

**BRIEF REPORT**

# Investigating the Effect of Weather Events on Primary Care Clinicians across the United States

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**Background:** When we consider weather impacts, we mainly consider how the event affects the person, not the clinicians treating them. There is a paucity of studies discussing the effect of weather on the clinicians and the care of their patients.

**Methods:** A survey covering weather effects was distributed to American Academy of Family Physicians National Research Network (AAFP NRN) members in August 2020. Descriptive statistics and Fisher's exact tests were completed on the survey responses. Postsurvey interviews were conducted with selected respondents about specific weather events.

**Results:** Survey respondents were US physicians (88.7%) and 84.9% indicated more than 1 type of event has affected their practice. Respondents were most affected by snow/snowstorm (81.1%) and indicated they had to close for the day or longer and staff were unable to make it into clinic (79.2%). Respondents indicated respiratory (94.5%), mental health (81.8%), and musculoskeletal conditions (50.9%) were most affected by weather. Interviews with selected respondents covered weather topics including winter, summer, and flooding.

**Discussion:** Survey respondents/interviewees indicated weather affects them in a variety of ways including issues with patients' conditions and practice effects. Clinicians have noticed a change to their areas' weather over the years, but, generally, warming is occurring. (J Am Board Fam Med 2023;00:000–000.)

**Keywords:** Climate Change, Family Physicians, Primary Health Care, Surveys and Questionnaires, Weather

## Introduction

When we think about weather and the effect on people, we consider how the person is affected and not the clinicians treating them. Numerous studies explore weather effects on people including extreme heat;<sup>1–11</sup> excess deaths with cold weather;<sup>1,4,7,11–13</sup> changes in pressure and temperature,<sup>14–24</sup> among others<sup>25–30</sup>. Additional studies detail how patients with asthma,<sup>28,31–33</sup> COPD,<sup>34–36</sup> arthritis,<sup>23,37,38</sup> and other conditions<sup>9,39–41</sup> are affected by weather. Conversely, there are also studies questioning weather's impact on patients.<sup>42,43</sup>

Studies discussing the impact on clinicians are rare. However, studies provide ideas and principles for practices, clinicians, and societies for coping with extreme weather,<sup>44–47</sup> adapting to climate change,<sup>47–49</sup> and coping with weather challenges.<sup>50–52</sup> The biggest weather impacts on practices are still relatively unknown, which led to investigating how weather affects primary care clinicians, their practices, and their patient panel. Survey respondents were differentiated by regional location and time in patient care.

## Methods

This study seeks to address gaps in knowledge about how clinicians react to weather in their area. To achieve this, a survey was sent to American Academy of Family Physicians National Research Network (AAFP NRN) members and selected AAFP NRN members were interviewed. This study was approved by the AAFP Institutional Review Board.

## Survey Instrument and Administration

The survey instrument was constructed based on our knowledge of weather and potential related

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disruptions. Survey questions included demographics, weather types, and ways practices and patients were impacted. Most AAFP NRN members are primary care clinicians in the US. The survey was built and distributed in Qualtrics (Provo, Utah). Respondents could proceed to the survey only after acknowledging the Informed Consent on the first page. The survey had no back button, 5 pages, 12 questions, and no incentive (Appendix).

The initial invite went out July 30, 2020, with a reminder on August 12, 2020, and closing September 14, 2020. The survey was distributed to every person in the AAFP NRN database (1584 active e-mails) who had previously consented to receiving surveys.

### Interviews

Within the survey, 1 question asked the respondents if they would be willing to participate in an interview. Out of 16 people who agreed, 9 responded to further contact. The interview questions (Appendix) were derived based on respondents' answers to the survey. The first author conducted phone interviews lasting approximately 15 minutes each. They were conducted, recorded, and transcribed mid-August through mid-September 2020.

### Analysis

Descriptive statistics were completed for all survey questions. We used all available data, assuming ignorable missingness. Fisher's Exact Tests were completed using  $R^{53}$  in the survey analysis. For the interviews, the authors read the transcripts and determined themes from the interviewees' responses.

