Seasonal variation of mortality in Novi Sad (Serbia): a role of air temperature*

Daniela Arsenović[1], Branislav Đurđev[2], Stevan Savić[3]

Abstract

Existing research of effects of temperature on mortality demonstrated associations between mortality and air temperature. Many regions experience increase in mortality during winter period. Recent results suggested that countries and regions in temperate climate has higher winter mortality, than regions in colder climate. Objective of this paper is to research seasonal variations of mortality-related air temperature among urban population of Novi Sad (Serbia) in the period from 1953 until 1997 and analysis is based on 45 465 recorded death. Data on monthly mortality was linked with monthly average temperature. Analysis show strong correlation between mortality and air temperature and coefficient of seasonal variation in mortality (CSVM) indicated that mortality in winter period is higher than mortality in non-winter period. A main finding of this paper is that low temperature cause increase in crude death rate (CDR) but this effect has decreasing trends.

Introduction

A strong evidence exist that seasonal variation of mortality are caused by differente physiological parameters, e.g. haemostatic factors, blood presure, as well as malnutrition (Stout and Craword 1991; Woodhouse et al. 1993). Several research articles suggested that this changes are cosequence of seasonal variation of temperature (Rose 1966; Kalkstein and Greene 1997). Strong relation between mortality and temperature was find during 2003 heatwave. During the summer 2003 a big part of Europe was affected by heatwave. The most affected were countries of Western Europe, expecialy France, where unprecedented temperatures resulted in a dramatic increase in the number of death during heatwave period compared with the seasonal average from previous years (Le Tertre et al. 2006). During the 1995, Chicago experienced a recor-breaking hight temperature and during four day of heatwave, over 400 heat-related death were reported (Naughton et al. 2002).

[1] University of Novi Sad, Faculty of Science, Center of Spatial Information of Vojvodina Province
[2] University of Novi Sad, Faculty of Science, Center of Spatial Information of Vojvodina Province
[3] University of Novi Sad, Faculty of Science, Climatology and Hydrology Research Centre
e-mail daniela.arsenovic@dgt.uns.ac.rs
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Nevertheless, Long term seasonal variation of mortality show that during the year, in most country, a mortality peak was found during the winter period. Most country has from 5% to 30% excess winter mortality (Healy 2003). Seasonal variation of mortality appears lowest in countries with cold winters, for example Russia, Scandinavian countries and Canada and is higher in Great Birtain, Greece and Portugal where winters are milder (Rau 2006; Davie et al. 2007). This article examines the support of this hypothesis and findings.

Main objectives of this paper is to research seasonal variation of mortality–related with temperature in urban area of Novi Sad, in the period 1953-1997. Novi Sad is located in north part of Serbia and it is a second largest city in country. According to data of Statistical Office of the Republic of Serbia in 1997 in urban area of Novi Sad was lived about 185 000 inhabitants.

Data and metod

Mortality data was colected from civil registers for the period 1953-1997 and number of death was aggregated on monthly level. Monthly crude death rate (CDR) per 100 000 were calculated with all months standardised to 30 days. For analysis was used average temperature (Tsr). Data for temperature was taken from NOAA (National Oceanic and Atmospheric Administration, United States Department of Commerce).

