Higher all-cause mortality in children during autumn 2009 compared with the three previous years: pooled results from eight European countries

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The paper describes weekly fluctuations of all-cause mortality observed in eight European countries during the period between week 27 and 51, 2009, in comparison with three previous years. Our preliminary data show that the mortality reported during the 2009 influenza pandemic did not reach levels normally seen during seasonal influenza epidemics. However, there was a cumulative excess mortality of 77 cases (1 per 100,000 population) in 5-14-year-olds, and possibly also among 0-4-year-olds.

Introduction

Since the autumn 2009, monitoring of weekly all-cause mortality has been piloted in countries across Europe, as part of the *European monitoring of excess mortality for public health action* (EuroMOMO), a project funded by the European Union Health Programme [1]. The general objective of EuroMOMO is to develop and operate a routine public health mortality monitoring system aimed at detecting and measuring, as timely as possible, excess numbers of deaths related to influenza and other possible public health threats across European countries. A major task of the project was the development and implementation of a common statistical algorithm to estimate excess mortality. At the present, this algorithm is applied in 13 participating countries to generate weekly indicators for age-specific excess mortality that are comparable across countries. Data outputs from individual partner countries are compiled by the project coordination team at Statens Serum Institut, Copenhagen.

The current data outputs are still preliminary because the validity of the model and the added benefits and relevance of pooling data are under evaluation. Therefore, the results have until now only been available to a restricted audience. Nonetheless, bearing these limitations in mind, data from the pilot project have been used as one of many indicators to monitor the severity of the 2009 influenza A(H1N1) pandemic in Europe in terms of total and age specific all-cause mortality.

The aim of the present paper is to describe the weekly fluctuations of all-cause mortality observed in eight European countries during the period from week 27 to week 51 in 2009, in comparison with the deaths observed during the same period in the three previous years. This provides an early estimate of the impact of the 2009 pandemic on different age groups in Europe.

Methods

Countries acquired mortality data from the national sources (e.g. national death registries) and analysed their own data by applying a common algorithm in order to model the expected weekly all-cause mortality taking into account trend and seasonality. The algorithm, termed A-MOMO, is a time series Poisson regression model with number of weekly deaths as dependent variable and the time series decomposed with a trend and seasonal component (details available from the authors). Outputs were examined for consistency and errors using standardised methods such as control charts provided by the algorithm. Subsequently these national data outputs were submitted to Statens Serum Institut in Copenhagen where further pooled analysis using the same algorithm as the countries was carried out for countries that provided age-specific data numbers of weekly deaths. Of the 13 pilot countries in EuroMOMO, eight provided such datasets in week 1 of 2010. These datasets were included in the present analysis and preliminary assessment.

Deaths in week 52 and 53, 2009, were removed from the analysis because the delays in death registrations affect the completeness of weekly numbers of deaths. The variables "number of weekly deaths" and "number of deaths above and below the modeled baseline of expected deaths" were derived from the model output of the pooled analysis both for total mortality and mortality by age groups (0-4 years, 5-14 years, 15-64 years and 65 years and above).

The variables were plotted as crude weekly numbers and as weekly cumulative sums over four season-years from week 27 to week 26 the following year, covering the 2006-7, 2007-8, 2008-9, 2009-10 influenza seasons and allowing uninterrupted visualisation of winter seasons.

Crude weekly numbers with baseline of expected deaths and cumulative seasonal sums of the residual deaths relative to the modeled baseline of expected deaths were additionally analysed for each of the eight countries individually.

