http://hdl.handle.net/1765/110571

Erasmus MC
Universitair Medisch Centrum Rotterdam

# Amenable mortality in the EU – has crisis changed its course?

Marina Karanikolos, Johan P Mackenbach, Ellen Nolte, David Stuckler, Martin McKee

*Published in: European Journal of Public Health, doi:10.1093/eurpub/cky116 (July 2018)*

Erasmus University Rotterdam

## ABSTRACT

Background: Did the global financial crisis and its aftermath impact upon the performance of health systems in Europe? We investigated trends in amenable and other mortality in the EU since 2000 across 28 EU countries.

Methods: We use WHO detailed mortality files from 28 EU countries to calculate age-standardized deaths rates from amenable and other causes. We then use joinpoint regression to analyse trends in mortality before and after the onset of the economic crisis in Europe in 2008.

Results: Amenable and other mortality have declined in the EU since 2000, albeit faster for amenable mortality. We observed increases in amenable mortality following the global financial crisis for females in Estonia [from −4.53 annual percentage change (APC) in 2005–12 to 0.03 APC in 2012–14] and Slovenia (from −4.22 APC in 2000–13 to 0.73 in 2013–15) as well as males and females in Greece(males: from −2.93 APC in 2000–10 to 0.01 APC in 2010–13; females: from −3.48 APC in 2000–10 to 0.06 APC in 2010–13). Other mortality continued to decline for these populations. Increases in deaths from infectious diseases before and after the crisis played a substantial part in reversals in Estonia, Slovenia and Greece.

Conclusion: There is evidence that amenable mortality rose in Greece and, among females in Estonia and Slovenia. However, in most countries, trends in amenable mortality rates appeared to be unaffected by the crisis.


## KEY POINTS:

- Amenable mortality has declined in all EU countries between 2000 and 2015; however Estonia, Greece and Slovenia have seen a reversal in previously favourable trends in recent years.
- Individual causes of death contributing to the reversal in amenable mortality suggest a complex picture but the rise in mortality from infectious diseases in at least three countries calls for further investigation.
- Mortality trends in Greece show a sustained rise in deaths from a number of amenable causes, which predated the crisis, while progress stalled in reducing deaths from stroke corresponding to the onset of health expenditure cuts.
- The use of amenable mortality to detect the impact of economic fluctuations on health system performance is limited, due to delayed data availability, ever-reducing scope for improvement, and the focus on death rather than other less adverse health outcomes.

## INTRODUCTION

The global financial crisis of 2007–08 and its consequences have had a severe long-term impact on many European economies. National economies, as measured by gross domestic product (GDP), were most negatively affected in 2009, however some European Union (EU) member states, especially Greece, are yet to recover fully.[1] Challenges arising from low or no economic growth, coupled with rising deficits and borrowing costs, impacted on the availability of resources for public spending, including for health, across Europe.[2] Thus, per capita public spending on health fell in several countries, with a small number experiencing sustained reductions during 2009–12, in particular Greece, Ireland and Slovenia, but also Italy, Portugal, Spain and the UK. [3] The slowdown in health spending impacted upon the provision of health services[4] and access to care,[5] with large increases in unmet medical need observed in Greece, Estonia and Latvia during and following the crisis.[1] Other evidence points to an increase in the proportion of European citizens aged 50 years and older who incurred a rise in out-of-pocket expenditures during the same period, with significant increases in the proportion of those experiencing catastrophic expenditures in the Czech Republic, Italy and Spain.[6] It is plausible that these barriers to accessing care impact health outcomes, while reduced public health spending may result in deterioration of quality of care. At the same time, a well-functioning and resilient health system should be capable of maintaining adequate levels of services, unless gaps in financing, coverage or service delivery are unsurmountable.

As was demonstrated previously,[7-10] European health systems have continued to contribute to improving population health by reducing deaths that can be avoided with timely and effective care (amenable mortality), a concept that is now used by several governments and international organizations as an indicator of health system performance. [11-15] The pace of improvement varied across countries, reflecting differences in the availability of and access to technologies and treatment, the effectiveness of service delivery and wider healthcare policies. In this study, we analyse amenable mortality trends from 2000 onwards in the countries of the EU in order to understand the possible impacts of the global financial crisis by means of Joinpoint regression analysis. We contrast amenable deaths with those where healthcare may have a less obvious impact (other mortality).

