Influence of environmental temperature on incidence patterns of cardiovascular and cerebrovascular events in Siberia

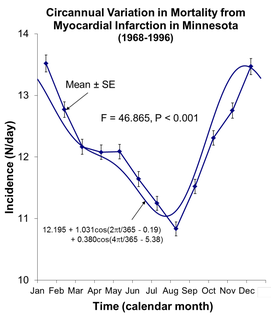
Tony Tran[1], Denis Gubin[2], Oleg Ragozin[2], Cathy Lee Gierke[1], Germaine Cornelissen[1]
[1]Halberg Chronobiology Center, University of Minnesota, Minneapolis, MN, USA; [2]Department of Biology, Medical Academy, Tyumen, Russia

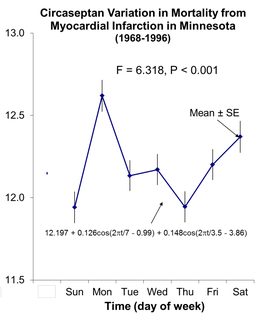
Aims

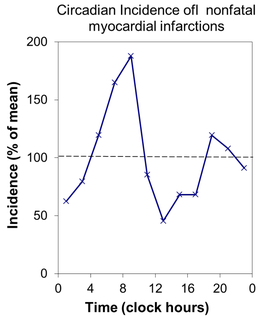
To determine whether the incidence of cardiovascular and cerebrovascular events in western Siberia follows circadian (about-daily), circaseptan (about-weekly) and circannual (about-yearly) patterns, and, if so, whether these patterns are influenced by air temperature.

Background

The incidence of cardiovascular diseases has been shown to follow circadian, circaseptan and circannual patterns in varying locations, with more cases on Mondays, mornings, in winter. Herein, we examine whether air temperature influences these patterns in a region of western Siberia.







Materials and Methods

The incidence of **cardiovascular** (ICD10-**I20s**) and **cerebrovascular** (ICD10-**I60s**) conditions was extracted from a database on ambulance calls in Khanty, Siberia (386,693 cases) and merged in Microsoft Access on the attributes of date and time with local **air temperature** recorded during 2001-2013 (37,982 measurements). There were *fewer I60s than I20s* ($P<0.001$). The two sets (I20s and I60s) were each split into three subsets depending on air temperature (T) at the time of event:
cold ($T<-15^oC$); **mild** ($-15\ ^oC \leq T \leq 25^oC$); and **warm** ($T>25^oC$).
The **circadian**, **circaseptan** and **circannual** patterns were determined by counting the number of cases in bins (by clock hour, day of week, and month of year), normalized to account for the relative representation of temperatures during each bin. Components accounting for a large proportion of the overall variance in least squares spectra were included in multiple-cosine models to describe the incidence patterns of I20s and I60s in each temperature range. Parameter tests compared rhythm characteristics after expressing the data as a percentage of mean.

Results

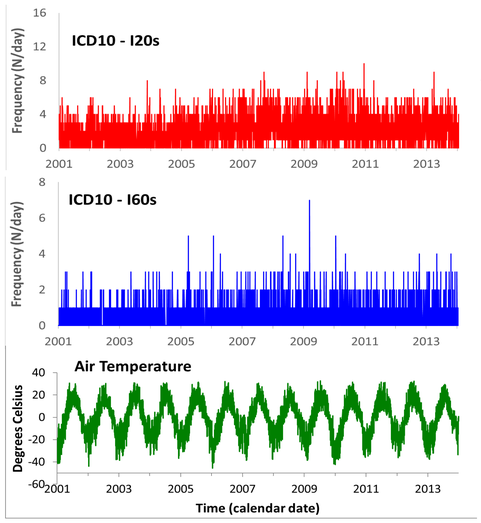


Figure 1: An annual pattern is visible to the naked eye in the temperature data, but no pattern is apparent in the incidence of morbidity.

i. Circadian

I20s and I60s follow a circadian rhythm ($P<0.001$) [except for I60s at $T>25^oC$; for 6 hours during the night, T never reached 25^oC]. Minima occur at night for both I20s (~04:00) and I60s (~03:20); maxima around 11:40 and 22:00 differ in prominence between the I20s, peaking in the evening, and the I60s peaking late morning.