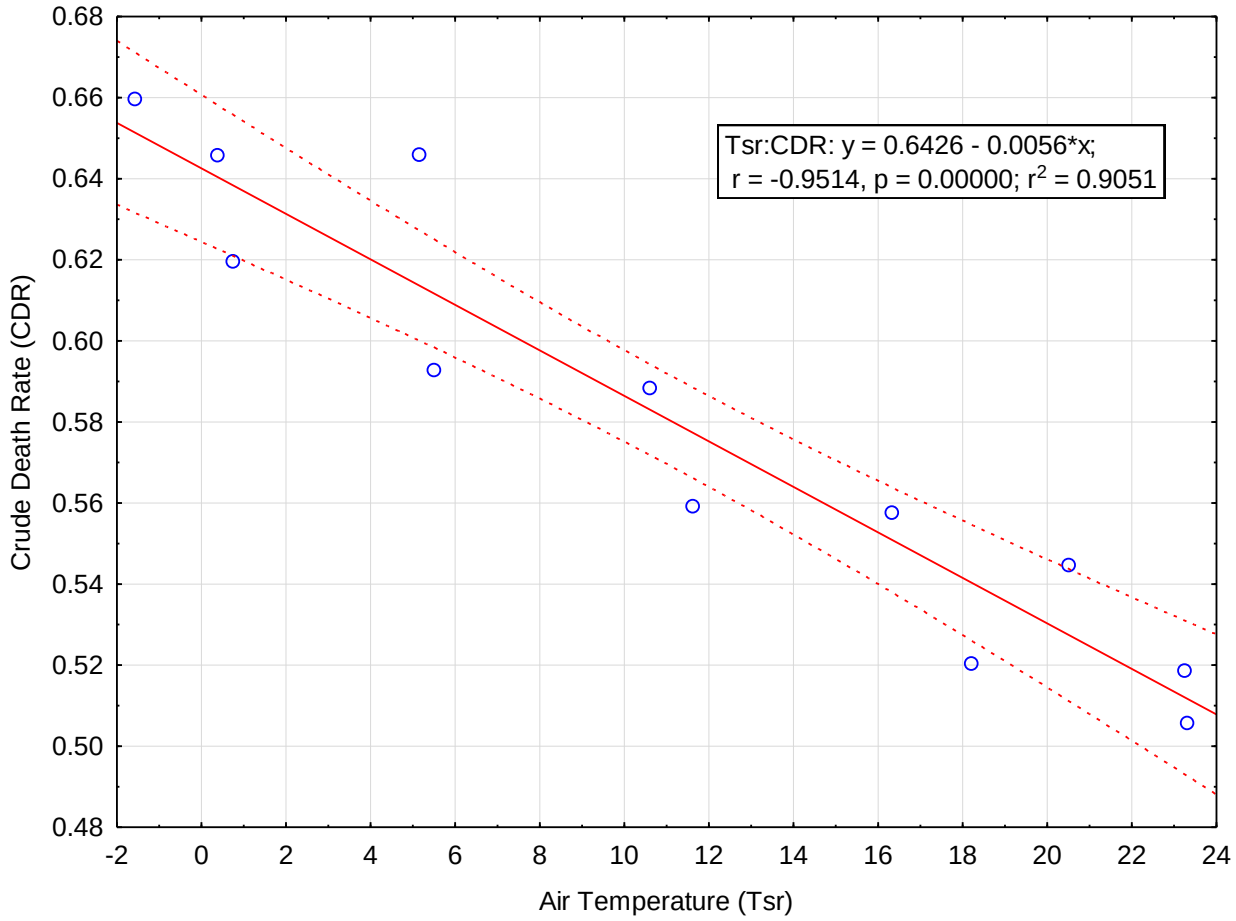
Scatter diagram was used to determinated relation between crude death rate and average temperature. In order to research temporal changes the data were split into four periods and coefficient of seasonal variation in mortality (CSVM) was used to detect seasonal variation of mortality during year. CSVM is calculated as difference between the number of death in four winter month (December-March) and the average number of deaths in two four-month periods which precede winter (August-November) and follow winter (April-July).

Finally, Student`s *t*-test was used to confirm differences between crude mortality rate in winter and non-winter period (preceding and following).

Results

During the period 1953-1997 about 45465 deaths were registered. Analyses on graph 1 demonstrate relation between season of the year and trend of crude death rate. Crude death rate and temperature are negatively associated, decreased of average temperature is followed with increase of crude death rate. Coefficient of correlation (r) has high value and coefficient of determination (r^2) explaned about 90% of variation of crude death rate with regard to average temperature. Annual peak varies from year to year, but always was in winter month (usualy, it was January). Lowest value of crude death rate in observed period, was found in August.

