

# The Effect of Weather and Sporting Events on Ambulatory Visits and Hospitalizations at a Veterans Affairs Medical Center

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## ABSTRACT

**Background:** We explored the impact of weather and sporting events on clinic and emergency department (ED) visits and hospitalization.

**Methods:** Weather, dates of sporting events, ED visits, hospitalizations, clinic visits, no-shows, and same-day patient cancellations from 2015 to 2018 were abstracted from Milwaukee's Veterans Affairs (VA) medical system.

**Results:** Inclement precipitation increased clinic cancellations. Snowfall reduced ED visits. Green Bay Packer football games, University of Wisconsin-Madison football games, and the Super Bowl reduced ED visits but not hospitalizations. Milwaukee Brewers baseball home games didn't affect ED visits, but hospital admissions increased slightly. Basketball events (Milwaukee Bucks, University of Wisconsin–Madison, University of Wisconsin–Milwaukee, Marquette University) had no impact.

**Conclusion:** Inclement weather increased clinic cancellations, and snow reduced ED visits. Football games reduced ED visits, while baseball increased hospitalizations, probably because the Milwaukee Brewers stadium is located on the VA property.

## BACKGROUND

Health care professionals often carry various superstitions and preconceptions, such as a full moon brings in unusual cases, and severe weather or major sporting events cause fewer admissions and more clinic cancellations. However, previous research on the influence of weather and sporting events on emergency department (ED) visits, urgent care visits, and hospitalizations has been mixed.<sup>1-3</sup> There are numerous studies that demonstrate a modest effect of weather on ED visits,<sup>4,5</sup> with a larger impact from the day of week and season. ED visit prediction models that incor-

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porate these factors have been developed for staffing purposes.<sup>6</sup> Some studies have found that sporting events reduce ED visits, mostly for low-acuity visits and among males, during the event.<sup>7,8</sup> There have been no studies examining the effect of weather and sporting events on veterans or in Wisconsin. Our purpose was to study the impact of these factors on ED and clinic visits and hospitalization among veterans.

## METHODS

For this study, the number of ED visits, hospitalizations, clinic visits, no-shows, and same-day patient cancellations from 2015 to 2018 from a Veterans Affairs (VA) medical system located in the Midwest

region of the United States were obtained from electronic health records. Included VA primary care clinics were all located in Wisconsin: Green Bay, Cleveland, Appleton, Union Grove, and Milwaukee. ED visits and hospitalizations were to the Clement J. Zablocki VA Medical Center in Milwaukee. These data are aggregated on a daily basis and were abstracted by day but did not include hourly information. From the National Oceanic and Atmospheric Administration, we abstracted daily minimum and maximum temperatures and type and amount of precipitation. From team websites, we abstracted the days the state's professional baseball (Milwaukee Brewers), basketball (Milwaukee Bucks), and football teams (Green Bay Packers) played, as well as nonprofessional football (University of Wisconsin-Madison) and basketball (University of Wisconsin–Madison and University of Wisconsin–Milwaukee) and Marquette University), as well as Super Bowl dates. For teams that play home games in Milwaukee (Marquette, Brewers, Bucks), we

**Table 1.** Impact of Weather on Clinic Visits, Emergency Department (ED) Visits and Hospitalizations

	Clinic Visits B (95% CI)	Clinic Cancellations B (95% CI)	Clinic No-Shows	ED Visits B (95% CI)	Hospitalizations B (95% CI)
Rainfall (inches)	135.6 (-19.2 to 290.4)	18.1 (3.2 to 33.0) <sup>a</sup>	9.0 (-4.1 to 22.2)	0.21 (-2.5 to 2.9)	1.4 (-3.5 to 0.72)
Snow (inches)	-91.8 (-215.4 to 31.8)	23.1 (11.2 to 34.9) <sup>b</sup>	-1.1 (-11.7 to 9.4)	-2.9 (-5.0 to -0.67) <sup>c</sup>	-0.15 (-1.8 to 1.6)
Snow on ground (inches)	13.0 (-32.8 to 58.9)	0.36 (-4.1 to 4.8)	0.54 (-3.4 to 4.5)	0.20 (-0.61 to 1.00)	-0.001 (-0.63 to 0.63)
Temperature (Minimum)	-3.8 (-11.2 to 3.6)	0.14 (-0.51 to 0.80)	0.35 (-0.23 to 0.93)	-0.06 (0.19 to 0.07)	-0.006 (-0.11 to 0.10)
Temperature (Maximum)	13.0 (-32.8 to 58.9)	-0.3 (-1.0 to 0.40)	-0.28 (-0.92 to 0.35)	0.10 (-0.02 to 0.22)	0.01 (-0.08 to 0.11)

<sup>a</sup> $P=0.02$ , <sup>b</sup> $P<0.005$ , <sup>c</sup> $P=0.01$

abstracted whether games were at home or away. Multivariable regression assessed the relationship between continuous outcomes and dependent variables (Stata 16.1). This study was approved by the Clement J. Zablocki VA Medical Center Institutional Review Board.

