Effects of cold weather on the risk of ischemic stroke in a mild climate country

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Introduction

The association between temperature and mortality from all causes has been well described in a cross country European study, showing that Portugal has the highest coefficient of seasonal variation in mortality among 14 countries, despite having the highest mean winter temperature - Limits (- 3.5ºC to 13.5ºC) .

The excess winter mortality from acute myocardial and cerebral infarction has also been documented in ecological studies. Several studies have reported seasonal variation in these diseases with an increased risk of hospitalization during winter months.

Nevertheless the effect of low temperatures on the incidence of ischemic stroke in community-based studies is less well documented and results are heterogeneous. The high incidence of stroke in Portugal may in part be explained by environmental factors such as an unusual exposure to low temperatures.

Objective

Is cold exposure associated with an increased risk of ischemic stoke ?

1. study of seasonal variation

2. definition of exposure – “cold weather condition”

3. estimation of the lag between exposure and the peak risk

Are specific population strata more susceptible to exposure than others?

1. estimation of risk according to stroke aetiology

2. estimation of risk according to stroke risk factors

Methods

Data

All patients suffering a first ever ischemic stroke over a 2-year period (October 1998 to September 2000) within a population of 86 023 inhabitants in the city of Porto – n=348.

Stroke etiology (TOAST classification) – Cardioembolism (CE), Large-artery atherosclerosis (LAA), Small-artery occlusion (SAO) and others (including other determined or undetermined etiology)

Data from the National Meteorological Office – maximum and minimum daily temperature over the 26 months period – September 1998 to October 2000.

Statistics

Comparison of observed and expected number of occurrences, assuming a constant population during the study period

Methods

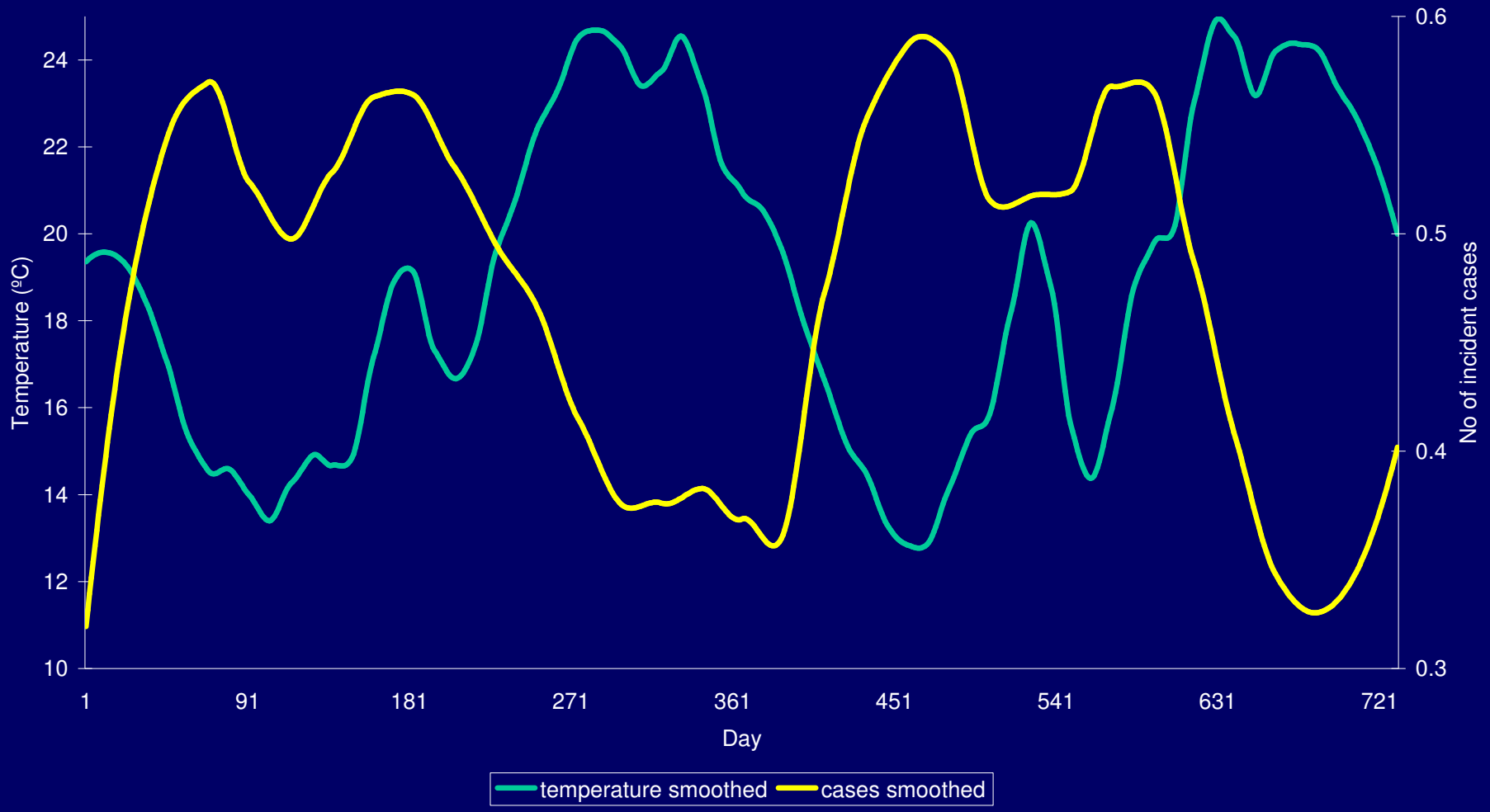
A symmetric bidirectional case-crossover design was used to estimate the risk of ischemic stroke on the day following a 24h exposure to low temperature (5th percentile of maximum temperature distribution)

