



The Effect of Climate on Free Clinic Attendance by Individuals Experiencing Housing Insecurity

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Abstract

Individuals experiencing housing insecurity are a population with inherently transient needs and resources and are particularly vulnerable to climate events such as extreme temperatures and precipitation. Prior studies have examined the relationship between weather and clinic attendance, but few focus specifically on the housing insecure population. This study evaluated the effect of weather events on attendance at Norfolk Street Choir-Street Health - a weekly student-run, walk-in free clinic in the central, downtown city population of Norfolk, Virginia. Clinic attendance and weather data were retrospectively reviewed for 2021-2022. In this period, there were 101 clinic dates and 775 patient visits. Descriptive statistics and Analysis of Variance were performed using Statistical Analysis System to analyze attendance against temperature and precipitation, as well as monthly and seasonal trends. The warmer months of August and September had statistically significantly higher attendance rates compared to June, February, and March. There was also a positive correlation between clinic attendance and average temperature on the day before, night before, and day of clinic. This data helps clarify which climate-related factors most significantly impact individuals experiencing housing insecurity, allowing clinics to allocate resources more effectively and proactively address these barriers in the future.

Introduction

Individuals experiencing housing insecurity represent a particularly vulnerable population with inherently transient and evolving needs, such as evolving health concerns and inconsistent access to transportation.^{1,2,3} These transient factors in turn affect free clinic usage, creating inconsistent demand for clinic services.² Weather is one factor that may impact the demand for clinic services due to its strong effect on homeless and housing-insecure individuals.¹ Prior research has found that climate events such as extreme temperatures and natural disasters negatively impact both the physical and mental health of unhoused individuals and those who are housing insecure, broadly defined as individuals lacking stable, safe, and adequate housing. This population is also disproportionately exposed to such events.³

Studies have shown mixed results regarding the strength and direction of weather's effect on attendance to various types of healthcare clinics.⁴⁻⁸ Several studies found no relationship between weather and clinic attendance. A 2021 study found that temperature (mean, maximum and minimum) on the day of clinic had no effect on attendance at an otolaryngology clinic in New Zealand.⁴ Another found varying attendance by month, but no relationship between attendance and weather factors such as percent humidity, temperature, and precipitation in a pulmonary rehabilitation program for chronic obstructive pulmonary disease patients in Spain.⁵ At a walk-in university counseling program in Canada, neither variations in precipitation, hours of daylight nor temperature were statistically significant in relation to the number of individuals who attended those sessions.⁶

Conversely, a 2022 study which evaluated clinic attendance in relation to weather and household factors among low-income families in Chicago, Illinois found a significant increase in missed appointments on days with mild weather compared to moderate weather. However, no difference in the number of missed appointments was found between days of moderate and inclement weather. The study further found that attendance did not differ with accumulated snow depth.⁷ A 1986 study also found that weather was reported as a reason to miss an appointment at an oncology clinic in an inner-city hospital in New York City.⁸

While prior studies have examined the relationship between weather and clinic attendance, very few focus specifically on housing insecure populations. One study that explored the relationship between weather and emergency department attendances by the housing insecure found a small, non-significant positive correlation between attendances and daily temperature.⁹ These previous studies provide some insight into the relationship between climate and health care attendance. Individuals experiencing housing insecurity are poorly represented in this research, especially in the setting of free clinics. The goal of this study is to determine if an association exists between weather and attendance of a free clinic that focuses on serving the local housing insecure community. The results will guide management and distribution of the limited clinic resources to better match clinic demand.

Methods

Description of the Free Clinic

The Norfolk Street Choir-Street Health (SH) clinic is a weekly, walk-in, pop-up type clinic that serves individuals experiencing housing insecurity. Individuals who visit the clinic are primarily uninsured or insured under Medicaid. The clinic is located at a church where SH's partner organization provides concurrent non-healthcare related services (e.g. breakfast, showers, and music/art opportunities). SH provides physician appointments, blood pressure and blood glucose checks, over-the-counter medications, health/hygiene supplies, Medicaid enrollment support, and healthcare navigation. The clinic is entirely staffed by volunteer Eastern Virginia Medical School graduate students (predominantly Medical Doctor (MD), Master of Public Health, and Biomedical Sciences Master of Science students) and volunteer local physicians. SH operates for 2 hours every Friday morning except for holidays and student breaks.

