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RESEARCH ARTICLE

Association of the Meteorological Parameters and Epileptic Seizures

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Abstract

Background: Climate changes may be among the triggering factors in predicting epileptic seizures. In this study, we aimed to investigate the effects of changes in weather conditions and phases of the moon on epileptic seizures in epilepsy patients.

Materials and methods: This is a dual-center, cross-sectional, observational study. The patients' age, sex, medications, and the hours of seizures were recorded. Meteorological data such as daily average temperature, atmospheric pressure, relative humidity, wind speed, and moon cycles at the time of the patients' seizures were noted.

Results: Of 110 patients who met the conditions of the study. The average air temperature was found to be 1 (-35 - + 32) °C, relative humidity 77.50% (10-100), atmospheric pressure 1018.00 (1003-1035) hPa, and wind speed was found to be 7.00 (0-26) km/hour during the hours of seizures. There was statistical significance between the annual average air temperature, wind speed and relative humidity average values, and the average values for the day of seizure.

Conclusion: Epileptic seizures are observed to intensify in epilepsy patients when temperature, relative humidity, and wind speed are low, and the moon is full. There is a need for new studies to be conducted in regions with larger populations and different climates.

Keywords

Meteorology, Epileptic seizure, Temperature, Wind speed, Relative humidity

Abbreviations

ES: Epileptic Seizures; ED: Emergency Department; SPSS: Statistical Package for Social Sciences Program; PNES: Psychogenic Non-Epileptic Seizures; GTC: Generalized Tonic-Clonic

Introduction

Epilepsy is one of the most common neurological diseases, which occurs due to different etiological reasons, is chronically recurrent and characterized by seizures. Epileptic seizures (ES) are characterized by stereotypical disorders in cognitive, behavioral, and movement functions emerging as a result of increased or synchronized neuronal activity in the brain [1]. Epilepsy is a neurological disease that can be observed at any age, significantly affects the quality of life and is encountered frequently [2]. In the meta-analysis of incidence studies, the incidence rate of epilepsy was determined to be 61.4 per 100,000 people annually [3].

In recent years, a significant increase has been observed in the prevalence of epilepsy. The reasons for the increase in the prevalence and incidence of seizures are low socio-economic status, inadequate use of health facilities, and chronic alcohol and substance use [4]. Epilepsy may differ according to the patient's age, etiology, antiepileptic drugs, psychological factors, and the frequency, severity, duration, and type of seizures [5]. It has been suggested that epilepsy patients have a seizure threshold, and this may be affected by various endogenous or exogenous (environmental) factors, including seizure-inducing and seizure-triggering factors. These factors may lead to a temporary decrease in the seizure threshold [6]. Infections, electrolyte disorders, insomnia, stress, insufficient or irregular use of medication, drug use and alcohol consumption are considered among the causes triggering ES [7].

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When we reviewed the scientific database sites, we observed that there were studies investigating the effects of changes in meteorological parameters on human health [8]. Studies were conducted on the effect of chronobiological and environmental risk factors such as the hour of the day and climatic change on significant medical emergencies such as cardiovascular diseases, cerebrovascular diseases, chronic obstructive pulmonary disease, and asthma [9-11]. Considering the correlation between ES and environmental factors, there is a general assumption that seizures may result from the interaction of the person with the environment [12]. However, the correlation of meteorological changes and moon cycles among environmental factors with ES is still not clear. This is the first study investigating the effect of meteorological parameters and the phases of the moon on the ES experience of epilepsy patients and their relationship with the medications used. In this study, we aimed to determine whether changes in meteorological parameters and moon phases have a triggering effect in patients with epilepsy.

Material and Methods

Study patients

This study was carried out after the ethics approval was obtained from the Ethics Committee of Kafkas University, Faculty of Medicine with the number 80576354-050-99/75 and with the date 06.02.2020. It was conducted as a cross-sectional study in two different university hospitals in the provinces of Kars and Erzurum in Turkey. The population of our study consisted of patients over the age of 18 who were admitted to the emergency department (ED) in one year between 06.02.2020 and 06.02.2021 and enrolled with the G40 and G41 codes according to the International Classification of Diseases -10 code classification [13].

Study design

All the patients were first evaluated by an emergency specialist. The age, sex, complaints of admission, medications, time of the seizure, duration of the seizure, and laboratory results of the patients who had ES were recorded. Seizures due to psychogenic causes were considered psychogenic non-epileptic seizures (PNES). Seizures in PNES patients often occurred after a stressor. Those below the age of 18, those taking antiepileptic drugs irregularly, those with hypoglycemia, severe head trauma, brain tumors, metabolic diseases, central nervous system infections, cerebrovascular bleeding or ischemia, alcohol, and drug use were excluded from the study. We included patients who had previously been diagnosed with epilepsy and had epileptic seizures. All this information was obtained from hospital computer data and patient files. Since the patients came to the emergency room after an epileptic seizure, the data obtained from meteorology were determined according to the time of admission to the emergency service.