4 control windows – same day – 2 weeks before and after

Statistics

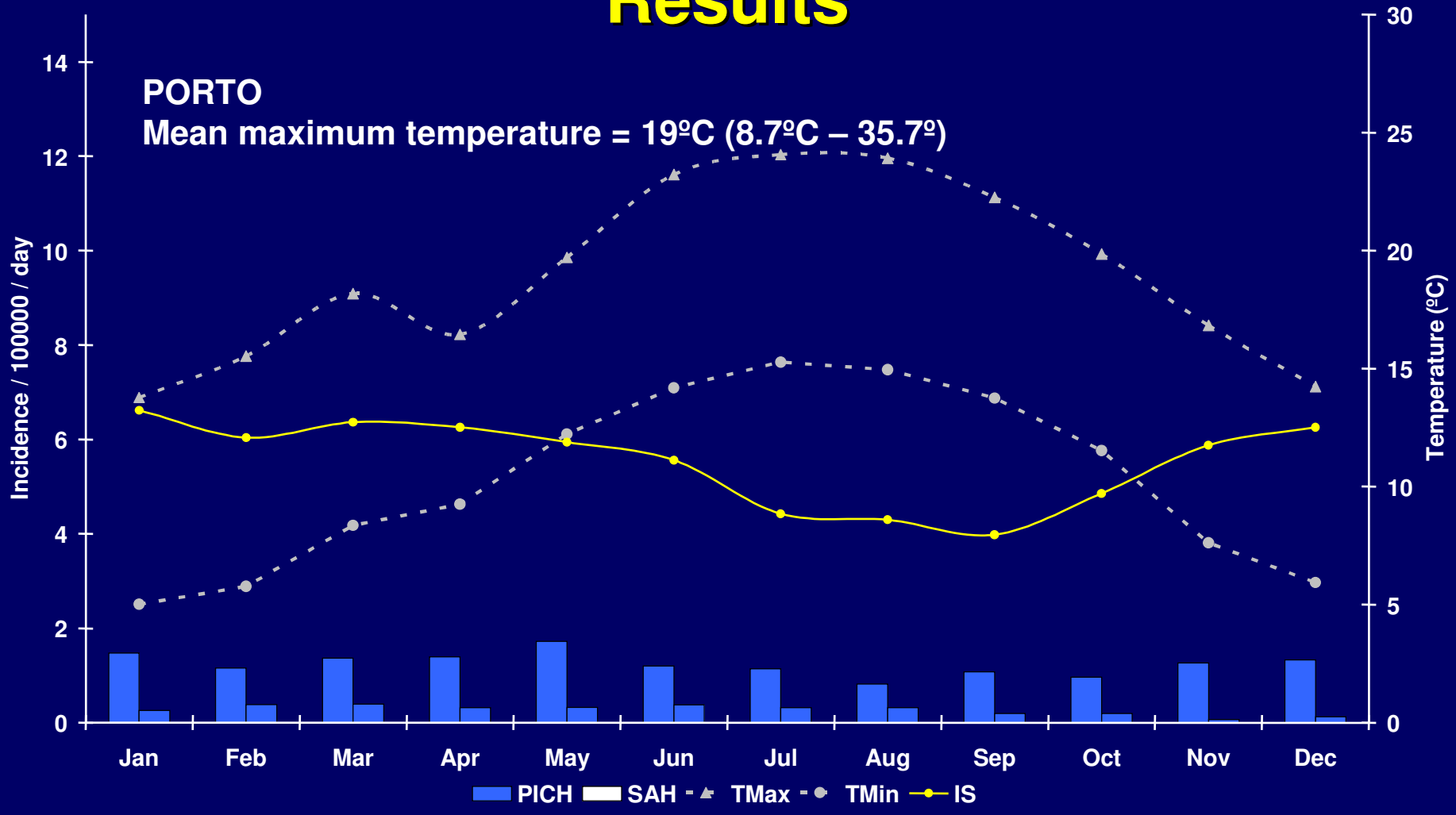
Mantel-Haenszel stratified analysis / Conditional logistic regression models