## METHODS

### Definition

We used the list of conditions included in amenable mortality proposed by Nolte and McKee in 2004 (Supplementary appendix S1).[7] For consistency with previous work, we applied an upper age limit of 75 years and include 50% of ischaemic heart disease deaths as potentially amenable. We also measured 'other' mortality (all remaining causes) under the age of 75 years as a comparator to help interpret changes in amenable mortality.

### Data and availability

We used the WHO detailed mortality files[16] to obtain data on the number of deaths in the 28 EU member states by country, year, sex and cause by 5-year age-group and the corresponding population denominators, for the years 2000–15. We calculated age-standardised mortality rates using the European Standard Population 2013. Mortality data for Italy (2004, 2005) and Portugal (2004–06) were not available and we only calculated trends from 2006 and 2007, respectively. Data for Greece included a change in ICD-coding of cause of death in 2014 (from ICD-9 to ICD-10). This resulted in marked changes in certain causes of amenable deaths, so we only used data for 2000–13 to examine trends over time.

### Joinpoint regression

We used Joinpoint regression analysis to identify significant changes in mortality trends for amenable and other causes in each EU country, starting in 2000. We then identified countries which experienced significant reversal (flat-lining or increase) in amenable mortality in either males or females in or after 2009, while mortality from other causes continued falling. Although we recognize that economic crisis can also potentially affect mortality beyond amenable causes, trends in other causes provide a comparator between these two mortality groups, one of which is a widely recognized marker of health care sector performance. We performed further Joinpoint analysis on specific amenable causes of death in those countries where we found reversals in trends. The overall change in trend was measured in terms of annual percentage change (APC). We used Joinpoint Trend Analysis Software v4.5.0.1.[17]

### Pre- and post- crisis period

The global financial crisis affected the economies of EU member states in or after 2008, with the earliest plausible impact on health service effectiveness and mortality expected in or after 2009. We therefore defined the years 2009 onwards as the post-crisis period, consistent with established usage. However, we recognize that the timing of the crisis differed across countries. [2]

## RESULTS

Overall, amenable and other mortality declined in all EU countries between 2000 and 2015. For amenable mortality, the average pace of decline varied between and APC of 0.4 in Lithuania to 5.6 in Ireland for males and between 1.8 in Lithuania and Italy to 5.0 in Ireland for females. The pace of decline of other mortality ranged from APC 1.2 in Bulgaria, Greece and Lithuania to 3.6 in Croatia and Slovenia for males and from 0.5 in Portugal to 4.6 in Cyprus for females. With the exception of Cyprus (females) and Lithuania (males), amenable mortality declined faster, on average, than other mortality (table 1).