Meteorological data

Meteorological data belong to the measurement station of the 12th regional directorate of meteorology, where Erzurum and Kars provinces are located. The climatic and geographical characteristics of both centers, where the study was carried out, were quite similar to each other. Due to this similarity, there were no situations that would create differences in data. Daily average-maximum-minimum temperature (Celsius), atmospheric pressure (hPa), humidity (%), wind speed (kilometers/hour) and lunar cycle (new moon, first quarter, full moon, last quarter) data, General Directorate of Meteorology of Turkey accessed from the website (mgm.gov.tr). During the study, the correlation between the phases of the moon and the number of patients who presented to the ED with ES was examined.

Statistical analysis

In the analysis of all data, SPSS (SPSS Inc., Chicago, USA) Windows 20 statistical program was used. The results were assessed according to p value and mean values. Numerical variables were expressed as mean ± standart deviation (SD), and categorical variables were expressed as percentage (%). The assumption of normal distribution was checked using the Shapiro-Wilk W-test when the sample size was < 50, and the Kolmogorov-Smirnov test when the sample size was ≥ 50. Comparison of the groups for variables with a normal distribution was performed with Student's t-test, and group comparisons for variables that did not have a normal distribution were made with the Mann-Whitney U test. In all the tests, $p < 0.05$ was considered significant.

Results

During the study, a total of 202 patients presented to ED with the complaint of having seizures. However, 35 patients were excluded from the study due to having psychogenic non-epileptic seizures (PNES). After applying the other exclusion criteria specified in the Materials and Methods section, our study was completed with the remaining 110 patients (Figure 1).

The age median of the patients was calculated to be 28 (18-83) years. When we examined the days of the week, Wednesday was the day in which ES was seen most with 26 (23.6%) cases. Considering the distribution of ES rates by month, the most cases were observed in February with 25 (22.7%) cases. In terms of seasons, ES was found to be experienced in winter at most with 53 (48.2%) cases. When it comes to hours, 57 (51.8%) cases presented due to ES between 08:01 and 16:00, which was the interval for the majority of the presentations. When we examined the phases of the moon, ES was seen mostly in the full moon phase with 39 (35.5%) cases (Table 1).

We examined these patients, who regularly used

antiepileptic drugs, in four groups by the diversity of drugs. According to the results, 51 (46.4%) patients used combined drugs, followed by 39 (35.5%) patients using levetiracetam, 11 (10.0%) patients using carbamazepine, and 9 (8.2%) patients using valproic acid.

The mean values of air temperature, relative humidity, air pressure, and wind speed during the hours of ES, standard deviations, and 95% CI values are given in Table 2.

The statistical analysis between the results of the mean air temperature, wind speed and relative humidity of the whole year and the average air temperature, wind speed and relative humidity of the days with ES was significant (p = 0.001). However, no statistical significance was observed between the annual mean atmospheric pressure value and the mean value in ES days (p = 0.141) (Table 3).

Considering the distribution of males and females suffering from ES by month, females were found to suffer from seizures more in January, February, and March, while males had seizures more in other months, especially in June, July, and August, compared to females (Figure 2).

Air temperature, wind speed, and relative humidity rates of patients suffering from ES by month are shown in Figure 3. Accordingly, the patients were observed to have seizures at temperatures between -35 °C and + 35 °C, wind speed between 0-26 km/hour, and relative humidity between 30-100%. When the months during which ES was experienced were reviewed in general, an inverse correlation was detected between the temperature value and relative humidity at the time

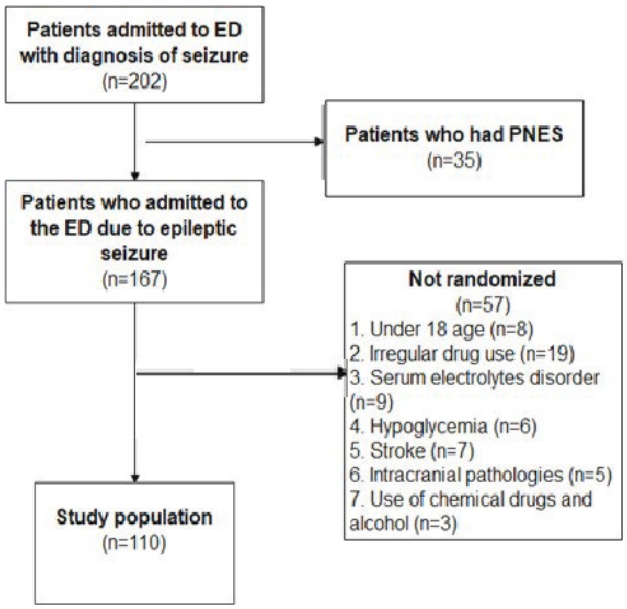

Figure 1: Flowchart of the study population.

