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Influence of weather on seizure frequency — Clinical experience in the emergency room of a tertiary hospital

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ABSTRACT

Introduction: Some patients with epilepsy identify weather as a typical seizure trigger. However, it is yet to be confirmed. Thus, we aimed to evaluate possible relationships between daily meteorological conditions and the daily incidence of seizures.
Methods: This was a retrospective single center study that included adult patients who were admitted to the emergency room of a tertiary hospital in Lisbon, with a seizure, between January and December 2015. The influence of temperature, atmospheric pressure, relative humidity, wind, precipitation, sunlight duration, and the seasons on seizure frequency was evaluated.
Results: Three hundred seven seizure episodes were included (from 286 patients) in a total of 365 days, 117 (38.1%) first unprovoked seizures and 190 (61.9%) with previous seizure episodes. There were 82 days with higher incidence of seizures (≥2) and 171 days without seizures. We found a statistical significant relation between lower ambient temperatures, higher atmospheric pressure, and higher maximum humidity with days with two or more seizures. We also found a statistically significant higher incidence of seizures in the winter days (p-value: 0.001) and in days with lower daylight duration (10.8 vs. 12.7 h; p-value: 0.0001). With the exception of humidity, these findings remained true when analyzing the subgroup of patients with previous seizures, but there was no significant difference in the subgroup of first unprovoked seizures.
Conclusions: Our results support the possible influence of the weather on seizure frequency in the overall admissions of the emergency department of a tertiary hospital. In particular, these findings suggest that winter conditions, such as, lower ambient temperatures, higher atmospheric pressure, higher humidity, and reduced sunlight exposure, may have impact in the occurrence of higher incidence of seizures in patients with epilepsy.

1. Introduction

The unpredictability of seizures is a concern of relevant impact in people with epilepsy. Many surveys indicate that a substantial proportion of these patients identify environmental, physical, or emotional factors that are associated with an increase in seizure frequency [1–7]. Stress is the most frequent trigger reported by patients with epilepsy, followed by sleep deprivation and tiredness. For a better seizure control, in addition to anticonvulsant therapy, avoiding seizure triggers may be important for many patients. The recognition and understanding of these triggers is therefore of significant importance.

In spite of some patients report of the weather, or weather changes, as one of their possible seizure triggers [1, 7], the evidence supporting a significant influence of specific meteorological parameters in seizure frequency is scarce and inconsistent [8–16]. Thus, it is still unclear what the influence of weather is on the general risk of seizures. The aim of our study was to assess if daily weather conditions and variations were associated with an increase in seizure frequency.

2. Material and methods

2.1. Type of study

This was a retrospective single-center study, based on the review of medical records of all patients observed in the emergency room assessed by a neurologist, in a tertiary hospital in Lisbon, from January to December 2015. The incidence of seizure was recorded every day.

2.2. Population inclusion and exclusion criteria

Patients were included in the study if they fulfilled the following criteria: 1) age older than 18 years, 2) admitted to the emergency

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room with an episode clinically compatible with a seizure, including patients with a first unprovoked seizure. Acute symptomatic seizures and seizures in noncompliant patients with epilepsy or patients with changes in antiepileptic medication in the last 3 months were excluded. In patients with more than one seizure in a 24-hour period, only one seizure was considered.

This study was approved by all relevant ethics committees.

2.3. Data collected

2.3.1. Patients

Demographic and clinical characteristics were collected for all patients, including age, gender, seizure type (generalized tonic–clonic, focal with impairment of consciousness, or focal without impairment of consciousness), and seizure time.

2.3.2. Meteorological data

For each day, the following data were collected from the Portuguese Institute for Sea and Atmosphere, I. P. (IPMA, IP): minimum, maximum, and mean values of daily ambient temperature (°C); mean value of daily atmospheric pressure (hPa); minimum, maximum, and mean values of daily relative humidity (%); mean and maximum values of daily wind (km/h); and total daily precipitation (mm).

Additionally, for each day, the total hours of daylight duration was collected as well.

2.4. Statistical analysis

A day with a higher incidence of seizures was defined as a day with more seizures than the daily average for the whole study period. We decided to use this definition to allow the inclusion of days with a higher than average frequency of seizures and exclusion of days with the mean number of seizures. By doing so, we wanted to compare days with extreme values — no seizures versus higher number of seizures — and see if the meteorological parameters were significantly different in the latter days.

Considering the whole year, we sorted out four groups: days without seizures, days with at least one seizure, days with higher seizure incidence, and a final group that includes the days before those with a higher seizure incidence.

