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Do Weather Changes Affect Veterans' Outpatient, Pain Management Clinic Attendance? A Five-Year Longitudinal Analysis

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Abstract

Adherence to appointments has been found to be a strong predictor of successful chronic disease self-management, yet up to 30% of health appointments are missed. Many factors have been found to influence attendance, including patients not having enough time, facing transportation issues, lack of childcare, administrative errors, and inclement weather. The current study investigated weather indices as possible factors related to missed appointments among patients who suffer from chronic pain. In a five-year longitudinal study, 911 veterans participated in a patient pain education program. Attendance was tracked and weather indices were recorded for the day before, the day of, and the day after class. Significant associations were found between attendance and wind-chill for the day of class and temperature change for the day after class. No other weather indices, seasonality, nor education class topic, were found to influence attendance in this study. Although pain was not measured directly, findings may offer some support for pain sensitivity as it relates to weather predictability, as attendance for classes was lower when a significant temperature change occurred the day after class. These findings have important clinical implications for veterans with chronic pain conditions, as weather is often implicated as barrier. We recommend future studies take efforts to measure pain levels, and conduct individual analysis on demographic information, pain history, and mental health history to identify other possible obstacles.

Keywords: weather, chronic pain, attendance, pain education, veterans, U.S. medical center

Introduction

The notion that weather influences physical health has been around since the fifth century BC when Hippocrates reported an association between rain, wind, and chronic disease.¹ In the 21st century, there continues to be a public debate about weather, specifically climate change, and the greater incidents of extreme weather and its effect on health.² Findings support that climate change has a direct impact on health,³ and some evidence suggests it may also serve as a barrier to treatment compliance.⁴ This is problematic since poor adherence to treatment regimens, including continuation of care plans and follow-up appointments, contributes to ineffective pain management.⁵ There is a precedence in past research looking at the effects of weather indices on participation in health programming.⁶ For example, research has shown weather to have an influence on treatment compliance with different types of health engagements, including exercise programming⁷⁻¹⁰ and pediatric appointments.¹¹

Patients with chronic, non-cancer pain often attribute nonadherence to prescribed treatment regimens to certain weather indices. Patients who suffer from chronic pain frequently report that their pain is influenced by temperature,¹² barometric pressure,¹³⁻¹⁵ humidity,¹⁶ and wind speed.¹⁷ Certain pain diagnoses have also been reported to be especially sensitive to weather changes, such as rheumatoid arthritis,¹⁸ osteoarthritis,^{15,19-20} fibromyalgia,^{14,21} headaches/migraines,²²⁻²⁴ sickle cell,^{16,17,25-28} and low back pain.²⁹ Research with a focus on broader pain populations may help define which weather factors are deterministically correlated with pain appointment attendance.

Adherence to appointments, independent of visit frequency, has been found to be a strong predictor of successful chronic disease self-management,³⁰ yet up to 30% of health appointments are missed.³¹⁻³³ Furthermore, patients who suffer from a chronic disease and missed at least one appointment in the last month were found to be significantly less engaged in their health care.³⁴ Further efforts to identify determinants of daily self-care of chronic pain patients will allow healthcare professionals to provide more precise and tailored guidance regarding self-management of chronic pain. Findings may also facilitate interdisciplinary research collaborations, and narrow gaps between institutions, such as higher-education and health care.

With an observed event, such as a pain management appointment, one is able to explore a fluid aspect of the environment, such as weather, in a period of time when it is most likely to affect self-care decisions.⁶ Therefore, the purpose of the current, five-year study was two-fold: 1) to investigate if weather the day before, the day of, and/or the day after a scheduled pain education class affected attendance; and 2) if so, to identify the specific measures of weather change that predicted attendance. Seasonal influence and the effects of weekly education topics on attendance were also examined. Informed by the literature on weather and pain, it is hypothesized that attendance will be significantly influenced by weather indices. However, given that, to our knowledge, this is one of the first studies to examine the influence of actual weather indices in a sample of veterans who suffer from chronic pain, we make no prediction regarding which weather indices will impact attendance.