Table 1: Demographic data of patients suffering from seizures and the categorical distribution of seizures.

		n (110)	%
Median Age (min-max)	28 (18-83)		
Gender	Male	56	50.9
	Female	54	49.1
The days of the week	Monday	20	18.2
	Tuesday	14	12.7
	Wednesday	26	23.6
	Thursday	8	7.3
	Friday	19	17.3
	Saturday	15	13.6
	Sunday	8	7.3
Months	January	16	14.5
	February	25	22.7
	March	14	12.7
	April	5	4.5
	May	6	5.5
	June	9	8.2
	July	6	5.5
	August	4	3.6
	September	1	0.9
	October	5	4.5
	November	7	6.4
	December	12	10.9
Seasons	Winter	53	48.2
	Spring	25	22.7
	Summer	19	17.3
	Autumn	13	11.8
The hours of the day	00:01 am - 08:00 am	19	17.3
	08:01 am - 16:00 pm	57	51.8
	16:01 pm - 00:00	34	30.9
The phases of the moon	New moon	24	21.8
	First quarter moon	23	20.9
	Full moon	39	35.5
	Last quarter moon	24	21.8

Table 2: Values of meteorological parameters during the hours of ES.

	Mean (SD)	**%95 CI (Lower-Upper)**
Temperature (°C)	1.1 (± 13.9)	-1.52 - 3.74
Relative humidity (%)	69.9 (± 22.3)	65.69 - 74.13
Air pressure (hPa)	1019.0 (± 6.5)	1017.83 - 1020.31
Windy speed (km/h)	8.9 (± 6.6)	7.62 - 10.14

ES: Epileptic Seizure; CI: Confidence Interval; °C: Degrees Centigrade; km: Kilometer; h: Hour

Table 3: The association between epileptic seizures and meteorological parameters.

Meteorological Parameters	Mean	Annual Mean	Mean Difference	%95 CI (Lower-Upper)		P*value
Temperature (°C)	1.1 (± 13.9)	5.7	-4.6	-7.22	-1.96	0.001
Windy speed (km/h)	8.9 (± 6.6)	12	-3.1	-4.37	-1.85	0.001
Relative humidity (%)	69.9 (± 22.3)	82	-12.1	-16.31	-7.87	0.001
Air pressure (hPa)	1019 (± 6.5)	1020	-1	-2.17	0.31	0.141

