10089 - Patterns in aeroallergen abundance and their associations with short-term climate changes in Budapest (1992-2001)

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Human health effects of climate variability have been assessed as one of the newly proposed research issues of the Hungarian NEHAP. The analysis of aeroallergen abundance related to climatic conditions is a relatively new field that may have great public health importance, concerning the increasing number of patients suffering from hay fever and/or asthma in Hungary. Descriptive results of a shorter data collection period were introduced previously. Weather database (temperature /daily average T, min, max, range/; relative humidity, rainfall, winspeed, sunshine hours, and barometric pressure) were collected by online air pollution monitoring stations. 10-year-long records of the Hungarian Aerobiological Network were used to examine variabilities in meteorological factors and their associations with main groups of aeroallergen (trees, grasses and weeds, total pollen count, mold spores as *Alternaria, Cladosporium,* and other spores) concentrations. Additionally, special features of aeroallergens were characterized, like the start of pollination seasons, duration, and pollen amount produced of 8 different allergenic plants (ragweed, grasses, ash, birch, common oak, hornbeam, planetree, poplar) and outdoor mold spores. Correlations and linear regression models were applied to examine associations between pollen and spore counts, their yearly catches; and meteorological factors. Results showed significant increase in the allergenic mold concentrations by years (β= 623,28, $p<0.000$). Significant correlations were observed with daily Tmax in aeroallergen pollen groups, except trees; and this correlation was high in the case of grasses ($r=0.51$, $p<0.000$). There were also significant positive associations between Tmax and allergenic spores (highest $r=0.35$, $p<0.000$ for *Alternaria*), however outdoor mold concentrations followed remarkably the relative humidity patterns too. Converse associations were found between all pollen grain groups and relative humidity. Barometric pressure was also negatively associated with aeroallergen concentrations, but other spores, as that group displayed positive, but non-significant association. Starting date of pollen seasons were examined by years with retrospective method relative to the total pollen catch. Among spring pollinating trees, more than 4-week-long time difference of starting dates was possible, but in the case of ragweed, smaller changes (max. 10 days) were observed. These results can be integrated immediately in the Hungarian community outreach programs related to aeroallergen monitoring and health effects of climate change.

10100 - The impact of Climate variability on human mortality in a sub-tropical city

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Objectives: To study the impact of weather on human mortality in Brisbane, a sub-tropical city, over the period of 1986-98.
Methods: Spearman correlation and AutoRegressive Integrated Moving Average (ARIMA) regression analyses were conducted between monthly climate variability (maximum and minimum temperatures, rainfall, relative humidity and cloudy cover) and monthly mortality in general population, aged population (65 years old and over), as well as the deaths from various causes such as from cardiovascular and respiratory diseases and cancers.
Results: In summer, there were only positive correlations between monthly mean minimum temperatures and the mortality in general and aged populations. In winter, reverse correlations were found between cardiovascular disease mortality and monthly mean maximum temperatures, relative humidity and cloudy cover in the afternoon; respiratory disease mortality and monthly mean minimum temperatures. In annual data analyses, there were reverse correlations between climate variability including monthly mean temperatures (maximum and minimum), rainfall, relative humidity in the afternoon and cloudy cover in the morning and afternoon, and mortality from general and aged population, cardiovascular and respiratory diseases. There was no correlation between climate variability and the mortality from cancers. Regression models were developed in different target populations. Temperatures seemed played a more important role than other climatic variables. In annual analysis of general population, for instance, the regression coefficient was –1.68 (R^2=0.33) while other weather factors were not significant.
Conclusion: Climatic variables, especially maximum and minimum temperatures played a certain role for human mortality in Brisbane. A great attention paid on temperatures is important to control mortality in cold and hot weather, especially aged people and the people with cardiovascular and respiratory diseases. This should be one of important preventive strategy to decrease the cardiovascular and respiratory mortality in such areas.

10254 - Triggering of Ischemic Stroke Onset by Decreased Temperature

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Abstract

Background and Purpose: Some studies suggest that cold temperatures can affect mortality, especially increasing circulatory and respiratory deaths. The authors investigated the association between ischemic stroke onset and cold temperature change for 545 patients over a 3-year period (January 1998 to December 2000) in Incheon, Korea.
Methods: We used a case-crossover study design to assess the change in risk of ischemic stroke during a brief hazard period after exposure to a temperature change. For each subject, 1 case period was matched to 3 control periods exactly 1 week apart before the date and time of the onset of the ischemic stroke.
Results: Decreased ambient temperature was associated with a risk of acute ischemic stroke onset. One day after the exposure to cold weather, we found a statistically significant increase of odds ratio of 2.38 (95% CI 1.33, 4.35) for the onset of ischemic stroke for an interquartile range decrease in temperature. Elevated risk period of ischemic stroke was 24 to 54 hours after exposure to the cold. Risk estimates of decreased temperature changed depending on the season, greater in winter than in summer. We also found that women, the elderly, and those who have hypertension or hypercholesterolemia are more susceptible to the cold-induced ischemic stroke.
Conclusions: We suggest that stroke incidence rises with falling temperature, and even

moderate decrease can lead to excess occurrence of ischemic stroke. We noted that the impact of cold on the stroke incidence becomes most important 1 day after the cold weather.