Methods

Participants

A total of 911 veterans participated in the Pain Education School program at a large Midwestern United States Veterans Affairs (VA) Medical Center. The study had no exclusion criteria except that veterans must be diagnosed with a chronic, non-cancer pain condition. Veterans voluntarily participated in the Pain Education School program.

Procedure

Attendance and non-attendance were recorded over a five-year period for an outpatient, pain education program in a Midwestern VA Medical Center from November 6, 2009 to October 31, 2014. The program was limited to one class location and on a set day (Friday) and time (11am) of the week, year-round. Enrollment data was collected as part of standard care. In order to participate in the pain education program, the referring provider submitted a consult in the computerized patient record system. Potential candidates were initially added to the waiting list for the next available monthly mandatory introduction class of the program. Subsequently, veterans attended 11 weeks of classes. Each class was one hour, with the exception of the first session, which was two hours. The first two-hour session included an hour-long introduction to the program and then was followed by the first class. The current study protocol was reviewed and approved by the Institutional Review Board and the VA's Research & Development office. A waiver of informed consent was approved, as this study used archival data.

Observed Event

The "Pain Education School" was developed in November 2009 at a Midwestern VA medical center using the Agency for Healthcare Research and Quality's principles and the VA's National Center for Health Promotion and Disease Prevention's manual.³⁵ This education-focused, professionally driven program assumes that if individuals are provided with adequate education, they will self-manage their chronic illness.³⁶ A goal-based evaluation of the development and implementation of the program is available in the literature.³⁷ The program consisted of an

introduction class followed by 12 one-hour classes offered weekly that were led by guest speakers from over 20 different disciplines within the facility. The introduction class reviewed the ground rules, schedule of classes, and basic principles of the bio–psycho–social–spiritual approach to pain self-management. A menu of treatment modalities was then scheduled on a rotating basis regardless of the veteran’s entry point—the providers from each discipline rotated on a schedule, not the veterans. The general outline of the modules of the program presented after the introduction class are included in Appendix A.

Providers from each discipline shared information about chronic, non-cancer pain from their perspective, what treatments were available in their service, and how to access their respective clinics. Four factors were used to improve attendance as suggested in past research:^{38,39}

(1) Encouragement and social support: at the end of each class, veterans had the opportunity to ask questions and receive direct, practical responses from the providers; (2) Education counseling: audio, visual, and tactile methods were implemented during each class to account for differences in adult learning; (3) Reminders before the appointment: Veterans were sent appointment letters two-weeks in advance; and (4) Financial incentives: Veterans were given free parking validation/transportation reimbursement if they were in attendance and were qualified for such programs.

Fluid Aspects of the Environment

End-of-day summaries of meteorological conditions of the city and state of the study were collected for the day before, the day of, and the day after the scheduled appointment using the Old Farmer’s Almanac.⁴⁰ Objective weather indices included temperature change, wind-chill index (temperature under 20°F), heat-index (temperature above 90°F), minimum/mean/ maximum temperatures, mean sea level pressure, mean dew points, total precipitation, snow depth, visibility, mean/maximum sustained wind speed, and maximum wind gusts.

Data Analyses

The effects of weather on outpatient, pain management clinic attendance was examined across three time frames: previous day, same-day, and the next day’s weather. The proportions of attendance, or count data (derived from the ratio of the number of veterans who attended to the total number of veterans scheduled), were transformed using arcsine transformation (ASIN), making the distribution normal. These transformations are most often employed in the analysis of a dependent variable in multivariate analysis of variance (MANOVA), when the raw values are proportions. The test statistics (*F*- and *t*-values) and their associated probabilities will be identical because each expression is a linear combination of the other. One technique, often used in the social sciences,⁴¹ is to let the transformed variable be equal to twice the angle (measured in radians) whose trigonometric sine equals the square root of the proportion being transformed, or new variable = 2 * ARSIN(SQRT(raw score/max possible score)).