*: Student's t-test

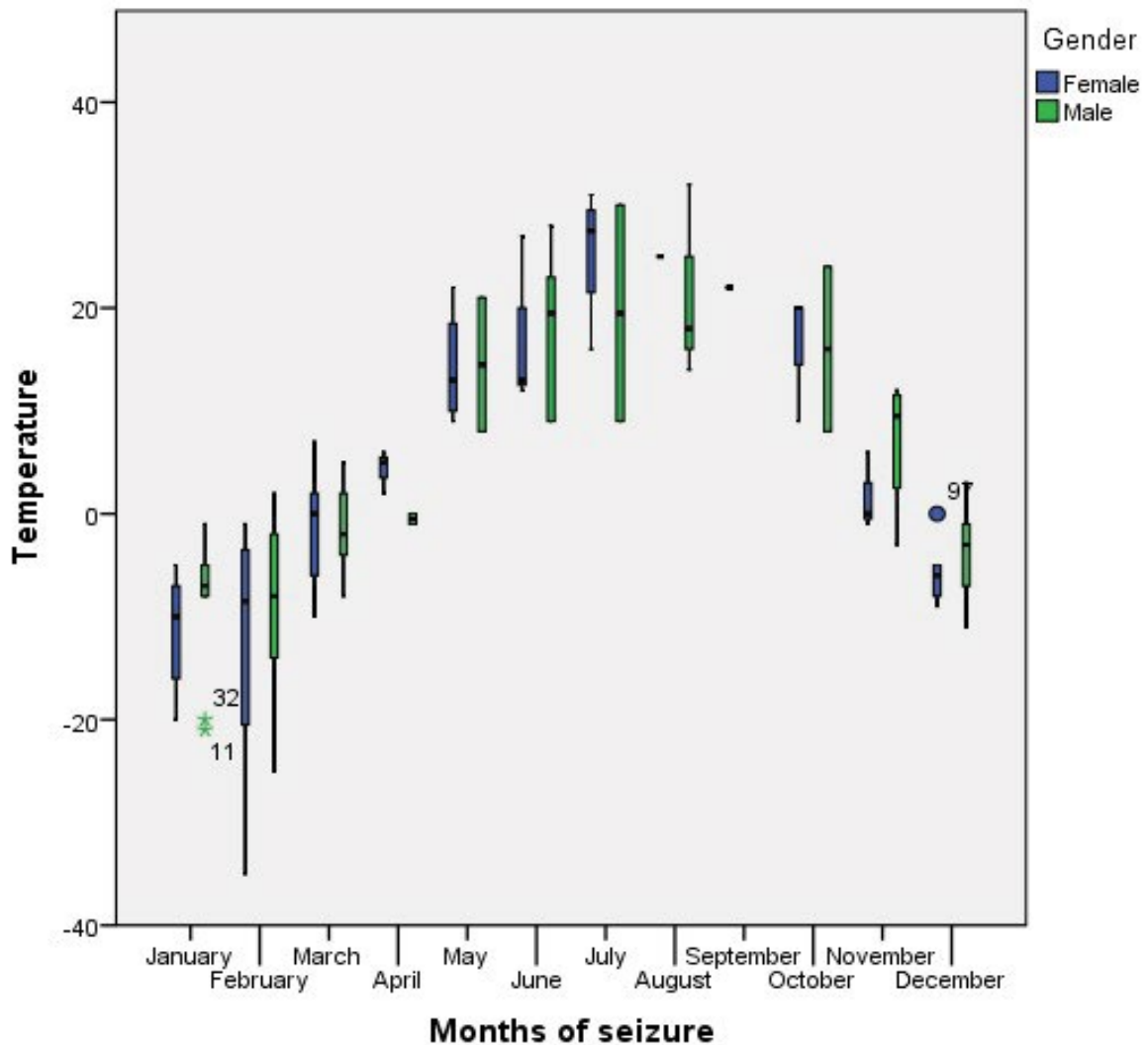

Figure 2: The boxplot comparison of the sex distribution in patients suffering from ESs by month.

of seizures (pearson correlation = -0.722; p = 0.000) (Figure 3).

When the association between the phases of the moon and meteorological parameters was assessed, no association was revealed between the phases of the moon, temperature and wind speed. However, it was observed that there was a difference between the phases of the moon and relative humidity, and seizures were suffered when relative humidity was low at full moons (Figure 4).

When meteorological parameters were evaluated according to the time periods when there were ES, ES were observed at the times when the relative humidity was lower between 08:01 and 16:00, and the frequency of having seizures was higher at these hours (Figure 5).

Discussion

Epileptic seizures: It is divided into three generalized, focal, and epileptic spasms. The subtypes of generalized seizures are generalized tonic-clonic (GTC), myoclonic, absence, and atonic. GTC seizures consist of symmetrical convulsive movements of all limbs with impaired consciousness. Myoclonic seizures are sudden, short-lived jerking movements that are not associated with a disturbance of consciousness. Absence seizures are in the

