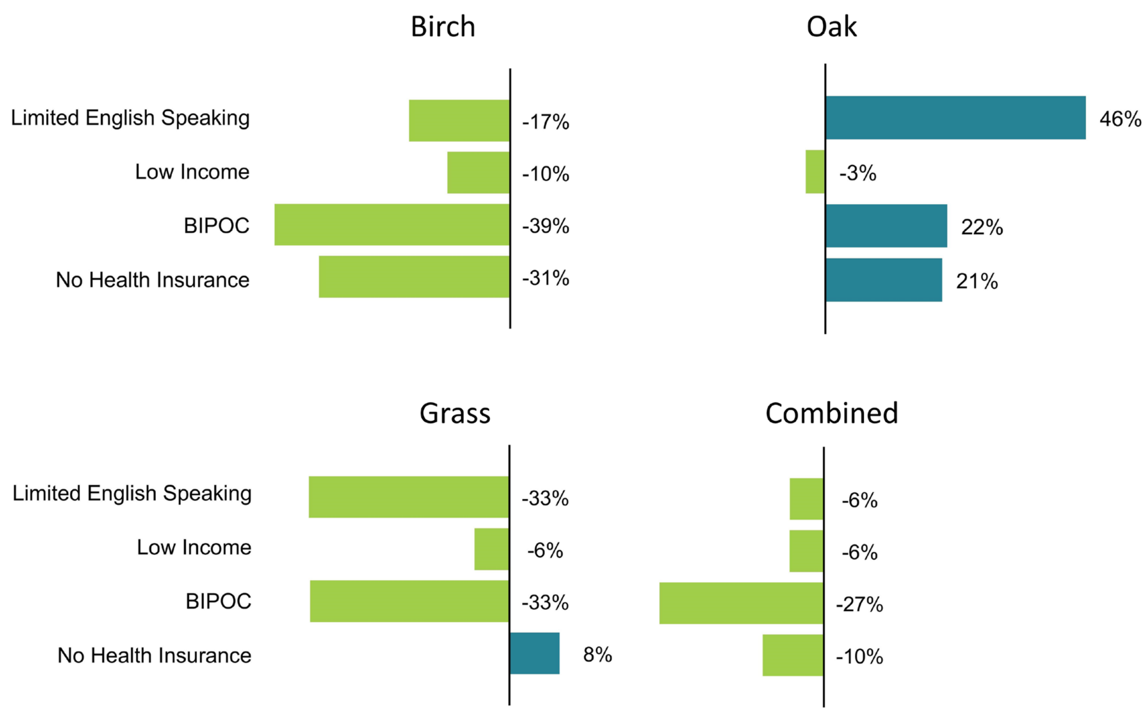
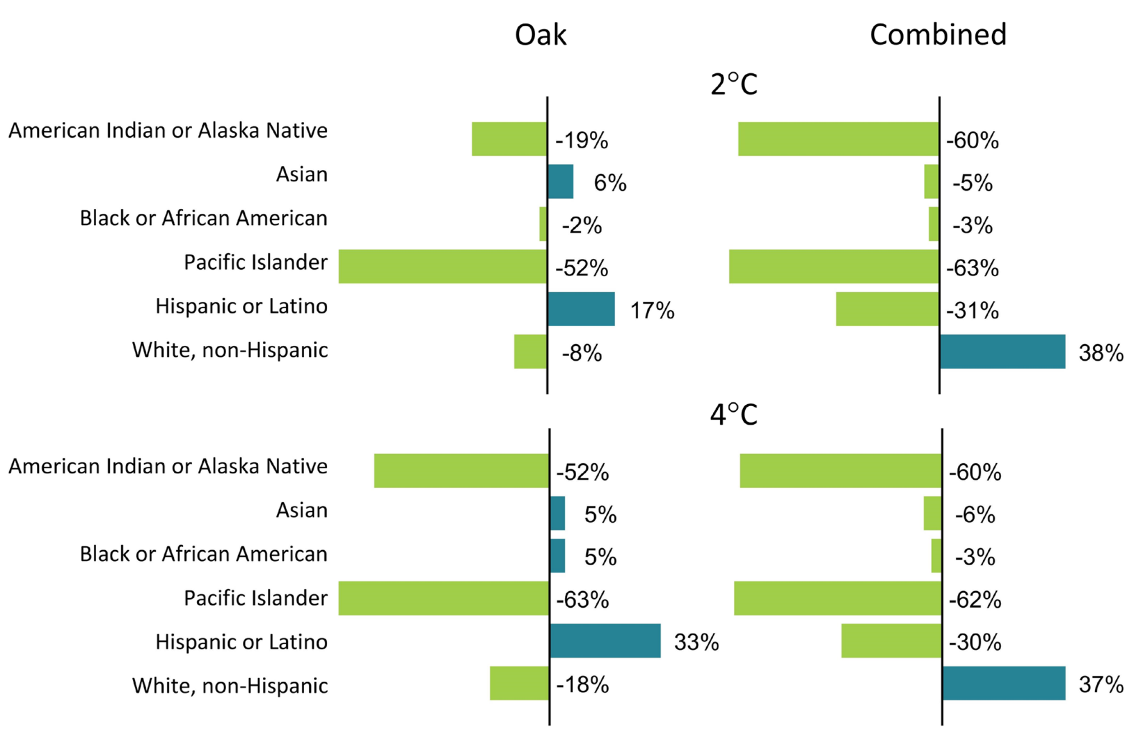