As there were multiple, end-of-day, weather measurements per week (independent variables), we focused on the variables most likely to determine attendance using different methods. First, some variables were dropped from the analysis due to being a constant or having missing correlations (e.g., heat-index). The authors then removed any variable used to create another variable (e.g., minimum/maximum temperatures were used to calculate temperature change). Determining multicollinearity was an iterative process. Diagnostics were run with each variable alone as the dependent variable and only variables with variance inflation factors (VIF), below the threshold (3 = probably have multicollinearity issues) were included in the final analysis as outlined in past research.⁴² Thus, the following variables were not entered in the final stepwise linear regression analysis: sea level pressure, mean dew points, maximum sustained wind speed, and maximum wind

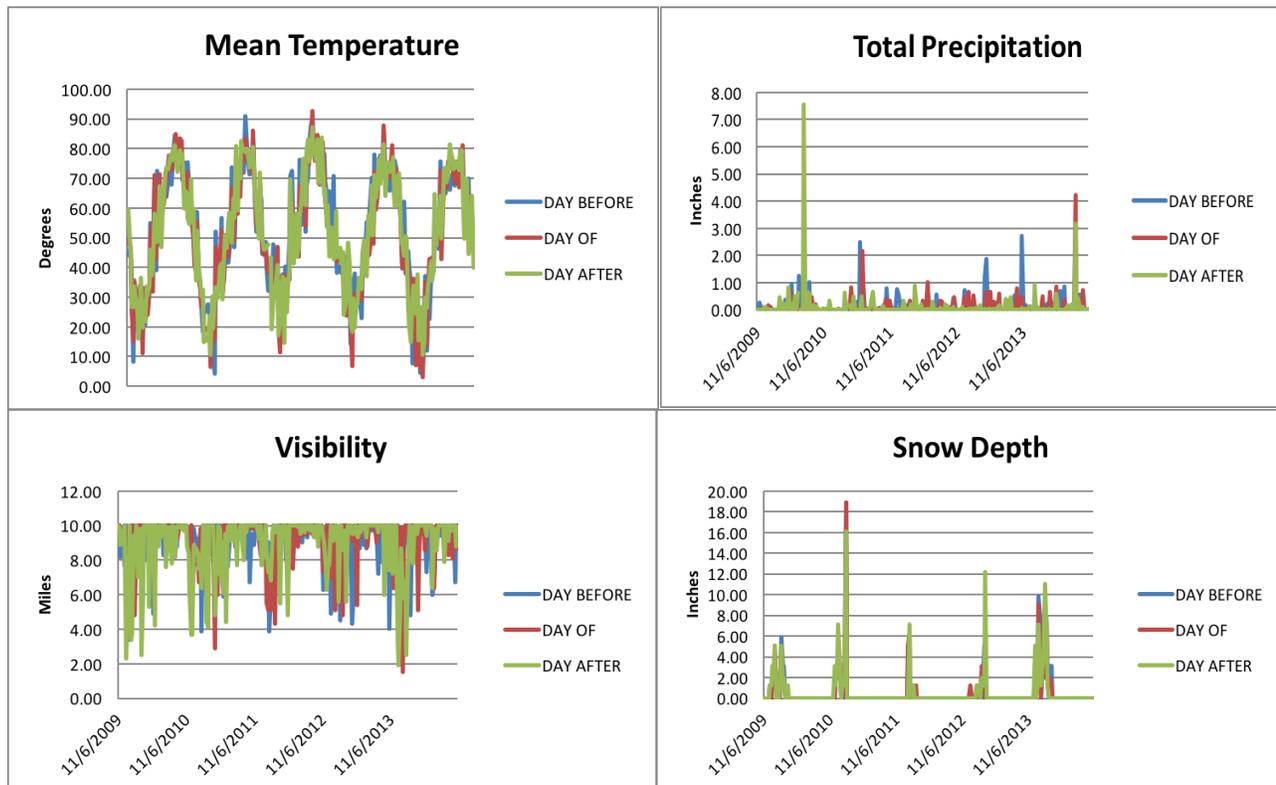
gusts. Finally, data were submitted to a one-way analysis of variance (ANOVA) to identify any differences by season and/or module covered in the Pain Education School class. SPSS version 22 was used for all outcome analyses.

