

## RISK FACTORS OF STROKE AND SEASONAL VARIATION IN ITS INCIDENCE IN VIGAN CITY, PHILIPPINES

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**DOI No. – 08.2020-25662434**

### *Abstract*

*Stroke is one of the most worrisome diseases troubling mankind today. The increasing unwholesome lifestyles and industrialization, with the associated global warming, are some of the contributing factors to stroke incidence. The Philippines has also shared in the ravaging effects of stroke. According to World Health Organization, stroke is the second leading cause of death, after coronary heart disease, in the Philippines. However, virtually no research has been conducted to study the seasonal variation in stroke incidence in the Philippines. Thus, this research deemed it necessary to study risk factors of stroke and seasonal variation in its incidence in Vigan City, Philippines. A retrospective descriptive cross-sectional study design was used in this study. A review of hospital records of 303 patients admitted for stroke from January-December, 2017 was done at Ilocos Sur Provincial Hospital, Vigan City. Statistical data was interpreted using Excel Data Analysis Tools. There was a significant difference in the stroke occurrence among the three seasons in Vigan City--Wet season (40%), Dry-cold (33%), and Dry-hot (27%). From the results, hypertension was the most common risk factor, followed by smoking, concomitant heart disease, diabetes mellitus, obesity, family history of stroke, and asthma. Stroke incidence varies with seasons in Vigan City, with highest incidence in the cold season, whether dry or wet, and hypertension as the most common risk factor.*

**Keywords:** *Stroke, Risk factors, Seasonal Variation, Incidence, Philippines*

### INTRODUCTION

Stroke, also known as Cerebrovascular accident (CVA), is one of the leading causes of death in the world today. A stroke is a sudden interruption in the blood supply of the brain. It is the abrupt onset of neurological deficit which results from focal vascular ischemia or hemorrhage. It occurs when a blood supply to the brain becomes interrupted (ischemic stroke) or when a blood vessel is ruptured (hemorrhagic stroke); depriving the brain of oxygen and nutrients, which eventually can cause the brain cells to die. About 85 percent of strokes are ischemic strokes. Ischemic strokes occur when the arteries to the brain become narrowed or blocked, causing severely reduced blood flow (ischemia)<sup>2</sup>. Hemorrhagic stroke occurs when a blood vessel in the brain leaks or ruptures (Xian Y, et al, 2012).<sup>31</sup> Brain hemorrhages can result from many conditions that affect your blood vessels, including uncontrolled high blood pressure (hypertension), overtreatment with anticoagulants and weak spots in the blood vessel walls (aneurysms).<sup>2</sup> A less common cause of hemorrhage is the rupture of an abnormal tangle of thin-walled blood vessels (arteriovenous malformation) present at birth.<sup>2</sup> Some people may experience only a temporary disruption of blood flow to their brain; hence another type of stroke called transient ischemic attack, or TIA. In TIA, the symptoms last for only a short time, like less than an hour (O'Donnell, 2017).<sup>18</sup> Like an ischemic stroke, a TIA occurs when a clot or debris blocks blood flow to part of

the brain. A TIA does not leave lasting symptoms because the blockage is temporary. Because stroke occurs rapidly and requires immediate treatment, stroke is also called a brain attack.

According to the World Health Organization, stroke is the second leading cause of death in the world, and also in the Philippines, after coronary heart disease. In the Philippines, it has a prevalence of 0.9%—ischemic stroke comprises 70% while hemorrhagic stroke comprises 30%. Out of the total deaths in the Philippines, WHO published that 12.4% (63,261 deaths) are caused by stroke, with the age adjusted death rate as 119.21 per 100,000 populations, thereby ranking the Philippines 54th in the world.

In the Philippines, just like elsewhere in the world, many factors—certain traits, conditions, and habits—can raise the risk of having a stroke. These traits, conditions, and habits are known as risk factors. Some risk factors can be controlled—thus, they are known as modifiable risk factors while other risk factors cannot be controlled—hence, they are known as non-modifiable factors. The major risk factors for stroke include high blood pressure, diabetes, heart diseases, smoking, age and gender (the risk increases with age), race and ethnicity, family history of stroke, brain aneurysms or arteriovenous malformations. The incidence of stroke increases with age, with the incidence doubling for each decade after 55 years of age.<sup>3</sup> At younger ages, men are more likely than women to have strokes. However, women are more likely to die from strokes. Contrarily, Kapral M.K., et al (2005) claimed that at young ages, women had as high or higher risk of stroke as men, although at older ages the relative risk is slightly higher for men.<sup>8</sup> Other risk factors are alcohol and illegal drug use, certain medical conditions (like sickle cell disease, vacuities and bleeding disorders), lack of exercise, obesity, stress and depression, unhealthy cholesterol levels, unhealthy diet, and use of no steroidal anti-inflammatory drugs (NSAIDs), but not aspirin, particularly in patients who have had a heart attack or cardiac bypass surgery. Of all the risk factors, hypertension is the major risk factor for stroke.