10506 - Modifiers of the temperature and mortality association in four U.S. Cities

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Daily mortality levels tend to be higher on days of extreme ambient temperatures (hot or cold) in cities throughout the world. However, factors that modify this association have not been well explored, and may be relevant for determining who is at highest risk from the effects of global climate change. We used Poisson regression to fit city-specific models of daily non-injury mortality in four U.S. metropolitan areas: Chicago, Detroit, Minneapolis and Pittsburgh, during 1986-1993. Predictors included smoothed functions of time, barometric pressure and day of week; a linear term for PM_{10}, and polynomial distributed lag terms for mean daily temperature and relative humidity on the day of death and lags out to two weeks previous. Separate models were fit to death counts stratified by potential effect modifiers: age, race, gender, education level, and whether death occurred in or outside of a hospital. We calculated the percent change in mortality at 30^o and -15^o C, relative to the temperature at which the lowest mortality association was observed at lag 0 for each stratum. In addition, a combined effect estimate across all four cities was calculated using inverse variance weighted averages. Comparing the combined estimates of the cold (-15^o C) effect immediately and summed over the seven days following the cold weather, cold temperatures during the previous week strongly influenced mortality for the entire population, with a 9.4% excess (95% CI: 5.7%-13.2%) when summing the effects at lags 0-7 compared to a 2.3% excess (95% CI: 0.9%-3.5%) for lag 0 alone. By contrast, the effects of heat were more immediate, with evidence for harvesting: at lag 0, the 30^o C effect for the whole population was 8.3% (95% CI: 5.1%-11.5%), but summing lags 0-7, the heat effect was –4.7% (95% CI: -10.9%-2.0%). Deaths among blacks and outside a hospital were more strongly associated with temperature (particularly hot temperature) than deaths among whites, and deaths inside a hospital, respectively. These associations were consistent across all four cities, except for Minneapolis, where stronger associations were observed among in-hospital deaths. Mortality among those with less education was higher than for those with more education for cold temperatures, and among those less than 65 years of age for the 30^o C effect, sum of lags 0-7. Otherwise, age and gender did not modify the association. The stronger temperature-dependence of out-of-hospital deaths is plausible, in that people outside a hospital are likely more exposed to ambient conditions. The possible reasons why race and educational level were also markers of differing vulnerability are likely more complex, but these observations are consistent with other U.S. and U.K.-based studies that examined related indicators of socio-economic conditions. The heterogeneity we observed between cities suggests that some of the indicators of susceptibility have complex relationships with other city-specific factors affecting associations between temperature and daily mortality.

Abstract # 10538

INTERNATIONAL STUDY OF TEMPERATURE AND HEATWAVES ON URBAN MORTALITY IN LOW & MIDDLE INCOME COUNTRIES (ISOTHURM)

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BACKGROUND. Current projections suggest that we may see an increase in global temperatures of around 1.4 to 5.8 degrees Celsius over the next 50 years and an increase in weather extremes. The ISOTHURM study was established to characterize the temperature-mortality relationships in urban populations in low and middle income (LMI) countries to examine the potential vulnerability of their populations to global warming. METHODS. We studied mortality in 12 cities from LMI countries in five continents. They were (north to south): Ljubljana, Bucharest, Sofia, Delhi, Monterrey, Mexico City, Chiang Mai, Bangkok, Salvador, Sao Paulo, Santiago, Cape Town. For each one, daily all-cause mortality was examined in relation to ambient temperature using Poisson models with adjustment for season, particulate air pollution, day of the week and public holidays. Generalized additive models were used to construct graphs of mortality as smoothed functions of temperature, and hockey-stick models to estimate gradients and thresholds of increases in mortality related to both low and high temperatures. Two-day mean lags were assumed for heat effects, and two-week mean lags for cold effects. RESULTS. Smoothed graphs revealed a wide range of non-linear temperature-mortality relationships, with clear evidence of cold-related deaths in all cities except Ljubljana and Salvador, and of heat-related deaths in all cities. Particularly large temperature-related fluctuations in daily mortality rates were apparent in Monterrey (in relation to both heat and cold), Mexico City (mainly cold-related), and in Delhi, Bangkok and Sofia (mainly heat-related). Point estimates of the temperature threshold below which cold-related mortality first occurred ranged from -3 to 28 °C; the threshold above which heat-related deaths occurred ranged from 16 to 31 °C. Cold thresholds tended to be lowest in cities with low minimum temperatures, and heat thresholds highest in cities with high maximum temperatures, though several thresholds were imprecisely defined. The increase in mortality per °C fall in temperature below the cold-threshold was greatest in Chiang Mai, Bangkok, Mexico City, Monterrey and Santiago; the increase in mortality per °C above the heat-threshold was greatest in Monterrey, Bangkok, Chiang Mai and Sao Paulo. But both cold- and heat-related gradients in mortality were often sensitive to the selection of the threshold. CONCLUSIONS. The wide variation in temperature-mortality relationships between these cities may in part relate to the large differences in temperature distributions, but they may also reflect variation in such factors as socio-economic development, underlying prevalence/incidence of temperature-sensitive diseases (especially cardio-respiratory and diarrhoeal disease) and population age structure. Although populations may steadily adapt to increasing temperatures, the mortality patterns we observe suggest that populations in many cities in low and middle income countries are likely to have substantial vulnerability to predicted patterns of climate change.

