MATHEWS

Research Article

Mathews Journal of Emergency Medicine

Weather and Migraine: Is there a Relationship between Barometric Pressure Change and ED Migraine Visits?

Tessa Ndille[1], James Espinosa[2,*], Themy Ngo[3], Syrita Farrow[4], Alan Lucerna[2], Victor Scali[5], Henry Schuitema[6]

[1]Department of Emergency Medicine, Vassar Brothers Medical Center Poughkeepsie, NY, USA

[2]Department of Emergency Medicine, Jefferson NJ, Stratford, NJ, USA

[3]Department of Emergency Medicine, Baylor Scott & White Medical Center, Waxahachie, Texas, USA

[4]Department of Emergency Medicine, Virtua Voorhees Hospital, Voorhees, NJ, USA

[5]Director of Problem-Based Learning and Faculty, Rowan-Virtua SOM School of Medicine, Stratford, NJ, USA

[6]Chief, Department of Emergency Medicine and Associate Chief Medical Officer, Jefferson NJ, USA

ABSTRACT

Background: Migraine headache is one of the most common causes of chronic headaches. Many internal and external triggers for migraine episodes have been identified. Weather as a migraine trigger has been reported as the most common trigger and as the 4th most common trigger. **Aim of Study:** The purpose of our study was to look for a relationship between barometric pressure and migraine presentations. **Materials and Methods:** The study design was a retrospective chart review. A random sample of 50 days was selected for the study. A random number generator was used to select the random dataset. Weather data from those days included the variable of mean barometric pressure on the index (study) day, from the previous day and from the following day. The barometric pressure was obtained from a national online weather database. [weatherunderground.com] The barometric pressure was recorded in inches of mercury. Emergency department data from the index day, the preceding day and the following day was obtained from a three-community hospital/University affiliated system in reference to the number of migraine headache patients seen in the emergency department for the 24 hours of the 50 study days. For each study day, all patients with a diagnosis of migraine headache were also included. In addition, the number of patients with a diagnosis of headache, of any unspecified type was studied. Patients less than 18 years of age, patients with trauma, fever, stroke or a diagnosis of meningitis were excluded. Means for barometric pressure were calculated for the index day as well as the preceding and following day. Migraine data and overall headache data were compared for above average and below average barometric pressure days for the index days. Changes in barometric pressure between the day preceding and the day following the index day were studied. **Results:** There were more migraine patients seen on days with above-mean barometric pressure than on days with below mean barometric pressure.

Vol No: 08, Issue: 02

Received Date: June 16, 2023

Published Date: July 03, 2023

***Corresponding Author**

James Espinosa

Department of Emergency Medicine, Jefferson Health NJ, 18 East Laurel Road, Stratford, NJ 08084, USA

E-mail: Jim010@aol.com

Citation: Ndille T, Espinosa J, Ngo T, Farrow S, Lucerna A, Scali V, Henry Schuitema H. (2023). Weather and Migraine: Is There a Relationship Between Barometric Pressure Change and ED Migraine Visits? Mathews J Emergency Med. 8(2):58.

This difference was statistically significant (P-value=0.02) using the parametric measure of the Two-Sample T-Test and Confidence Interval as well as with a non-parametric measure of the Mann-Whitney Test and Confidence Interval, (P-value=0.01). **Conclusions:** Our data showed a correlation between days with higher barometric pressure and migraine presentations. This finding is consistent with some migraine studies and is inconsistent with others. Possible theories to explain the differences in these findings have been proposed in the literature, including differences in methodology, possible differences in subsets of patients and the conflicting influence of other weather variables. We did not find a relationship between migraine presentations and changes in barometric pressure from the day prior to the study day, or from the study day to the following day. We saw no relationship between barometric pressure and non-migraine headache presentations.

INTRODUCTION

The diagnostic domain of headaches of all types accounts for approximately 1 million visits to the Emergency Department (ED) per year in the United States. Migraine headaches are a common problem worldwide that causes significant suffering and economic impact. Many ED headache visits are linked to a migraine diagnosis.

Given the long history of migraine as a diagnostic entity, it is remarkable that the underlying etiology is still not clearly understood. One hypothesis is that migraine headache is of vascular origin with an initial phase of cerebral vasoconstriction resulting in neurologic symptoms such as an aura and is followed by a vasodilatory phase, manifested as a pulsatile headache. This simple explanation is becoming less satisfactory because it does not fully explain all the features of acute migraine. Another more contemporary theory is that neurons in a migraine patient may become excitable, with a wave of neuronal activation that results in pain [1].

Whatever the etiology, migraine headaches are a common problem worldwide that causes significant suffering and economic impact. Recently, the international literature has begun to take a very careful look at migraine triggers, with an eye on possible clues to both underlying pathophysiology as well possible prevention measures. It has been the observation of several members of this study team that patients often self-report weather conditions as an environmental trigger to their migraines. Despite multiple clinical studies, the link between weather and migraine remains unclear [2]. And yet, as one article frames it, "Can so many patients be wrong?" [3].