Furthermore, stroke occurrence has been believed to be influenced by seasons and climatic changes. However, the studies done so far on seasonal variation in the incidence of stroke have marked discrepancies in the results. For example, Oberg, et al., (2000), concluded that strokes occur more in mid- to late spring in America,<sup>19,25</sup> while Takizawa, et al.,(2013), in their own study, concluded that there was a temporal variation of stroke incidence in Japan, with different patterns of variation depending on stroke subtype.<sup>27</sup> Meanwhile, in Taiwan, Lee HC, et al, (2008) concluded that seasonality of ischemic stroke was not in existence in the country, emphasizing that ischemic stroke significantly related to atmospheric pressure.<sup>10</sup> In India, Raj .K, et al, (2014), a journal published a study, where the diurnal rhythm timing was incorporated into the research. 583 patients who they documented showed an obvious relationship of the occurrence with time of the day, where there is greater occurrence in the morning hours than the afternoon hours. They noted a slight increase of occurrence of stroke between November and February; they did not believe stroke has got a seasonal variation.<sup>20</sup> In Seoul, South Korea, a group of researchers led by Han M.H, YI .H.J, and Kim .Y.S, (2015) carried out a research on the effect of seasonal and monthly variation. They involved a different variable like air pollution, when they narrowed down to different types of stroke. They found out that ischemic stroke has a strong predilection for occurring during summer, while intracerebral stroke has no relationship with the weather, but has a strong relationship with the concentration of carbon monoxide in the Atmosphere.<sup>5</sup>

Zheng. H, et al, (2017), on their own, carried out a different research to correlate the level of atmospheric pollutants and hospital emergency room visit for stroke. Thus, they discovered a positive correlation for Sulphur (IV) Oxide, Nitrogen (IV) Oxide, and Particulate matter in Autumn, with the occurrence of stroke<sup>30</sup>. However, Israeli scientists, Telman .G, et al, (2017) spread their own research across seasonality in weekdays. They discovered that intracerebral hemorrhage does not appear to have any inclination towards any particular period, be it weekday or weekend<sup>28</sup>. In a high resolution analysis published on world Neurosurgeon journal, Neidert M.C, et al, (2016), discovered that there was no clear influence of meteorological parameters like pressure, temperature, relative humidity, wind gusts, and precipitation, and intracerebral incidence<sup>17</sup>. Incidentally, an obvious contrasting result was recorded in a temperate country, Finland. According to Sipila J.O., et al, (2017) in that study, the rate of stroke ironically reduced in summer and had pointer that it rather increased in Autumn.<sup>25</sup> In a research conducted in the southern part of Africa, Mozambique, Joana, G. et al (2017) got results that were in affirmative with that of Finland, and found out that the rate increased slightly with immediate drop in temperature.<sup>7</sup> In Buenos Aies, Argentina, [Díaz A](#), et al (2017), published a research titled seasonal variation and trends in stroke hospitalizations and mortality in a South American community hospital, where they discovered that the crude seasonal stroke attack rate (ischemic and hemorrhagic) was highest in winter and lowest in summer and that Stroke admissions followed a seasonal pattern.<sup>4</sup> In Canada, [Alorizi S.M](#), et al (2016) conducted a research which they captioned Stroke in Canon of Medicine. From the study, they concluded that Avicenna has cited in Canon of Medicine that women have cold and wet temperament compared to men.<sup>1</sup>

In the same vein, Williams B.G, et al (2017) conducted a research in Hong kong, where they found out that the predilection between various meteorological interplay and stroke have an increased incidence at days when the temperature drops sharply, as published in international journal for Biometereology. Again, from their research, it appeared that women and older men are at higher risk for the effect.<sup>29</sup> Heweh .C, et all, (2017) published a report where they considered air pressure and temperature on the day of attack. They also considered the anatomical location of the severed artery (Basal ganglia, cerebellum, and the lobar artery)<sup>6</sup>. They therefore concluded that air pressure has more significant contribution than temperature, and that it has a predilection to younger age.

Slatina, E, et al, correlated the changes in air humidity and the incidence of stroke, concluding that only old age has a predilection for stroke, with the highest percentage between 70-79 years of age.<sup>26</sup> Meanwhile, Reary. M, et al explored the periodicity of cardiovascular events in Switzerland.<sup>21</sup> Their variables were hospitalizations and deaths in relation to season, days of the week, and hour of the day. They found out that the day did not count, the hospitalization was less in summer but the timing of the day has a positive correlation with two peak periods (8-12am, and 2-6 pm). While in Puerto rico, Mendez-Lazaro, P., et al, correlated the effect of extreme summer heat with occurrence of different disease etiologies like hypertension, diabetes, lower respiratory tract diseases, and cardiovascular diseases in the tropical country of Puerto rico<sup>15</sup>. They concluded that there was significant increase in cardiovascular events (stroke and cardiac events) in the extreme heat period of summer of 2012-2013. Somewhere in Beijing, China, Li .T, Horton R.M, et al, (2017) did a study on Long-term projections of temperature-related mortality risks for ischemic stroke, hemorrhagic stroke, and acute ischemic heart disease under the

changing climate in Beijing, China, as published on the Environmental International Journal. From their findings, they projected that the temperature-related mortality associated with ischemic stroke would increase dramatically due to climate warming.<sup>11</sup>

Meanwhile, in South Korea, Lim J.S Kwon H.M, et al (2017) researched on Effects of Temperature and Pressure on Acute Stroke Incidence Assessed Using a Korean Nationwide Insurance Database. After a rigorous analysis, they arrived at the conclusion that temperature change during the day was positively correlated with ischemic stroke in men and older patients ( $\geq 65$  years), and that diurnal temperature change, temperature differences over the preceding 24 hours, and diurnal variation of atmospheric pressure were associated with daily stroke incidence<sup>12</sup>