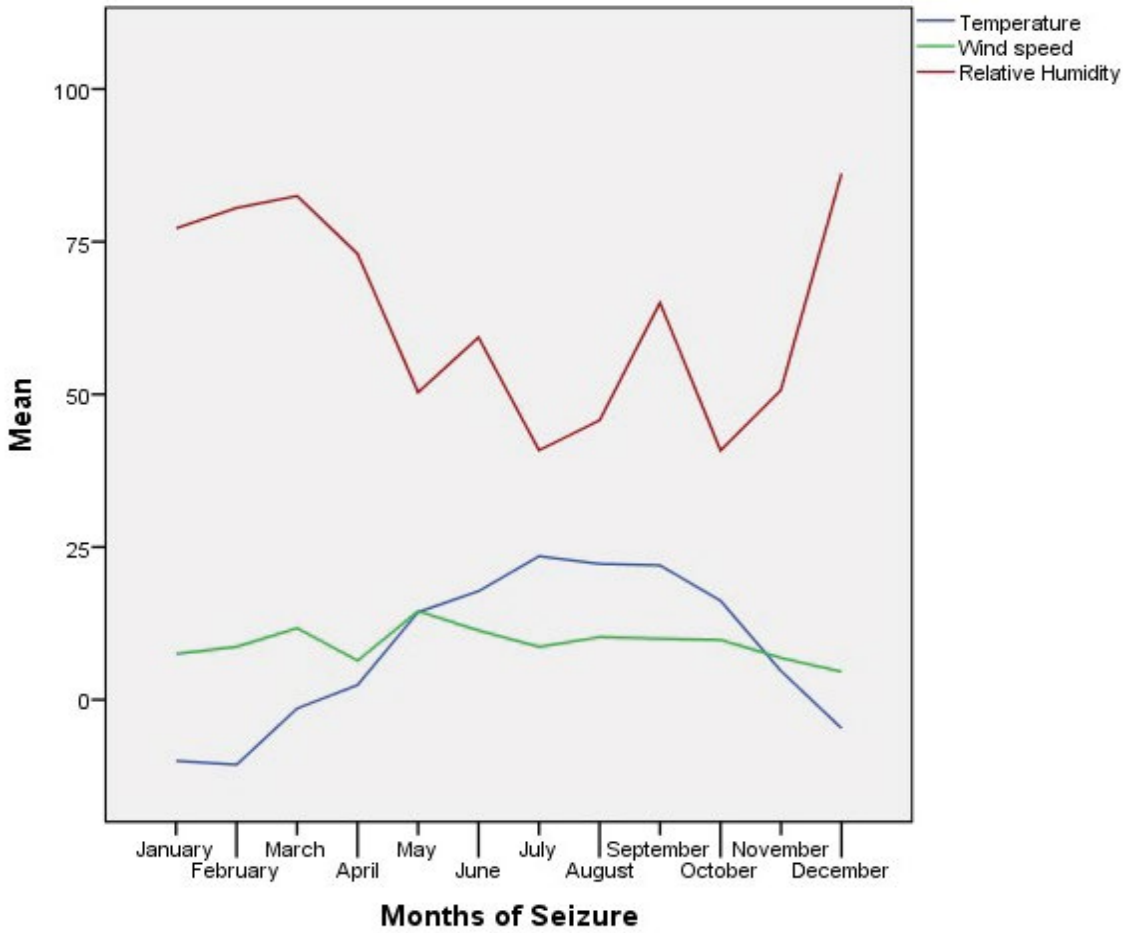

Figure 3: The temperature, wind, and relative humidity distribution of epileptic seizures by month.

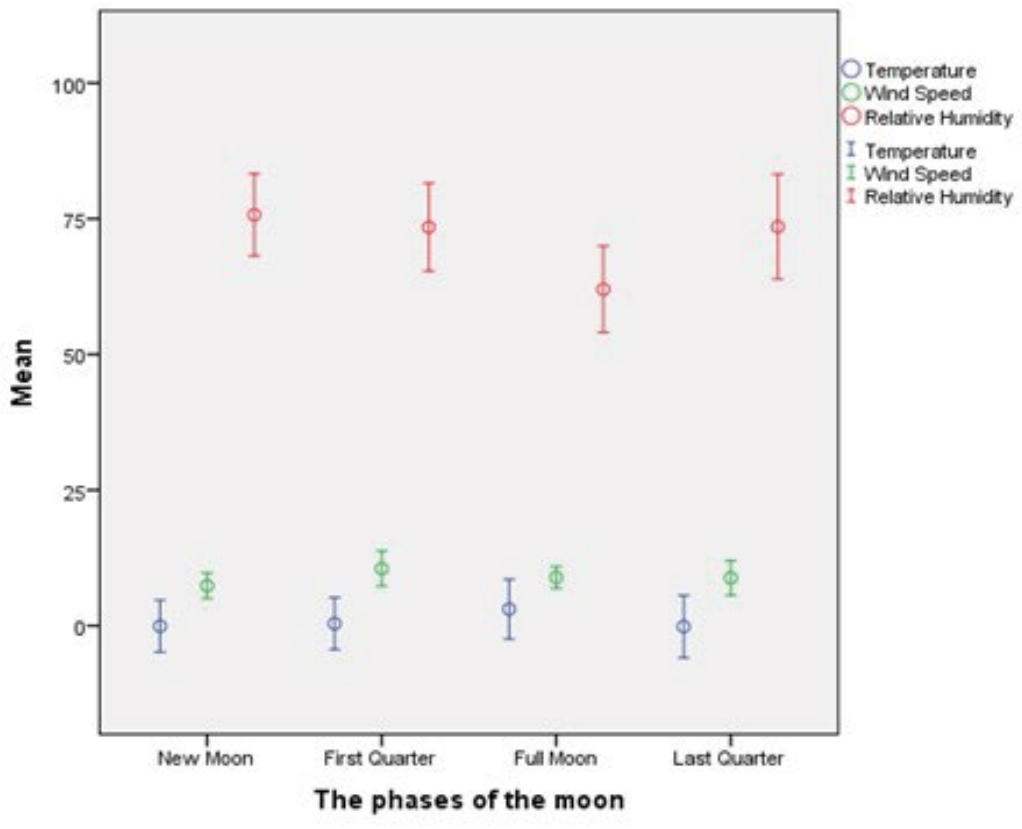

Figure 4: The boxplot comparison of the correlation of epileptic seizures with meteorological parameters according to the phases of the moon.