Results

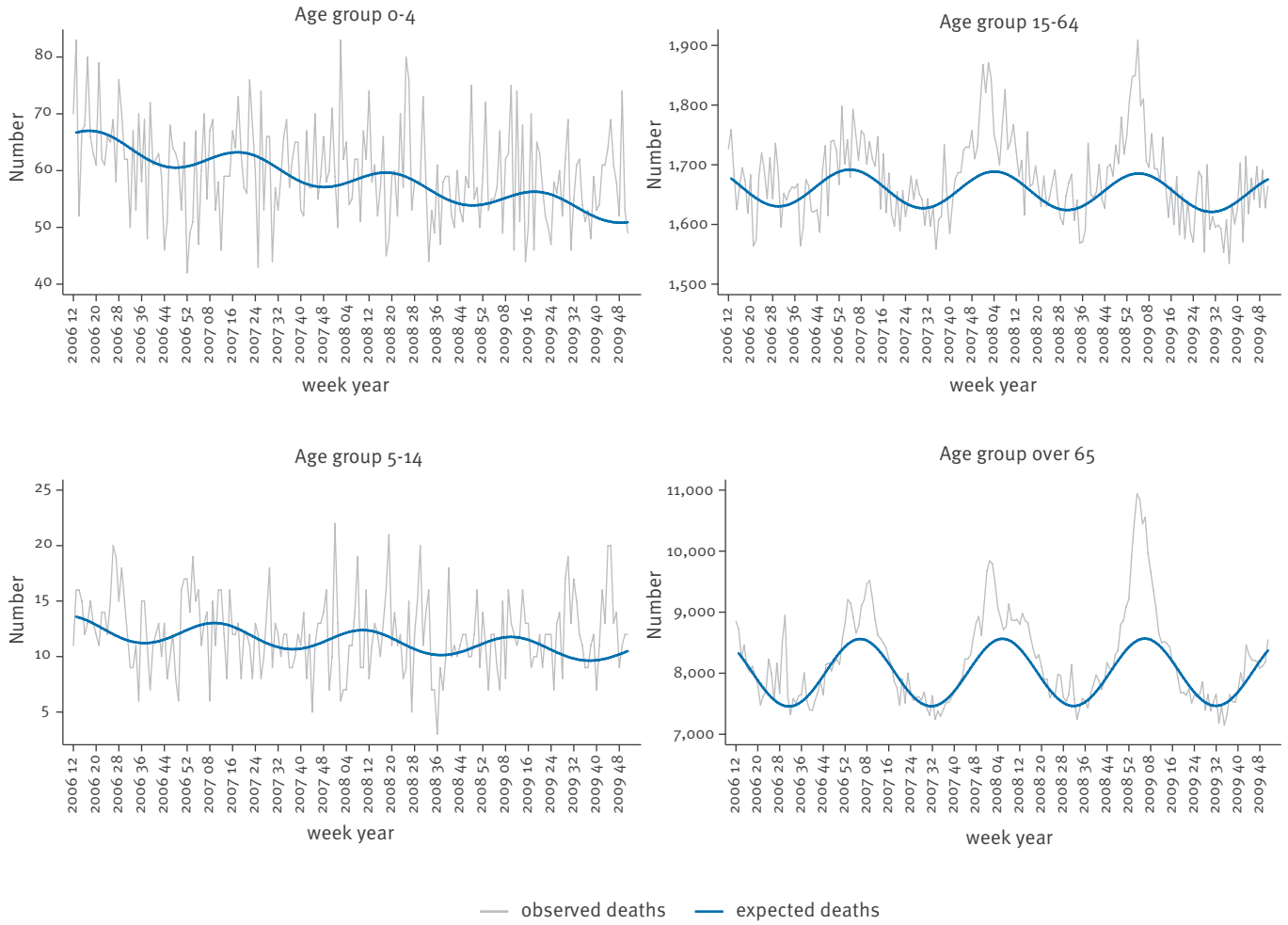
Eight countries (including one region) were included in the pooled analysis: Belgium, Denmark, Greece, Hesse (region of Germany), Malta, Netherlands, Sweden and Switzerland. The population size of the countries including the German region, ranges from 0.5 - 16.4 million, with a total of 66.8 million inhabitants [2].

Figure 1 shows the crude number of deaths by week and age group from week 12 in 2006 to week 51 in 2009 over a season-year covering the three influenza seasons 2006-7, 2007-8 and 2008-9. The time series show typical patterns with seasonal increases and excess mortality peaks during winter in the two older age groups; for the autumn of 2009, there is no apparent increase in mortality for the two older age groups. In the 0-4 and 5-14-year-olds seasonal patterns are not clearly evident. In 2009, there are spikes above the baseline for these age groups, but it is difficult to see any consistent patterns due to the small numbers and the large random variation around the baseline.