Contrarily, Kintoki, F., et al, (2017), in their own research, titled Impact of Seasons on Stroke-Related Morbidity and Mortality in Kinshasa, Congo, found out that while it seemed there was no much impact on seasonal variation, there was a significant increase in ischemic stroke with reduction in temperature, and that there seemed to be a significant increase in the events of hemorrhagic stroke with increase in temperature<sup>9</sup>. On the Journal Chronobiology International, Mao Y., Schnytzer Y., Busija L., et al, (2015), published their hospital-based study of "Moonstroke: Lunar patterns of stroke occurrence combined with circadian and seasonal rhythmicity", which measured the association of stroke incidence with a particular lunar phase using an incidence rate ratio. In that research, they found no association between lunar phase or illumination and ischemic stroke. They also discovered that all stroke subtypes were less likely to happen between 12 am and 6 am than the remaining 18 hours of the day. According to them, ischemic stroke occurrence was significantly higher during the spring than summer. For the patients older than 65 years, they maintained the incidence of both intracerebral hemorrhage and Ischemic hemorrhage was higher in spring than in summer. The lunar phase and illumination are associated with both intracerebral hemorrhage and transient ischemic attack incidence (TIA).<sup>14</sup>

Incidentally, in Kyoto Japan, Shigematsu K., et al (2015), carried out a research on higher ratio of ischemic stroke to hemorrhagic stroke in summer. From their analysis, they concluded that Seasonal variations differed among stroke subtypes. The ratio for cerebral hemorrhagic/cardioembolic stroke and for subarachnoid hemorrhagic/cerebroembolic stroke was lower in summer and higher in the rest of seasons independent of age, gender, and risk factors<sup>24</sup>

Indeed, it is expected that a similar study would have been done in the Philippines, considering the high rate of stroke occurrence in the country. But unfortunately, no such research had been conducted yet in the Philippines. Although researchers have continued to study the causes and risk factors for stroke, the increasing incidence of stroke over the years in the country has proved that more studies are needed to be done on this subject. Therefore, we considered it necessary to conduct similar research in the Philippines to determine if there is seasonal variation in the incidence of stroke, using the citizens and residents of Vigan City as the target population. This is because the knowledge of seasonal influence on the incidence of stroke would be useful in preventing and reducing the high occurrence of stroke in the Philippines. Thus, the aim of this research is to study the risk factors of stroke and seasonal variation in its incidence in Vigan City,

Ilocos Sur, Philippines.

### STATEMENT OF THE PROBLEM

The main objective of this study is to determine the risk factors of stroke and seasonal variation in its incidence in Vigan City, Ilocos Sur, Philippines January 2017-December 2017.

Specifically, this study seeks to answer the following questions:

1. What is the profile of stroke patients in Vigan City, Philippines?

Demographic profile:	Clinical profile:	Family history: History of stroke and other heredofamilial diseases in:
Age	History of present illness	Parents
Gender	Date of onset—what season (dry or wet season)?	Siblings
Civil status	Past medical history—Hypertension, Diabetes, Heart diseases, Certain medications, etc	Spouses
Location		Children

2. What are the risk factors?

Modifiable Risk Factors	Non-modifiable Risk Factors
Smoking	Age
Alcoholism	Gender
Physical activity	Family history
Weight management (Obesity)	Race and ethnicity
Nutrition	

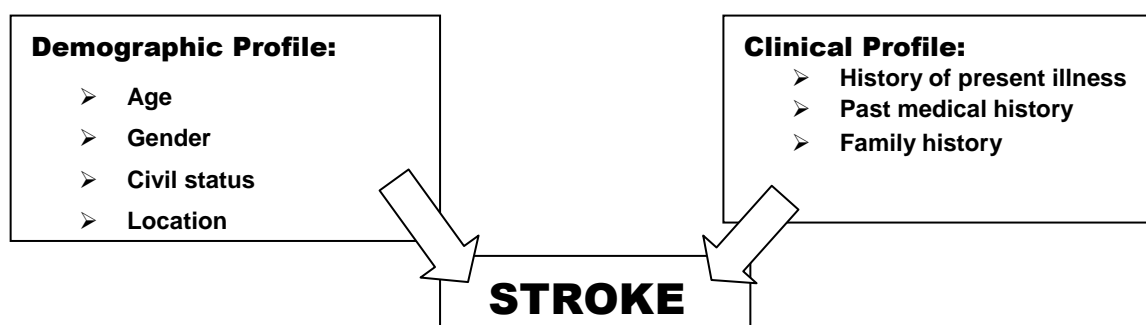
3. What is the incidence of stroke in incidence of stroke in wet season, dry-cold season and dry-hot season in Vigan City, Philippines?
4. Is there a significant difference in the incidence of stroke compared among the three recognized seasons?
5. Is there a significant contribution of risk factors to the incidence of stroke?

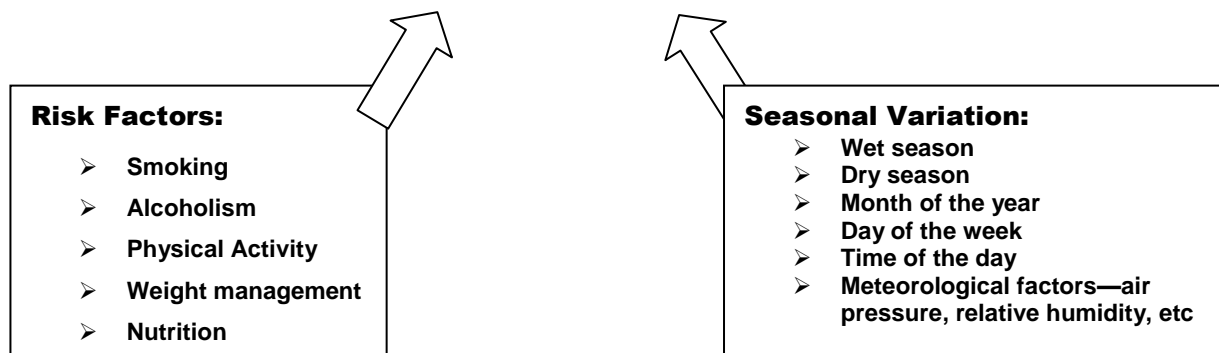
### SCOPE AND DELIMITATIONS

A retrospective descriptive cross-sectional study design was used in this research to determine the risk factors of stroke and seasonal variation in its incidence in Vigan City, Ilocos Sur, Philippines. A review of the existing records and charts of the patients diagnosed and admitted for stroke from January-December 2017 at the hospital was done from August 2017 to May 2018. However, any records of stroke patients from other hospitals in Vigan City were not used in the study.