10623 - Climate variability and the transmission of malaria in China

Bi P, Tong S, Donald K, Parton K, Ni J

To study the impact of climate variability on the transmission of vector-borne diseases, a time-series data analysis was conducted between monthly climatic variables and monthly incidence of malaria in Shuchen County, China over the period 1980-91. Spearman's correlation analyses showed that monthly mean maximum and minimum temperatures, relative humidity and monthly amount of precipitation were positively correlated with the monthly incidences of malaria in the county. Regression analysis suggested that monthly mean minimum temperature and the monthly amount of rainfall, with a one-month lagged effect, were significant climatic variables in the transmission of malaria in Shuchen County. "Seasonality" and "Year" were also significant in the regression model. The results indicated that these climatic variables might be treated as possible predictors for regions with similar geographic, climatic and socio-economic conditions to Shuchen County.

10859 - Weather Changes Associated with Hospitalizations for Cardiovascular Diseases and Stroke in California, 1983-1998

Ebi KL, Exuzides KA, Lau E, Kelsh MA, Barnston A

Understanding how temperature changes affect disease patterns can enhance provision of health care services. Poisson regression models were used to evaluate associations between weather changes (lagged 7 days) and hospitalizations for acute myocardial infarction, angina pectoris, congestive heart failure, and stroke during normal weather periods and El Niño events in three California regions. Associations varied by region, age, and gender. Associations were found between health outcomes and a 3°C decrease in maximum temperature and/or a 3°C increase in minimum temperature over 4 days (temperature changes). In Los Angeles, temperature changes resulted in small changes in hospitalizations. Among San Francisco residents 70+ years of age, temperature changes increased hospitalizations from 6 percent to 20 percent. Among residents 55–69 years old, temperature changes increased congestive heart failure hospitalizations 10-20 percent. Associations among Sacramento residents were similar but weaker; temperature changes increased hospitalizations 6-11 percent for acute myocardial infarction and congestive heart failure; and 7-13 percent for stroke among men 70+ years old. El Niño events were not associated with hospitalizations in Los Angeles. For women, hospitalizations for angina pectoris increased during El Niño events in San Francisco and Sacramento. In Sacramento, El Niño events were associated with increased hospitalizations among women for acute myocardial infarction and congestive heart failure and with decreased hospitalizations among men for congestive heart failure and stroke.

10875 - Does the effect of temperature on mortality in Mexico City depend on socio-economic conditions?

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As part of efforts to quantify the impacts on global climate change on human health, a number of studies relating ambient temperature to daily mortality fluctuations have been performed. One question of interest is whether certain population groups are more affected by temperature extremes and should therefore be targeted for preventive measures. We assessed whether associations between daily mortality and temperature in metropolitan Mexico City differed by socio-economic characteristics of the region where people lived. We modeled daily mortality during 1996-1998 with Poisson regression, including as predictors smoothed functions of time and relative humidity; day of week indicators; and a linear term for PM_{10}. We also included two terms for temperature which accounted for the effect of heat depending primarily on the temperature on day of death (lag 0), but the effect of cold being dependent on temperatures over longer lag times. To estimate the effect of heat on mortality we used a smoothed function of mean daily temperature for lag 0, comparing the effect at 25^{o} C to the effect at 15^{o}. The cold effect was estimating using a smoothed function of the mean daily temperature, averaged over the three days preceeding the day of death, comparing the effect at 10^{o} C to the effect at 15^{o} C. Mean temperature was used because the model with this parameter had a lower Akaike's Information Criterion than models with minimum or maximum temperature. We calculated the effects for the entire population, then stratified the death counts by six geographic socio-economic indicators created from census data, and fit separate regressions for each socio-economic level. For the entire metropolitan area, the heat effect was a 2.05 % increase in mortality (95% CI: -1.1%-5.1%), comparing a day when the temperature was 25^{o} C to the effect at 15^{o}. The cold effect was 8.5% (95% CI 6.8%-10.2%), comparing a mean temperature averaged over three days previous of 10^{o} to 15^{o} over the same period. The heat effect was higher in areas with the lowest literacy rate as well as in areas with the lowest percent of homes with electricity and indoor plumbing. The cold effect was higher in areas ranked as less well-off using a composite socio-economic index created from several census variables, including income and crowding. For the heat effect, no particular trends were apparent using the composite index. For stratifed models using percent indigenous language speakers and percent homes with piped water, no monotonic dose-response trend of effect modification across the socio-economic gradient was seen for either the hot or cold effects. Although Mexico City is a relative temperate climate, temperature-associated daily mortality depends on some geographic socio-economic characteristics we studied.