## Results

### Survey Results

Of the 62 who at least partially completed the survey (response rate: 3.9%), 88.7% were physicians and the remaining 11.3% held other titles. Most respondents (61.3%) spent 50% or more of their time in direct patient care. The respondents' practices were from across the US—30.6% from the South, 25.8% from the West, 24.2% from the Midwest, and 19.4% from the Northeast (Table 1).

Most respondents (84.9%) indicated that more than 1 type of weather event has affected their practice, the most common being snow/snowstorm (81.1%) regardless of time in patient care or region.

**Table 1. Survey Respondent Demographics**

	n, %
Respondent titles* (n = 62)	
Physician (MD/DO)	55, 88.7
PsyD, PharmD, PhD	1, 1.6
Other	6, 9.7
Time spent in direct patient care (n = 62)	
0%	6, 9.7
1% to 49%	18, 29.0
50% or more	38, 61.3
Census region where practice is located <sup>+</sup> (n = 62)	
Northeast	12, 19.4
South	19, 30.6
Midwest	15, 24.2
West	16, 25.8

\*Titles with no responses: Resident, Medical Student, NA/PA.

<sup>+</sup>The lists of states in each division can be found at: [www2.census.gov/geo/pdfs/maps-data/maps/reference/us\\_regdiv.pdf](http://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf).

Though snow/snowstorm affected practices equally, ice/sleet/ice storm did not. Although the majority (52.8%) indicated being affected by ice and time in patient care did not make a difference, the region did. Virtually all Midwest respondents (90.0%), and almost no West respondents (14.3%) were affected by ice ( $P = .001$ ). Nearly half (40.0%) of Midwest respondents indicated lightning affected practices; Northeast and West respondents indicated no effect (0.0%;  $P = .009$ ). Almost half (43.8%) with less and only 10.8% with more time in patient care indicated extreme heat events affect their practices ( $P = .011$ ; Table 2).

Respondents indicated their practices were affected by weather with 79.2% had to close for the day or longer and staff were unable to make it in. Three-fourths (75.5%) had an increased number of cancellations or no shows. The respondents from the Midwest, Northeast, and South were more likely to be affected by loss of internet (70.0%, 66.7%, 64.7%, respectively) than the West (21.4%;  $P = .038$ ) as well as loss of telephones (60.0%, 50.0%, 76.5%, 14.3%;  $P = .005$ ) and electric power (40.0%, 50.0%, 70.6%, 7.1%;  $P = .003$ ; Table 3).

Respondents were asked which diseases/conditions, in their opinion, were affected by weather. Most (94.5%) indicated respiratory conditions are affected, as well as 81.8% for mental health and 50.9% for musculoskeletal conditions. However, respondents with less time in patient care were more likely (22.2%) to indicate that digestive conditions