### CONCEPTIONAL FRAMEWORK

The research paradigm which guides the researchers in the conduct of this research is presented in Figure 1.





**Figure 1: The Research Paradigm**

This paradigm shows the relationship between the profiles of the patients and the occurrence of Stroke. It also demonstrates certain factors like the demographical, clinical, seasonal and risk factors that may influence the occurrence of stroke in Metro Vigan City.

### **HYPOTHESES**

At the 0.05 level of significance, the following hypotheses will be tested:

1. There is no significant incidence of stroke in wet season, dry-cold season and dry-hot season in Vigan City, Philippines.
2. There is no significant difference in the incidence of stroke compared among the three recognized seasons.
3. There is no significant contribution of risk factors to the incidence of stroke.

### **METHODOLOGY**

#### **Research Design**

A retrospective descriptive cross-sectional study design was used in this research. The study, which covered from January-December 2017, targeted Ilocos Sur Provincial Hospital, Vigan City, Ilocos Sur, Philippines. A review of the existing hospital records and charts of the patients, diagnosed and admitted for stroke from January-December 2017 at the stroke unit of the hospital was done to compare the seasonal variation of stroke occurrence.

#### **Research Locale**

The study was conducted Ilocos Sur Provincial Hospital Tamag, Vigan City, Ilocos Sur, Philippines.

#### **Selection of Subjects**

The study population was the stroke patients admitted from January-December 2017 based on the existing records and charts at the stroke unit of Ilocos Sur Provincial Hospital Tamag, Vigan City, Ilocos Sur, Philippines.

#### **Samples and Sampling Technique**

This study made use of the total enumeration of all stroke patients admitted from January-December 2017.

#### **Data Collection Technique**

The researchers reviewed the existing hospital records and charts on stroke patients admitted from January-December 2017 at the selected hospital to compare the seasonal variation of stroke

### Data Gathering Instrument

This research study used Data Extraction Tool to gather information from the existing hospital records and charts on the admitted stroke patients.

### Ethical Considerations

To ensure confidentiality of the collected data, number codes were used as the names of the subjects, which were destroyed immediately after use to avoid being accessed by the unauthorized persons. To this end, the University of Northern Philippines Research Center guidelines were strictly followed

### Data Gathering Procedure

Prior to data collection, official permission was secured from the selected hospital, and also from University of Northern Philippines Research Center-Ethics Review Committee

### Statistical Data Analysis

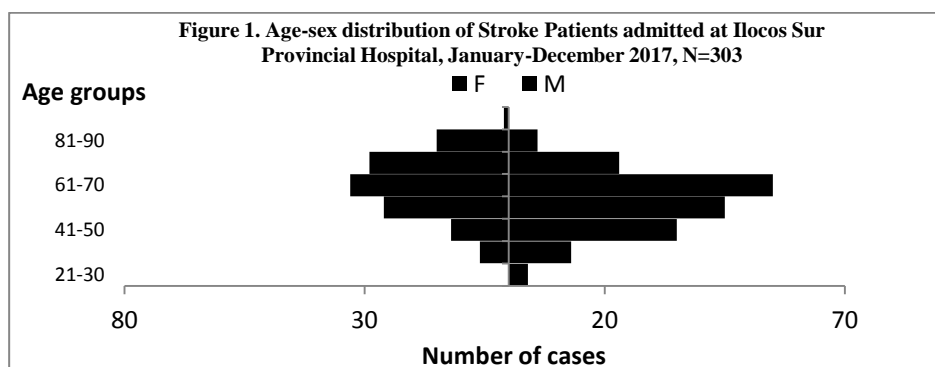
The gathered data was analyzed using Excel Data Analysis Tools, and frequency and percentage counts were used to determine the profile of the collected data of the patients. To interpret the data, the University of Northern Philippines Research Center guidelines were used.

## RESULTS

The results of the study are analyzed in the tables below. Out of the 303 patients whose hospital records were reviewed, 181 (~60%) were male, while 122 (~40%) were female, with the age range of 21-91 years old (Table 1a and Figure 1). Out of the total patients, 264 (~94%) were married, while 19 (~6%) were single (Table 1b).