Norfolk is a large urban center in southeast Virginia. According to the 2025 County Health Rankings & Roadmaps data, 20% of households in Norfolk experienced severe housing problems, defined as overcrowding, high housing costs, lack of kitchen facilities, or lack of plumbing facilities. In addition, 9% of Norfolk residents were uninsured. The data also highlights substantial socioeconomic need among children, with 25% of children in Norfolk living in poverty in 2025 compared with 13% of children statewide in Virginia.¹⁰

Measures

Clinic attendance and weather data were retrospectively reviewed for clinic dates ranging from January 8, 2021 to December 16, 2022. As part of normal clinic flow, patients sign-in once per clinic day to use any clinic service, and the sign-in data is saved to the clinic's secure, online data repository Research Electronic Data Capture (REDCap) system (version 16.1.7, Vanderbilt University, Nashville, TN). Clinic attendance data was queried from REDCap to create deidentified attendance numbers. Weather data was extracted from wunderground.com, which provided detailed historical weather data in 5-minute time increments. This data was evaluated to find the average temperature (°F) and the total accumulated precipitation during three 12-hour periods: 8am to 8pm the day before clinic, 8pm the night before clinic to 8am the day of clinic and, 8am to 8pm the day of clinic. To further evaluate monthly trends, monthly weather data in the form of average temperature and sum precipitation (monthly total of precipitation in inches) was extracted from <https://www.weather.gov> for January 2021 through December 2022.

Table 1. Monthly Weather and Attendance at Norfolk Street Choir-Street Health Clinic, 2021 to 2022

Months	Weather Metric						Participants (N)
	Day Before (mean ± SD)		Night Before (mean ± SD)		Day Of (mean ± SD)		
	T (°F)	P (in)	T (°F)	P (in)	T (°F)	P (in)	
January	41.8 ± 8.3	0.0 ± 0.0	36.5 ± 7.1	0.0 ± 0.0	41.6 ± 8.6	0.0 ± 0.0	6.3 ± 4.4
February	48.8 ± 10.6	0.1 ± 0.1	42.9 ± 7.5	0.1 ± 0.2	49.5 ± 12.0	0.1 ± 0.1	5.5 ± 4.5
March	60.7 ± 10.0	0.2 ± 0.4	52.6 ± 11.2	0.1 ± 0.2	57.2 ± 16.0	0.0 ± 0.1	5.9 ± 4.5
April	57.9 ± 5.8	0.1 ± 0.0	50.8 ± 7.3	0.0 ± 0.0	61.7 ± 9.5	0.0 ± 0.1	6.4 ± 6.0
May	71.9 ± 11.0	0.0 ± 0.0	64.8 ± 7.3	0.2 ± 0.1	76.5 ± 10.5	0.1 ± 0.1	6.3 ± 5.8
June	77.8 ± 4.6	0.1 ± 0.2	70.7 ± 3.9	0.1 ± 0.2	81.3 ± 6.3	0.2 ± 0.5	5.3 ± 3.8
July	87.1 ± 5.4	0.1 ± 0.3	78.2 ± 4.3	0.0 ± 0.0	85.6 ± 5.9	0.4 ± 0.5	9.2 ± 4.1
August	85.9 ± 5.5	0.1 ± 0.2	77.0 ± 4.4	0.0 ± 0.0	85.6 ± 5.1	0.0 ± 0.1	12.9 ± 5.8
September	77.7 ± 4.9	0.1 ± 0.3	70.9 ± 4.0	0.0 ± 0.0	77.2 ± 4.0	0.0 ± 0.0	10.5 ± 4.9
October	68.5 ± 5.1	0.0 ± 0.0	62.4 ± 5.2	0.1 ± 0.2	69.6 ± 6.1	0.2 ± 0.6	8.7 ± 2.7
November	60.1 ± 9.2	0.0 ± 0.0	52.5 ± 9.1	0.1 ± 0.1	57.7 ± 10.1	0.1 ± 0.3	6.4 ± 4.3
December	52.2 ± 9.1	0.1 ± 0.3	47.8 ± 9.7	0.0 ± 0.0	53.2 ± 6.6	0.0 ± 0.0	9.6 ± 3.5

Monthly mean ± standard deviation for temperature, precipitation, and number of participants attending Street Health clinic visits from January 2021 through December 2022. Weather variables include daytime conditions on the day before clinic, evening conditions before clinic, and daytime conditions on the day of clinic. Values were averaged by month across the 2-year study period. “Day Before” variables were measured from 8am to 8pm on the day preceding the clinic, “Night Before” variables were measured from 8pm to 8am directly prior to the start of the clinic, and “Day Of” variables were measured from 8am to 8pm on the day of the clinic.

