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Original Article

Correlation of Variation in Weather Conditions and Non-Traumatic Intracerebral Hemorrhage (NTICH)

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Abstract

Objective: To assess the correlation of non-traumatic intracerebral hemorrhage with variation in weather conditions in Sialkot.

Methods: A cross-sectional survey was conducted, 178 patients that reported with intracerebral hemorrhage at the emergency department were included in this study. After the diagnostic confirmation through imaging studies patients' demographic information, month of ICH was recorded. Weather pattern (low, high, and average temperature) corresponding to the incidence of ICH were also recorded. The frequency of NTICH was calculated by measuring the NTICH event reported at the study setting during each month of the year. The relationship between NTICH frequency with seasonal variations and the risk factors was measured using Pearson correlation at $p \leq 0.05$ level of significance.

Results: Statistically strong relation was found between the number of NTICH cases reported with the variation in average temperature corresponding month ($p=0.01$) as well as the seasonal variation ($p=0.01$). Similarly, strong positive relation of hypertension with frequency of NTICH cases ($p=0.01$).

Conclusion: There is increased risk of non-traumatic intracerebral hemorrhage during winter months, especially with ambient temperature around less than 10°C. This risk specifically high in patients with known comorbidity of hypertension.

Keywords: Hypertension, Non-traumatic intracerebral hemorrhage, Cold Weather, Seasonal Variation.

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Introduction

Non-traumatic intracerebral hemorrhage (NTICH) indicate bleeding within the brain parenchyma due to loss of integrity of cranial vessel without any external cause or trauma.[1] It has an annual incidence of 24.6 per 100,000 individuals, it is a serious condition with high mortality and morbidity and poor prognosis.[2] It leads to permanent disability including cognitive impairment, mental and emotional disorders along other symptoms.[3] The estimated global annual incident of intracerebral hemorrhage (ICH) 29.9 per 100000 per year.[4] Asians have the highest incident of ICH than any other population with 51.8 per 100000 person per year.[5]

As compared to ischemic stroke, mortality and morbidity associated with ICH is high.[6] There are several risk factors of NTICH such as hypertension, aneurysm, altered hemostasis, cerebral amyloid angiopathy, hemorrhagic necrosis due to neoplasm or infection, hypocholesterolemia, chronic kidney disease and cerebral microbleeds, smoking, excessive alcohol consumption, drugs use, old age, male sex, Asian ethnicity.[7,8] Simultaneous variations in meteorological conditions leads to several weather changes such as humidity, temperature, and air pressure. These changes in turn have known to influence various human body health conditions including cardiovascular events, respiratory diseases are influence by it. In recent decade research have indicate that there might be a relationship between intracerebral hemorrhage and changes in weather conditions.[9,10,11]

NTICH association with weather has been discussed in literature, studies have showed association of seasonal pattern with incidence of NTICH.[7,9-11] Higher number of cases reported during winters, with a positive association with colder temperature.[12] Various different plausible explanation has been described in studies for this association from lower temperature, blood vis-

cosity, platelet count, and arterial pressure.[13-15] Similarly, lower ambient temperatures tend to cause peripheral vasoconstriction, which increase arterial blood pressure and the risk of ICH.[16] Although these findings are inconsistent, and the exact mechanism of this association weather conditions, and increased risk of non-traumatic ICH is still not clear.[17]

Understanding the relationship between weather patterns and NTICH has important clinical implications. It can help clinicians identify high-risk periods and populations, allowing for targeted preventive strategies and enhanced patient management. Additionally, knowledge of weather-related risk factors may prompt individuals to take necessary precautions, such as maintaining optimal blood pressure control, staying hydrated, and adjusting medications as recommended during extreme weather events. Further research is required to establish causality and elucidate underlying mechanisms, healthcare providers should be aware of the potential impact of weather on ICH risk. Increased understanding of this relationship can contribute to improved prevention, early detection, and management of NTICH, ultimately leading to better patient outcomes. The aim here is to assess the correlation of NTICH with variation in weather conditions in Sialkot.

Methods

A descriptive cross-sectional survey was conducted at Government Allama Iqbal Memorial Teaching Hospital, Sialkot. Patients that reported with ICH at the emergency department Government Allama Iqbal Memorial Teaching Hospital, Sialkot over the course of one year from 1st November 2021 to 31st October 2022. After the diagnostic confirmation through imaging studies using magnetic resonance imaging (MRI) and/or computed topography (CT) a total 178 patients were included in this study. Their demographic information, age, gender and medical history was recorded as well as date and month of ICH was reported. Patients with the history of trauma, secondary complication or neoplasm were excluded from the study. Weather pattern corresponding to the incidence of ICH were also recorded. Information such the low, high, and average temperature were recorded for a year from November 2021 to October 2022. Seasonal boundaries were also recorded for the city of Sialkot for this period.