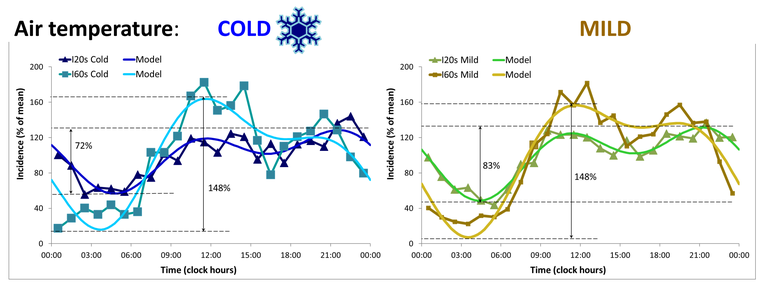


Figure 2: The predictable extent of change accounted for by the circadian pattern is larger for the I60s than for the I20s ($P<0.005$), and amounts to 72% (cold) to 83% (mild) for I20s and to 148% for I60s.

ii. Circaseptan

A half-weekly pattern accounts for 7.0% to 35.2% variation for I20s and 17.4% to 71.0% variation for I60s. Maxima occur on Mondays (or Sundays) and Thursdays. At warm temperatures, I60s follow a weekly pattern with maxima on Mondays. At warm temperatures, there are more I60s ($P<0.05$) and a slightly larger half-weekly amplitude of I20s ($P<0.10$) than at mild or cold temperatures.

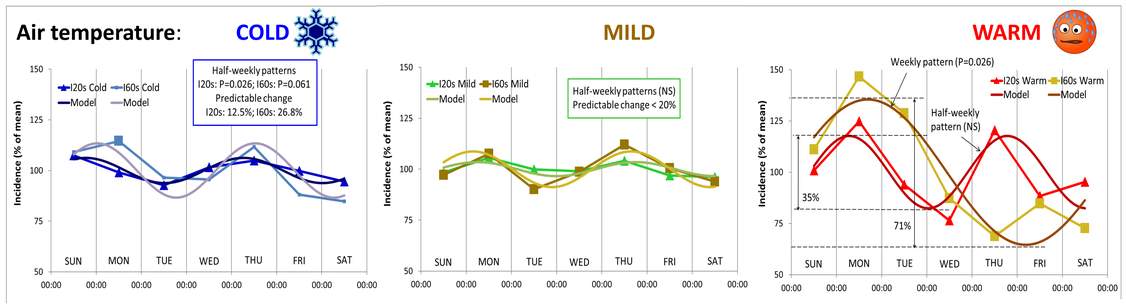


Figure 3: The predictable extent of change accounts for 7.0% to 35.2% variation for I20s and 17.4% to 71.0% variation for I60s.

iii. Circannual

A circannual pattern at mild temperatures (there were no cases in summer at cold temperatures or in winter at warm temperatures) is significant for both I20s and I60s ($P<0.005$), peaking in the winter.

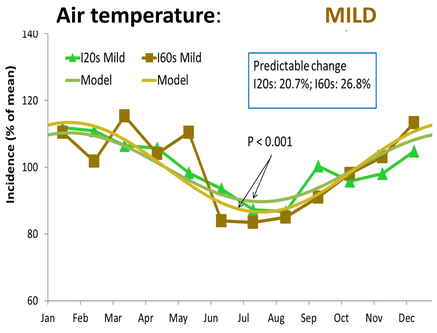


Figure 4: The predictable extent of change accounts for 20.7% (I20s) and 26.8% (I60s) variation.

Discussion and Conclusion

As expected, predictable about-daily, -weekly (or half-weekly), and –yearly patterns with peaks in the morning, on Mondays, in winter were found to characterize the incidence of cardiovascular and cerebrovascular conditions. Similar patterns have also been reported for blood pressure. Further work plans to examine whether older people may be more affected by air temperature than younger individuals. The influence of other atmospheric variables (atmospheric pressure, dew point, relative humidity, rainfall, wind speed, and cloudiness), measured concomitantly in the available weather database, on the incidence of I20s and I60s will also be examined. Information thus gathered will help issue weather warnings and aid first-responders and medical institutions in areas such as staffing and medication inventory decisions.