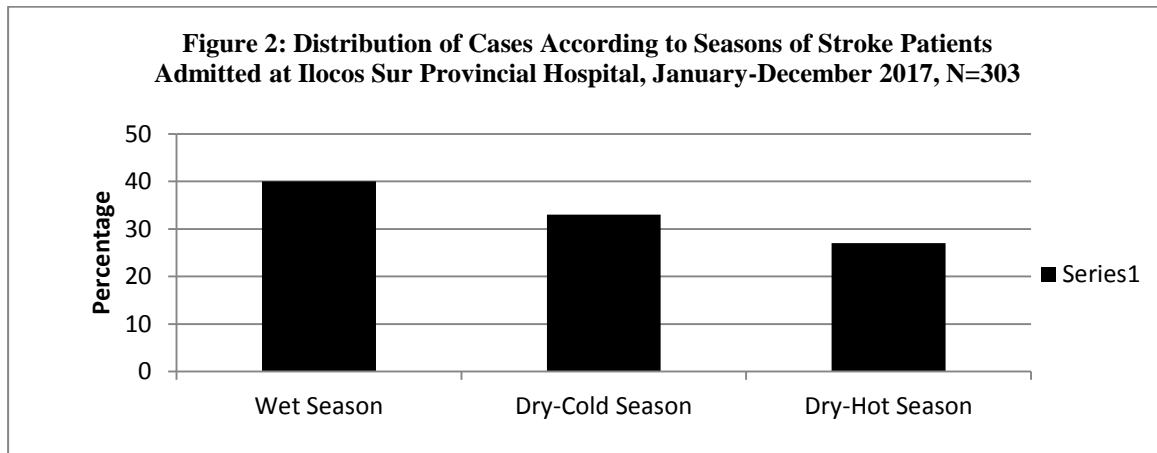
**Table 1a: Age-Sex Distribution of Stroke Patients Admitted at Ilocos Sur Provincial Hospital, January -December 2017, N=303.**

Age-Group	Male	Female	Grand Total
21-30	4		4
31-40	13	6	19
41-50	35	12	47
51-60	45	26	71
61-70	55	33	88
71-80	23	29	52
81-90	6	15	21
91-100	0	1	1
<b>Total</b>	<b>181</b>	<b>122</b>	<b>303</b>



**Table 1b: Civil Status of Stroke Patients Admitted at Ilocos Sur Provincial Hospital, January -December 2017, N=303**

Civil Status	Number	Percentage (%)
Married	284	94
Single	19	6



**Wet Season:** June-October; **Dry-cold Season:** Nov-Feb; **Dry-hot season:** March-May

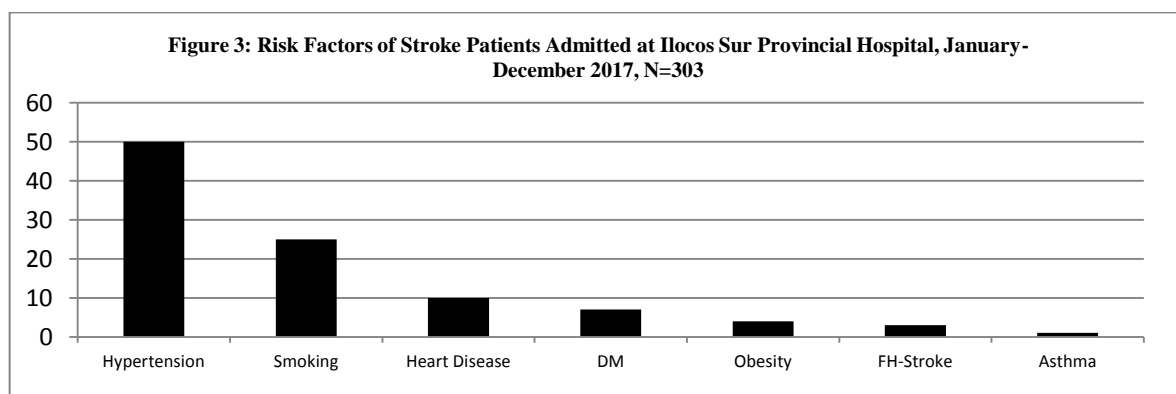
From the Table 2, according to the three seasons in the Philippines, stroke seasonal variation was recorded as follows; Wet season (40%), Dry-cold season (33%), and Dry-hot season (27%). Of all the stroke risk factors identified in the study, hypertension was the most common (50%), followed by smoking (25%), by concomitant heart disease (10%), diabetes mellitus (7%), obesity (4%), family history of stroke (3%) and then asthma (1%), as shown in Table 3 and Figure 3.

**Table 2: Distribution of Cases According to Seasons of Stroke Patients Admitted at Ilocos Sur Provincial Hospital January -December 2017, N=303, p<0.05**

Season	Number	Percentage
Wet (June-Oct)	120	40
Dry cold (Nov-Feb)	101	33
Dry hot (March-may)	82	27

**Table 3: Risk Factors of Stroke Patients Admitted at Ilocos Sur Provincial Hospital January -December 2017, N=303**

Risk factors	Hypertension	Smoking	Concomitant Heart Disease	Diabetes Mellitus	Obesity	Stroke Family History	Asthma
Percentage(%)	50	25	10	7	4	3	1