Results

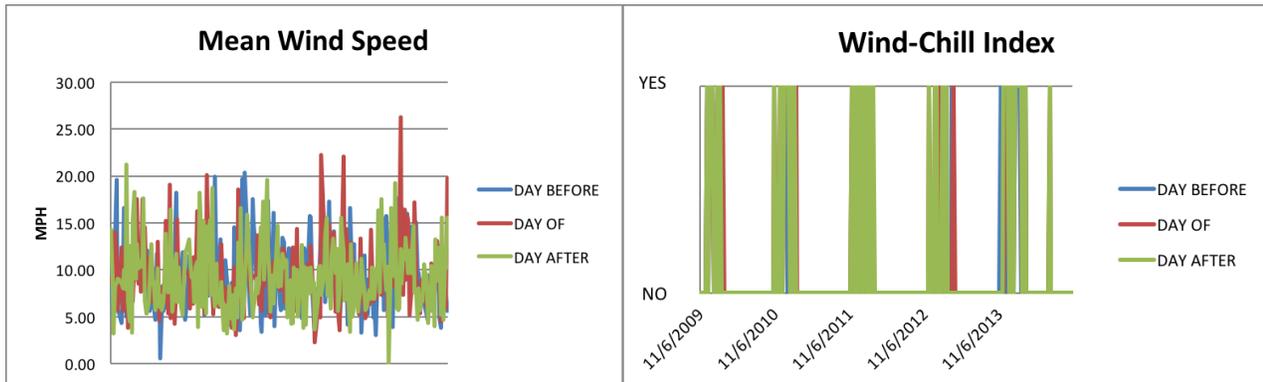
Characteristics

Of the 260 calendar weeks, 14 classes were cancelled due to national holidays, resulting in 246 possible classes. A total of 911 veterans participated in the Pain Education School program at the Midwestern U.S. VA medical center between November 6, 2009 and October 31, 2014. Veterans had mixed idiopathic chronic, non-cancer pain conditions, including back pain (75%), neck pain (13%), extremity pain (7%), head pain (3%), and fibromyalgia/soft tissue pain (2%). Most veterans were African American (64%), male (85%), and between the ages of 55 to 64 years old (40%). The average veteran attended 6/12 classes, with 14% only attending the introduction class. The average attendance for each class was 25 and approximately 182 veterans participated in the education program each year. While demographic information on those who participated in the study was kept, attendance records were kept based on a ratio of attendees versus non-attenders. Due to this record keeping limitation with the archival data, individual attendance analyses were not possible.

The mean temperature for the city year-round was 52°F, with a range from 34 to 45°F. On average, the city had 0.01 feet of rain and/or melted snow reported during the day. Visibility was approximately 9 miles, and the last report for the day for snow depth was approximately 0.25 feet on average during snowfall. The mean wind speed in the city was 9 mph. The measures of weather change by date are charted in the figures below.



Weather Indices by Date



Weather Indices by Date

Outcome

A stepwise linear regression was conducted to evaluate which measures of weather change were necessary to predict attendance in a pain education program (Table 1). At step two of the analysis, temperature change (or the degree shift) for the day after class and the wind-chill for the day of class were significantly related to attendance, $F(2, 240) = 6.93, p = .01$. The multiple correlation coefficient was 0.23, indicating approximately 5.5% of the variance of the attendance rate could be accounted for by these variables. The temperature change for the day after class had a shared contribution of 3.5% and a unique contribution of 3.4%; and the wind-chill for the day of class had a 3.0% shared and a 2.9% unique contribution. The remaining variables (i.e., mean temperatures, precipitation, snow depth, visibility, and mean wind speed) did not enter into the equation at step 3 of the analysis. No significant differences were found for season, $F(3, 197) = 2.04, p = 0.11$, or class module, $F(12, 197) = 0.25, p = 0.99$, on patient attendance in the pain education program.

Table 1. Stepwise Regression to Evaluate Which Weather Indices Predict Attendance

Variable	<i>B</i>	<i>SE(B)</i>	β	<i>t</i>	<i>p</i> -value
Step 1: Temperature Change Day After	-0.005	0.002	-0.159	-2.497	0.013*
Step 2: Temperature Change Day After Wind-Chill Day Of	-0.006 -0.119	0.002 0.044	-0.188 -0.174	-2.947 -2.731	0.004* 0.007*

*= Significant at the $p < .01$ level.