**Table 2. Types of Weather Events That Have Affected Respondents' Practices (n = 53)**

	Overall % (n = 53)	Percent Care			Region				Sig.
		1-49% (n = 16)	50%+ (n = 37)	Sig.	Northeast (n = 12)	South (n = 17)	Midwest (n = 10)	West (n = 14)	
Snow/Snowstorm	81.1	81.3	81.1	1.000	91.7	64.7	100.0	78.6	0.116
Ice/Sleet/Ice Storm	52.8	43.8	56.8	0.550	50.0	64.7	90.0	14.3	0.001*
Blizzard	35.8	37.5	35.1	1.000	50.0	29.4	50.0	21.4	0.339
Thunderstorm	35.8	25.0	40.5	0.358	41.7	47.1	50.0	7.1	0.056
Rain	24.5	25.0	24.3	1.000	16.7	41.2	30.0	7.1	0.155
Flooding	24.5	31.3	21.6	0.499	16.7	41.2	20.0	14.3	0.333
Hurricane	20.8	6.3	27.0	0.142	33.3	35.3	0.0	7.1	0.052
Extreme Heat Events	20.8	43.8	10.8	0.011*	16.7	23.5	20.0	21.4	1.000
Windstorm	18.9	18.8	18.9	1.000	8.3	29.4	40.0	0.0	0.027
Tornado	15.1	25.0	10.8	0.224	8.3	5.9	40.0	14.3	0.133
Lightning Strikes	11.3	6.3	13.5	0.655	0.0	11.8	40.0	0.0	0.009*
Wildfire	7.5	6.3	8.1	1.000	16.7	0.0	0.0	14.3	0.134
Hail	5.7	12.5	2.7	0.213	0.0	0.0	20.0	7.1	0.080
Bomb Cyclone	5.7	12.5	2.7	1.000	8.3	0.0	10.0	7.1	1.000
Other	5.7	6.3	5.4	1.000	0.0	11.8	0.0	0.0	1.000
Dust Storm	1.9	0.0	2.7	1.000	0.0	5.9	0.0	0.0	1.000
Cold/Warm Fronts	1.9	6.3	0.0	0.302	0.0	0.0	10.0	0.0	0.189

\* =  $P < 0.05$ .

were affected by weather than respondents with more time in patient care (2.7%;  $P = .035$ ; Table 4).

### Qualitative Results

#### Winter

Clinicians were prepared by having services on-call to plow their parking lots, haul away snow if there is too much, and systems in place to inform patients of closures. A clinician in the South disclosed their city purchased a snowplow, but they get too much snow for 1 snowplow.

#### Summer

The main summer weather events the clinicians experienced were thunderstorms and heat. One clinician is in an area prone to wildfires and has noticed wildfires getting worse/more frequent in recent years. Houses in their area are being built with fire resistant materials.

#### Flooding

Although hurricanes were most discussed, 1 clinician mentioned flooding occurred when the snow melted quicker than normal, and drainage could not handle runoff. Another mentioned they live in a very flood-prone area, but their

clinic sits on higher ground and is typically unaffected by flooding.

#### Specific Health Effects

Clinicians agreed that weather affects their patients. They noted trends in patient complaints depending on the time of year or there was a weather event. Clinicians mentioned not only the physical effects, but also mental outcomes including anxiety and seasonal affective disorder.

#### Power

Most clinicians interviewed do not have generators for their practices. A few mentioned they rarely lose power for more than a few hours, as they are part of the group to be restored first. One clinician mentioned they will close their practice until power is restored. A few commented that if power is lost, a designated person will take vaccines to someplace with power. They had lost thousands of dollars' worth of vaccines due to power loss.

#### Telemedicine

Clinicians hoped telemedicine continues after the pandemic, because it is easier and more effective to meet with patients who cannot get out of their homes due to weather.