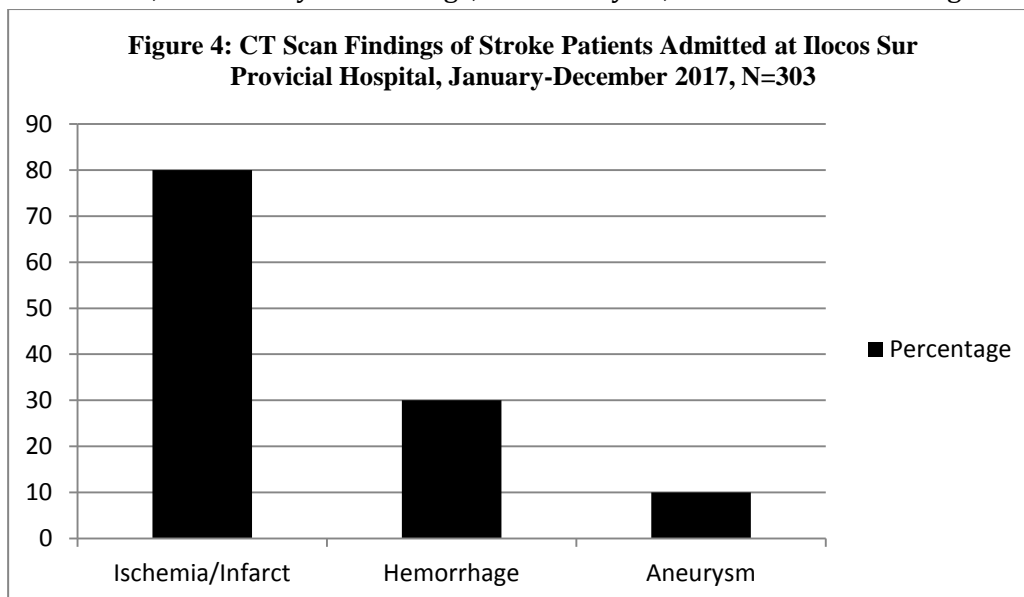


The rate of the incidence of stroke, based on the ages of the patients, is shown in Table 4, with 70 years as the cut-off age. These results show that stroke occurs more in male (~76%) than in female (~24%) at younger ages (below 70 years), while it occurs more in females (~61%) than in males (~39%) at older ages (above 70 years).

**Table 4: Rate of Stroke Incidence Based on the Age of Patients Admitted at Ilocos Sur Provincial Hospital, January -December 2017, N=303, Cut-Off Age: 70 Years**

Sex	Below 70 Years	Above 70 Years
Male (%)	76	39
Female (%)	24	61

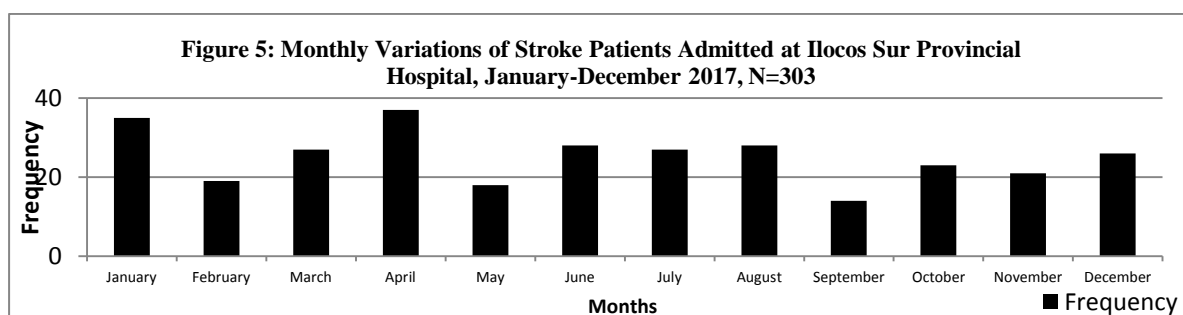
From the CT Scan findings of the stroke patients, cerebral infarct together with ischemia had the highest occurrence, followed by hemorrhage, and aneurysm, as demonstrated in Figure 4.



The monthly variation of stroke patients admitted at Ilocos Sur Provincial Hospital is presented in Table 5 and Figure 5. Out of the 303 medical records reviewed, April had the highest incidence with 37 patients, followed by January with 35 patients, June and August with 28 patients each, March and July with 27 patients each, December recorded 26 patients, October with 23 patients, November had 21 cases, February with 19 cases, while May had 18 cases, and then September had 14 patients.

**Table 5: Monthly Variations of Stroke Patients Admitted at Ilocos Provincial Hospital January -December 2017, N=303**

Month	January	February	March	April	May	June	July	August	September	October	November	December
Frequency	35	19	27	37	18	28	27	28	14	23	21	26