Results



Incidence density and temperature in the study period

Results



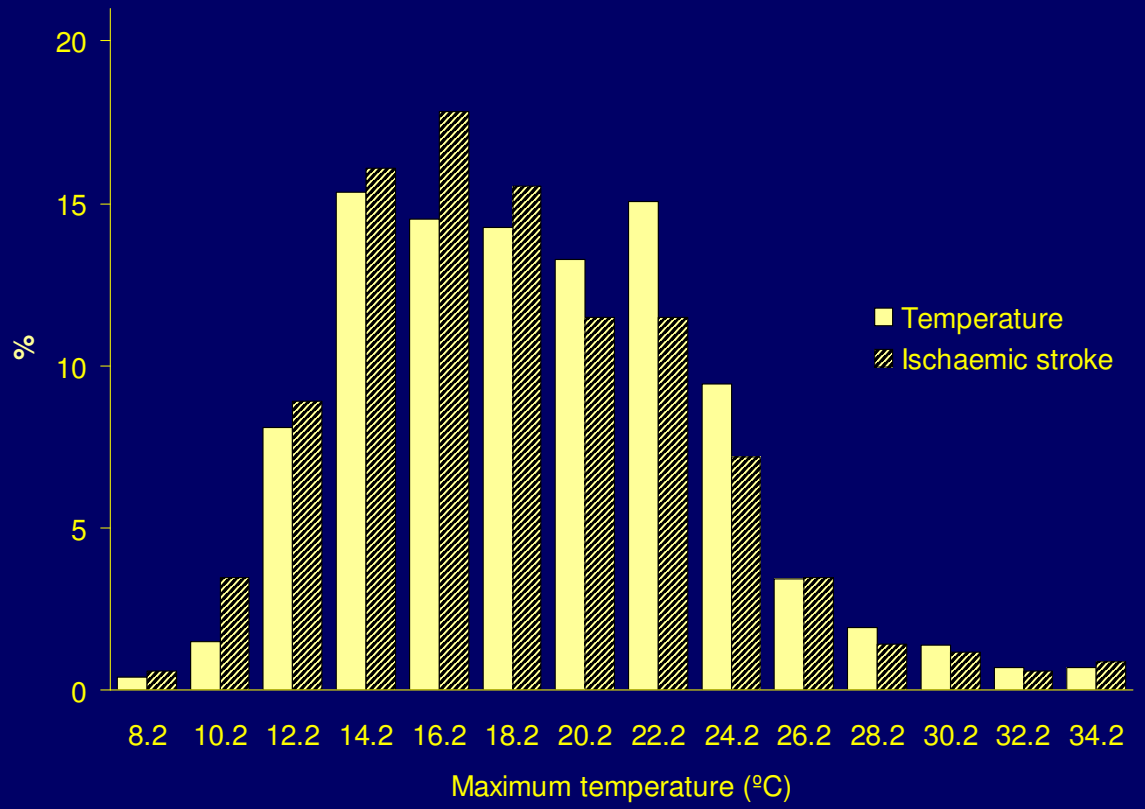
PICH – primary intracerebral haemorrhage ; SAH – subaracnoid haemorrhage; IS – ischemic stroke