**Table 1.** Overall change in amenable and other mortality (APC) since 2000

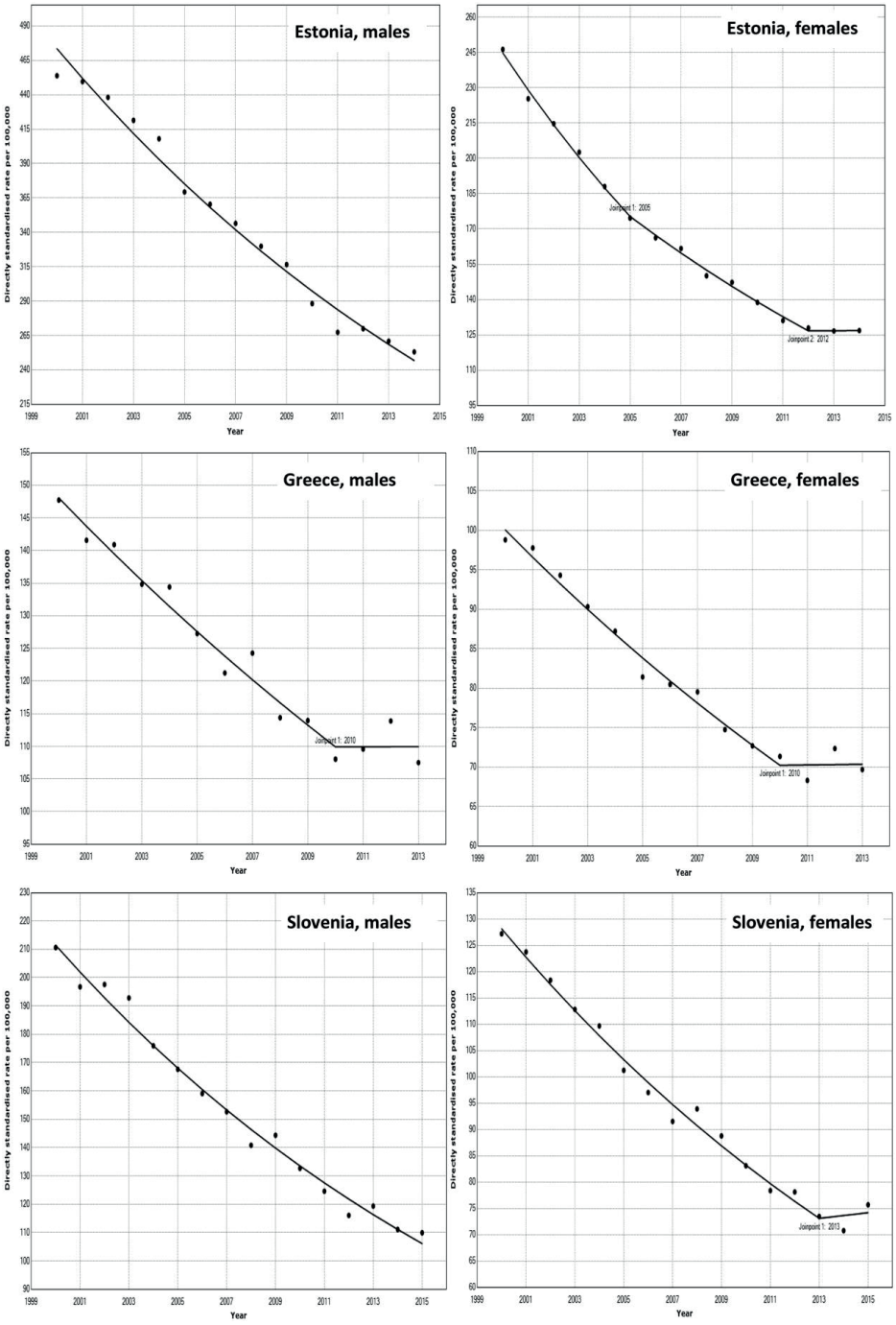
| | **Amenable mortality** | | **Other mortality** | |
|---|---|---|---|---|
| | **Males** | **Females** | **Males** | **Females** |
| Austria | -4.4 | -3.5 | -1.7 | -0.9 |
| Belgium | -3.9 | -3.0 | -2.0 | -0.9 |
| Bulgaria | -2.0 | -2.8 | -1.2 | -2.2 |
| Croatia | -3.7 | -4.5 | -3.6 | -3.2 |
| Cyprus | -4.0 | -4.3 | -2.9 | -4.6 |
| Czech Republic | -3.4 | -4.0 | -2.0 | -1.6 |
| Denmark | -4.3 | -4.5 | -2.5 | -2.7 |
| Estonia | -4.5 | -4.6 | -2.9 | -3.1 |
| Finland | -4.3 | -3.6 | -1.8 | -1.0 |
| France | -3.6 | -2.6 | -2.2 | -1.3 |
| Germany | -3.6 | -2.9 | -1.9 | -1.1 |
| Greece | -2.3 | -2.7 | -1.2 | -1.5 |
| Hungary | -2.8 | -2.9 | -2.3 | -1.4 |
| Ireland | -5.6 | -5.0 | -3.0 | -2.4 |
| Italy | -2.1 | -1.8 | -2.0 | -0.9 |
| Latvia | -2.7 | -2.8 | -1.9 | -1.8 |
| Lithuania | -0.4 | -1.8 | -1.2 | -1.0 |
| Luxembourg | -4.4 | -3.8 | -3.2 | -2.2 |
| Malta | -4.8 | -4.4 | -2.7 | -2.6 |
| Netherlands | -4.6 | -3.3 | -2.7 | -1.2 |
| Poland | -3.5 | -3.7 | -1.7 | -1.4 |
| Portugal | -4.5 | -2.5 | -3.3 | -0.5 |
| Romania | -2.4 | -3.2 | -1.5 | -2.1 |
| Slovakia | -3.4 | -3.4 | -2.1 | -1.7 |
| Slovenia | -4.5 | -3.6 | -3.6 | -2.9 |
| Spain | -3.3 | -3.2 | -2.6 | -1.9 |
| Sweden | -3.5 | -2.9 | -1.7 | -1.2 |
| United Kingdom | -4.9 | -4.2 | -2.2 | -1.6 |