Figure 7: Social Vulnerability Analysis Results by Racial and Ethnic Minority Group Results for Pollen and ED Visits for Asthma Among Children



LIMITATIONS

Below are some of the limitations of this analysis:

1. ***Using the Neumann et al. ED visit projections as a basis for predicting the number of future doctor visits for allergic rhinitis and prescriptions filled for allergies.*** This analysis describes several major assumptions in the "Analysis Steps" section of this appendix that are made in order to apply the results of the Saha et al. paper results. Ragweed exposure is considered within the scope of the Saha et al. paper, along with tree and grass pollen more broadly, but is excluded from the scope of the Neumann et al. paper. The functions for change in season length associated with climate factors in Zhang et al. for ragweed appear similar in structure to those estimated for birch, which provides some support for the scaling approach used in this analysis (i.e., applying the Neumann et al. ED-visit metric to the Saha et al. physician visit and prescriptions filled metrics). The Zhang et al. functions show greater sensitivity to temperature, suggesting that the impacts of climate change on ragweed season length and pollen concentration might be more extreme for ragweed-driven health impacts than estimated for trees and grasses. Therefore, the impact of ragweed pollen changes on the Saha et al. health outcome metrics could grow faster than is estimated by the approach used in this analysis.
2. ***Limited health effect scope***. Inclusion of the results of the Saha et al. paper, while limited by available data, is responsive to the limitation noted in Neumann et al. that the focus on asthma-related ED visits as the sole measure of health endpoints in that study. Existing epidemiologic literature in Canada, the Netherlands, and elsewhere suggests that aeroallergen exposure may also be linked to cardiovascular disease, allergen sensitization, and allergic rhinitis[6,7,8] as well as lost school or workdays and lower overall productivity. Therefore, this report likely underestimates the full impact of climate change on pollen and on increased exposure to aeroallergens on human health.
3. ***Estimation of baseline number of future doctor visits allergic rhinitis and prescriptions filled for allergies.*** This analysis starts with a sample of future doctor visits for allergic rhinitis and prescriptions filled for allergies presented in a table in Saha et al. then applies multipliers to estimate potential baseline numbers. The approach assumes doctor visits and prescriptions filled in the non-represented MSAs occur at the same rate as represented MSAs. It is unknown how this assumption affects the analysis.
4. ***Results of this analysis are available at the county level as the finest spatial scale.*** The BenMAP analysis was run using county-level baseline incidence and population data, which limits the geographic level to which health impacts associated with pollutant changes can be specified. Therefore, results may underrepresent the spatial precision of the 36-km grid air quality surfaces.
5. ***This analysis does not capture fine-scale health effects of populations that may be at greater risk of exposure or disproportionate impacts, including racial and ethnic minorities, low income individuals, the unhoused, and children with other types of comorbidities.*** This analysis estimates health effects at the county-level using 50-km square pollen concentrations and

may not capture localized health effects experienced by fenceline and near-road children, who are likely disproportionately vulnerable.