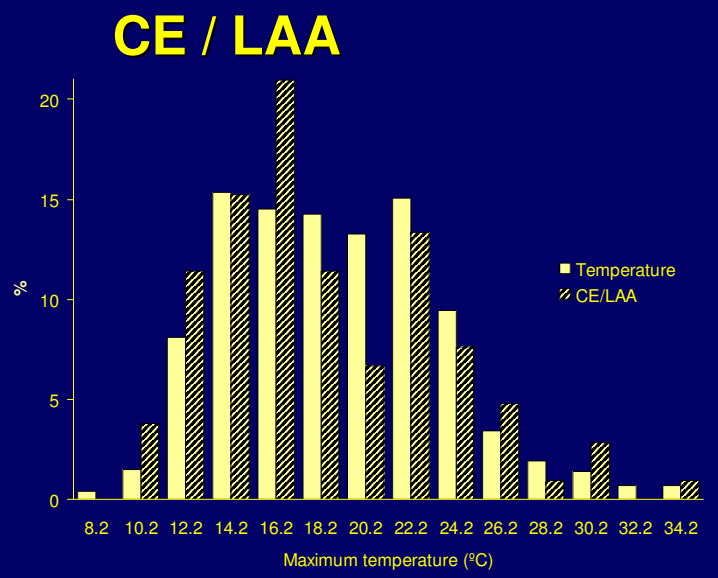
Incidence of stroke types and average maximum/minimum temperature by month – 1998-2000

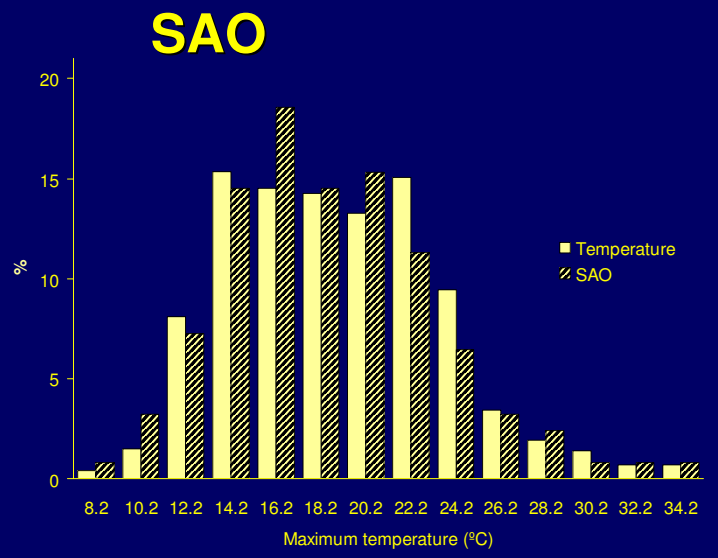
Results

Observed and expected number of ischemic stroke and incidence 1998-2000 by maximum temperature

