Seasonal variation in mortality in Moscow
Martin McKee, Colin Sanderson, Laurent Chenet, Sergei Vassin and Vladimir Shkolnikov

Abstract

Background Seasonal variation in mortality has been investigated in many countries but not, until recently, in Russia. There are some grounds for suspecting that it may differ in Russia from what is seen in western countries. This paper explores patterns of seasonal variation in mortality in Moscow between 1993 and 1995.

Methods Analysis was based on individual data on deaths occurring in Moscow between January 1993 and December 1995, grouped by four-week period and by calendar month and on mean monthly temperature in Moscow for the same period. Crude, smoothed and deseasonalized trends were inspected. Auto-correlation functions were estimated and deaths were regressed against temperature.

Results As in other northern hemisphere countries, there is a winter excess of deaths but this is much smaller than in many western countries. It is restricted to some causes of death, such as ischaemic heart disease and cerebrovascular disease, and is associated with low temperature. In contrast, there is a marked summer increase in deaths among young people, especially from accidents and other deaths associated with alcohol consumption. Over the three-year period studied, there was an initial underlying increase in alcohol-related deaths that subsequently fell, coinciding with a previously observed increase in life expectancy.

Conclusions It is possible that the low level of excess winter mortality reflects warmer indoor environments than in the west. The seasonal variation of deaths among young people reinforces evidence of the important role of alcohol in the Russian mortality crisis.

Keywords: Russia, seasonal variation, mortality, accidents, temperature

Introduction

The scale of the mortality crisis facing Russia is now well recognized. A period of steadily decreasing mortality following the second world war, which paralleled improvements in the west, came to an end in the mid-1960s. Life expectancy at birth began to stagnate and lag behind that in the west. By 1984, at just 68 years it was seven years less than in western Europe. The following years were marked by a series of dramatic fluctuations. Between 1984 and 1986 life expectancy at birth in Russia increased to 70 years but this improvement rapidly reversed, falling to 64 years by 1994, before improving slightly in 1995.

Recent research has added considerably to understanding of the reasons behind this pattern, in particular highlighting the importance of alcohol in the recent fluctuations in mortality, but there are still many unanswered questions.¹ It is now well recognized that many countries exhibit seasonal variation in death rates. In temperate countries, mortality displays a U-shaped association with ambient temperature, with higher death rates during both hot and cold spells. In northern Europe, the predominant effect of low temperatures means that death rates in winter are typically between 5 and 15 per cent greater than those in summer. The size of the difference varies considerably and is greatest in the British Isles and lowest in Scandinavia.² These winter increases are due, largely, to cardiovascular, cerebrovascular and respiratory diseases, and to accidents.³

An understanding of the nature and causes of seasonal variation in mortality may have implications for health policy, by identifying those at particular risk and suggesting potentially avoidable risk factors. Apart from some research on seasonal trends in the 1930s and 1950s,⁴ this information has not previously been reported for Russia, but there are prima facie reasons to suppose that the pattern may be different from that in other European countries. In the absence of a protective effect from the Gulf Stream, Moscow experiences much colder winters than most of western Europe, averaging —9°C in January. This might be expected to lead to larger excess mortality than in, for example, the British Isles, but this could be counteracted by the fact noted by Sakamoto-Momiyama that Nordic countries, with which Russia has some similarities, tend to have better-insulated dwellings⁵ and, especially in the Russian context, by the large-scale provision of district heating schemes.

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We report an analysis of seasonal variation in deaths in Moscow during the years 1993–1995, describing patterns by age group and by broad cause of death as well as relationship with ambient temperature.

**Methods**

Mortality data are derived from a computerized file containing information on all deaths occurring in Moscow during the years 1993–1995, supplied by Mosgorstat (the Moscow Statistical Office). Deaths are categorized using the Soviet classification, which contains 175 causes of death. For the purpose of this analysis, data have been aggregated to produce seven major diagnostic groupings and five age groups. For clarity, the two youngest age groups have been combined when displayed graphically because of the small numbers involved. Mean monthly temperature data from Moscow were supplied by the UK Meteorological Office.