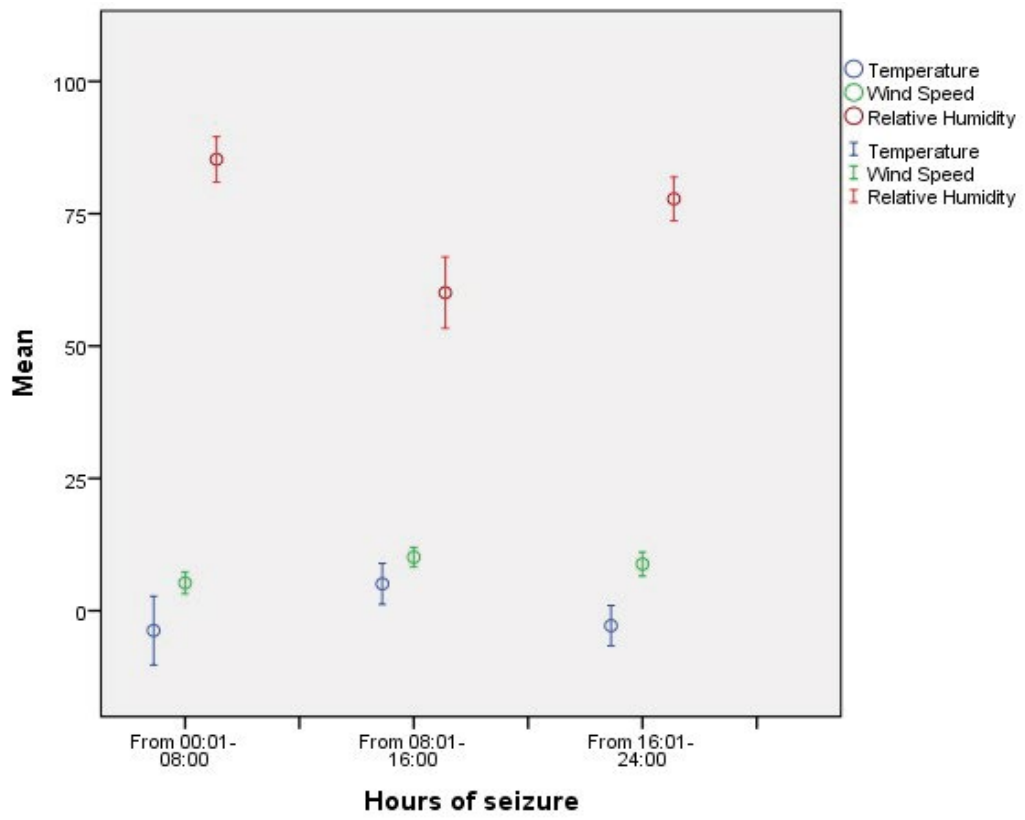

Figure 5: The boxplot comparison of the correlation of sexes with meteorological parameters according to the hours of epileptic seizures.

form of blinking, nodding, or unresponsiveness to verbal stimuli. Atonic seizures, on the other hand, usually cause a drop of the head or loss of body tone [1]. Although it is known that there are triggering factors for epileptic seizures, most of the seizures occur in an unexpected and unpredicted way [14]. In addition to it is comprehensive in terms of environmental etiological reasons, it is the first prospective study to investigate whether wind speed also has a triggering effect on seizures.

The incidence of epilepsy is higher in males than females. In the study conducted by Bilgin A. on patients suffering from ES, males constituted more than twice the number of female patients [15]. In our study, female and male percentages were very close to each other. We obtained interesting results when we evaluated the chronobiological times when ES occurred in terms of hours, days, months, and seasons. There was no statistical correlation between the incidence of EP and the degree of cloud cover or sunlight [16]. In our study, we could demonstrate that our cases had ES only on partly cloudy days by 39.1%, on clear days by 44.5%, and on heavily cloudy and rainy days by 16.4%. However, we did not assume this outcome as a cause that would trigger ES. The cases were observed to be at the peak level on Wednesdays and Thursdays [17]. In our study, we also found the highest number of cases on Wednesday. Similar to another study, the monthly average number of cases was observed to be maximum in winter months [18].

The data of our study support the perception that certain weather conditions increase the risk of seizures in most of epilepsy patients. In one study, high ambient temperatures (> 20 °C) seemed to be a protective factor for ES, while the effect of low temperatures on seizure formation could not be demonstrated [19]. In their study, Rüegg, et al. asserted that high relative humidity and high temperature were protective in terms of seizures [17]. Since cold temperature is also a well-known risk factor for cardiovascular diseases, cold air-related changes in the autonomic functioning, especially temperatures colder than 18 °C may affect the occurrence of seizures [20]. Studies conducted in different countries show that low temperatures have a potential effect on the occurrence of seizures [21,22]. In this study, in which we calculated the average temperature of the days when ES cases were observed throughout a year as 1.1 °C, the frequency of ES was higher on extremely cold days of the year.