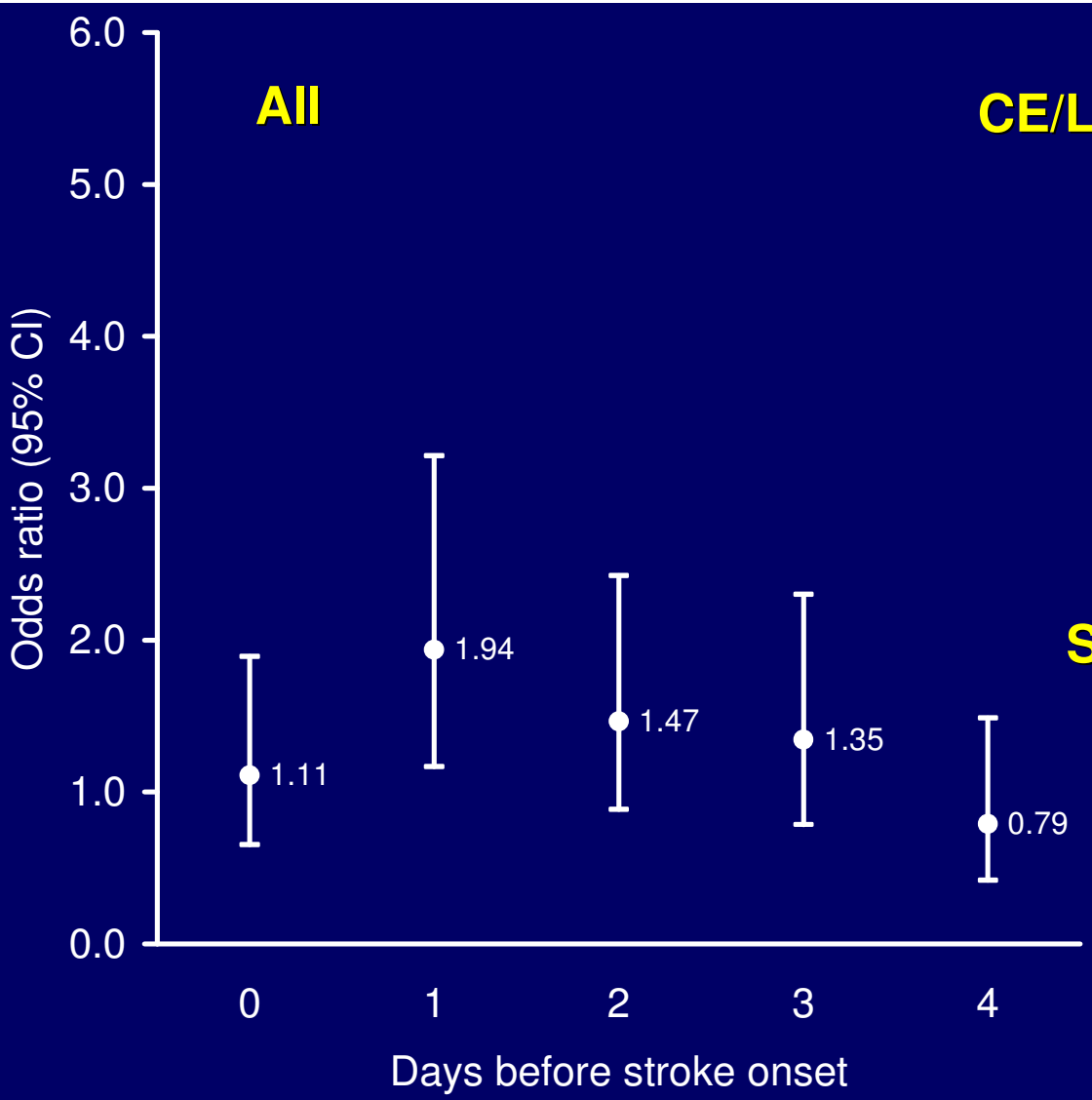
		Maximum temperature (ºC)						
		08-12	12-16	16-20	20-24	24-28	>28	All
	No days	32	205	197	199	69	29	731
Cases	Observed	24	107	105	68	33	11	348
	Expected	15.2	97.6	93.8	94.7	32.8	13.8	
	Incidence	8.7	6.1	6.2	4.0	5.6	4.4	