Since 2000, 30 Joinpoints in 18 countries were identified across both genders in amenable mortality trends. Most of these were related to amenable mortality displaying either more favourable, or a similar direction of change compared to other mortality (Supplementary appendix S2). There were only four instances of reversals in amenable mortality coinciding with the onset of the economic crisis (from decreases to 0 APC change or increases), against a background of a continued fall in other mortality. These were observed for females in Estonia (from −4.5 APC in 2005–12 to 0 APC in 2012–14) and Slovenia (from −4.2 in 2000–13 to 0.7 in 2013–15), as well as males and females in Greece (males: from −2.9 APC in 2000–10 to 0 APC in 2010–13; females; from −3.5 APC in 2000–10 to 0.1 APC in 2010–13) (figure 1).

To better understand drivers of amenable deaths behind the post-crisis reversals, we performed Joinpoint analysis by cause of death for Estonia, Greece and Slovenia, for males and females (table 2). An observed reversal in female amenable mortality in Estonia was attributable, mainly, to a large relative increase in deaths from infectious diseases after 2012, on top of an underlying increasing trend in amenable deaths from respiratory conditions and treatable cancers since 2007. Among males, there was a small increase in amenable respiratory deaths, from 2011. A similar picture is seen in Slovenia, where a reversal in amenable mortality in females can be attributed to an increase in deaths from infectious diseases after 2010, accompanied by underlying slowing in the rate of decrease of amenable deaths from ischaemic heart disease after 2007, while the rate of reduction in other amenable causes remained consistent. Unlike in Estonia, there was a similar pattern among males in Slovenia, with a reversal in amenable deaths from infectious diseases after 2012, but also an underlying reduction in the pace of decline in deaths from ischaemic heart disease and respiratory conditions. Further examination of trends of infectious diseases found substantial recent rises in deaths from sepsis in both countries, although absolute numbers remain small (data not shown).

In Greece, amenable mortality reversed for males and females in 2010. This was driven by a complex set of changes, which also differed between males and females. Thus, the observed changes occurred against the background of small, but sustained increases in selected amenable causes of death since 2000. These included mortality from amenable infectious diseases, and from digestive and respiratory conditions among males and females, which rose at a pace of between 1 and 3% per year between 2000 and 2013. In addition, males experienced sustained increases in mortality from amenable cancers (APC 0.6) and diabetes (APC 1.1) from 2000 onwards. Mortality from stroke fell throughout the entire observation period but we observed a significant deceleration of the pace of decline that coincided with the crisis (from −7 APC in 2000–10 to −0.8 APC in 2010–13 in females and from −6.6 APC in 2005–10 to −0.2 APC in 2010–13 in males). Reversals in mortality were observed for males for amenable perinatal and congenital conditions,