Together with the decrease in the atmospheric air pressure, hyperventilation occurs as a result of the decrease in oxygen pressure. This mechanism can particularly affect neurological events such as seizures [23]. Another study revealed that hyperventilation was a triggering factor for ES in patients with epilepsy of the generalized type [24]. In the study of Doherty, et al. its interaction with the occurrence of seizures and the increase or decrease in the daily atmospheric pressure could not be correlated [25]. The high altitudes (around

1800 m) of both cities where we carried out our study led to low atmospheric air pressure. However, neither altitude nor cold temperature had any significant contribution, which would trigger seizures.

In their study, Rüegg, et al. referred to high relative humidity as a protective factor for epileptic seizures [17]. While high relative humidity was associated with the increase in the ES risk, low relative humidity was found to cause no changes in the risk of seizures [19]. In our study, the relative humidity was 69.9% on the days of ES, whereas the annual average value was 82%. We observed ES more frequently on the days when the relative humidity was lower than the annual average.

Headache has often been addressed in studies on the effects of wind speed. In a study conducted with randomly selected 52 headache patients, the increase in the incidence of headache caused by the wind speed in warm months was found statistically significant ($p < 0.05$) [26]. However, no studies have been conducted to examine the effect of wind speed on epilepsy to date. In this respect, our study is the first prospective cohort study carried out in its field. While our wind speed value on the days of ES cases was 8.9 km/hour, this value was 12 km/hour for the whole year. We saw that the low wind speed in the spring and summer months increased the seizure frequency.

The idea that the moon may influence human behavior is highly common, especially among neurologists [27]. The full moon or new moon cycles have been blamed as a cause for the occurrence of cardio-respiratory arrest, birth event, psychiatric exacerbations, and seizures [28]. The changes caused by the moon in the electromagnetic field of the earth via gravity are thought to trigger ES as a result of the cerebral reactions created on the water mass of the brain [29]. In a series involving 859 patients, Polychronopoulos, et al. detected an increase in the presentations to the ED due to seizures at the moon's quarter phase [12]. Benbadis, et al. could not identify an increase in the seizure frequency in patients diagnosed with epilepsy at the full moon. However, they reported that the possibility of such increases at the last quarter of the moon was high [30]. We observed that the number of ES cases increased at the full moon phase. On the other hand, the relative humidity appeared to be lower at the full moon.

In line with the data we have obtained, it is not possible to say that no meteorological changes can affect seizures directly in epilepsy patients. In addition, our study results are not highly representative of the general population.

Despite the strengths of this study, there are several limitations. The first of the limitations of our study is that the effects of the variables of weather conditions can differ according to the time spent outside. Secondly, this was a hospital-based study. Therefore, the study population did not represent the general population.

Conclusion

Among the regional meteorological parameters, low temperature, low relative humidity, low wind speed, and full moon phase may trigger seizures rather than a direct effect in epilepsy patients. In these meteorological conditions, patients' sleep patterns may be disturbed and seizures may be triggered. Unfortunately, we did not have any data to correlate this event. Our data can contribute to the limited information about the effects of meteorological changes on seizures, and more research is required to understand the definite pathomechanisms.

Declarations

Authors' contributions

LS designed and interpreted the data and was a major contributor in writing the manuscript. LS drafted the initial manuscript and reviewed and revised the manuscript. AG analyzed and interpreted the data, designed figures and critically reviewed and revised the manuscript. All authors read and approved the final manuscript.

Conflict of interest

The authors declare no competing interests.

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Ethical approval

Ethical approval for this study was obtained from the Ethics Committee of the Faculty of Medicine of Kafkas University, dated 06.02.2020 and numbered 80576354-050-99/75.

Informed consent

Informed consent was obtained from all individual participants included in the study.

References

1. Stafstrom CE, Carmant L (2015) Seizures and epilepsy: An overview for neuroscientists. Cold Spring Harb Perspect Med 5: a022426.
2. Ouellette E, Chong J, Drake K, Labiner DM (2011) Emergency department care of seizure patients: Demographic trends in southern Arizona. Epilepsy Behav 21: 382-386.
3. Fiest KM, Sauro KM, Wiebe S, Patten SB, Kwon CS, et al. (2017) Prevalence and incidence of epilepsy: A systematic review and meta-analysis of international studies. Neurology 88: 296-303.
4. Banerjee PN, Filippi D, Hauser WA (2009) The descriptive epidemiology of epilepsy. Epilepsy Res 85: 31-45.
5. Koponen A, Seppälä U, Eriksson K, Nieminen P, Uutela A, et al. (2007) Social functioning and psychological well-being of 347 young adults with epilepsy onlypopulation-based, controlled study from Finland. Epilepsia 48: 907-912.