6. ***Reliance on pollen season length as metric for aeroallergen exposure is a limitation of the underlying study.*** A key assumption in Neumann et al. is the reliance on pollen season length as the best metric of the effect of climate change on pollen exposure. Implicitly, there is an assumption that the average daily pollen concentration remains the same, which is reasonable based on current information. Nonetheless, further research is needed to better understand the effect of climate change on the full temporal distribution of daily pollen concentrations during the lengthened season.
7. ***The underlying study does not consider the extent to which pollen-producing species will respond to global warming***. Another important assumption in Neumann et al. is that the future season-length models assume that in each location the set of species that contributed to the baseline pollen data are going to be the same in the future. At the time that study was published, tree and grass species prevalence modeling was not available, and would have to be coupled with species-specific pollen production data as well. There is some evidence that climate change could alter the geographic range of tree species in the future,[9,10,11] and Zhang and Steiner also consider effects on pollen emissions rates. The extent to which this factor affects the results presented here is currently unknown, but the Zhang and Steiner results suggest this report may underestimate the full effect of climate change on pollen season exposure.

DATA SOURCES

Table 7: Summary of Data Sources Used in the Pollen and Children's Health Analysis

Data Type	Description	Data Documentation and Availability
Baseline health impact incidence rates	Analysis followed methods described in Neumann et al. Asthma-related emergency department morbidity incidence rates were obtained from BenMAP-CE and the Health Care Utilization Project's (HCUP) Nationwide Emergency Department Sample Database and State Emergency Department Database.	Neumann, J.E., Anenberg, S.C., Weinberger, K.R., Amend, M., Gulati, S., Crimmins, A., Roman, H., Fann, N. and Kinney, P.L., 2019. Estimates of present and future asthma emergency department visits associated with exposure to oak, birch, and grass pollen in the United States. *GeoHealth*, *3*(1), pp.11-27. • U.S. EPA. (2018). Environmental Benefits Mapping and Analysis Program: Community Edition (BenMAP-CE) User Manual and Appendices. Washington, DC. Accessible at: https://www.epa.gov/benmap. • HCUP data are available at: https://hcup-us.ahrq.gov/nedsoverview.jsp
	MarketScan data used in Saha et al. covers 8 years (2008-2015) and 40 million individuals of all ages per year, which is 13.1% of individuals in the contiguous U.S. based on 2010	Saha, S., Vaidyanathan, A., Lo, F., Brown, C. and Hess, J.J., 2021. Short term physician visits and medication prescriptions for allergic disease associated with seasonal tree, grass, and weed

Data Type	Description	Data Documentation and Availability
	population. We scale the sample to a CONUS number using this percentage. Saha et al. does not document the portion of individuals in their dataset that are children, so the analysis inflates based on a multiplier that considers all ages.	pollen exposure across the United States. *Environmental Health*, *20*(1), pp.1-12. • MarketScan data available at: https://www.ibm.com/watson-health/merative-divestiture
Pollen counts modeling	National Allergy Bureau (NAB) data were used via aggregated average pollen counts and season lengths for birch, oak, and grass pollen	NAB daily pollen data are available at: https://pollen.aaaai.org/#/
Modeling lengths of pollen season	Based on Zhang et al.	Zhang, Y., Bielory, L, Mi, Z., Cai, T., Robock, A., and Georgopoulos, P. 2015. Allergenic pollen season variations in the past two decades under changing climate in the United States. Global Change Biology, 21, 1581–1589.
Future climate modeling	*See Appendix A for data sources*	
Future population growth for children	*See Appendix A for data sources*	
Demographics for social vulnerability analysis	*See Appendix A for data sources*	

Outdoor Recreation

Chapter 5 highlights various studies that forecast how changing seasonality will impact the number of outdoor recreation trips. The summary considers impacts across all outdoor recreation types observed in the American Time Use Survey, as well as winter recreation, freshwater fishing, and recreation activities at reservoirs. The chapter summarizes the main findings from the underlying studies, which forecast trips across people of all ages, then cites other data sources that provide perspective on the portion of total trips that may include children. No new analysis is included in the chapter.

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