SD: Standard Deviation; T (°F): temperature in degrees Fahrenheit; P (in): precipitation in inches

Analysis

All statistical analyses were performed using Statistical Analysis System (SAS) (9.4, SAS Institute, Cary, NC). The mean and standard deviation were used to calculate the average show rate and precipitation and temperature metrics for the day before and after each month during the 2-year data collection period. The impact of changes in precipitation and/or temperature compared to the number of patients seen was analyzed using Pearson’s Correlation. Analysis of Variance (ANOVA) was utilized to analyze the number of patients seen across weeks, months, and seasons. Post-hoc analysis was completed using Tukey’s Honestly Significant Difference analysis. To detect differences in trends over time, linear regression analysis was utilized. For all statistical testing, a two-sided alpha level of <0.05 was considered statistically significant.

Results

Demographics

The data included 101 clinic dates with 775 patient visits between 2021-2022, with an average of 8 patients per clinic. The mean age of patients was 52 ± 16 years and 69% of patients were male. Attendance numbers, temperature, and precipitation metrics were collected for each clinic date. Averages were calculated for each month, and both years of data were combined (Table 1).

Patient Attendance Numbers

Attendance numbers for the two-year period were averaged based on week, month, and season. The monthly results are in Table 2. No significant differences in show rates were observed from comparing the week in any given month. When extrapolated to monthly show rates, significant differences were seen across the 12 months; specifically, August had significantly higher show rates

Table 2. Monthly Clinic Attendance at Norfolk Street Choir-Street Health Clinic, 2021 to 2022

Variable	Participants (N ± SD)	p-value
Month		
January	6.3 ± 4.4	
February	5.5 ± 4.5	
March	5.9 ± 4.5	
April	6.4 ± 6.0	
May	6.3 ± 5.8	
June	5.3 ± 3.8	0.02*
July	9.2 ± 4.1	
August	12.9 ± 5.8	
September	10.5 ± 4.9	
October	8.7 ± 2.7	
November	6.4 ± 4.3	
December	9.6 ± 3.5	

Mean ± standard deviation of monthly clinic attendance across the 2-year study period. The p-value reflects the overall comparison in attendance across months using one-way analysis of variance.

SD: Standard Deviation

*p < 0.05 is statistically significant

compared to June (p=0.001), February (p=0.002, and March (p=0.003). Similarly, September showed significantly higher show rates compared to June (p=0.025), February (p=0.033), and March (p=0.048). Show rates were further broken down by traditional seasonal periods. No significant differences were found when comparing all four seasons, though significant differences were seen when comparing summer and spring show rates (m=2.93, p=0.032).

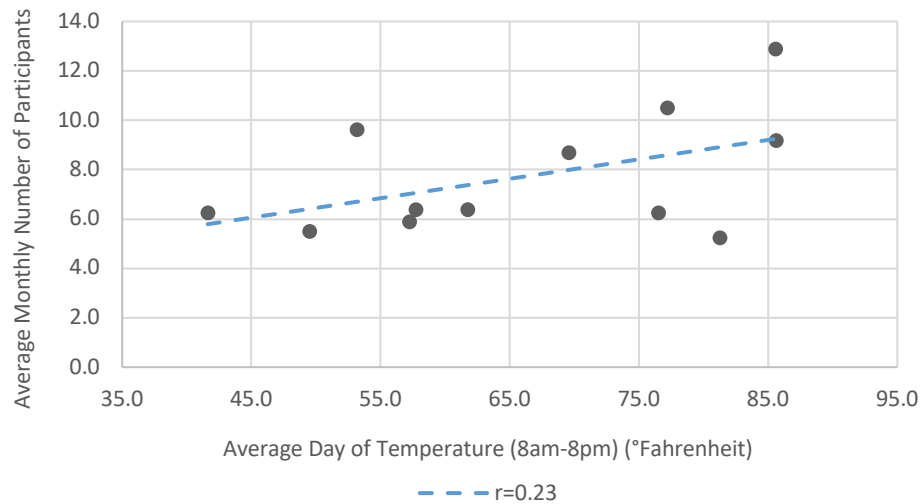
Show rates were then compared with the following variables: average daytime temperature and precipitation on the day prior to clinic, average evening temperature and precipitation on the day prior to clinic, and average temperature and precipitation on the day of the clinic. Statistically significant positive correlations were seen when comparing show rates to the average temperature the day before clinic (r=0.20, p=0.047) and similarly when comparing show rates to the average evening temperature before clinic (r=0.24, p=0.049). Significant correlations were also seen when comparing the average temperature on the day of the clinic (r=0.23, p=0.03, Figure 1). No significant findings were found when examining the effect of precipitation amount the day before or the day of clinics.