Statistical Analysis: Frequencies and percentages were calculated for all the demographic characteristics including age, gender, and risk factors, as well as the weather conditions including annual temperature variations, seasonal variations. The frequency of NTICH was calculated by measuring the NTICH event reported at the study setting during each month of the year. The seasonal variations in NTICH frequency were also measured. The relationship between NTICH frequency with seasonal variations and the risk factors was measured using Pearson correlation with $P \leq 0.05$ level of significance. Statistical Analysis was done using Statistical Package for Social Sciences (SPSS) version 26.

Results

Participant characteristics: A total of 178 participants were include in this study of which 55.1% were male and 44.9% were female, majority of the participants 68% were between 40-60 years of age. The complete demographic characteristics of NTICH patients in Sialkot are presented in Table 1. The high, low, and average temperature recorded for each month during the course of the study a recorded (Graph 1). The highest temperature (41.8°C) was recorded during the month of June and lowest temperature (8.7°C) was recorded in January. The seasonal boundaries for the city of Sialkot as identified by Pakistan meteorological department, winter comprised of month of December, January, and February. Spring season included March, April and May months; summer month included June, July, and August. Autumn consisted of month of September, October and November.

Table 1: *Demographic Characteristics*

Variables	Categories	N	Percentage
Age	20-40	30	16.9
	41-60	121	68
	61-80	27	15.2
Gender	Male	98	55.1
	Female	80	44.9
Risk Factors	Hypertension	153	86
	Diabetes	78	43.8
	Smoking	70	39
	Ischemic Heart Disease	21	11.8
	Chronic Kidney Disease	15	8.4

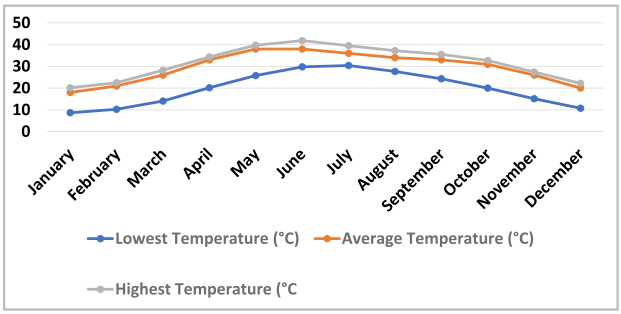

Figure 1: *Showing Annual Average Lowest and Highest Temperature Variations*

The high, low, and average temperature recorded for each month during the study a recorded. The highest temperature (41.8°C) recorded in June and lowest temperature (8.7°C) recorded in January.

Incidence of NTICH: Number of cases of NTICH reported in each month were calculated, highest frequency of NTICH was recorded during the month of December 2021 (24 cases) followed by January 2022 (21 cases) and February 2022 (20 cases). The lowest number of NTICH cases were recorded during summer months with June and July 2022, reporting 7 NTICH cases each (Table 2).

Table 2: *Reported NTICH Cases and Average Temperatures of 12 Months (2021-22)*

Month	Ntich Frequency	Percentage	Average Temperature (°C)
November	20	11.2	26
December	24	13.5	20
January	21	11.8	18
February	20	11.2	21
March	16	9	26
April	13	7.3	33
May	9	5.1	38
June	7	3.9	38
July	7	3.9	36
August	9	5.1	34
September	14	7.9	33
October	18	10.1	31
Reported cases of non-traumatic intracerebral hemorrhage in a year on average monthly temperature (°C), p=0.01			

Relation of NTICH frequency with Temperature and Seasonal Variation: A statistically significant relation was observed with each variation in average temperature corresponding month with p value= 0.01. (Figure. 2). Similarly, the seasonal variation was also observed to be significantly related with the frequency of NTICH cases (p=0.01).

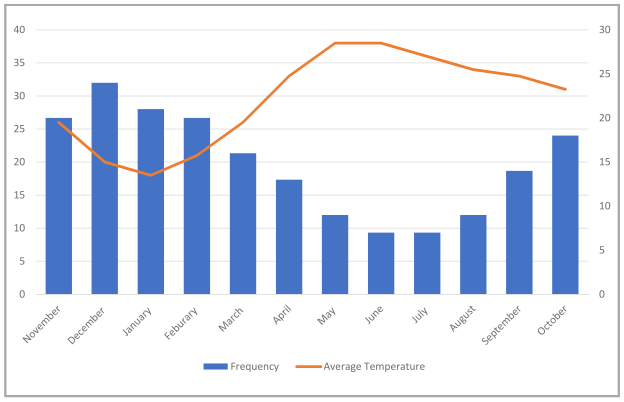

Figure 2: *Showing all the Changes in NTICH frequency with Temperature Variation*

Table 3: *Frequency of ICH Patients Admission in Four Seasons*

Season	Frequency	Percentage	P-Value
Winter	65	36.5	0.01*
Spring	38	21.3	
Summer	23	12.9	
Autumn	52	29.2	
Seasonal variation and frequency of non-traumatic intracerebral hemorrhage patients in hospital (2021-22), *significant correlation with p=0.01			

Relation of NTICH frequency with Risk Factors: The relation of NTICH frequency was measured against the prevalent risk factors, it showed a strong positive relation of hypertension with frequency of NTICH cases (p=0.01) as shown in figure 3 (Table 3).