We searched for an association between weather changes and seizures by a) comparing meteorological parameters between days with at least one seizure and days without seizures, b) comparing meteorological parameters between days with higher seizure incidence and days without seizures, c) comparing meteorological parameters between days with higher seizure incidence and the preceding days, and d) comparing the absolute 24-hour variation value of all the meteorological data between days with higher seizure incidence and days without seizures.

Finally, we compare the seizure frequency between the four seasons of the year (winter, spring, summer, and autumn).

We performed the same analysis for the two subgroups: patients with first unprovoked seizure and patients with previous seizures.

2.5. Statistical tests

The program SPSS 20.0 was used to conduct all statistical tests. Statistical significance of relationships was assessed with p-value < 0.05.

Mann–Whitney tests were applied to compare medians between days with higher seizure incidence and days without seizures.

Wilcoxon signed rank tests were used to compare medians between days with higher seizure incidence and the previews days.

Kruskal–Wallis *H* test was first performed to assess seizure frequency main effect within the four seasons of the year. Then paired Mann–Whitney tests were used to compare the seasons.

3. Results

In the 365-day period analyzed, from a total of 3544 urgency episodes, 532 were seizures, of which 225 were excluded, since they occurred in patients with unstable antiepileptic therapy (noncompliant patients or those with changes in antiepileptic medication in the last 3 months) (n = 155) or were acute symptomatic seizures (n = 70). A total of 307 seizures were included, the majority (87.9%) tonic–clonic generalized seizures and 81.4% diurnal seizures (Table 1).

These occurred in a total of 286 patients, 165 males (57.5%). Mean age was 54.1 ± 20.6 years. The mean number of seizures per patient and seizures per day were 1.07 ± 1 (maximum 3) and 0.84 ± 1 (maximum 5), respectively.

The group of days with no seizures comprises nearly half of the year (n = 171, 46.8%), and the group with at least one seizure (≥1 seizures) included the other 194 (53.2%) days. On the other hand, 82 (22.5%) days had two or more seizures (≥2 seizures), so they represented the group with higher seizure incidence. The maximum number of seizures per day was 5 (n = 3, 0.82%).

In Table 2 are the results of the comparison of the meteorological data between days without seizures and days with the following: A) at least one seizure and B) higher incidence of seizures. Of relevance, there was a statistically significant lower temperature (maximum, minimum, and average) only in the days with higher seizure frequency (18.6 vs. 22.4 °C, p-value: 0.004; 11.3 vs. 14.2 °C, p-value: 0.001; and 15 vs. 17.5 °C, p-value: 0.002) (Fig. 1.a). In addition, we found a statistically significant higher atmospheric pressure (1022.6 vs. 1018.6 hPa; p-value: 0.003) (Fig. 1.b) and higher maximum humidity (97 vs. 94%; p-value: 0.043) (Fig. 1.c) only in days with two or more seizures. However, when comparing days without seizures with days with at least one seizure there were not a statistically significant difference between them.

The number of hours of daylight duration was significantly lower on days with at least one seizure (11.8 vs. 12.7 h; p-value: 0.019) and in days with two or more seizures (10.8 vs. 12.7 h; p-value: 0.0001).

No difference was found in any meteorological data between the days with higher incidence of seizures and the days before these.

As shown in Fig. 2, the seizure distribution by season revealed a peak in winter (34.5%) and a nadir in spring (19.2%). Thereafter, seizure counts progressively increased: 21.8% in summer and 24.4% in autumn.

The Kruskal–Wallis *H* test revealed a statistically significant difference in seizure frequency between the different seasons, with a main effect of $\chi2(2) = 14.655$, p-value: 0.002 (with a mean rank seizure frequency of 214.76 for winter, 161.15 for spring, 174.27 for summer, and 183.15 for autumn) (Fig. 2). Posthoc comparison of winter seizure frequency with those of the other seasons revealed significant difference for spring (p = 0.0003), summer (p = 0.004), and autumn (p = 0.038). The difference between the percentage averages in winter and spring was 28.4%.

In the subgroup of first unprovoked seizures, with 117 episodes, the analysis revealed no statistically significant difference between days without seizures and days with higher seizure incidence (Table 3). However, in the other subgroup, with 190 seizures in patients with previous seizures, the same statistical significant difference described above for the all group was identified, with the exception for humidity (p-value: 0.098) (Table 4).

Table 1
Seizures characteristics, n = 307.

	n (%)
First seizure	117 (38.1)
Nocturne seizure	57 (18.6)
Seizure type	
Generalized tonic–clonic	270 (87.9)
Focal with impairment of consciousness	18 (5.9)
Focal without impairment of consciousness	19 (6.2)