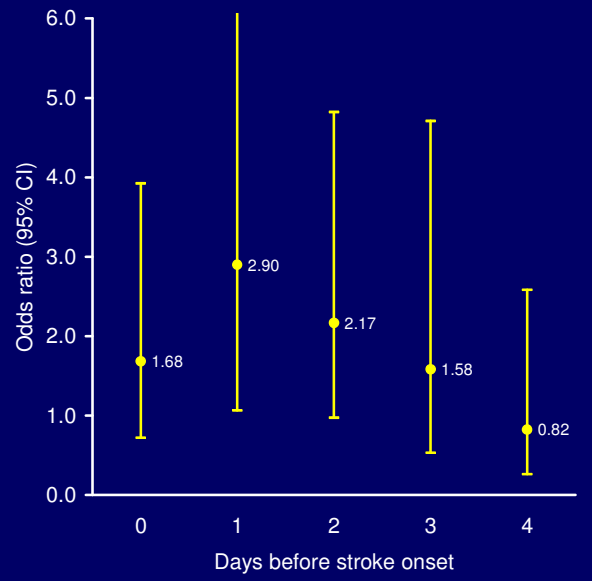


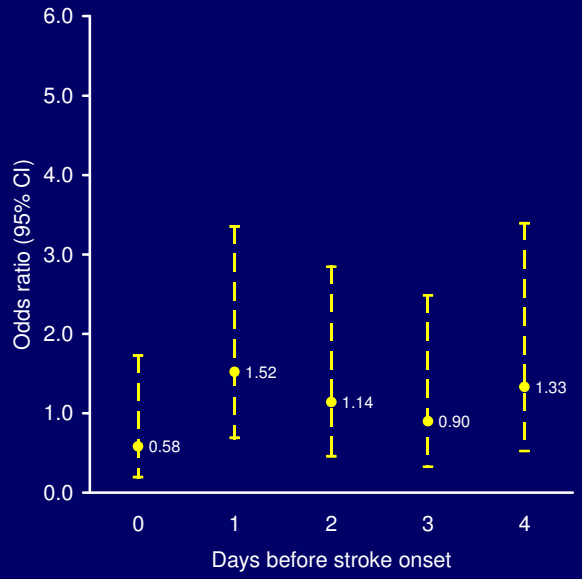




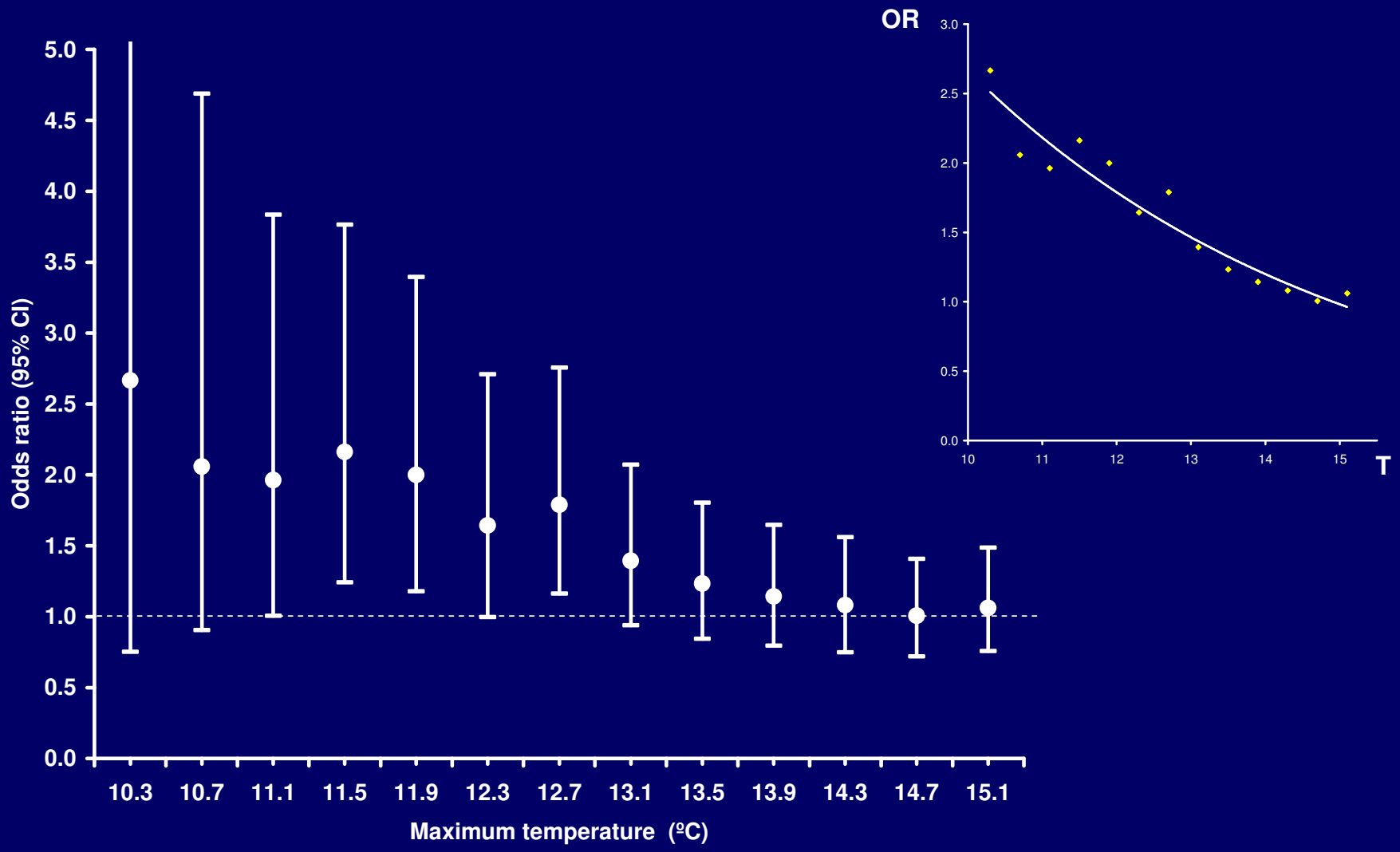
Distribution of Max temperature in the two-year period and in days of stroke occurrence