What sort of weather conditions have been proposed as possible links to migraine? As it turns out, humidity, wind speed, and temperature have not shown a clear link. However, a promising possible link may exist between changes in atmospheric pressure (barometric pressure) and migraine [4].

It is clear that migraine headaches have substantial morbidity and economic impact.

The purpose of this study is to look for a correlation between changes in barometric pressure as a migraine trigger in an ED population. It is possible, given the availability of some preventive medications that such a link, if identified, might contribute to a science of preventative therapy based on better patient and provider understanding of weather changes.

MATERIALS AND METHODS

The study design was a retrospective chart review. A random sample of 50 days was selected for the study. A random number generator was used to select the random dataset. Weather data from those days included the variable of mean barometric pressure on the index (study) day, from the previous day and from the following day. The barometric pressure was obtained from a national online weather database. [weatherunderground.com] The barometric pressure was recorded in inches of mercury.

Emergency department data from the index day, the preceding day and the following day was obtained from a three-community hospital/University affiliated system in reference to the number of migraine headache patients seen in the ED for the 24 hours of the 50 study days. For each study day, all patients with a diagnosis of migraine headache were also included. In addition, the number of patients with a diagnosis of headache, of any unspecified type was studied. Patients less than 18 years of age, patients with trauma, fever, stroke or a diagnosis of meningitis were excluded.

Means for barometric pressure were calculated for the index day as well as the preceding and following day. Migraine data and overall headache data were compared for above average and below average barometric pressure days for the index days. In addition, a modified method of Kimoto, et al. was used to define changes in barometric pressure between the day preceding and the day following the index days [5]. Data were compared for presentations of migraine headaches and all headaches for changes greater than 0.0015 inches Hg (which is equivalent to Kimoto's use of 5 hPa (hectoPascal

units.) Data were analyzed to look for the relationship between barometric pressure and migraine headache as a specific diagnosis, as well as for the relationship between barometric pressure and all headaches as a diagnosis.

RESULTS

Migraine headache diagnosis: index days, below mean barometric pressure and above mean barometric pressure compared: Of the 50 index days, 27 were below mean barometric days and 23 were above mean barometric pressure days. The average number of migraine diagnoses on above mean barometric pressure days was higher (mean=1.52, SD 1.14, median 1) than the number of migraine diagnoses on below mean barometric days (mean=0.81, SD 1.14, median 1) this difference is statistically significant (P-value=0.02) using the parametric measure of the Two-Sample T-Test and Confidence Interval. [Estimate for difference: -0.79, 95% CI for difference: (-1.427, -0.161)] This difference is also statistically significant (P-value-0.01) using a non-parametric measure [Mann-Whitney Test and Confidence Interval (CI)] P-Value=0.01. [95.1 Percent CI for ETA1-ETA2 is (-1.000, 0.000)].

Non-migraine headache diagnosis: index days, below mean barometric pressure and above mean barometric pressure compared: There was no statistical difference seen for non-migraine headaches, comparing above mean barometric pressure index days and below mean barometric days (P=0.74).

Migraine headache presentations in relationship to changes in barometric pressure between index day and preceding day: There was no statistically significant relationship (P=0.45) between migraine headache presentations on index day in relationship to changes in barometric pressure between index day and preceding day. [Mann-Whitney Test and CI, P=0.45] Regression analysis also showed no relationship (P=0.45).

Non-migraine headache presentations in relationship to changes in barometric pressure between index day and preceding day: There was no statistically significant relationship between non-migraine headache presentations on index day in relationship to changes in barometric pressure between index day and preceding day. [Mann-Whitney Test and CI, P=0.61].

Migraine headache presentations in relationship to changes in barometric pressure between index day and following day: There was no statistically significant relationship between migraine headache presentations on index day in relationship to changes in barometric pressure between index day and the following day. [Mann-Whitney Test and CI, P=0.78] Regression analysis also showed no relationship (P=0.78) Regression analysis also showed no relationship (P=0.74).

Non-migraine headache presentations in relationship to changes in barometric pressure between index day and following day: There was no statistically significant relationship between non-migraine headache presentations on index day in relationship to changes in barometric pressure between index day and the following day. [Mann-Whitney Test and CI, P=0.50].

DISCUSSION

Migraine headaches are one of the most common causes of chronic headaches [6]. Mukamal, et al. estimate that migraine headaches affect 18% of woman and 6% of men in the United States, with estimated annual costs on the order of 17 billion dollars [7]. Migraine is associated with the loss of approximately 150 million work days per year [8].