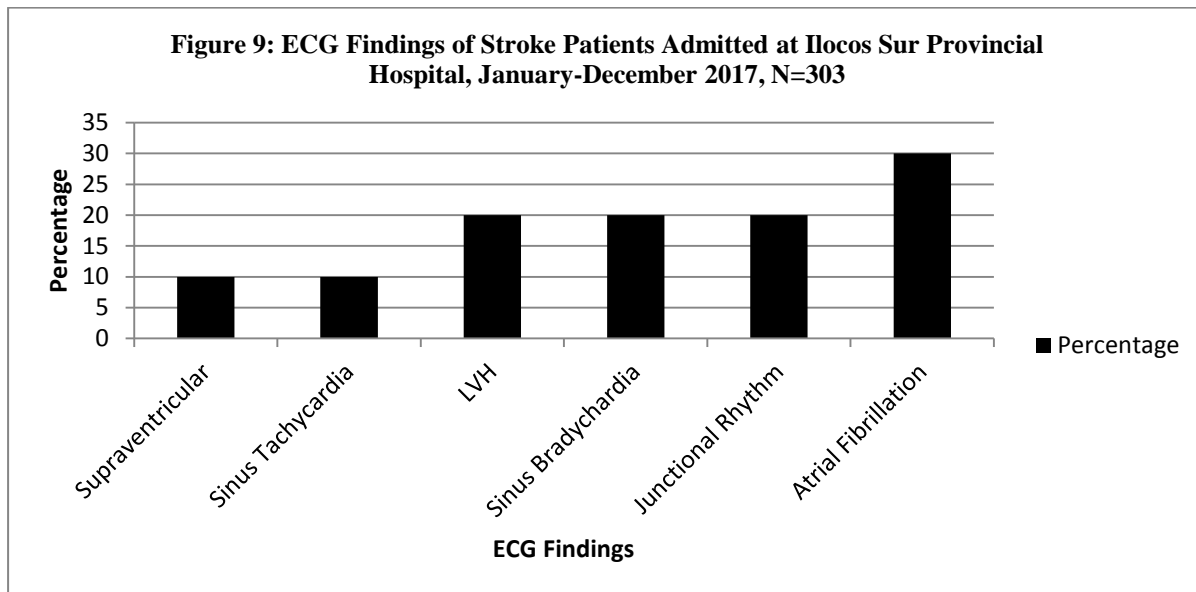


Figure 9 presents the ECG findings of the stroke patients, with atrial fibrillation having the highest occurrence, followed by junctional rhythm, sinus bradycardia and left ventricular hypertrophy with equal occurrence, then by sinus tachycardia and supraventricular tachycardia with the same occurrence.

## DISCUSSION

Our study was the first to investigate the seasonal variation of stroke occurrence in the Philippines. A total of 707 stroke patients were admitted, but only 303 hospital records and charts were available for the study. Thus, we investigated a patient population of 303 stroke patients (male: ~60% and female: ~40%), with age range of 21-91 years old, who were hospitalized from January 01, 2017-December 31, 2017 at Ilocos Sur Provincial Hospital, Vigan City, Philippines (table 1a and figure 1). The results of our study indicate that there is a significant seasonal variation in the incidence ( $p < 0.05$ ) of stroke among the three recognized seasons of Vigan City, Philippines—wet, dry-cold, and dry-hot seasons, and that there is a significant contribution of the risk factors to the occurrence of stroke in the patients. From our findings, stroke incidence was highest in the wet season (40%), followed by dry-cold season (33%), and then lowest in dry-hot season (27%), as shown in table 2 and figure 2. The results also reveal hypertension as the most common risk factor, followed by smoking, concomitant heart disease, diabetes mellitus, obesity, family history of stroke, and Asthma (table 3 and figure 3). Our study further shows that approximately 77% of the patients were above 50 years, while 23% were below 50 years, and that stroke occurs more in males than in females at earlier ages (below 70 years), but more in females at older ages (above 70 years) than in males (table 4).

Contrary to the hypothesis, our study demonstrates a significant seasonal variation and difference in the incidence ( $p < 0.05$ ) of stroke among the three seasons in Vigan City, Philippines. The Philippines has unique seasons--wet season (June-October) is marked with rainfall and the average temperature of 26.6°C; dry-cold season (November-February) is the coldest period, with the average temperature of 25.6°C; while dry-hot season (March-May), also known as summer, is the hottest period, with the average temperature of 27.2°C. To arrive at the conventional cold and hot seasons, we factored the three seasons into cold and hot seasons, based on the prevailing temperatures of the year in the country. On this basis, we infer that the incidence of stroke is

higher in the cold season, whether wet or dry, in Vigan City, Philippines.

Our findings are similar to most of the studies done in other countries, where stroke occurrence was higher in the cold seasons.<sup>4,7,25,29,30</sup> Unlike some other studies that compared the seasonal variations of stroke subtypes, the specific objective of our study was to determine the seasonal variation of stroke in general, and not to compare the seasonal variations of stroke subtypes. For example, separate studies in Japan and South Korea concluded that ischemic stroke occurred more in hot seasons while hemorrhagic stroke was more in cold seasons.<sup>12,24</sup> Another study in Congo compared the seasonal variation of stroke subtypes, but with contrary results; ischemic stroke was more in cold season and hemorrhagic was more in hot season.<sup>9</sup> However, in Canada, a unique research compared incidence of stroke subtypes, using the temperaments of men and women as the seasons. It concluded that ischemic stroke was higher in women because of their 'cold and wet temperament' unlike men.<sup>1</sup> Invariably, the study inferred that stroke (ischemic) occurred more in cold seasons. Although the major goal of our research was not to determine the seasonal variations of the subtypes of stroke, we compared the CT Scan findings of the available records of the stroke patients, where we found out that 80% of the stroke was ischemic while 30% was hemorrhagic, with 10% of aneurysm-induced (Figure 4). This finding was supported by some previous studies which indicated that ischemic stroke was about 85% of all the strokes.<sup>4</sup> With this finding of our research, it therefore may be safe to imply that ischemic stroke occurs more in cold seasons, since we discovered that stroke occurs more in cold season in Vigan City (Philippines), and that 80% of which was found to be ischemic.

Moreover, from the reviewed literature, we observed that previous studies on this subject have showed inconsistent and conflicting results. Some concluded that stroke had seasonal variation in its occurrence, while others concluded otherwise. In different studies, done in South Korea, Puerto Rico, and China, it was concluded that stroke occurred more in hot seasons than in cold seasons.<sup>5,15,11</sup> Considering the trend of results as discussed in the review of literature, using the studies done in a tropical country of Puerto Rico and temperate country of Canada, it may be argued that stroke occurs more in hot seasons in tropical countries but occurs more in cold seasons in temperate countries,<sup>15,1</sup> though there were some exceptions, like in Mozambican research.<sup>7</sup> Likewise, ischemic stroke seemed to have a strong predilection for hot seasons while hemorrhagic stroke for cold seasons,<sup>24, 12</sup> but the Congolese research disproved it.<sup>9</sup> In our research, we had a contrary finding, with stroke incidence more in the cold season, even though the Philippines (Vigan City) is a tropical country, too. In Vigan City (Philippines), the hottest month is May while the coldest month is January. In our study, May had second-to-last stroke incidence and January had second-highest stroke incidence, as shown in figure 5 and table 5. Inasmuch as we found the incidence of stroke to be highest in April (summer), closely followed by January (coldest month), there were sharp drops in the other months of summer—March and May. Owing to the fact that our study specifically focused on the seasonal variation, and not monthly variation, we considered the results of all the months that make up each season in the city, before arriving at the conclusion. When compared together, wet season had the highest incidence, followed by dry-cold season, while dry-hot season (summer) had the lowest incidence, as shown in figure 5 and table 5. With this, the results of our study disagree with the claim of Mendez-Lazaro, et al (2018) that incidence of cardiovascular events (stroke and cardiac events) increase in hot season (summer), especially in tropical a country.<sup>15</sup> This disagreement may be due to local seasonal variations and demographic profiles of the study population or due to