Graph 1 Sactterplot diagram of crude death rate (CDR) and air temperature (Tsr) in Novi Sad, for the period 1953-1997



Value of CSVM, presented in table 1, show that mortality in winter period (December-March) is higher than average number of death in preceding (Avgust-November) and following period (April-July). CSVM varied over time and in the first observed period 1953/54-1936/64 coefficent has the highest value (winter mortality was 25% higher). CSVM in other three periods also shown that winter mortality is higher than in preceding and following period but decreasing trend of CSVM is evident. During the period 1964/65-1974/75 winter mortality was 19% higher, in period 1975/76-1985/86 mortality during winter months was about 11% higher and in the period 1986/87-1996/97 winter mortality was 12% higher than in preceding and following period.

Table 1 Coefficient of seasonal variation in mortality (CSVM) in Novi Sad, 1953/54-1996/97

Period	**CSVM**
1953/54-1963/64	0.25
1964/65-1974/75	0.19
1975/76-1985/86	0.11
1986/87-1996/97	0.12

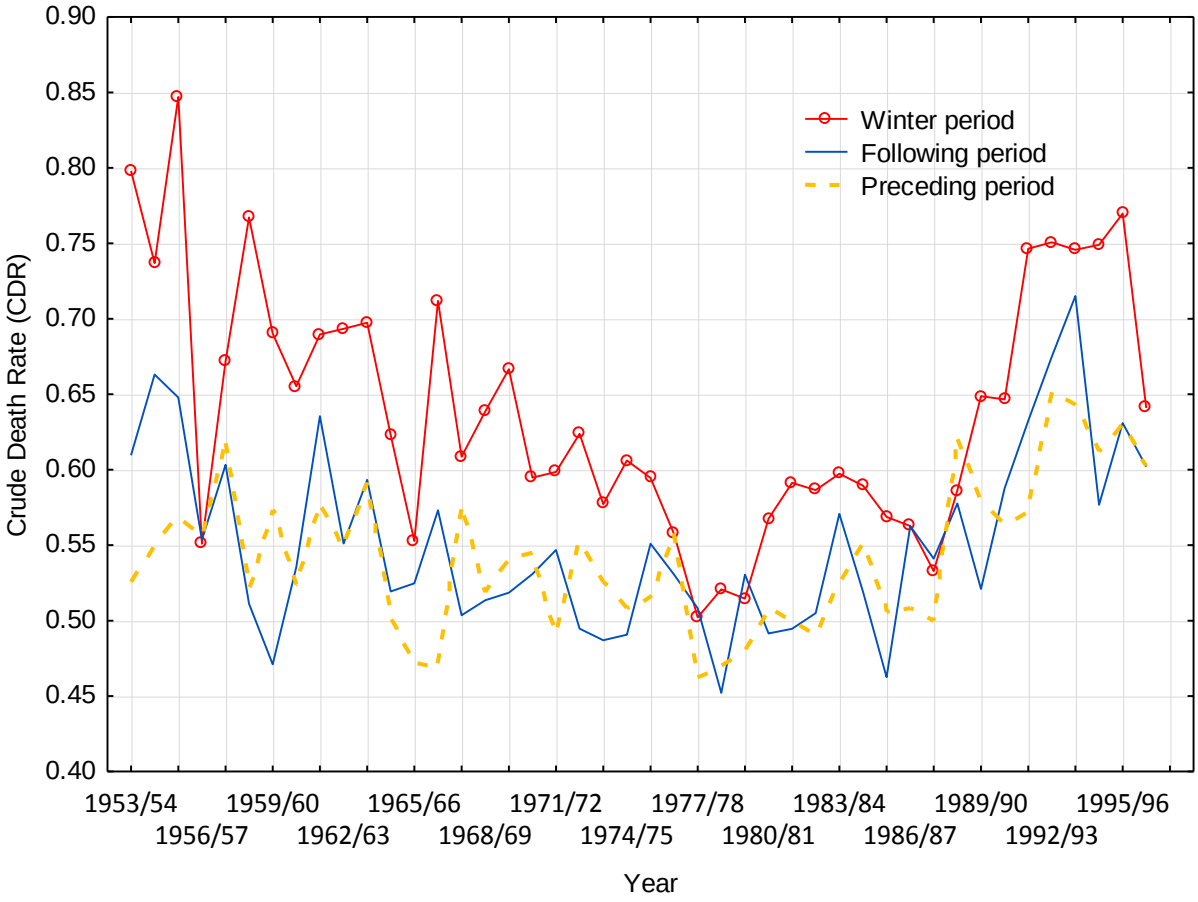
To improve results of CSVM was used *t*-test (Student`s). *t*-test was used to confirm whether exist statistically significance differences between crude death rate in winter period with regard to crude death rate in preceding and following period. According to *t*-test crude death rate in winter period is statistically different compared to crude death rate in preceding, as well as following period ($p<0.05$). Preceding and following periods were separately tested and analysis show that there is no statistically significant difference (($p>0.05$) between crude death rate in preceding period compared to crude death rate in following period (table 2).

