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Observational Study: Examining the Meteorological Relationship Between Subarachnoid hemorrhage

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Abstract

Background: Subarachnoid hemorrhage (SAH) is a critical condition involving bleeding into the subarachnoid space, commonly presenting with severe headache, nausea, vomiting, dizziness, and loss of consciousness. It is a significant cause of morbidity and mortality, especially in middle-aged and elderly populations, with many deaths occurring within the first 24 hours of hemorrhage onset. Some studies suggest a potential link between SAH and weather conditions, but findings are inconclusive.

Aims: This study aims to investigate the relationship between climatic conditions and SAH incidence by focusing on variables such as air temperature, dew point, humidity, weather conditions, wind speed and atmospheric pressure. Thus, patients should be aware of weather changes and take necessary precautions to reduce SAH risk factors.

Methods: A retrospective study was conducted on patients diagnosed with non-traumatic SAH admitted to a tertiary care hospital's emergency department between January 1, 2023, and December 31, 2023. Inclusion criteria were definitive diagnosis of SAH in patients aged 18 and older and subsequent hospitalization. Weather data at the time of SAH diagnosis were retrospectively reviewed, including daily average air temperature, dew point, humidity, weather conditions(fair, cloudy, windy, or rainy), wind speed, atmospheric pressure, and precipitation. Data were analyzed using SPSS 25.0, employing Pearson chi-square and Fisher's exact test for group comparisons.

Results: The study included 309 SAH patients. Significant findings include a lower average dew point and higher wind speed and atmospheric pressure on days with non-traumatic SAH admissions. SAH incidence was higher on fair and cloudy days. The lowest SAH prevalence was in June, while the highest was in January. Seasonal analysis showed the highest prevalence in spring and the lowest in autumn.

Conclusion: SAH incidence varies by month and season, decreasing in June and autumn. Climatic conditions, particularly dew point, wind speed, and atmospheric pressure, are associated with SAH occurrence. Further research is needed to fully understand the impact of weather on SAH risk.

Keywords: Subarachnoid hemorrhage; weather ; month; season.

Introduction

Subarachnoid hemorrhage (SAH) is a condition where blood enters the subarachnoid space between the pia and arachnoid membranes, and it can occur due to traumatic or spontaneous causes [1]. It is an emergency medical condition typically presenting with sudden severe headache, nausea, vomiting, dizziness, and loss of consciousness [2]. SAH is a significant cause of morbidity and mortality, especially in middle-aged and elderly populations, with a substantial proportion of deaths occurring within the first 24 hours of the hemorrhage [3].

Some studies suggest a potential link between subarachnoid hemorrhages and weather conditions

[4]. Research has both supported and refuted the impact of weather and air pollution on the occurrence of aneurysmal subarachnoid hemorrhage (SAH) [5, 6]. While some studies indicate a lower incidence of SAH in summer months, additional research has found no seasonal variation in SAH occurrence [7]. High atmospheric pressure changes are particularly noted for potentially increasing the risk of SAH, possibly due to sudden and significant changes in air pressure causing blood vessel dilation and constriction, leading to changes in blood pressure within brain arteries and thus increasing SAH risk [8]. Although studies have examined the relationship between temperature, atmospheric pressure, and other weather conditions and SAH, comprehensive and conclusive research on this topic remains lacking [9, 10]. Therefore, further investigation into the relationship between subarachnoid hemorrhage and weather conditions is warranted. Patients should be aware of weather changes and take necessary precautions to reduce risk factors [11]. This study aims to examine the relationship between climatic conditions and SAH.

Materials and methods

our retrospective study includes patients diagnosed with SAH who were admitted to the emergency department of a tertiary care hospital and subsequently hospitalized in the neurosurgery department between January 1, 2023, and December 31, 2023. Inclusion criteria were definitive diagnosis of SAH in patients aged 18 and older and subsequent hospitalization. SAH patients are non-traumatic. Patients transferred to other hospitals or with incomplete data were excluded. Demographic data of the patients were recorded, and definitive SAH diagnoses were analyzed based on patient history and computed tomography scans from the hospital's electronic records. The date of admission, season, month of admission, and weather conditions were analyzed for each patient. Weather data at the time of SAH diagnosis were retrospectively reviewed, including daily average air temperature, dew point, humidity, weather condition (fair, cloudy, windy, or rainy), wind speed, pressure, and precipitation obtained via an API storing previous weather data. Patient findings were compared with seasonal and climatic conditions.

Statistical Analysis

The database in which meteorological data and case numbers were processed was analyzed with the statistical software package SPSS version 27 (IBM Co., USA), and graphics were generated with Graphpad Prism 9. Categorical data were defined as percentages and frequencies and analyzed with a chi-square test. Numerical data were determined to be normally distributed after a distribution analysis and are presented as means ± SD. The relationship between the two sets of data was analyzed with a t-test. Among the data sets, those with p values below 0.05 were considered significant.

Results

A total of 81 patients presented to the emergency department in 2023, yielding a prevalence of 0.021%. The mean relative humidity for the 289 days without a case was found to be 55.36 ± 22.11%, while the mean relative humidity for the 76 days with a case was 49.96 ± 1.94%. No significant correlation was observed between the relative humidity and the number of cases (p = 0.053). Table 1 illustrates the correlation between meteorological variables and the incidence of cases. No statistically significant relationship was identified between weather conditions and the number of cases (p=0.303) (Table 2).