Discussion

Past studies have investigated the relationship between weather and specific chronic pain conditions, often with inconclusive results.⁴³ To our knowledge, no study has investigated the link's impact on attendance amongst mixed idiopathic chronic, non-cancer pain conditions over several seasons in a location with comparably high weather variability. The answer to such a relationship has important implications for veterans living with chronic pain and their ability to comply with their pain management treatment plans, especially given the increase in extreme weather.⁴⁴ The purpose of the current study was to determine how fluid aspects of the environment, as measured by weather changes that occurred the day before, the day of, and the day affected observed events, as measured

by attendance in weekly pain education program classes. The current study found that the wind-chill for the day of class and temperature change for the day after class were significantly related to lower attendance.

The wind-chill index (temperature under 20°F) for the day of class is somewhat consistent with the reasoning that pain severity is highest on cold days,^{45,46} and that colder temperatures lead to lower attendance. However, other studies have failed to show a relationship between cold weather and pain. For example, past scholars have found that patients living in colder areas did not report higher pain scores, frequencies, or greater influence of the weather on their pain.⁴⁷ Additionally, researchers have proposed that patients may develop an equilibrium based on the local climate. The equilibrium theory is supported by the current study's findings in that temperature changes [rather than the weather indices (i.e., rain, wind, and humidity) themselves] were found to influence treatment compliance. This is consistent with other research investigating the impact of the weather on pain.^{13,48} There were no significant differences found by season, as it was expected that winter months would be marked by poorer attendance due to the colder weather. This is inconsistent with the reasoning that patients with pain report higher pain severity in cold temperatures, which would be more common during winter months.⁴⁹

Many people report being able to forecast the weather based on changes in chronic pain levels. This was somewhat supported in the current study such that veterans' lack of attendance was partially explained by a change in the temperature for the day after a missed class. That is, veterans may have had greater pain the day of class because they "predicted" the poor weather the next day, thus did not attend. A majority of people with chronic pain in past polls reported perceiving some level of pain sensitivity to weather.⁴⁵

Several studies indicate specific physical and psychological factors that account for weather sensitive people.⁴⁶ Weather sensitive individuals have been found to suffer from stress, emotional instability, sleeping difficulties, and changes in energy level when compared to non-sensitive individuals.^{1,50} Higher levels of anxiety and depression have also been found to be predictors of weather sensitivity.⁵¹ Likewise, there is overwhelming evidence that pain is influenced by mood disorders.⁵²⁻⁵⁶ Past scholars have suggested a mediating relationship such that weather affects mood and, in turn, mood affects pain.^{1,56} Future studies may benefit from identifying and investigating those who meet weather sensitivity criteria.

Beyond the wind chill for the day of and change in temperature for the day after, there were no other weather indices that accounted for attendance to the pain education classes on the day before, of, or after the scheduled pain management class. There are many reasons given for why the impact of weather on pain is often inconclusive. First, researchers point to the idea that weather is a complex phenomenon, making it difficult to measure. On a related note, there may be limitations in the way weather is typically measured (macro weather variables as opposed to the individual's microenvironment).⁵⁷ Past researchers have suggested that the mixed results found when measuring the relationship between weather and pain may be due in part to individual exposure to the weather. Patients spend varying amounts of time outside exposed to the weather and time in climate controlled indoor conditions. It is recommended that exposure to actual weather (versus time spent in climate controlled conditions) and type of clothing worn should also be considered.^{57,58} Additionally, past research has also shown that some patients may be influenced by low levels of a weather index whereas others by high, thus cancelling out significant results when taken together.¹⁴

Another explanation for the inconsistent findings between weather and treatment compliance for patients with chronic pain conditions are considered belief-based. Studies have shown that patients engage in the misattribution of the impact of weather on pain, especially when the true causes of the pain is unknown.¹ Cultural beliefs and expectations may contribute to this

misattribution. For example, it is arguably a long held cultural belief that weather has an impact on physical health. The term “under the weather,”⁵⁹ may prime patients with variable chronic pain to blame the weather in the absence of other explanations, perhaps engaging in superstitious behavior, as explained by operant conditioning.⁶⁰ On a related note, past researchers have found that the lack of an explanation for chronic pain has been associated with greater treatment dissatisfaction, indicating that patients look for and perhaps find comfort in identifying sources to explain their pain and/or change in pain intensity.⁶¹ Furthermore, researchers have found that weather sensitive patients had longer pain histories than non-sensitive patients.¹ They suggest that time has allowed the belief about the relationship between pain and weather to increase in saliency over time. There is also research that shows patients’ tendency to search for, or interpret weather information that confirms their anecdotal beliefs.⁶² Patients may engage in a confirmatory bias and selective attention where they look to changes in the weather to explain changes in pain, but weather factors remain unnoticed when their pain is stable.⁶³

