Seasonal Components of Annual Life Expectancy Change across Area-Level Deprivation Groups in Belgium: The Role of Influenza Outbreaks and Heatwaves

Background

Seasonality in mortality is characterized by higher mortality during the cold season and lower mortality in the warm season (1,2). This pattern varies across socio-economic groups: populations with poor housing conditions (e.g., lack of central heating and low thermal efficiency) (3) and low income (4) may experience higher excess winter mortality. The magnitude of winter mortality peaks varies from year to year and is often influenced by respiratory disease outbreaks (5,6). On the other hand, in the summer, mortality may rise due to heatwaves (7,8), which are becoming increasingly frequent and more intense because of climate change (9). These season-specific events contribute to annual mortality estimates. Previous research has shown that excess winter mortality strongly affects life expectancy trends in European countries (10). In Belgium, the magnitude of seasonality, measured as the ratio of deaths in the winter period (December to March) compared with deaths in the non-winter period, remains relatively high (11). Therefore, understanding the seasonal components of annual mortality changes – both for the entire population and across socio-economic groups – is essential.

According to Statbel, between 2000 and 2024, life expectancy at birth (e_0) in Belgium increased from 77.8 to 82.4 years (12). However, this growth was not uniform: some years showed stagnation or even declines. The most notable drop occurred during the COVID-19 pandemic in 2020, but earlier declines were observed in 2012 and 2015, while growth in 2017 and 2018 was minimal. Examination of intra-annual mortality patterns during these years reveals higher-than-expected numbers of deaths in the beginning of the year, likely linked to influenza outbreaks. Similarly, the summer mortality increases in 2018 and 2019 can be attributed to heatwaves. However, it remains unclear how these local within-year mortality peaks contributed to annual changes in e_0.

The aim of this study is to assess, for the first time, the contribution of seasonal mortality fluctuations to annual changes in e_0 for Belgium as a whole and across area-level deprivation groups, based on the recently developed Belgian Index of Multiple Deprivation (13), which is associated with large disparities in survival chances (14).

Method to assess the seasonal components of annual life expectancy changes and application to Belgian trends

We propose a method whose technical implementation is very similar to the traditional life expectancy decomposition by age (15–17) and cause of death (15,18), but treats within-year time units (e.g. weeks, months, year quarters) as causes of death. This approach is

similar to that proposed by Marinetti et al (10) but applies decomposition technique from the 1980s rather than the stepwise replacement algorithm. The Andreev-Arriaga-Pressat algorithm is relevant since the task is to decompose the difference between two life expectancies.

To illustrate the application of the method, we used data from Short-Term Mortality Fluctuations data series (19). We took two episodes of negative e_0 growth in Belgium: 2011-2012 and 2014-2015. The method allowed us to break down the overall decline in e_0 into components – months of the year and age groups (Figure 1). Results show that the decline in 2012 was driven by increased mortality among those aged 65+ during the months of February-April, while the decline in 2015 was due to elevated mortality among the same age group in January-April. Both episodes coincided with severe influenza epidemics, suggesting that influenza-related mortality at the beginning of the year was the primary driver of these declines.

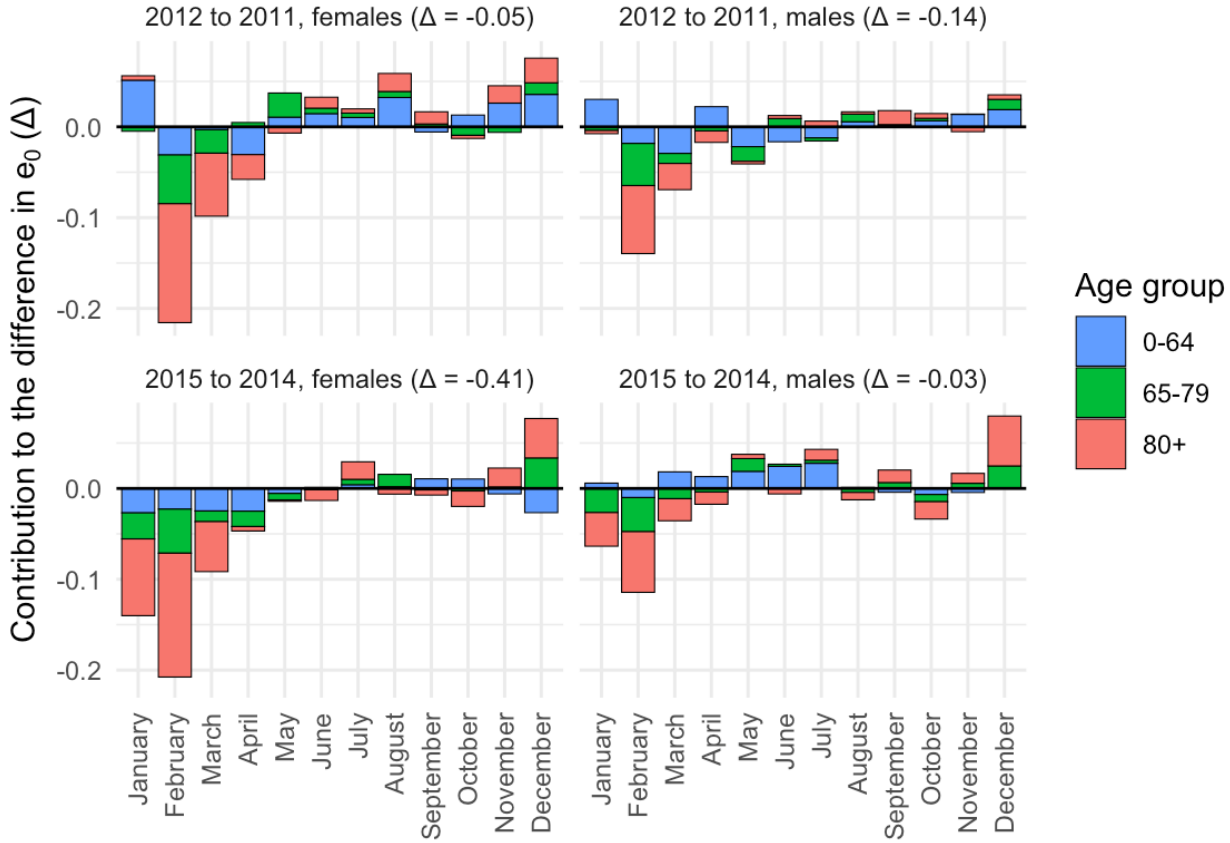

Figure 1. Decomposition of e_0 change (Δ) in 2011-2012 and 2014-2015 by months and age groups in Belgium, years

Data used to decompose annual fluctuations by level of deprivation

We used Belgian population register data from Statbel to calculate deaths and population at risk by year, age, sex, and statistical sector (>18,000 territorial units). Then these data by statistical sector grouped into deprivation deciles based on the Belgian Index of Multiple Deprivation (13). We used both an overall deprivation score and domain-specific deprivation scores (housing conditions, education, employment, crime, and income) to divide statistical sectors into groups.

Expected Results

We expect that annual fluctuations in e_0 in Belgium during the 21st century have been driven primarily by seasonal variations in mortality during the cold months among older adults. However, the relationship between socio-economic deprivation and the magnitude of winter and summer mortality peaks remains unclear. On the one hand, vulnerable groups may be more affected by influenza and heatwaves due to factors such as fuel poverty or limited access to air conditioning. On the other hand, in populations with higher baseline mortality, the impact of influenza outbreaks or heatwaves on mortality may appear less pronounced.

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