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SEASONAL MORTALITY IN ROMANIA
(Part I – General Methodology)

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Abstract. Aim. The aim of the present study is to examine the form and relationship between total mortality/morbidity and temperature variations within the cities of Romania during a 2004-2007 as well as to assess the magnitude of this association. **Method.** The epidemiological evaluation of the dynamic relationship between environmental temperature and health is undertaken using both simple analysis and ARIMA models. In this article we present methodologies appropriate for the available data in Romania. **Results**. A statistically significant association is expected to be found between temperature and mortality/morbidity. **Conclusions**. Research on the association between temperature and mortality/morbidity has relevance to the formulation of health policy serving at-risk populations.
Key words: climate change, extreme temperature, excess mortality, morbidity, ARIMA models

Rezumat. Scop. Studierea relației dintre mortalitate/morbiditate şi variațiile de temperatură în România, în perioada 2004-2007, precum şi evaluarea gradului de asociere dintre aceste variabile. **Metodă**. Evaluarea epidemiologică a relației dinamice dintre temperaturile extreme şi/sau modificările rapide de temperatură şi sănătate folosind atât metode de statistică descriptivă cât şi prin metode de modelare a seriilor cronologice (ARIMA). În acest articol vom prezenta metodologia adaptată pentru datele disponibile din România. **Rezultate.** Metodología propusă ne conduce la verificarea ipotezei conform căreia există o asociere semnificativă din punct de vedere statistic între valorile extreme ale temperaturii şi ratele de mortalitate/morbiditate. **Concluzie.** Studierea asocierii dintre valorile extreme ale temperaturii şi ratele de mortalitate şi respectiv morbiditate este importantă pentru formularea politicilor de sănătate publică adresate comunităților cu risc.
Cuvinte cheie: modificări climatice, temperaturi extreme, exces de mortalitate, morbiditate, ARIMA (modele ale seriilor cronologice)

INTRODUCTION

The health impact produced by extreme temperature events has been studied by epidemiologists for a while (1,2,3,4). Peer-reviewed literature reveals that very low and very high ambient temperature as well as sudden changes in weather conditions may be fundamental factors in determining the seasonal behavior of some forms of illness and may be strongly connected with a number of major causes of death in population (e.i. circulatory, cerebrovascular and respiratory diseases as well as violence, suicide and homicide, etc.).

The relationship between climate and mortality/morbidity is a complex one.

The chain of causality in morbidity and mortality due to extreme temperature involve beside the *climate change*, some other important links like *socioeconomic and urban living factors* (e.i. income/wealth, education, housing conditions, marital status, living arrangements), *age* (all ages are affected) and *preventive behaviors* which together drive to *biomedical reaction to climate* (e.i. infections of the respiratory tract, etc.), and next to *demographic reaction to biomedical changes* (e.i. the body loses its ability to maintain temperature balance and increase mortality risk) (4,5,6).

Rates of morbidity and mortality due to climate change related illnesses can rise during and immediately after a cold/heat wave (according to some experts in around 14 days after a cold/heat wave). The magnitude of these health effects is difficult to predict and depends on a variety of factors such as city planning for climate emergencies, regional climate tolerance, wave duration, and macroclimate adaptability. A city with no prior experience with extreme weather conditions and in consequence with no detailed climate emergency plans, very high or very low ambient temperature can create considerable health risks in the witness population. The greater part of the mortality and morbidity rates linked to heat and cold often occurs during the week after the change in temperature.

The factors which go together with extreme temperatures (e.i. relative humidity, air pollution, wind speed, etc) are usually treated as individual variables within the model. Looking for significantly better results we can compare the separate use of meteorological variables with the use of variables or indices which combine the most important element – temperature – with other meteorological variables.

DATA

The model is generated based on measurements of the health effects (morbidity and mortality rates) of observed unusually variations in climate in time.

The causal groups considered are total mortality excluding external causes, and hospitalization in Romania over the period 2004-2007. The data can also be stratified by gender. The daily number of death and hospitalization can be obtained from Ministry of Health. The mean daily temperature and daily relative humidity figures can be obtained from National Meteorological Office. We also consider the fact that the temperature of a locality is modified by urban agglomeration.

The analysis is carried out for entire period of study and for two periods grouped by the colder months November-April, and the hotter months May-October.

METHODOLOGY

Among the different methodologies available to evaluate the health impact of environmental variables two methods are most commonly used:

generalized additive models (GAM) and Box-Jenkins (ARIMA) models.

Considering the lack of available data, our option to evaluate the association between mortality/morbidity and the meteorological variables included in the models (daily maximum, minimum and average temperature) is to apply ARIMA models. The ARIMA model takes into account the history of the modeled series through auto-regressive (AR) and moving average (MA) components which are both based on the concept of random disturbances or shocks. The external variables are introduced linearly at varying lags and deal with different simultaneous effects thus enabling an effective identification of the individual role associated with each specific predictor. The ARIMA models provide the results expressed as the absolute increase of mortality associated with an increase in temperature of 1°C.

Because in our study we are seeking to describe the impact of higher (for warm months) or lower (for cold months) than usual temperatures regardless of whether they occur in a sequence or as isolated events we choose to refer to extreme temperatures on a local basis and define the extreme hot days (EHD) on a percentile approach. EHD is considered any day with a T_{max} value above the 95 percentile value of T_{max} for that particular station (similar definition for extreme cold days -ECD (6, 7, 8, 9,10, 11).

The possible effects on mortality and morbidity of other meteorological phenomena associated with extreme temperature can be considered.

We have also in view to estimate the extent of excess mortality during a certain period (2007) by making comparisons with mortality rates in one or more earlier years.

RESULTS

A statistically significant association is expected to be found between temperature and mortality/morbidity. Previous investigations carried out in different European countries suggest that mortality rates rise progressively as the ambient temperature becomes hotter or colder and the greater part of the mortality occurs during the week after the change in temperature. The modeling of the time series data proposed in this study is undertaken following an accepted methodology and adjusted to the information available for Romania.

CONCLUSIONS

Research on the association between temperature and mortality/morbidity has relevance to the formulation of health policy serving at-risk populations. Similar analysis can be developed based on disease stratification.

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