## RESULTS

Over the 3 years, there was an average of 1695 clinic visits, 69 ED visits, and 30 hospital admissions on nonholiday weekdays. There were fewer ED visits on weekends and holidays (69 vs 49,  $P<0.001$ ) but no difference in daily admissions (28.1 vs 27.6,  $P=0.50$ ). The temperatures ranged from -10°F to 95°F. Snow was on the ground for 134 days (12.3%). It snowed on 58 days (5.3%), with more than 1 inch of accumulation on 21 days during the study period.

On average, there were 100 same-day clinic cancellations and 94 clinic no-shows. There were significantly more same-day clinic cancellations when there was rain or snow (Table 1), with a step-wise increase in clinic cancellations with greater rain (none: 96 cancellations;  $\leq 1$  inch: 106 cancellations,  $> 1$  inch: 140 cancellations) or snowfall (none: 98 cancellations,  $\leq 1$  inch: 122 cancellations,  $> 1$  inch: 179 cancellations) ( $P<0.001$  for both).

Temperature, rain, and snow did not affect the total number of clinic visits or rates of hospitalizations, although snow reduced the number of ED visits (Table 1). There were fewer ED visits on days the Packers, the University of Wisconsin-Madison (UW-Madison) football team played, or the Super Bowl was held (Packers: 49 vs 63,  $P<0.0005$ ; UW-Madison: 52 vs 63,  $P<0.0005$ ; Super Bowl: 48 vs 63,  $P=0.04$ ). However, there was no difference in hospitalizations (Packers: 27.9 vs 28.6,  $P=0.63$ ; UW-Madison: 27.9 vs 27.2,  $P=0.65$ ; Super Bowl: 27.9 vs 20.4,  $P=0.22$ ). Brewers home games didn't affect ED visits (49 vs 50,  $P=0.98$ ), but admissions increased (27.9 vs 30.3,  $P=0.002$ ). Basketball games (Marquette, UW-Madison, Bucks) had no impact on ED visits or admissions (Table 2), whether in-town or away (data not shown).

**Table 2.** Impact of Sporting Events on Emergency Department (ED) Visits and Hospitalizations

	ED visits (95% CI)	P value	Hospitalizations (95% CI)	P value
Green Bay Packer games	-15.3 -18.9 to -11.6)	<0.005	0.73 (-2.2 to 3.6)	0.62
Super Bowl	-15.8 (-30.7 to -0.85)	0.04	7.5 (-4.5 to 19.4)	0.22
Milwaukee Brewers games	0.03 (-1.9 to 1.9)	0.98	2.4 (0.99 to 3.9)	.002
Milwaukee Bucks games	0.54 (-1.9 to 3.0)	0.67	2.4 (0.99 to 3.9)	0.27
Marquette University games	-0.67 (-3.5 to 2.1)	0.64	-1.1 (-3.0 to 0.85)	0.65
UW-Madison football	-12.7 (-16.8 to -8.6)	<0.005	-0.51 (-2.7 to 1.7)	0.65
UW-Madison basketball	-1.3 (-4.0 to 1.5)	0.36	-0.79 (-2.9 to -1.3)	0.47

Abbreviation: UW, University of Wisconsin.

## DISCUSSION

This is the first study to our knowledge that has examined clinic visits, same-day cancellations, and no-show rates due to weather and sporting events. Temperature had no impact on any outcomes. There were more clinic cancellations when it was raining or snowing, with cancellations increasing with greater amounts of precipitation. Snow, Packer games, and the Super Bowl reduced ED visits. At our facility, the decrease was clinically meaningful, with nearly a quarter fewer visit on those days. There was a statistically, but not clinically meaningful, increase in hospitalization rates when the Brewers played at home. The paradoxical finding of no increase in ED visits but increased hospitalizations may be due to most home games being played on weekends. Previous studies have found that low-acuity ED visits were less likely during sporting events. This also might help explain why admissions increased without an increase in the number of visits. American Family Field (the Brewers' home stadium) is located on the VA campus. With an average attendance of nearly 32,000, the proximity might explain the increase in game-day admissions.

The discordant finding of fewer ED visits with unchanged hospital admissions over the weekend suggests that those who present over the weekend may be more ill. This has been mentioned as a possible explanation for the increased mortality rate seen for weekend admissions.<sup>9</sup>

A limitation of this study is that it uses data from a single VA medical center, limiting generalizability to other medical centers. While the demographics of our VA are similar to other VAs

(93% male, median age 64, 78% White), veterans are older, more likely to be male, and more likely to be White than nonveteran populations.<sup>10</sup> Previous research has shown that sporting event impact on ED visits was largely limited to males. Our results may not generalize to health systems with more women. Another limitation is that the retrospective nature of this study limits any comments on causality. Further, we have no information on the specific types of admissions increased by Brewer games, and we don't have hourly data. Based on other studies, it is likely that there would be a lull in ED visits immediately before and during games with a spike afterwards. Finally, we don't have detailed demographic information. The elderly may be more susceptible to weather than other populations. Future studies should gather hourly data, obtain patient-level information, and include non-VA health facilities.

## CONCLUSIONS

Snow and rain increased clinic cancellations, and snow decreased ED visits. There were fewer ED visits with football games and more admissions with baseball games. Temperature had no impact.

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**Availability of Supporting Data:** The datasets generated and analyzed during the current study are not publicly available due to confidentiality issues related to patient information.

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