The mortality data were aggregated over time in two ways. Previous work has identified a ‘day of week’ effect, in which there is an increase in deaths from alcohol-related causes at weekends. To overcome the possibility of months having different numbers of Saturdays or Sundays, the dates of death for the three years were grouped into 39 four-week (28-day) periods. Underlying trends and seasonal factors were separated by, for the former, calculating a 13-point moving average, and for the latter, calculating the mean differences between the observed values and the underlying trend. Auto-correlation functions were derived using SPSS.

The use of four-week periods was not, however, possible for the comparison with temperature as these data were provided on the basis of calendar months. For analyses of the association of deaths with cancer a second method was used. Here, to allow for differences in the number of days in each month, the monthly totals of deaths were adjusted to give the expected number in a standard month of 30 days. It is recognized that the ‘day of week’ effect may have introduced some imprecision for certain combinations of causes and age groups but this is not likely to have been substantial as the number of Saturdays and Sundays per month only varies within the range 8–10. As the number of deaths in the last week of the three-year period was much lower than expected, presumably because of failure to
capture a backlog of deaths in this particular data set, we discarded that point in regression analyses.

**Results**

Overall, the excess winter mortality (the additional deaths from October to March compared with the period from April to September expressed as a percentage of the latter) was 3.5 per cent. This definition of winter was used for consistency with the figures noted above.

Smoothed (four-point moving average) trends in deaths are shown for four major cause groups: ischaemic heart disease, cerebrovascular disease, accidents and violence, and 'other' causes (Figs 1–4). The downturns at the end of the period almost certainly represent artefact due to delays in registering deaths over the new year and Christmas, which is celebrated on 7 January according to the Orthodox religion. For clarity, age groups with very small numbers are not shown. There are suggestions of winter increases for infectious diseases (although the numbers are small and there is much random variation), cancer, and cardiovascular, cerebrovascular and respiratory diseases among the late middle aged and elderly. There is a suggestion of a summer peak for 'other' causes superimposed on a steady increase among those aged under 50 that reached a plateau between autumn 1994 and autumn 1995 and subsequently fell. This is confirmed when seasonal and underlying trends are separated (Figs 5 and 6). Deaths from accidents and violence show a striking summer excess among those aged under 30. There is also a suggestion of spring (1993) and autumn (1995) peaks among older age groups and, when seasonal and underlying trends are separated, a similar underlying trend to that for 'other' causes, although of lower amplitude, is seen. Where a seasonal pattern was observed, auto-correlation functions generally also suggested a peak with a lag of 12 or 13 periods although, with only three years of data, these did not reach statistical significance. This can be seen in Fig. 7, which shows the auto-correlation functions for ischaemic heart disease in the 70-plus age group, where there is a peak at period 12.

Further analysis has been undertaken to identify which types of accidents are responsible for the summer increase. A summary of results for the most common component causes
is given in Table 1. The greatest contribution was by injuries of undetermined cause. Other work has shown that this category consists largely of people found dead with head injuries but the cause of the injury could not be established. The second greatest contribution is from drowning, which increases almost four-fold in summer. These occur almost exclusively on Saturdays and Sundays; 83 per cent are among males and only 11 per cent are aged under 15, with a peak in the age group 35-39.

An association with temperature was sought for those causes displaying winter peaks in at least one age group using linear regression. The results are summarized in Table 2. A significant association is noted only at the extremes of age. As in other countries, the associations are strongest for cardiovascular, cerebrovascular and respiratory disease but, unlike what has been observed elsewhere, there is also an association with cancer among the elderly although this is very small. The results suggest an extra 17 deaths from ischaemic heart disease and 10 from cerebrovascular disease for each 1°C fall in temperature, in each case equivalent to approximately 0.7 per cent of the overall number of deaths from each cause.

The reason for the increase in deaths from ‘other’ causes was also sought by comparing the categories making up this group in the first and second halves of the period studied (Table 3). This indicates that the increase can largely be explained by a group of conditions that are associated with alcohol consumption. Earlier work has suggested that the category ‘other forms of heart disease’ contains many cases that are likely to be alcoholic cardiomyopathy.