**Figure 1.** Amenable mortality trends in Estonia, Greece and Slovenia, 2000-15




Axis x – year; axis y – directly standardised rate per 100,000

**Table 2.** Changes in amenable mortality by cause in Estonia, Greece and Slovenia

| | Estonia | | | | Greece | | | | Slovenia | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Males | | Females | | Males | | Females | | Males | | Females | |
| **Cause** | **Segments** | **APC** | **Segments** | **APC** | **Segments** | **APC** | **Segments** | **APC** | **Segments** | **APC** | **Segments** | **APC** |
| Infectious diseases | 2000-2014 | -10.6* | 2000-2012 | -15.7* | 2000-2013 | 2.9* | 2000-2013 | 2.5 | 2000-2006 | 2.7 | 2000-2006 | 7.7 |
| | | | 2012-2014 | 91.4 | | | | | 2006-2012 | -26.0* | 2006-2010 | -32.6 |
| | | | | | | | | | 2012-2015 | 20.4 | 2010-2015 | 15.9 |
| Treatable cancers | 2000-2014 | -0.9* | 2000-2007 | -3.6* | 2000-2013 | 0.6 | 2000-2013 | -0.6* | 2000-2015 | -1.4* | 2000-2015 | -2.3* |
| | | | 2007-2014 | 0.0 | | | | | | | | |
| Diabetes | 2000-2014 | -0.2 | 2000-2014 | -5.9 | 2000-2013 | 1.1 | 2000-2013 | -1.7 | - | - | - | - |
| IHD (50% amenable) | 2000-2002 | 0.1 | 2000-2014 | -9.6* | 2000-2013 | -2.7* | 2000-2013 | -3.9* | 2000-2006 | -6.2* | 2000-2007 | -9.0* |
| | 2002-2014 | -7.0* | | | | | | | 2006-2015 | -2.2* | 2007-2015 | -0.7 |
| Stroke | 2000-2005 | -5.8* | 2000-2014 | -11.2* | 2000-2005 | -3.5* | 2000-2010 | -7.0* | 2000-2015 | -5.7* | 2000-2015 | -5.2* |
| | 2005-2014 | -11.9* | | | 2005-2010 | -6.6* | 2010-2013 | -0.8 | | | | |
| | | | | | 2010-2013 | -0.2 | | | | | | |
| Respiratory disorders | 2000-2011 | -10.6* | 2000-2007 | -14.7* | 2000-2013 | 1.3 | 2000-2013 | 1.9 | 2000-2004 | 2.8 | 2000-2015 | -8.2* |
| | 2011-2014 | 23.4 | 2007-2014 | 4.6 | | | | | 2004-2007 | -22.0 | | |
| | | | | | | | | | 2007-2015 | -7.0* | | |
| Digestive disorders | 2000-2014 | -4.2* | 2000-2014 | -3.3* | 2000-2013 | 1.1 | 2000-2013 | 1.8 | 2000-2015 | -9.2* | 2000-2015 | -8.0* |
| Perinatal and congenital | 2000-2014 | -7.4* | 2000-2014 | -8.0* | 2000-2007 | -8.0* | 2000-2013 | -5.2* | 2000-2015 | -4.8* | 2000-2015 | -5.9* |
| | | | | | 2007-2013 | 0.3 | | | | | | |
| Other amenable causes | 2000-2009 | 10.3* | 2000-2014 | 5.3* | 2000-2004 | -7.2 | 2000-2013 | -2.1* | 2000-2015 | -4.2* | 2000-2015 | -4.0* |
| | 2009-2014 | 0.0 | | | 2004-2013 | 2.4* | | | | | | |

*Significant at $P < 0.05$; Note: In Slovenia, the number of deaths from diabetes is 0 for some years; therefore, the cause has been excluded from joinpoint regression analysis.

which had been declining until 2007 (–8 APC in 2000–07 to 0.3 APC in 2007–13) and the remaining amenable causes of death (–7.2 APC in 2000–04 to 2.4 APC in 2004–13).

## DISCUSSION

This study found wide variations in both levels and pace of change in amenable mortality over time across EU member states. Although rates have, overall, declined, some countries experienced reversals in recent years, at least in the short-term. These are still fairly small in Estonia, Greece and Slovenia, but these countries have seen no increase in other mortality, suggesting that while overall population health is improving, health services may have experienced some challenges. However, observed trends have to be interpreted with caution as they affected males and females differently. In any case, a significant reversal in what has been a very long-term decline in mortality in any country should be a cause of concern, requiring further investigation.