**Table 3. Types of Effects from Weather Disasters/Systems That Have Affected Respondents' Practices (n = 53)**

	Overall % (n = 53)	Percent Care			Region				Sig.
		1-49% (n = 16)	50%+ (n = 37)	Sig.	Northeast (n = 12)	South (n = 17)	Midwest (n = 10)	West (n = 14)	
Having to close for the day or longer	79.2	75.0	81.1	0.716	75.0	82.4	90.0	71.4	0.742
Staff unable to make it into the clinic	79.2	81.3	78.4	1.000	66.7	88.2	70.0	85.7	0.417
Increased number of cancellations or no shows	75.5	87.5	70.3	0.299	75.0	82.4	60.0	78.6	0.632
Loss of internet	54.7	43.8	59.5	0.372	66.7	64.7	70.0	21.4	0.038*
Loss of telephones	50.9	37.5	56.8	0.241	50.0	76.5	60.0	14.3	0.005*
Loss of electrical power	43.4	31.3	48.6	0.366	50.0	70.6	40.0	7.1	0.003*
Unable to get into parking lot/building due to snow	39.6	37.5	40.5	1.000	50.0	17.6	60.0	42.9	0.115
Uptick in patient calls/requests	18.9	6.3	24.3	0.250	16.7	29.5	20.0	7.1	0.469
Seasonal scheduling difficulties	18.9	6.3	24.3	0.250	41.7	11.8	10.0	14.3	0.208
Unable to get into parking lot/building due to flooding	13.2	25.0	8.1	0.179	8.3	17.6	10.0	14.3	0.947
Unable to get into parking lot/building due to downed trees or power lines	11.3	12.5	10.8	1.000	8.3	17.6	20.0	0.0	0.316
Patients get sicker	7.5	0.0	10.8	0.303	0.0	17.6	0.0	7.1	0.379
Other	7.5	6.3	8.1	1.000	8.3	0.0	20.0	7.1	1.000
Building was destroyed/damaged	5.7	12.5	2.7	0.213	0.0	5.9	10.0	7.1	0.878
Patients have new or more complaints	3.8	0.0	5.4	1.000	0.0	5.9	10.0	0.0	0.679
Loss of natural gas hookup	0.0	0.0	0.0	1.000	0.0	0.0	0.0	0.0	1.000

\* =  $P < 0.05$ .*Weather Changes*

Most clinicians interviewed mentioned they have seen changes occurring to their weather in the time they have lived in their respective locations (all

more than 10 years). They mentioned changes in rain, for example, less rain/having to rely on the aquifer more; snow, for example, seeing less snow, more ice; and air quality. In addition, they

**Table 4. Diseases/Conditions Affected by Weather Events (n = 55)**

	Overall % (n = 55)	Percent Care			Region				Sig.
		1-49% (n = 18)	50%+ (n = 37)	Sig.	Northeast (n = 12)	South (n = 17)	Midwest (n = 10)	West (n = 16)	
Respiratory	94.5	94.4	94.6	1.000	91.7	100.0	90.0	93.8	0.533
Mental Health	81.8	88.9	78.4	0.470	83.3	82.4	80.0	81.3	1.000
Musculoskeletal	50.9	50.0	51.4	1.000	75.0	35.3	60.0	43.8	0.174
Cardiovascular	47.3	44.4	48.6	1.000	50.0	52.9	50.0	37.5	0.847
Other (e.g., stress, fatigue)	45.5	44.4	45.9	1.000	50.0	52.9	40.0	37.5	1.000
Occupational Health	32.7	38.9	29.7	0.550	16.7	35.3	30.0	43.8	0.505
Dermatological/Skin Disease	30.9	27.8	32.4	1.000	16.7	29.4	30.0	43.8	0.522
Cognitive Health	29.1	33.3	27.0	0.754	25.0	41.2	20.0	25.0	0.655
Infectious	25.5	27.8	24.3	1.000	25.0	35.3	10.0	25.0	0.589
Endocrine, Metabolic	20.0	22.2	18.9	1.000	16.7	23.5	30.0	12.5	0.726
Neurological	16.4	16.7	16.2	1.000	25.0	5.9	20.0	37.5	0.535
Digestive	9.1	22.2	2.7	0.035*	50.0	52.9	40.0	37.5	0.925

\* =  $P < 0.05$ .

expressed that it seems to be generally getting warmer.

## Discussion

Clinicians indicated weather affects their patient population in a variety of ways, mainly by winter weather and rain events. This is in line with previous studies where patients were more likely to visit emergency rooms around snow<sup>54–57</sup> and flooding.<sup>58–60</sup> Extreme heat affected all practices equally, but respondents who saw patients less stated more issues with extreme heat than those who saw more patients. This could be due to patient panels and practice location/type.