6. Antebi D, Bird J (1992) The facilitation and evocation of seizures. Br J Psychiatry 160: 154-164.
7. Haut SR, Vouyiouklis M, Shinnar S (2003) Stress and epilepsy: A patient perception survey. Epilepsy Behav 4: 511-514.
8. Zebenholzer K, Rudel E, Frantal S, Brannath W, Schmidt K, et al. (2011) Migraine and weather: A prospective diary-based analysis. Cephalalgia 31: 391-400.
9. Manfredini R, Boari B, Gallerani M, Salmi R, Bossone E, et al. (2004) Chronobiology of rupture and dissection of aortic aneurysms. J Vasc Surg 40: 382-338.
10. Ruidavets JB, Cournot M, Cassadou S, Giroux M, Meybeck M, et al. (2005) Ozone air pollution is associated with acute myocardial infarction. Circulation 111: 563-569.
11. Low RB, Bielory L, Qureshi AI, Dunn V, Stuhlmilleret DFE, et al. (2006) The relation of stroke admissions to recent weather, airborne allergens, air pollution, seasons, upper respiratory infections, asthma incidence, September 11, 2001, and day of the week. Stroke 7: 951-957.
12. Polychronopoulos P, Argyriou AA, Sirrou V, Huliara V, Aplada M, et al. (2006) Lunar phases and seizure occurrence: Just an ancient legend? Neurology 66: 1442-1443.
13. Jette N, Beghi E, Hesdorffer D, Moshé SL, Zuberi SM, et al. (2015) ICD coding for epilepsy: past, present, and future a report by the International League Against Epilepsy Task Force on ICD codes in epilepsy. Epilepsia 56: 348-355.
14. Nakken KO, Solaas MH, Kjeldsen MJ, Friis ML, Pellock JM, et al. (2005) Which seizure-precipitating factors do patients with epilepsy most frequently report? Epilepsy Behav 6: 85-89.
15. Bilgin A, Avcı S, Ramadan H, Coşkun F (2009) Factors triggering seizures in patients presenting with epileptic seizures to the Emergency Department (ED) and the frequency of seizure recurrence during one-week period of follow-up. Van Med J 26: 206-211.
16. Baxendale S, Fisher J (2008) Moonstruck? The effect of the lunar cycle on seizures. Epilepsy Behav 13: 549-550.
17. Ruegg S, Hunziker P, Marsch S, Schindler C (2008) Association of environmental factors with the onset of status epilepticus. Epilepsy Behav 12: 66-73.
18. Chang KC, Wu TH, Fann JCY, Chen SLS, Yen AMF, et al. (2019) Low ambient temperature as the only meteorological risk factor of seizure occurrence: A multivariate study. Epilepsy Behav 100: 106283.
19. Rakers F, Walther M, Schiffner R, Rupprecht S, Rasche M, et al. (2017) Weather as a risk factor for epileptic seizures: A case-crossover study. Epilepsia 58: 1287-1295.
20. Claeys MJ, Rajagopalan S, Nawrot TS, Brook RD (2017) Climate and environmental triggers of acute myocardial infarction. Eur Heart J 38: 955-960.
21. Altimiras-Roset J, Brunet-Gomez A, Aragones J, Roura-Poch P (2014) Influence of meteorological and chronological factors in epilepsy. Rev Neurol 59: 345-348.
22. Kim SH, Kim JS, Jin MH, Lee JH (2017) The effects of weather on pediatric seizure: A singlecenter retrospective study (2005-2015). Sci Total Environ 609: 535-540.
23. Sirven JI, Claypool DW, Sahs KL, Wingerchuk DM, Bortz JJ, et al. (2002) Is there a neurologist on this flight?. Neurology 58: 1739-1744.
24. Holmes MD, Miller JW, Voipio J, Kaila K, Vanhatalo S (2003) Vagal nerve stimulation ınduces ıntermittent hypocapnia. Epilepsia 44: 1588-1591.
25. Doherty MJ, Youn J, Gwinn RP, Haltiner AM (2007) Atmospheric pressure and seizure frequency in the epilepsy unit: Preliminary observations. Epilepsia 48: 1764-1767.
26. Yang AC, Fuh JL, Huang NE, Shia BC, Peng CK, et al. (2011) Temporal associations between weather and headache: Analysis by empirical mode decomposition. PLOS One 6: 14612.
27. Vance DE (1995) Belief in lunar effects on human behavior. Psychol Rep 76: 32-34.
28. Raison CL, Klein HM, Steckler M (1999) The moon and madnes reconsidered. J Affect Disord 53: 99-106.
29. Persinger MA, Psych C (1995) Sudden unexpected death in epileptics following sudden, intense, increases in geomagnetic activity: Prevalence of effect and potential mechanisms. Int J Biometeorol 38: 180-187.
30. Benbadis SR, Chang S, Hunter J, Wang W (2004) The influence of the full moon on seizure frequency: Myth or reality?. Epilepsy Behav 5: 596-597.