

# Seasonal variation in ischaemic stroke frequency in Podlaskie Province by season

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## Abstract

**Purpose:** The aim of the present study was to assess seasonal differences in ischaemic stroke among patients hospitalized in Department of Neurology in Białystok during 2002-2005.

**Material and methods:** To examine the seasonal incidence of ischaemic stroke, we analyzed data from the Department of Neurology in Białystok in a retrospective study. The year was divided into four seasons: spring (March, April, May), summer (June, July, August), autumn (September, October, November), and winter (December, January, February). Seasonal differences were studied in relation to the following clinical characteristics: age, gender, history of stroke, and time of stroke onset.

**Results:** Age of patients with ischaemic stroke ranged 19 between 101 years, a mean age was 72.4±12 years. Incidence of ischaemic stroke increased in the last years. We noted a higher incidence of ischaemic stroke in older patients (mean 74.36 years old) during winter months than in patients (71.40 years) in summer months. Gender had no effect on incidence of ischaemic stroke. Significant seasonal variation of ischaemic stroke in all years ( $p=0.0010$ ) and for 2005 year (0.0090) were found. Incidence of ischaemic stroke was depend on month of year. Significant increase of ischaemic stroke was noted in December. The lowest incidence of stroke was observed in August and September.

**Conclusion:** Incidence of ischaemic stroke increased in the last years. The present findings suggest an increase in the incidence of ischaemic stroke in winter in December.

**Key words:** ischaemic stroke, seasonal variation, year.

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## Introduction

In recent years, many studies have been conducted to elucidate seasonal differences in stroke incidence [1-3]. These studies demonstrated that strokes, intracerebral hemorrhage in particular, occur most frequently in winter [3-5]. Seasonal variation of ischaemic stroke, however, has not been the focus of much research [4,5]. It was reported [1,4] that the incidence of ischaemic stroke peaked in winter, but others [6] demonstrated that ischaemic stroke increased during the warmer months. In contrast to these studies, Rothwell [7] showed that frequency of ischaemic stroke did not differ with season. The aim of the present study was to assess seasonal differences in ischaemic stroke among patients hospitalized in Department of Neurology in Białystok during 2002-2005.

## Material and methods

To examine the seasonal incidence of ischaemic stroke, we analyzed data from the Department of Neurology in Białystok in a retrospective study. Patients with transient ischaemic attack and haemorrhagic stroke were excluded from the study. Clinical characteristics, including age, sex, history of stroke, risk factors, time of stroke onset, stroke severity on admission, and outcome at discharge were recorded. Risk factors for ischaemic stroke include hypertension, diabetes mellitus, hyperlipidemia, current smoking, and atrial fibrillation. The year was divided into four seasons: spring (March, April, May), summer (June, July, August), autumn (September, October, November), and winter (December, January, February). Seasonal differences were studied in relation to the following clinical characteristics: age, gender, history of stroke, risk factors, time of stroke onset, and health status at the discharge. We used the chi-square test for analysis of seasonal differences for stroke occurrence.

**Table 1. Number of ischaemic stroke during 2002-2005**

Years	N	%
2002	217	18.5
2003	283	24.1
2004	325	27.7
2005	348	29.7

**Table 2. Number of ischaemic stroke during seasonal periods during 2002-2005**

Season	N	%	N*	N - N*
Winter	292	24.9	293	-1
Spring	321	27.4	293	28
Autumn	303	25.8	293	10
Summer	257	21.9	293	-36

**Table 3. Incidence of ischaemic stroke in patients in particular months during 2002-2005**

Month	Years									
	2002		2003		2004		2005		Total 2002-2005	
	N	%	N	%	N	%	N	%	N	%
1	20	9%	23	8%	18	6%	28	8%	89	8%
2	11	5%	15	5%	21	6%	25	7%	72	6%
3	20	9%	27	10%	26	8%	26	7%	99	8%
4	28	13%	27	10%	31	10%	26	7%	112	10%
5	21	10%	19	7%	38	12%	32	9%	110	9%
6	16	7%	37	13%	23	7%	39	11%	115	10%
7	22	10%	22	8%	26	8%	26	7%	96	8%
8	18	8%	20	7%	33	10%	21	6%	92	8%
9	13	6%	25	9%	28	9%	22	6%	88	8%
10	20	9%	20	7%	26	8%	25	7%	91	8%
11	13	6%	19	7%	18	6%	28	8%	78	7%
12	15	7%	29	10%	37	11%	50	14%	131	11%
p <sup>1</sup>	0.2463		0.1387		0.0787		0.0090**		0.0010***	

<sup>1</sup> chi-square test

## Results

The present study included 1 173 patients with ischaemic stroke during 2002-2005 years.

Age of patients with stroke ranged 19 between 101 years, a mean age was 72.4±12 years.

Incidence of ischaemic stroke increased in the last years. Gender had no effect on incidence of ischaemic stroke. We noted increase number of strokes more than 11% in 2005 year compared to 2002 year. Results are shown in *Tab. 1*. In non-parametric test we found seasonal variation (winter, spring, summer, autumn), of ischaemic strokes (chi<sup>2</sup> test p=0.0592) (*Tab. 2*). We noted a higher incidence of ischaemic stroke in older patients (mean 74.36 years old) during winter months than in patients (71.40 years) in summer months (data are not presented).

Hypothesis on differences of ischaemic stroke in the particular months of year was tested (for an each year and all years). Significant seasonal variation of ischaemic stroke in all years (p=0.0010) and for 2005 year (0.0090) were found (*Tab. 3*). Incidence of ischaemic stroke was depend on month of year. Significant increase of ischaemic stroke was noted in December. The lowest incidence of stroke was observed in August and September (*Tab. 3*).