Table 2 Student`s *t*-test: comparison of crude death rate (CDR) between winter and non-winter period (Preceding period: August-November, Following period: April-July)

Period	**t**	**p-value**
	1953/54-1963/64	
Winter/Preceding period	5.869207	0.000010
Winter/Following period	4.339391	0.000318
Preceding/Following period	-0.956071	0.350451
	1964/65-1974/75	
Winter/Preceding period	6.040179	0.000007
Winter/Following period	6.592432	0.000002
Preceding/Following period	-0.003651	0.997123
	1975/76-1985/86	
Winter/Preceding period	4.036809	0.000646
Winter/Following period	3.491150	0.002302
Preceding/Following period	-0.294826	0.771165
	1986/87-1996/97	
Winter/Preceding period	2.711786	0.013427
Winter/Following period	2.211166	0.038834
Preceding/Following period	-0.544919	0.591834

Results of *t*-test improve a finding of CSVM that difference between crude death rate in winter period compared to crude death rate in non-winter period (preceding and following period) has trend of declining.

Graph 2 Trends of Crude death rate (CDR) in winter and non-winter period (preceding and following period)



Discussion and conclusion

Winter mortality in Novi Sad in the period from 1953 until 1997 was about 15.6% higher than in preceding and following period. Results of Healy for the period 1988-1997 show that winter mortality in region EU 14 is about 16% higher than in non-winter period. Analysis for each country separately, gives evidence that Portugal has the highest seasonal variations in mortality in Europe (Healy 2003). According to the results of Healy, winter mortality is about 28% higher than in other part of the year. Evidence for Skoplje in Macedonia, for the period 1996-2000, show that mortality in winter period is about 15.9% higher than in non-winter period (Kendrovski 2006).

Compared with this results and other similar research in Europe it can be concluded that seasonal variation of mortality in Novi Sad follow seasonal pattern in most countries of North hemisphere.

According to CSVM, as well as *t*-test and trend of crude death rate (graph 2) it can be indentified two findings. First, that population in Novi Sad is more sensitive during the colder period of the year and second, that seasonal pattern of mortality has changes during observed period. During analysis it is noticed that in January, May, June, July and August, average temperature has been increasing. Such trend of average temperature may alter balance between mortality in winter and non-winter period. In regions, with temperate climate, such as and Novi Sad, even small changes of

temperature could influence on seasonal fluctuations of mortality during year. Similar result for Belgrade also shows that during second half of 20th century and first decade of 21th century, population is less sensitive to cold periods (Djurdjev et al. 2012). Research conducted by Nafstad et al. (2001), Pattenden et al. (2003) and Analitis et al. (2008) indicated that cold related mortality in colder regions started at lower temperatures than in warmer regions. This results support thesis that population in temperate climate are more sensitive to temperature changes.

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