The current study also found no significant difference in veterans’ pain education program attendance by the module of the class being instructed. At first glance, one would assume that veterans would be more likely to attend classes they found interesting. Past research has shown that veterans found specific modules (acupuncture and medication management) to be more relevant, and found other modules (tobacco cessation and hypnosis) to be less fitting.⁶⁴ However, the current study did not find that subject matter from any of the classes had any effect on attendance.

Results should be interpreted with the following limitations in mind. Many of the limitations are due to the use of archival data, in that we were limited in our investigation based on the way attendance records were kept for the pain education program. The biggest limitation is that pain frequency and intensity were not measured. Future studies aiming to investigate the link between pain and treatment compliance would benefit from taking efforts to measure pain frequency and intensity. A VA Evidence-based Synthesis Program report (ESP, intranet communication, December 2012) indicated that group visits focusing on education for the management of chronic conditions in veterans tends to suffer from high levels of attrition which was substantiated by the current study. It is recommended that future studies collect self-report reasons for nonattendance, allowing for other factors related to attendance to be measured. Past research has examined what themes veterans commented as being barriers to attendance in the pain education program, and found that veterans either reported not having any barriers (24%) or noted travel (24%), finances (21%), or other illness (18%) as being obstacles.⁶⁴ Other studies investigating military personnel have found the most frequently reported reason for missing appointments was administrative error (including believing their appointment was on another date, having cancelled the appointment, and not knowing they had an appointment).⁶⁵ Furthermore, due to limitations of this archival collection, demographics (e.g., gender differences^{15,51}) and other individual barriers to care (e.g., distance from the facility and/or finances⁶⁶) were not able to be assessed. Future studies would benefit from controlling for these variables to better understand the unique contribution of weather on treatment compliance for those with chronic pain conditions. Given that participants were all taken from one Midwestern city’s Veteran’s medical center, these results may not generalize to other regions of the U.S.

Despite these limitations, the current study provided several enhancements to previous weather and pain treatment compliance studies. The current investigation was a five-year longitudinal study, allowing the influence of weather and seasonality to be assessed over multiple years.⁴⁹ Additionally, the data were based on objective measures (weather patterns and attendance) rather than subjective (self-report) reasons given by veterans for nonattendance. Furthermore, the Midwestern city in which the current VA medical center is located is well suited to study variable weather conditions compared to other studies with more homogenous weather patterns.

Conclusion

The current study found support for the influence of cold temperatures (wind chill) on nonattendance to a pain education program in a sample of veterans who suffer from chronic pain for the day of class. Results also offered some support for weather sensitivity in chronic pain patients such that change in the temperature (up or down) for the day after class increased nonattendance. There was, however, no influence of season on attendance. These findings have the potential to help enhance treatment compliance such as using cold weather forecasts as a prompt to make veteran reminder calls—a supported method for appointment adherence—to help minimize this barrier to treatment.⁶⁷

Conflict of Interest

None of the authors have anything to disclose. There is no conflict of interest to report.

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Appendix A: Modules of the Pain Education School Program

1. Pain Clinic/Osteopathic Manipulation
2. Medication Management
3. Smoking Cessation/Addiction Services
4. Nutrition Services/MOVE! Weight Loss Program
5. Physical Medicine and Rehabilitation
6. Recreation Therapy/Sexual Health
7. Cognitive Behavioral Therapy (CBT)/Acceptance and Commitment Therapy Groups
8. Suicide Prevention and Mental Health/Vocational Rehabilitation
9. Hypnosis/Biofeedback
10. Healing Touch/Spirituality
11. Sleep Clinic/Insomnia CBT Group
12. Acupuncture and Traditional Chinese Medicine