The identification of triggers to migraine headaches "constitutes the first and most important step in the prevention of migraine attacks" [6]. Many internal and external triggers for migraine episodes have been identified. Weather as a migraine trigger has been reported as the most common trigger and the fourth most common trigger [9]. Environmental triggers from weather were common in a survey of headache triggers in adolescents [10]. As Becker points, out "some [patients] consider the weather to be their most important trigger and even go so far as to refer to themselves as 'human barometers'" [3].

Some studies have studied the relationship between migraine headaches and variety of meteorological factors, including barometric pressure.

The purpose of this study was to look for a relationship between barometric pressure and migraine presentations. There were more migraine patients seen on days with above-mean barometric pressure than on days with below mean barometric pressure. This difference was statistically significant (P-value=0.02) using the parametric measure of the Two-Sample T-Test and Confidence Interval as well as with a non-parametric measure of the Mann-Whitney Test and Confidence Interval, (P-value=0.01).

How do these data compare with other studies? As noted by

Martin, et al. "high atmospheric pressure has been reported to increase the frequency of headache…while others have shown the opposite effect or none at all" [11]. There have been a number of studies looking at the relationship between barometric pressure and migraine headaches. Several studies have shown a relationship to higher barometric pressure, as was seen in our study [12-16]. One of these studies that saw a relationship between higher barometric pressure and migraine headaches was ED based design [15].

We have identified three additional studies that had an emergency department based methodology [6-7, 17]. Yilmaz, et al. and Villeneuve et al. did not find a relationship to barometric pressure [6,17]. Mukumal, et al. found a relationship to lower barometric pressure [7].

There are conflicting results of studies concerning low atmospheric pressure and migraine. A review by Bolay, et al. did not find a relationship between migraine headaches to lower atmospheric pressure [4].

In reference to changes in barometric pressure, our data did not identify a relationship between migraine headache presentations and changes in barometric pressure. This relationship was seen in several studies using a headache diary model [5,18].

There was no statistical difference seen for non-migraine headaches, comparing above mean barometric pressure index days and below mean barometric days (P=0.74). There was no statistically significant relationship between migraine headache presentations or non-migraine headache in relationship to changes in barometric pressure between index day and preceding day, or in relationship to the index day and the following day. This was not unexpected, as the literature in which a relationship has been seen between barometric pressure and headaches has been seen in patients with migraine headaches.

The influence of weather in general "remains one of the most controversially debated aspects of the pathophysiology of migraine" [2]. Why the difference among studies concerning the relationship between migraine headaches and barometric pressure? The difference may be partly methodological. Some studies looked at a cohort of patients with migraine and asked them to log their headaches in diary form. Later, these data were compared to meteorological data. Such studies have the potential for bias on the part of the patient, for whom the weather data may be known. However, there are other theories in the literature to explain such differences. In an ED model, Szyszkowicz saw a positive relationship between migraine presentations and increased barometric pressure. However, increased migraine presentations were also related to markers of air pollution. The two factors may be interrelated [15].

Scheidt, et al. saw a relationship between temperature changes and migraine episodes. Temperature changes may interact with barometric pressure changes [19]. Barometric pressure change may be related to lightning—which has been shown in some studies to be related to migraine presentations [4,11].

Another interesting theory has been proposed by Hoffman et al. Their data suggests that there may be subsets of patients with migraine with various sensitivities to changes in certain weather components. As to etiology, the study notes that "one may speculate that certain changes of specific weather parameters lead to an increase in neuronal excitability of trigeminal neurons and thereby facilitate the beginning of a migraine attack." They propose that it is possible there may be a genetic predisposition to weather sensitive migraine headaches [2].

Becker suggests that the differences in results of studies of migraine and weather may be due to multiple triggers in some patients, differential thresholds to triggers, interaction of weather parameters and differences in timing in patients from trigger exposure to headache presentation. Lastly, Becker proposes, similarly to Hoffman et al., that migraine headache populations are heterogeneous in nature "and what may be a trigger for one patient may not be a trigger for another" [3].

CONCLUSIONS

Migraine headaches are one of the most common causes of chronic headaches. Many internal and external triggers for migraine episodes have been identified. Weather as a migraine trigger has been reported as the most common trigger and as the fourth most common trigger. The purpose of our study was to look for a relationship between barometric pressure and migraine presentations. There were more migraine patients seen on days with above-mean barometric pressure than on days with below mean barometric pressure. This difference was statistically significant (P-value=0.02) Thus, our data showed a correlation between days with higher barometric pressure and migraine presentations. This finding is consistent with some migraine studies and is inconsistent with others. Possible theories to explain the differences in these findings have been proposed in the literature, including differences

in methodology, possible differences in subsets of patients and the conflicting influence of other weather variables. We did not find a relationship between migraine presentations and changes in barometric pressure from the day prior to the study day, or from the study day to the following day. We saw no relationship between barometric pressure and non-migraine headache presentations.

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