Weather events can cause disruptions, with the practice needing to close a day or longer or having an increase in cancellations or no-shows. However, Midwest respondents were more affected by loss of internet and Southern respondents had loss of telephones and electric power more than the other regions. These and other problems are expected to get worse as the climate changes and are suggested as possible items to fortify to adapt accordingly.<sup>44–49</sup>

Weather can also cause issues for the patients by triggering a flare in their respiratory conditions, affecting mental health, among other physical and mental effects. The effect of weather on people/patients is in line with other studies.<sup>1,5–27,29–43,54–60</sup>

Interviewed clinicians have noticed a change to the weather in their areas over the years, and a pattern of warming. They also noted instances where they were not prepared, but then implemented processes to remedy the issues (eg, off-site refrigeration for vaccines). Further study is needed to understand the continued impact of weather on clinicians and the full effect of weather on a larger clinician population.

Although the response rate was low, it was in line with other surveys the AAFP NRN was conducting around the same time. We do understand the low response rate could affect the generalizability of the results. The response rate could be due to a lack of interest in the topic and the distribution during the COVID-19 pandemic. The voluntary nature of the survey may have introduced nonresponse bias. We endeavored to mitigate this by leaving the survey open for more than a month. An interview limitation was that they were asked to recall weather events from over the past several years.

## Conclusion

Weather will continue to affect clinicians and practices. Although there are some resources and studies for weather related effects and how weather affects patients, further study is needed to determine the full effect on clinicians and practices and ways to mitigate effects of weather on practices.

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To see this article online, please go to: <http://jabfm.org/content/00/00/000.full>.

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## Appendix.

### Weather Survey

Thank you for your willingness to help the American Academy of Family Physicians National Research Network (AAFP NRN) understand how weather and weather events have impacted you and/or your practice.

The survey will take 5–10 minutes to complete.

There are no personal benefits or risks to participating in this study. Participating is voluntary, and responses will remain anonymous and confidential.

The survey is for research purposes only, and the results will be reported only in aggregate. It's okay if you start the survey and decide to stop early. Choosing not to participate or choosing to withdraw from the study will not result in any penalty.

If you have any questions, please contact Elisabeth Callen at [ecallen@aafp.org](mailto:ecallen@aafp.org). For questions about the rights of research participants, you can the AAFP Institutional Review Board (IRB) at (813) 906 6134 or [jfarris@aafp.org](mailto:jfarris@aafp.org).

- Yes, I agree to take this survey
- No, I do not agree to take this survey

Display This Question:

If Thank you for your willingness to help the American Academy of Family Physicians National Research... = No, I do not agree to take this survey

If you are willing, can you tell us your reason for declining? (Select all that apply)

- ☐ Too busy with clinical work
- ☐ Too busy with other projects
- ☐ Have no interest in this topic
- ☐ I do not have clinic duties
- ☐ Other (please specify): \_\_\_\_\_

Skip To: End of Survey If Condition: If you are willing, can you... Is Greater Than or Equal to 0. Skip To: End of Survey.

What is your most appropriate title?

- Physician (MD/DO)
- Resident
- Medical student
- PsyD, PharmD, PhD
- NA/PA
- Other (please specify): \_\_\_\_\_

Please provide the zip code of your practice.

What percentage of your time is spent in direct patient care?

- 0%
- 1%–25%
- 26%–49%
- 50% or more

Skip To: End of Survey If What percentage of your time is spent in direct patient care? = 0%

Has your practice ever been affected by any of the following weather events? Select all that apply.

- ☐ Snow/Snowstorm
- ☐ Blizzard
- ☐ Ice/Sleet/Ice Storm
- ☐ Thunderstorm
- ☐ Rain
- ☐ Hurricane
- ☐ Flooding
- ☐ Wildfire
- ☐ Tornado
- ☐ Hail
- ☐ Lightning Strikes
- ☐ Dust Storm
- ☐ Windstorm
- ☐ Bomb Cyclone
- ☐ Cold/Warm Fronts
- ☐ Extreme Heat Events
- ☐ Other (please specify): \_\_\_\_\_