## Discussion

In the present study, we demonstrated that the frequency of ischaemic stroke was higher in winter compared to other seasons. We noted that ischaemic stroke occurred more frequently in December. The lowest frequency of stroke was observed in August and September. No significant differences in the frequencies of ischaemic stroke were observed among summer, autumn, or spring. It was previously reported that ischaemic stroke occurred more frequently in winter than in other seasons [1,5]. These data are consistent with our findings. In contrast Ogata et. [8] found significantly higher incidence of ischaemic stroke in summer. Incidence of ischaemic stroke is reported to be associated with enhanced platelet aggregation and blood hyperviscosity [9]. Furthermore, hyperviscosity may be particularly important in the pathogenesis of lacunar stroke [10]. As temperature rises in summer, dehydration is more likely to occur, leading to hyperviscosity and enhanced platelet aggregation [9,11]. In the present study ischaemic stroke was seen more often winter. It is well known that infectious respiratory diseases are more common during winter. Infection increases plasma fibrinogen concentration and anticardiolipin antibodies and decreases protein C level, leading to a hypercoagulable state [12]. These coagulation abnormalities can promote the formation of intracardiac thrombi, contributing to the occurrence

of cardioembolic stroke [13]. It is likely that the frequency of ischaemic stroke would peak in the winter. A winter excess of ischaemic stroke of the order of 20-30% is a consistent finding in mortality and hospital based studies [14,15]. However, mortality is partly determined by complications of stroke, some of which, such as pneumonia, are seasonal. "Indeed, mortality due to stroke is particularly high after influenza epidemics". Hospital based studies, on the other hand, may simply be measuring variation in the likelihood of hospital admission.

## Conclusions

In conclusion, incidence of ischaemic stroke increased in the last years. The present findings suggest an increase in the incidence of ischaemic stroke in winter in December. Ischaemic stroke may be associated with infection, occurs most frequently in winter.

## References

1. Shinkawa A, Ueda K, Hasuo Y, Kiyohara Y, Fujishima M. Seasonal variation in stroke incidence in Hisayama, Japan. *Stroke*, 1990; 21: 1262-7.
2. Kelly-Hayes M, Wolf PA, Kase CS, Brand FN, McGuirk JM, D'Agostino RB. Temporal patterns of Stroke onset. The Framingham study. *Stroke*, 1995; 26: 1343-7.
3. Ricci S, Celani MG, Vitali R, LaRosa F, Righetti E, Duca E. Diurnal and seasonal variations in the occurrence of Stroke: a communitybased study. *Neuroepidemiology*, 1992; 11: 59-64.
4. Jakovljevic D, Salomaa V, Sivenius J, Tamminen M, Sarti C, Salmi K, et al. Seasonal variation in the occurrence of Stroke in a Finnish adult population. The FINMONICA Stroke Register. Finnish Monitoring Trends and Determinants in Cardiovascular Disease. *Stroke*, 1996; 27: 1774-9.
5. Oberg AL, Ferguson JA, McIntyre LM, Horner RD. Incidence of Stroke and season of the year: evidence of an association. *Am J Epidemiol*, 2000; 152: 558-64.
6. Biller J, Jones MP, Bruno A, Adams Jr HP, Banwart K. Seasonal variation of Stroke – does it exist? *Neuroepidemiology*, 1988; 7: 89-98.
7. Rothwell PM, Wroe SJ, Slattery J, Warlow CP. Is stroke incidence related to season or temperature? The Oxfordshire Community Stroke Project. *Lancet*, 1996; 347: 934-6.
8. Ogata T, Kimura K, Minematsu K, Kazui S, Yamaguchi T; Japan Multicenter Stroke Investigators' Collaboration. Variation in ischemic stroke frequency in Japan by season and by other variables. *J Neurol Sci*, 2004; 225: 85-9.
9. Keatinge WR, Coleshaw SR, Easton JC, Cotter F, Mattock MB, Chelliah R. Increased platelet and red cell counts, blood viscosity, and plasma cholesterol levels during heat stress, and mortality from coronary and cerebral thrombosis. *Am J Med*, 1986; 81: 795-800.
10. Schneider R, Ringelstein EB, Zeumer H, Kiesewetter H, Jung F. The role of plasma hyperviscosity in subcortical arteriosclerotic encephalopathy (Binswanger's disease). *J Neurol*, 1987; 234: 67-73.
11. Berginer VM, Goldsmith J, Batz U, Vardi H, Shapiro Y. Clustering of Strokes in association with meteorologic factors in the Negev Desert of Israel: 1981-1983. *Stroke*, 1989; 20: 65-9.
12. Yasaka M, Beppu S. Hypercoagulability in the left atrium: Part II. Coagulation factors. *J Heart Valve Dis*, 1993; 2: 25-34.
13. Gustafsson C, Blomback M, Britton M, Hamsten A, Svensson J. Coagulation factors and the increased risk of Stroke in nonvalvular atrial fibrillation. *Stroke*, 1990; 21: 47-51.
14. Haberman S, Capildeo R, Clifford Rose F. The seasonal variation in mortality from cerebrovascular disease. *J Neurol Sci*, 1981; 52: 25-36.
15. Sobel E, Zhang ZX, Alter M, Lai SM, Davanipour Z, Friday G, McCoy R, Isack T. Stroke in the Lehigh Valley: seasonal variation in incidence rates. *Stroke*, 1987; 18: 38-42.