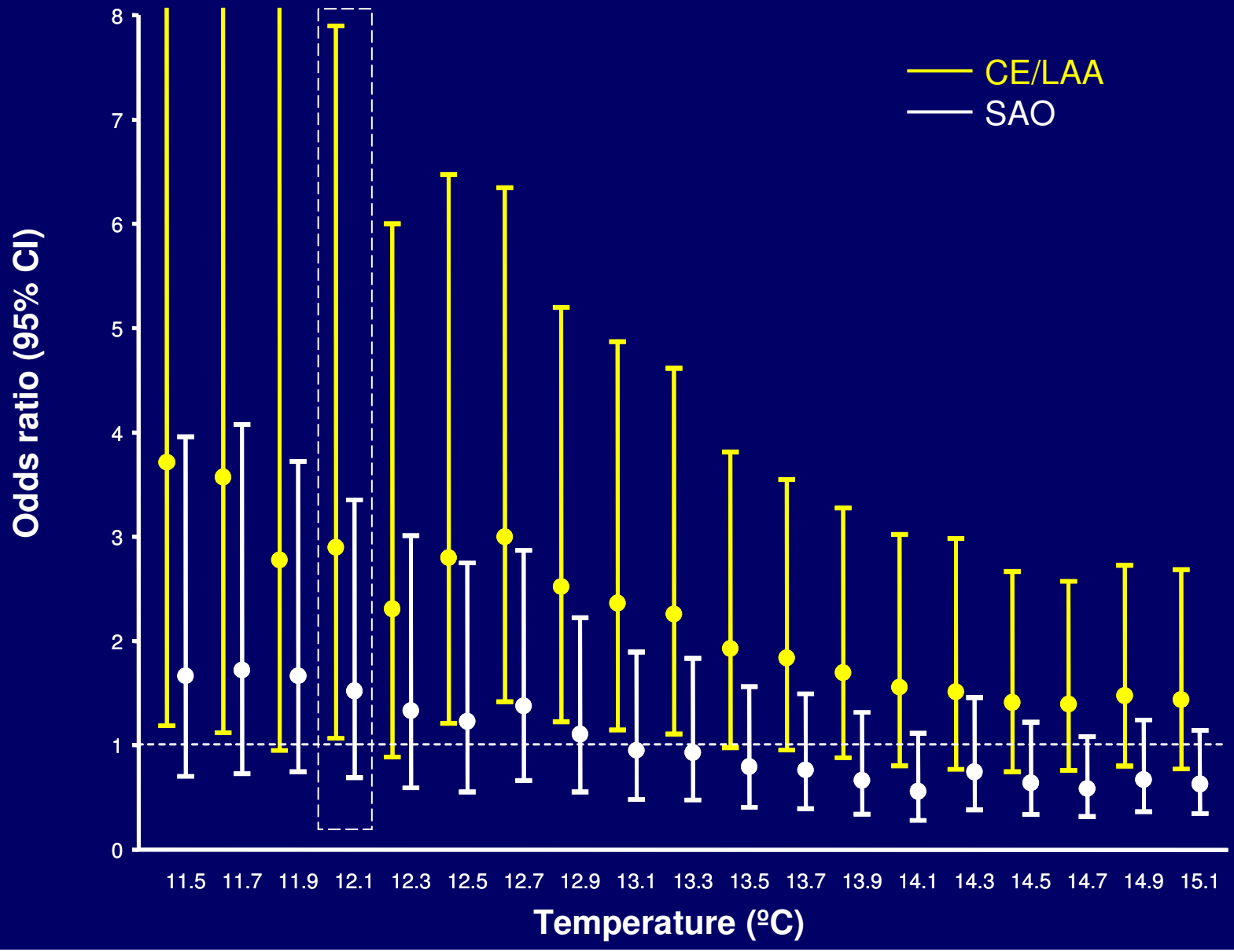


Risk of stroke according to cold exposure (Tmax < 12.2ºC) in the days before stroke onset