Amenable mortality, as used in this study, plays a dual role. First, it is one of the few existing indicators, which provides an initial assessment of the potential contribution of health services to population health. Second, as the outcome is deaths, it can help understand the impact of health system change. Although it is not possible, with aggregate data, to trace specific policies and actions affecting service delivery that lead to amenable deaths, it is known that the global financial crisis was associated with reduced access to care in multiple countries across the EU, particularly among more vulnerable groups.[18]

Trends in amenable mortality in Estonia, Greece and Slovenia present a complex picture. First, while total amenable mortality in Estonia and Slovenia has reversed only in women after the crisis, cause-specific data show that men have also been affected, although to a lesser extent. In Estonia, the rise in amenable mortality in females was driven partially by an increase in mortality from infectious diseases, but this was not replicated in males. At the same time, rise in deaths from respiratory conditions seen across both genders was more pronounced in males, while both sexes experienced rise in mortality from other amenable conditions throughout the period. In Slovenia, the rise in deaths from infectious diseases was sharp in both genders in recent years, but only in females did it result in a pronounced change of direction in overall amenable mortality. It is important to note that deaths from infectious disease present a very small proportion of total amenable mortality, and absolute numbers are particularly low when disaggregated by gender in countries with small populations, such as Estonia and Slovenia. The increase in mortality from infectious diseases in both countries was driven by a rise in deaths from septicaemia, a trend seen in other European countries, such as the Czech Republic [19] and Serbia [20]. Explanations of these trends are complex, including popu-

lation ageing and rising prevalence of complications of chronic diseases, while in Serbia the increase corresponded with the onset of the economic crisis. Suhrcke et al.[21] suggested various mechanisms by which economic crises can affect communicable disease control, such as through compromising the health of vulnerable population groups and placing additional pressures on health systems facing budgetary problems. However, the precise manifestations depended on the underlying epidemiological situation.

The effects of the measures imposed on Greece following the global financial crisis, including sustained reductions in public spending on health services, together with the broader impact of the crisis on population health, have been detailed elsewhere.[22-25] This body of research has shown that while crisis in itself can pose real threats to health, particularly of vulnerable people, through unemployment and loss of income, the austerity measures to health system exacerbate the issue and further limit access to and quality of health care services. In terms of mortality outcomes, there is some limited research on selected causes of death, such as suicides,[26] cardiovascular diseases and cancers, all of which show unfavourable trends since the start of the crisis. Our analysis of amenable mortality points to more long-standing challenges that people in Greece might have experienced regarding access to and effectiveness of health care which were present even before the economic crisis. Thus, we found small but steady increases in a number of deaths from amenable conditions from 2000 onwards, suggesting that the crisis might have exposed systemic problems in the Greek health system which eventually led to an overall reversal in amenable mortality in Greece. Available evidence has documented fragmentation of coverage, a poorly developed primary care system, and lack of referral systems, along with poorly coordinated care across the care pathway.[27] These underlying challenges have been exacerbated by the changes imposed by the economic crisis, including a cut of 40% of overall public spending on health between 2009 and 2013[1], coupled with exclusion of a large proportion of population from health coverage due to rising unemployment, as well as the sharply rising unmet medical need[28] observed since the start of the crisis. Others have suggested that an increase in mortality at older ages in Greece in 2011-12 may be linked to problems accessing care,[29] while one study reported an increase in deaths due to adverse events associated with medical treatment.[30] Consequently, deterioration in amenable mortality, along with other health outcomes, is not unexpected.

From a broader perspective, our findings suggest that amenable mortality may be a relatively insensitive indicator of the impact of the economic crisis on the quality of healthcare. This is partly due to the inherent limitations of amenable mortality indicator overall: setting the widely accepted age limit at 75 years to minimize issues with coding of multi-morbidity excludes large number of potentially amenable deaths in older people, reduces the potential of detecting significant change when low levels have been achieved, and increases chances of random year-on-year fluctuations in specific

amenable causes due to small numbers. In addition, amenable mortality captures only deaths thus missing the impact on morbidity. Moreover, given recent advances in health care, there is a need to keep the list of amenable causes under continuing review to accurately reflect the current capability of healthcare to prevent deaths. Concerning studying the impacts of the economic crisis, another set of limitations arises from the problem of defining the 'crisis', given how the range of possible economic indicators (GDP, employment, housing repossessions etc.) varied across countries, as did the extent to which cuts were directed at healthcare specifically, and differences in the ability of health system to withstand economic fluctuations. Finally, data availability and timeliness remains problematic, with many years of detailed mortality data missing even for high-income countries, leading to shorter or even interrupted timelines.