errors in study designs, which include inappropriate analytical methods, small sample size, focusing on a single region, and insufficient time for the study.

In addition, our study shows a significant contribution of the risk factors to the occurrence of stroke in the patients, thereby disapproving the hypothesis. From the results, hypertension was the most common risk factor, followed by smoking, concomitant heart disease, diabetes mellitus, obesity, family history of stroke, and asthma (table 3 and figure 3). These findings support the conclusions of Mendez-Lazaro, et al (2018) and Miah A.H., et al (2013) that hypertension, smoking, heart diseases, and diabetes mellitus were among the most contributing risk factors for stroke occurrence.<sup>15,16</sup> Likewise, age and gender were proven, by our work, to be significant contributing factors to the incidence of stroke among the citizens and residents of Vigan City. The results show that approximately 77% of the patients were above 50 years, while 23% were below 50 years, and also indicate that stroke occurs more in males (~76%) than in females (~24%) at younger ages (below 70 years), but more in females (~61%) at older ages (above 70 years) than in males (~39%), as in table 4. On this, our study agrees with Boehme, A.K., et al (2017) that stroke is a degenerative disease with increased risk as the age increases, and with Reeves, M.J., et al (2009) that stroke occurs more in men at younger ages and more in women at older ages, but disagrees with Kapral M.K., et al (2005), who claimed that women were at higher risk of stroke at younger ages than men, and vice versa.<sup>3,22,8</sup> However, our study did not take into consideration the effect of seasons on the prevalence of these stroke risk factors, although some precious studies had linked hypertension and other cardiovascular risk factors with cold and dry seasons.

As discussed in the literature, the previous studies on this subject have showed inconsistent and conflicting results. Some concluded that stroke had seasonal variation in its occurrence, while others concluded otherwise. Even among the studies that reported seasonal variation of stroke, there have been great discrepancies in the seasons of highest occurrence; some results indicated winter, summer, spring, while others indicated autumn. These discrepancies may be due to local seasonal variations and demographic profiles of the study population or due to errors in study designs, which include inappropriate analytical methods, small sample size, focusing on a single region, and insufficient time for the study. To avoid such inadequacies, we had a study of 12-month (January 01-December 31, 2017) coverage of patients diagnosed and admitted for stroke. We also selected a government provincial hospital to ensure a large population study. We carefully reviewed all the documented demographic, medical and clinical details of the stroke patients admitted within the stipulated period, which were made available to us for the study. No doubt, this study has remarkably scientific significance in the Philippines and the world at large. As an unprecedented research, it has set a noble precedence for subsequent cardiovascular research in the country, and will always serve as a standard reference for the future similar studies. The findings and discoveries of this research will certainly be useful to prevent and reduce the high occurrence of stroke in the Philippines and the world at large. Nevertheless, we encountered some limitations in our study. There were no available data on the subject in the Philippines, because no similar study had been done in the country. Within the stipulated period of time, a total of 707 stroke patients were admitted at the hospital, but only 303 hospital records were available at the records department of the hospital for this study, thereby making our study population smaller than we targeted. There were some missing vital details from the records of the patients that we studied; because they were either not documented at all or lost from the

hospital records. Our study covered only one year, which may not be sufficient for accuracy. We

carried out our research at only one city and one hospital, considering the climatic variations in different cities in the Philippines.

In as much as our unprecedented research was a success, and that we have faith in the authenticity of its outcomes, we still recommend for a follow-up study on similar subject in the Philippines. A follow-up research should consider the following:

1. To compare the seasonal variation of stroke incidence in other regions in the country.
2. To cover several years in the study.
3. To determine the seasonal variation of stroke subtypes.
4. To study the monthly, weekly, daily, and hourly variations of stroke subtypes.
5. To study the effects of other climatic parameters like atmospheric pressure on stroke incidence.
6. To study the effects of seasons on the prevalence of stroke risk factors.
7. Health institutions in the country should endeavor to maintain proper documentation of the medical and clinical records of their patients to ensure availability of the required information for the future research.

## CONCLUSION

Our study has demonstrated that there is a seasonal variation in the incidence of stroke in Vigan City, Philippines, with the highest stroke occurrence in cold season, and hypertension, smoking, heart diseases, and diabetes mellitus as the top most risk factors.

## CONFLICTS OF INTEREST

The authors have none to declare

## ACKNOWLEDGEMENT

The authors wish to appreciate **Sheryl Q. Racelis, MD** of Field Epidemiology Training Program, Epidemiology Bureau, Department of Health, Philippines, for her mentorship support during the research; University of Northern Philippines College of Medicine, and Ilocos Sur Provincial Hospital, Vigan City, Philippines.

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