**How was your practice affected by weather disasters/systems? Select all that apply.**

- ☐ Uptick in patient calls/requests
- ☐ Having to close for the day or longer
- ☐ Building was destroyed/damaged
- ☐ Unable to get into parking lot/building due to downed trees or power lines
- ☐ Unable to get into parking lot/building due to flooding
- ☐ Unable to get into parking lot/building due to snow
- ☐ Loss of electrical power
- ☐ Loss of natural gas hookup
- ☐ Loss of telephones
- ☐ Loss of internet
- ☐ Patients get sicker
- ☐ Patients have new or more complaints
- ☐ Increased number of cancellations or no shows
- ☐ Seasonal scheduling difficulties
- ☐ Staff unable to make it into the clinic
- ☐ Other (please specify): \_\_\_\_\_

**Any comments you would like to provide on how your practice has been affected by weather disasters/systems?**

**How well do you feel you and/or your practice is prepared for any natural disaster?**

	Very Well Prepared	Well Prepared	Fairly Well Prepared	Minimally Prepared	Not at All Prepared	Not Applicable
Snow/Snowstorm						
Blizzard						
Ice/Sleet/Ice Storm						
Thunderstorm						
Rain						
Hurricane						
Flooding						
Wildfire						
Tornado						
Hail						
Lightning Strikes						
Dust Storms						
Windstorm						
Bomb Cyclone						
Cold/Warm Fronts						
Extreme Heat Events						

**From the list of diseases/condition categories below, please select the conditions that, in your observations, are affected by weather events.**

- ☐ Respiratory (e.g., asthma, COPD)
- ☐ Cardiovascular (e.g., hypertension, atrial fibrillation, coronary artery disease)
- ☐ Neurological (e.g., pain, stroke)
- ☐ Infectious
- ☐ Musculoskeletal (e.g., all types of arthritis)
- ☐ Mental Health (e.g., depression, anxiety, post-traumatic stress disorder)
- ☐ Cognitive Health (e.g., dementia, developmental disabilities)
- ☐ Occupational Health
- ☐ Dermatological/Skin Disease
- ☐ Endocrine, Metabolic (e.g., diabetes)
- ☐ Digestive
- ☐ Other (e.g., stress, fatigue)
- ☐ Other (please explain): \_\_\_\_\_

Display This Question:

If It From the list of diseases/condition categories below, please select the conditions that, in your observations, are affected by weather events. q://QID10/SelectedChoicesCount Is Greater Than or Equal to 1

**Which weather events, in your observations, affect the disease/condition categories you selected.**

- Choices:
  - ☐ Snow/Snowstorm
  - ☐ Blizzard
  - ☐ Ice/Sleet/Ice Storm
  - ☐ Thunderstorm
  - ☐ Rain
  - ☐ Hurricane
  - ☐ Flooding
  - ☐ Wildfire
  - ☐ Tornado
  - ☐ Hail
  - ☐ Lightning Strikes
  - ☐ Dust Storms
  - ☐ Windstorm
  - ☐ Bomb Cyclone
  - ☐ Cold/Warm Fronts
  - ☐ Extreme Heat Events
- Statements:
  - ☐ Respiratory
  - ☐ Cardiovascular
  - ☐ Neurological
  - ☐ Infectious
  - ☐ Musculoskeletal
  - ☐ Mental Health
  - ☐ Cognitive Health
  - ☐ Occupational Health
  - ☐ Dermatological/Skin Disease
  - ☐ Endocrine, Metabolic
  - ☐ Digestive
  - ☐ Other

**How do you get your weather information? Select all that apply.**

- ☐ Local TV
- ☐ National TV
- ☐ Radio
- ☐ Weather Radio
- ☐ App
- ☐ National Weather Service
- ☐ Weather Channel
- ☐ AccuWeather
- ☐ Other Internet Site
- ☐ I don't check the weather
- ☐ Other (please specify): \_\_\_\_\_

**Can I contact you for a possible brief interview to further discuss how weather has affected you and/or your practice?**

- ☐ Yes (provide email address): \_\_\_\_\_
- ☐ No