Figure 2 shows the cumulative residuals of weekly deaths, i.e. the sum of the positive and negative

Figure 1

Observed and expected number of deaths by week and age group, week 12 2006 - week 51 2009, pooled data from eight European countries*



* Belgium, Denmark, Greece, Hesse (region of Germany), Malta, the Netherlands, Sweden, Switzerland.

variations around the individually modeled baseline of expected deaths, for each season-year. The figure shows an excess of mortality in the 5-14-year-olds. For this age group, the model estimated a total excess of 77 deaths (corresponding to a cumulative excess mortality risk of 1 per 100.000 population) between week 27 and week 51 in 2009. The steep rise of deaths after week 41 coincided with widespread pandemic influenza activity in the participating countries. In the previous three years the number of excess deaths that had occurred by week 51 varied between nine and 16. Deaths in 5-14-year-old children are not common. On average, 275 (range 272 to 279) annual deaths have been observed in the period from week 27 to week 51 in the previous three years. In other words, an excess number of 77 deaths corresponds roughly to a 28% increase in mortality among children 5-14 years old coinciding with the pandemic.

There was a similar tendency of excess mortality in children less than 5 years old. In the age groups 15-64 and over 65, a more or less prominent lack of deaths can be observed, however this may be partly attributed to incomplete reporting of deaths.