Table 1 Effect of seasonal characteristics on the number of cases

Characteristics	Free (n=289)	Case (n=76)	p-Value
Temperature (Mean±SD)	22.27±8.11	21.75±7.39	0.169
Dew Point (Mean±SD)	11.43±7.35	9.88±7.85	0.496
Humidity (%)(Mean±SD)	55.36±22.11	49.96±17.94	0.053
Wind Speed (km/H) (Mean±SD)	13.5±7.4	13.46±9.82	0.010
Pressure (Mean±SD)	1007.08±6.06	1008.07±5.57	0.366

Table 2 The impact of weather conditions on the number of cases

Conditions	Free (n=289)	Case (n=76)	p-Value
Fair	143 (%49.5)	40 (%52.6)	0.303
Windy	9 (%3,1)	5 (%6.6)	
Rainy	21 (%7.3)	1 (%1.3)	
Cloudy	116 (%40.1)	30 (%39.5)	

A comparison of the number of cases according to the seasons revealed that 15.8% of cases occurred during the autumn season, which was significantly lower than the other seasons (p=0.036). Figure 1 illustrates the number of cases according to the seasons. In the comparison of cases by month, 15.8% of cases were identified in November, while no cases were observed in July. A significant difference was observed in the distribution of cases by month (p=0.014). Figure 2 illustrates the distribution of cases by month.

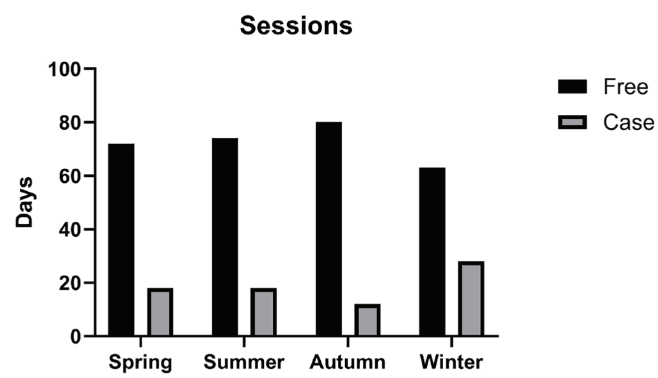

Figure 1 – Seasonal distribution of subarachnoid hemorrhages

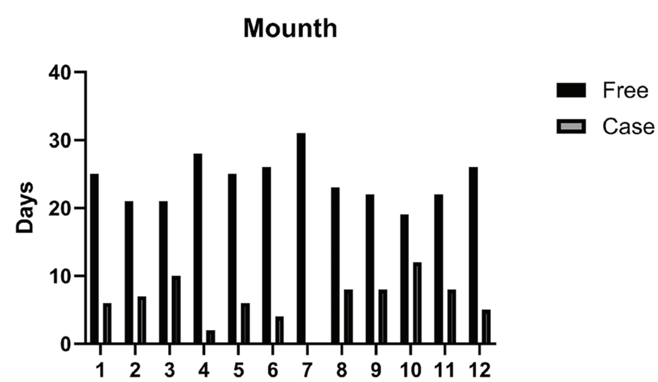

Figure 2 – Distribution of subarachnoid hemorrhages by months

Discussion

In our study, we examined the relationship between SAH incidence and seasonal, monthly, and climatic conditions such as air temperature, dew point, humidity, weather condition, wind speed, pressure, and precipitation. Our results indicate that SAH prevalence decreases in June and autumn. We found a relationship between SAH and climatic conditions such as wind speed, and higher SAH rates on fair and cloudy days.

Previous studies investigating the relationship between weather conditions and SAH have not definitively established the role of meteorological factors in SAH risk. Kockler et al. found no significant relationship between 24-hour weather changes or the absolute values of ambient temperature and relative humidity with SAH risk, reporting an uncertain SAH risk three days after exposure to high atmospheric pressure [12]. A recent multicenter study found no conclusive evidence linking weather conditions to SAH risk, suggesting adaptive mechanisms may play a role despite the lack of physiological explanations [13]. Vasquez et al. reported a potential significant relationship between ambient temperature, humidity, and SAH risk due to the sensitivity of cerebral perfusion to PaCO2 variability [14]. Another study suggested that changes in atmospheric gases leading to hypocapnia could contribute to SAH incidence, with high and low temperature combinations being associated with SAH occurrence [15]. Gill et al. found that a one-day drop in temperature and colder daily temperatures were linked to an increased risk of aSAH cases, independent of season, particularly during autumn when transitions from warm to cold occur [8]. A detailed review found an association between spontaneous SAH and temperature and humidity [16]. Lai et al. reported that increased sunshine and higher average morning humidity were associated with reduced hospital admissions due to ruptured cerebral aneurysms [16]. Our findings align with these studies, showing a relationship between SAH and wind speedwith higher SAH rates on fair and cloudy days.

Seasonal and monthly variations in SAH incidence have also been noted, with increased SAH admissions in winter and January linked to reduced sunlight [16]. Peters et al. found that SAH occurrence varied with seasons, being less frequent in summer and most common in January [17]. McDonald et al. showed that SAH was unrelated to temperature but was linked to climate, independent of mortality [18]. Huang et al. identified peak SAH onset periods in March (spring) and December (winter), with cold and extreme atmospheric pressure as triggers [19]. Our study found similar results, with reduced SAH prevalence in June and autumn.

Limitations

Our study has some limitations. The relationship between disease factors and climate changes could not be fully determined. Additionally, it was not possible to precisely identify sudden climatic fluctuations based on weather information at the time of admission. The exact onset time of the disease and symptoms was also unknown, representing a significant limitation. Prospective and multicenter studies are needed to understand the value of our findings.

Conclusıons

SAH admissions vary by month and season, with decreased prevalence in June and autumn. We found a relationship between SAH and dew point, wind speed, and pressure, with higher SAH rates on fair and cloudy days.

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