**Discussion**

Before discussing the results it is necessary to consider potential limitations of the study. Although it has not been possible to conduct validation studies comparing death certificates with, for example, hospital records, a detailed examination of the data set has identified no important discontinuities or other evidence of poor quality data. The analysis has used numbers of deaths, as it is not intended to compare levels of death rates between age groups. There is considerable uncertainty about the size of the Moscow population. Official estimates indicate a slow fall in the population of Moscow, of approximately 1.5 per cent over the three-year period, but these data are not available by age group and there is also some evidence that there may have been a slight increase. Thus, on the basis of data available to us we cannot exclude seasonal fluctuations in the population because of migrant workers but we think it unlikely that this is substantial given the shortage of accommodation in Moscow. Analysis of trends was mainly limited to visual inspection of graphs, as three years do not provide sufficient data points for the development of robust time series models, but it will be important to repeat these analyses when more data become available.
The pattern of seasonal variation in mortality in Russia displays some similarities with that in other European countries but also some important differences. As in other countries, there is an increase in overall deaths in winter but, at 3.5 per cent, this is somewhat lower than in most western European countries; the corresponding figures for the period 1976–1984 were 13 per cent in the United Kingdom, 11 per cent in Italy, 7 per cent in France, and 5 per cent in Germany. One possibility is that this reflects the different distribution of deaths among age groups but when examined within age group the differences become even greater, with a 19 per cent excess among the over-70s in England and Wales in 1992 compared with a 4 per cent excess in Moscow in the same age group. At all other ages the summer excess predominates in Russia, whereas there is a winter excess in England and Wales. The marked summer excess in deaths from accidents and violence is somewhat greater than is seen in other countries and, in theory, could smooth out the seasonal variation in total deaths. However, if deaths from all causes except accidents and violence are examined, the winter excess increases to only 4.1 per cent. The percentage increase in overall deaths with each 1°C fall in temperature is much lower than has been recorded elsewhere. For example, in the recent Eurowinter study, comparable figures were 1.37 per cent (London), 2.15 per cent (Athens), and 0.6 per cent (Baden-Württemberg). Only in Finland (0.27 per cent in south, 0.29 per cent in north) were the figures similar to those in Moscow. This is, however, consistent with the observation by the authors of the Eurowinter survey that the change in mortality with temperature falls with increasing latitude and thus lower ambient temperature. In this study, it was not possible to adjust for other factors such as air pollution.

There is increasing evidence about the possible physiological mechanisms underlying increases in death rates during cold weather. For cardiovascular disease these include cold-induced

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Winter</th>
<th>Summer</th>
<th>Additional deaths in summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>175 Injury of undetermined cause</td>
<td>3388</td>
<td>3711</td>
<td>323</td>
</tr>
<tr>
<td>168 Accidental drowning</td>
<td>59</td>
<td>235</td>
<td>176</td>
</tr>
<tr>
<td>166 Accidental falls</td>
<td>512</td>
<td>669</td>
<td>157</td>
</tr>
<tr>
<td>161 Motor vehicle accident involving a pedestrian</td>
<td>625</td>
<td>768</td>
<td>143</td>
</tr>
<tr>
<td>173 Suicide and self-inflicted injury</td>
<td>882</td>
<td>985</td>
<td>103</td>
</tr>
<tr>
<td>174 Homicide</td>
<td>1085</td>
<td>1177</td>
<td>92</td>
</tr>
<tr>
<td>160 Motor vehicle accident</td>
<td>351</td>
<td>425</td>
<td>74</td>
</tr>
<tr>
<td>Other accidents and violence</td>
<td>2027</td>
<td>1993</td>
<td>-34</td>
</tr>
</tbody>
</table>
Haemoconcentration and thrombosis, increased blood pressure and raised fibrinogen levels. There is also some evidence that sympathetic activity may mediate the increase in myocardial infarction rates and it has been suggested that seasonal variation in vitamin C levels may play a part. Respiratory deaths may be due to diminished ciliary action, prolonged survival of micro-organisms, or cold-induced sleep apnoea. Winter increases in accidents are thought to be due to, in part, to reduced levels of lighting.

It is not possible, on the basis of the present data, to know the relative importance of the widespread availability of district heating systems in Russia, and the habit of wearing clothes that are effective protection against the cold. Historically, Russia experienced large summer peaks in mortality during the 1930s because of an increase in food-borne infections, but this had ceased by the late 1950s when a winter excess emerged, which, at between 5 and 8 per cent (depending on the presence of influenza epidemics) was greater than that seen in the 1990s.