Risk of ischemic stroke according to Max temperature in the day before stroke onset

Risk of ischemic stroke according to Max temperature in the day before stroke onset by TOAST classification



Risk of ischemic stroke following cold exposure considering the aetiology and previous risk factors

Risk factors	CE + LAA			SAO			others			ALL		
	n	OR	95% CI	n	OR	95% CI	n	OR	95% CI	n	OR	95% CI
All	105	2.90	1.07-7.90	124	1.52	0.69-3.35	119	1.93	0.79-4.75	348	1.94	1.17-3.21
Age												
< 65 y	11	8.00	0.73-88.2	46	1.13	0.25-4.98	32	—	—	89	1.31	0.43-3.94
? 65 y	94	2.33	0.76-7.19	78	1.73	0.68-4.42	87	2.64	1.01-6.90	259	2.17	1.22-3.85
Sex												
Male	35	4.00	0.81-19.8	55	1.73	0.58-5.16	43	2.20	0.50-9.77	133	2.21	1.03-4.76
Female	70	2.43	0.68-8.71	69	1.33	0.43-4.19	76	1.80	0.58-5.57	215	1.76	0.90-3.45
Hypertension												
Yes	75	**3.63**	1.24-10.6	70	1.06	0.38-2.91	66	2.71	0.82-8.99	211	**2.03**	1.11-3.72
No	30	—	—	54	3.20	0.83-12.4	53	1.25	0.30-5.21	137	1.73	0.68-4.40
Diabetes												
Yes	34	2.26	0.57-11.8	31	4.00	0.56-28.4	34	1.33	0.27-6.61	99	2.23	0.88-5.69
No	71	3.20	0.86-11.9	93	1.29	0.54-3.09	85	2.33	0.77-7.06	249	1.83	1.00-3.34
Smoking habits												
Smoker	11	—	—	28	4.00	1.00-16.0	19	2.33	0.35-15.7	58	2.88	0.98-8.48
Smoker + Ex-s	18	1.33	0.14-12.8	43	4.75	1.23-18.4	25	1.17	0.22-6.32	86	2.31	0.93-5.72
No smoker	87	3.57	1.12-11.4	81	0.84	0.29-2.46	94	2.44	0.83-7.23	262	1.80	0.98-3.31
Cardiac disease												
Yes	60	**3.57**	1.12-12.4	32	1.60	0.31-8.25	40	1.67	0.32-7.52	132	**2.39**	1.09-5.22
No	45	1.33	0.14-12.8	92	1.50	0.61-3.69	79	2.11	0.69-6.47	216	1.67	0.85-3.26

Discussion / Conclusions

1. Cold exposure acts as a trigger for ischemic stroke - the risk increases after a “cold day” – Max temperature below the 5-8th percentiles of temperature distribution (one month per year)

2. Referral bias has been pointed out as a reason for identical findings mostly in hospital-based studies. The case-crossover design with “cases” from a community-based study avoids these bias, controlling at the same time for individual characteristics and day of the week.

3. Other designs were tested, beginning with the selection of a unique control period at the same day in the previous week, with identical results for the entire sample. Nevertheless we can try in the future the random selection of one control the week before or after, or even the selection of all the same week days within the same month.

Discussion / Conclusions

4. The risk of cold-induced ischemic stroke was higher in men, persons aged 65 years or more, and those with previous hypertension or cardiac disease - acknowledged risk factors for cardioembolic (CE) or large-artery atherosclerosis (LAA) strokes

5. Moreover in hypertensive persons or persons with previous cardiac disease the risk of cold-induced CE or LAA stroke was even higher, suggesting a synergy between cold exposure and these risk factors .

6. In conclusion factors that can trigger a stroke after cold exposure – elevation of blood pressure, peripheral vasoconstriction or elevation of fibrinogen concentration and blood viscosity – have really a greater impact in CE and LLA strokes.

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