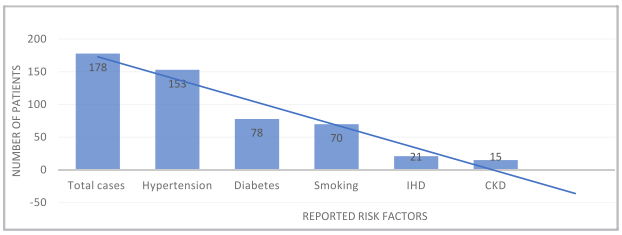

Figure 3: *Showing Risk Factors in NTICH Patients*

Discussion

The present study has showed that there is a relation of NTICH with temperature, which aligns with previous studies, which have reported a link between weather patterns and cerebrovascular disease.[7, 9-13, 15] Similarly, low ambient atmospheric temperature tends to increase the risk of ICH. Prior literature has tried to determine these change over hourly, day, month, and seasonal levels. Large temperature fluctuations within the 72 hours are more likely to influence NTICH incidence.[18]

The results have indicated that Increase in ambient temperature reported an inverse correlation with the incidence of ICH specifically high incidence of ICH was reported when the high ambient temperature is less than 8°C, these finding correspond to study conducted by Yamada and Natori where increase in incident of NTICH was observed at temperature below 17°C.[19] Similarly, another study reported the onset of NTICH is associated with lower temperatures, especially if the temperature falls below 10°C. Some studies have reported along with low ambient temperature duration is also important as the incidence of ICH increases if the ambient temperature decrease for two-three days prior to onset.[20] Although most of the prior literature emphasize that more persistent change in temperature can leads to NTICH, one study did report that exposure to sudden extreme temperature changes can be a caused for NTICH.[9,21]

Current study have reported a number of risk factors, such as Hypertension diabetes, smoking, ischemic heart disease, chronic kidney disease, with hypertension. Though several modifiable and unmodifiable risk factors exist, by far the greatest risk factor for NTICH is hypertension. The risk factors identified are in line with previous literature.[22] In a country like ours a large majority of the population is unaware of the established risk factors of NTICH. Only a small portion is aware of their hypertension and diabetes. It is essential to understand meteorological parameters as risk factors and mechanism by which temperature influence the incidence of NITCH.[23] Although hypertension is proven to be the most crucial risk factor, increasing age along with these factors further increase the risk of NTICH and incidence of hemorrhagic stroke in high in elderly.[24]

Our study has observed an inverse relationship with the ambient temperature and blood pressure, our finding align with several epidemiological studies that investigated and reported same trend between ambient temperature and blood pressure. According to these studies colder temperatures effects on the systemic arterial pressure are presumable cause of increase incident of NTICH.[25-28] Exposure to significant decreases in temperature can cause elevation in acute blood pressure. Although these temperature fluctuations lead to only small rise in blood pressure, but in an already hypertensive patient this would translate to an increased risk for NITCH.[9] Seasonal variations also bring about atmospheric temperature changes, these changes evidently influence the incidence of NTICH as the finding here has demonstrated. More than half of the cases were reported in during colder seasons like autumn and winter, with winter seasons reporting the most. Similar pattern was reported in studies from other countries around the world where incidence and outcome of ICH showed association with seasonal fluctuations.[29-36]

There are certain limitations of this study. One of the main limitations of this study is that it is restricted to a single center with limited sample size. A broaden scope on the subject would further understand the matter. To establish cold weather as risk factor for NTICH, large scale studies should be conducted. Research is needed to identify the underlying biological mechanism which are triggered due to weather variations. Awareness programs to prevent hemorrhagic stroke should consider measures to address environmental risk factors especially cold exposure. On individual level a better understanding of these factors so that patients and care givers can devise strategies, protection methods during these weather condition and avoid the incidents of NTICH from occurring.

Conclusion

Current evidence supports the influence of low temperature on incidence of intracranial hemorrhage as reported from prior studies. Hypertension as the most crucial risk factor for NTICH. Increased risk of ICH at low temperature with increasing age. The findings of the study indicate a significant relationship between colder temperature and winter months with non-traumatic intracerebral bleeding and the incidence of NTICH is not a chance event.

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