Discussion

Although no one season was statistically different from all others, summer demonstrated higher attendance when compared to spring. This trend is further explained by August and September having the highest average monthly attendance of any months in the study period. A positive correlation between average temperature and clinic attendance numbers was also noted. This may relate to the increased temperature and humidity during these months, as the clinic facility provides air conditioning and relief from the elements. Late summer is also associated with hurricanes in the Coastal Virginia area, with an increase in adverse weather events like heavy rains, flooding, and high winds. Interestingly, there was still a positive correlation between average temperatures and the number of patient visits, even within the winter months.

There are several possible reasons for the overall decrease in turnout in winter months. One is that the cold negatively affects one's ability to travel, as many patients walk and bicycle to the clinic.

Figure 1. Association Between Day-of-Clinic Temperature and Attendance at Norfolk Street-Choir Street Health Clinic



Scatterplot showing the relationship between average temperature on the day of clinic and the number of patients attending Street Health clinic visits during 2021 to 2022. The slope of the line, r , represents an average of 0.23 additional monthly clinic participants for each 1 °Fahrenheit increase in temperature.

The local light rail system, which is also used by patients, can be delayed or shut down entirely due to frost and ice.¹¹ It is also possible that the greater prevalence of winter pop-up shelters can provide the resources for which participants would otherwise travel to the clinic.

Although no significant association was found between precipitation and attendance in this data analysis, anecdotal reports from patients indicated that precipitation, particularly street flooding and disruptions to public transit (bus, light rail), may have impeded their ability to attend the clinic. The discrepancy between subjective complaints and data trends may be attributed to limited sample size. Of the 101 clinic dates evaluated, there was recorded precipitation either before or day-of clinic on 52 instances.

Lower attendance during the winter months suggests seasonal barriers may disproportionately affect individuals experiencing housing insecurity. Reduced daylight hours and competing demands, such as accessing winter shelter services, may also limit clinic attendance during this time. In response, the clinic can consider targeted strategies to help mitigate these barriers, such as increasing bus pass distribution during colder months or exploring alternative service delivery models when feasible. This may include providing bus tickets, which allow patients to avoid walking in cold temperatures. Another option would include creating a mobile clinic to meet the patients at their places of shelter. Finally, as precipitation does not significantly decrease clinic attendance rates, services should not be suspended or decreased on rainy or snowy days.

Limitations & Future Research

This study faces limitations primarily due to the limited sample size, reflecting the clinic's small size. To enhance the robustness of findings, future research could consider incorporating data from multiple free clinics in the southeast Virginia area. Additionally, this analysis describes a relatively short period of 2 years, which is how long the clinic has been well-established in the community. Data from earlier years was excluded, as attendance numbers were impacted by variable clinic schedules and the limited awareness of the clinic's existence among community members. Further investigations spanning a longer duration would provide a more comprehensive view of monthly attendance trends,

especially considering the evolving landscape of global warming and climate change. Increasing data collection would also account for other confounding variables such as coinciding events at the host location, which have occurred sporadically throughout the clinic's history.

Further studies can also longitudinally explore patients' perceptions of the effect of weather on their desire and ability to attend clinic, which may elucidate the discrepancy between the anecdotally reported effect of precipitation and the collected data. Conducting surveys across different seasons could reveal hidden factors that are otherwise overlooked when not a current concern. It would also be useful to survey modes of transportation during each season, as the clinic provides bus passes and may need to vary its ordering quantity according to the season. Moreover, analyzing patient medical histories in relation to attendance rates may elucidate demographic patterns. It may be that patients with greater comorbidities are more affected by weather than other patients. Despite these limitations, this study provides a foundation for future research into clinic attendance patterns. Addressing these limitations through expanded research efforts will enhance the understanding of the complex interplay between weather, individual characteristics, and clinic attendance behavior.

Conclusion

Overall, temperature plays a significant role in affecting clinic turnout. The positive correlation between temperature and attendance was observed most profoundly in August and September, some of the warmest months in Norfolk, VA. Although there was no statistical association between precipitation and attendance, patients have cited it as a factor determining their ability and decision to attend clinic. These results are similar to previously discussed climate studies, which find little to no relationship between weather and attendance, with temperature being the strongest climate modifier if one were to exist.⁴⁻⁸ Compared to prior research focusing specifically on housing insecure populations, similar results were found with higher temperatures associated with higher healthcare service usage. Future research at this clinic can explore patient perceptions of weather across time and guide clinic procedures to provide quality care in the most efficient manner.

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Disclosures

The authors have no conflicts of interest to disclose.

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