There has been long-standing debate about the relative importance of exposure to cold indoors and outdoors but the recent Eurowinter study, although not including Russian data, found that each has an independent effect on mortality. In the United Kingdom, a study of fractured femurs found an excess among young people in summer and old people in winter, reflecting different aetiologies. Closed head injuries among children were shown to be more common in summer in a US study. Deaths from road traffic accidents show differing patterns, with reports that they are most common in winter in the United States but in summer in Sweden. Especially in the age groups displaying the greatest seasonal variation in Russia, these studies have strongly implicated alcohol as a causal factor. Although this requires further research in Russia, given other evidence for extremely high levels of alcohol consumption, it seems likely that this is a major factor here as well. This is supported by the finding that, for causes such as drowning, deaths are overwhelmingly concentrated among adult males. Consequently, it will be important for policies directed at reducing the harmful consequences of alcohol consumption to address the observed summer peak.

Although not an initial objective, this analysis has also cast some light on the observation that the steady decrease in life expectancy seen in Russia since the late 1980s began to reverse in 1995. Examination of the trends for 'other' causes and accidents and violence suggests that causes associated with alcohol consumption levelled off between late 1994 and late 1995 before falling, providing further evidence for the role of alcohol in the recent changes in Russian life expectancy.

Table 2 Regression coefficients (with 95 per cent confidence intervals in parentheses) for monthly deaths and ambient temperature: Moscow 1993–1995

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Cancer</th>
<th>Ischaemic heart disease</th>
<th>Cerebrovascular disease</th>
<th>Respiratory disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–14</td>
<td>0.25 (–0.70, 1.39)</td>
<td>na</td>
<td>na</td>
<td>–0.12 (–0.21, –0.03)</td>
</tr>
<tr>
<td>15–29</td>
<td>0.50 (–0.25, 1.25)</td>
<td>1.19 (–0.87, 3.26)</td>
<td>0.39 (–0.15, 2.29)</td>
<td>0 (–0.14, 0.12)</td>
</tr>
<tr>
<td>30–49</td>
<td>0.7 (–1.7, 0.32)</td>
<td>0 (–0.14, 0.16)</td>
<td>0.10 (–0.27, 0.47)</td>
<td>0.12 (–0.07, 0.32)</td>
</tr>
<tr>
<td>50–69</td>
<td>–0.05 (–0.11, 0.1)</td>
<td>–0.04 (–0.08, –0.02)</td>
<td>–0.10 (–0.16, –0.03)</td>
<td>–0.14 (–0.26, 0.02)</td>
</tr>
<tr>
<td>70+</td>
<td>–1.3 (–2.4, –0.2)</td>
<td>–17.4 (–23.6, –11.2)</td>
<td>–10.2 (–13.1, –7.4)</td>
<td>–1.6 (–2.3, –0.9)</td>
</tr>
</tbody>
</table>

Where 95 per cent confidence intervals exclude zero, figures are shown in bold. na, not applicable.

Table 3 Leading contributors to increase in deaths from ‘other’ causes: Moscow 1993–1995

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>First 18 months</th>
<th>Second 18 months</th>
<th>Increase in second period*</th>
</tr>
</thead>
<tbody>
<tr>
<td>97 Other forms of heart disease</td>
<td>5956</td>
<td>9020</td>
<td>3064 (51)</td>
</tr>
<tr>
<td>75 Alcohol dependence</td>
<td>766</td>
<td>2431</td>
<td>1665 (217)</td>
</tr>
<tr>
<td>123 Other cirrhosis</td>
<td>1979</td>
<td>3063</td>
<td>1074 (54)</td>
</tr>
<tr>
<td>159 Symptoms and other non-specific conditions</td>
<td>3659</td>
<td>4162</td>
<td>503 (14)</td>
</tr>
<tr>
<td>74 Other psychosis</td>
<td>805</td>
<td>1209</td>
<td>404 (51)</td>
</tr>
<tr>
<td>Others</td>
<td>17850</td>
<td>20059</td>
<td>2169 (12)</td>
</tr>
</tbody>
</table>

Numbers in cause of death column are codes in Russian classification.

*Numbers, with percentages given in parentheses.
Postscript

After this paper was accepted, another study of seasonal variation in Russian mortality was published.24 It examined the relationship between temperature (indoors and outdoors) in the Sverdlovsk region, in the Urals, and came to a similar conclusion, that the association between mortality and cold in Russia is much less than in the United Kingdom. It also shed additional light on the mechanisms that may account for this.

Acknowledgement

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References


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