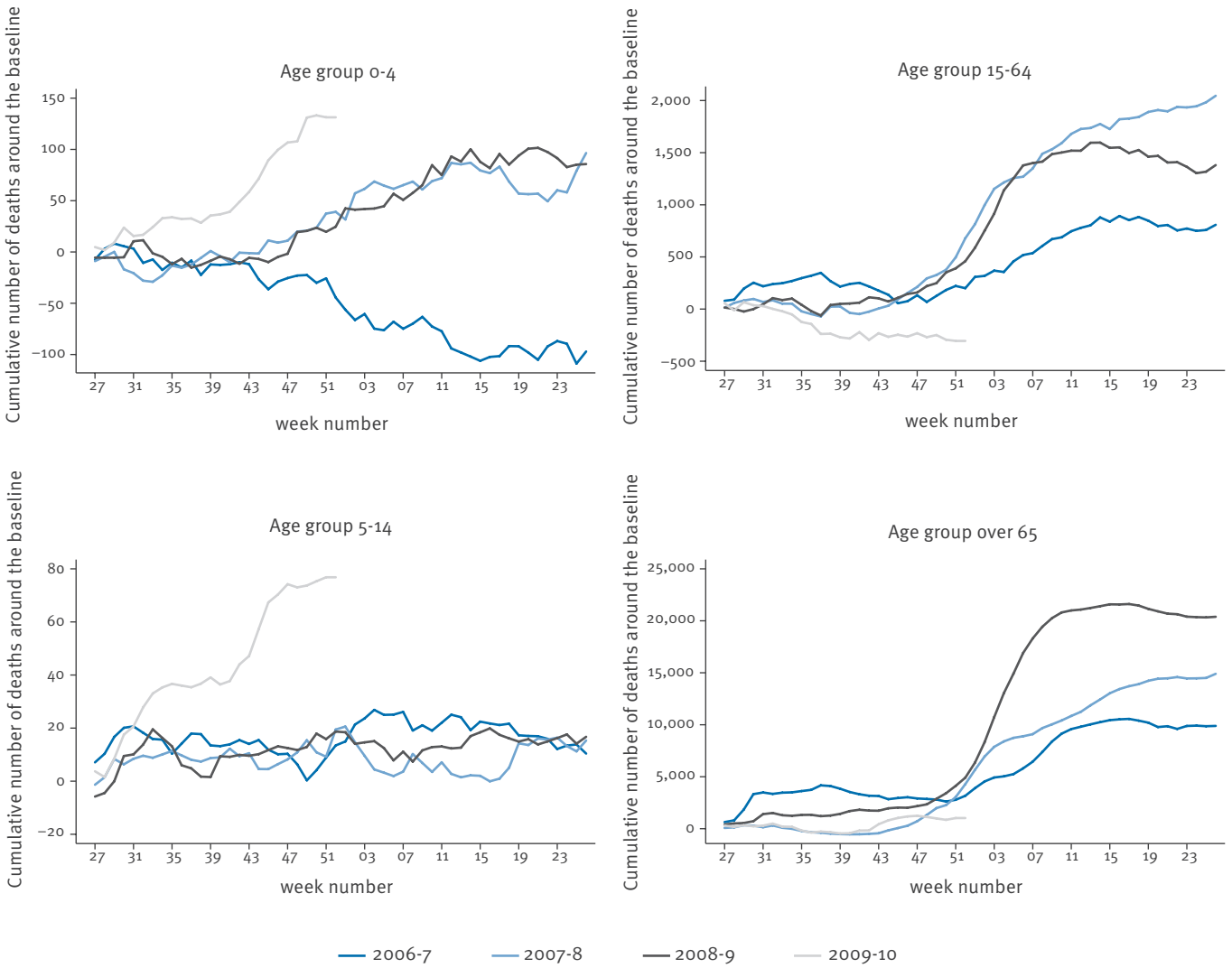
Discussion

The present analysis is subject to some limitations and results presented should thus be interpreted with caution.

A major limitation is that the expected numbers of deaths in the younger age groups are low overall, and therefore a few reported deaths, unrelated to the pandemic, in each of several countries may generate signals in the analysis. From a statistical point of view, the baseline for comparison is less precise when fitted on small numbers. By summing the residuals over time, artefacts may appear because the baseline due to random errors sits below or above the observed data. Another limitation relates to the fact that the influenza A(H1N1) pandemic started early in summer 2009 and peaked in most European countries around week 44

Figure 2

Cumulative numbers of deaths relative to the expected mortality by influenza season and age, influenza seasons 2006-7, 2007-8, 2008-9, 2009-10, pooled data from eight European countries*



* Belgium, Denmark, Greece, Hesse (region of Germany), Malta, the Netherlands, Sweden, Switzerland.

to 50, whereas seasonal influenza peaks usually occur after Christmas. This means that 2009 is not comparable with the previous years in a simple week-by-week analysis.

The aim of EuroMOMO is to provide near to real-time monitoring of excess mortality, however, delays in reporting are inevitable and vary between countries and possibly age groups. Although we removed the two most recent weeks (week 52 and 53, 2009) from our analysis, mortality during weeks 40 to 51 2009 has to be considered an underestimation of the true weekly mortality with increasing incompleteness over time. This also has to be taken into account in the interpretation of the results: delays in registration may mask excess deaths in recent weeks compared with the same weeks in previous years. Adjustment for known delay is an important target for further EuroMOMO research.

With these limitations in mind, our preliminary data indicate that there was no major excess of deaths during the 2009 influenza pandemic in the participating countries. Compared with excess mortality of the three previous years the mortality observed during the autumn wave of the 2009 pandemic did not reach levels normally seen during seasonal influenza epidemics when mainly senior citizens die. However, there was excess mortality in the 5-14-year-olds compared with excess levels of the previous three years. This estimate is probably conservative due to delay in reporting. An early estimate of a death toll of less than hundred deaths that may be attributable to the pandemic in a population of 7.4 million 5-14-year-olds [2], corroborates the notion that the overall burden on mortality remains low also among children [3,4]. It is not known how many of these children belonged to groups at risk for severe illness from influenza, but such a relatively limited number of deaths may be ascribed to deaths primarily in groups at risk of severe illness following influenza. We also found a similar pattern in children 0-4 years of age with an excess of almost the same magnitude as the older children. It is possible that this in part may be due to a declining baseline-trend among children 0-4 years (see Figure 1). Further research is necessary to disentangle the mortality pattern among children, in particular in light of the pandemic.

Modeling excess deaths during influenza epidemic periods based on historical baselines can capture excess mortality that otherwise would be missed [5]. However, the method does not permit to attribute any excess of death to influenza with certainty, and one has to be cautious in the interpretation of the present observations. For the period of interest, no competing risks are known to the authors that could explain the increase in child mortality during autumn 2009. We hope that our data can stimulate European countries to review causes of deaths particularly in children and to explain and clarify the present observation. In the United States, a substantially higher number of influenza deaths in children were reported during the present pandemic than in recent influenza seasons [4].

The results presented here demonstrate the potential usefulness of timely mortality monitoring to assess the severity of the pandemic and the impact on different age groups in Europe, and underscores the added value of pooling data to detect possible deviations from baseline that may have gone unnoticed in analyses in individual small countries.

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