Abstract for ISEE 2002

10915 - The impact of climate change on heat-related mortality in Australia and New Zealand

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Assessments of the public health impacts of climate change are currently in progress both in Australia and New Zealand. Local health impacts of global warming are expected to increase due to several factors: an increased frequency of extreme weather events, spread of mosquito-borne diseases into new areas, increased outbreaks of food- and water-borne diarrheal diseases, a net increase of direct heat-related mortality, and direct impacts of heat on ability to carry out daily tasks. The issue of mortality due to thermal extremes is the most amenable to quantification based on available data.

This report will focus on the latter effect using analysis from several cities in the two countries. Poisson regression time series analysis of the daily mortality effect of heat and cold temperature with PM10 as another independent variable was carried out using the APHEA protocol. For example, in Christchurch, daily mortality increased by 0.78% in the winter for each degree C that minimum hourly temperature went below 0.2 degrees C. In the summer the daily mortality increased by 3.2% for each degree C that maximum hourly temperature exceeded 27.9 degrees. The net effect is that the current heat-related additional annual mortality is 10 deaths. Prior to the current spurt in global temperature growth (i.e., 1975), and assuming the same population size and distribution, we estimate 7 deaths would have occurred. During the 1990s decade the average temperature in Christchurch increased by 1.1 degrees C (95% CI 0.8 - 1.4 degrees). If the average of daily maximum temperatures increases by 1 degree also in the next decade, the heat-related mortality in this population would be 17 deaths/year. If the temperature increase reaches the maximum predicted by the IPCC for this century, 5 degrees above current temperatures, the heat-related mortality in this population would be 74 deaths/year (3% of the total annual mortality in Christchurch). Data for Auckland and several Australian cities will be included in the final estimates. PM10 has an independent effect on daily mortality, and this will be reported separately.

10954 - Human Health Impacts of Climate Change in Portugal: Temperature-related deaths in Lisbon

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Background to study - The current study is a sub-study of an integrated project entitled: Climate Change in Portugal: Scenarios, Impacts and Adaptation Measures (SIAM). The primary objective of SIAM is to assess the vulnerability of Portugal to climate change.
Sub-study Methodology - Morbidity and mortality data for Portugal were collected from official records and available published literature. This health information was used as a baseline for projections of potential impacts of climate change on health. Historical temperature records were obtained from the Portuguese Meteorology Institute. Temperature forecast results from a regional climate model, PROMES (based on the HadCM2 GCM run), were used to determine climate changes for Portugal under $1xCO_2$ (baseline) and $2xCO_2$ (future) scenarios.
Results – By use of analogue studies, a heatwave of a national scale was identified in Portugal in June 1981. A threshold temperature of 32°C was established for Lisbon based on these studies. Potential temperature-related deaths were calculated for two additional heatwave episodes that occurred in Lisbon during 1989-1992 period. Previously calculated temperature-related death results of the 1981 heatwave in Lisbon were included for comparison. Results of the PROMES model were used to identify future potential heatwave episodes in Lisbon.

Table-1 depicts the excess deaths observed in three heatwaves.

Heatwave	Observed deaths	Expected deaths	Excess deaths	Excess deaths per day
June 1981	873	413*	460*	51.13
July 1990	546	449[1] 382[2]	97[1] 164[2]	12.1[1] 20.5[2]
July 1991	715	460[1] 393[2]	225[1] 322[2]	31.9[1] 40.2[2]

* Reproduced from Garcia, et al., 1999.
1 – Estimation method 1 (using heatwave month to calculate expected deaths during that month, all monthly deaths used).
2 – Estimation method 2 (heatwave days from respective month were removed, preceding and following two months deaths used to calculate expected deaths).

Conclusions - Climate change model results indicate that there is an increased potential for the occurrence of more severe heatwave episodes in Lisbon in the future. In the absence of adaptation measures to such climate changes, increased temperature-related deaths are anticipated for Lisbon.