In summary, this study adds to the growing body of evidence showing that amenable mortality continues to decline across Europe. At the same time, it highlights increases of deaths from infectious diseases which should either be treatable or preventable in a small number of countries, and calls for investigation of the factors underlying these developments. Other causes for concern include respiratory conditions, as well as the sudden slowdown in the decline in mortality from stroke in Greece. Amenable mortality is a useful tool to highlight the presence of potential concerns about health systems performance, but its ability to detect the impact of changes in public spending on health care on the outcomes achieved by an individual health system is limited.

## REFERENCES


1. European Commission. Eurostat database. 2017; Available at: http://ec.europa.eu/eurostat/data/database (accessed 01/08/2017).
2. Reeves, A., S. Basu, M. McKee, M. Marmot and D. Stuckler, Austere or not? UK coalition government budgets and health inequalities. J R Soc Med, 2013. 106(11): p. 432-6.
3. Cylus, J. and M. Pearson, The crisis and its implications for household financial security, government resources and health expenditure., in Economic crisis, health systems and health in Europe. , S. Thomson, et al., Editors. 2015, Maidenhead: Open University Press .
4. Reeves, A., M. McKee, S. Basu and D. Stuckler, The political economy of austerity and healthcare: Cross-national analysis of expenditure changes in 27 European nations 1995–2011. Health Policy, 2014. 115(1): p. 1-8.
5. Arora, V.S., M. Karanikolos, A. Clair, A. Reeves, D. Stuckler and M. McKee, Data resource profile: The European union statistics on income and living conditions (EU-SILC). International journal of epidemiology, 2015: p. dyv069.
6. Palladino, R., J.T. Lee, T. Hone, F.T. Filippidis and C. Millett, The Great Recession And Increased Cost Sharing In European Health Systems. Health Aff (Millwood), 2016. 35(7): p. 1204-13.
7. Nolte, E. and M. McKee, Does healthcare save lives? Avoidable mortality revisited, 2004, The Nuffield Trust: London.
8. Nolte, E. and C.M. McKee, In amenable mortality--deaths avoidable through health care--progress in the US lags that of three European countries. Health Aff (Millwood), 2012. 31(9): p. 2114-22.
9. Nolte, E. and C.M. McKee, Measuring the health of nations: updating an earlier analysis. Health Aff (Millwood), 2008. 27(1): p. 58-71.
10. Barber RM, Fullman N, Sorensen RJD, et al. Healthcare Access and Quality Index based on mortality from causes amenable to personal health care in 195 countries and territories, 1990–2015: a novel analysis from the Global Burden of Disease Study 2015. Lancet 2017; 390:231–66.
11. Australian Beaureau of Statistics. Potentially avoidable deaths. 2016; Available at:http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/3303.0~2014~Main%20Features~Potentially%20Avoidable%20Mortality%20~10043 (accessed 01/08/2017).
12. Department of Health. NHS outcomes framework: at-a-glance. 2016; Available at:https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/513157/NHSOF_at_a_glance.pdf (accessed 01/08/2017).
13. Eurostat. Amenable and preventable deaths statistics. 2017 01/08/2017]; Available at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Amenable_and_preventable_deaths_statistics (accessed 01/08/2017) .
14. Belgian Health Care Knowledge Centre, Performance of the Belgian health system - report 2015, KCE Report 259C Available at: https://kce.fgov.be/sites/default/files/ page_documents/KCE_259C_performancereport2015 .pdf (accessed 01/08/2017).
15. Schneider, E.C., D. Sarnak, D. Squires, A. Shah and M. Doty. Mirror, Mirror 2017: International Comparison Reflects Flaws and Opportunities for Better U.S. Health Care. 2017; Available from: http://www.commonwealthfund.org/interactives/2017/july/mirror-mirror/ (accessed 02/08/2017).
16. WHO. WHO Mortality database (released March 2017). 2017; Available from: http://www.who.int/healthinfo/statistics/mortality_rawdata/en/ (accessed 19/06/2017).
17. National Cancer Institute. Joinpoint Trend Analysis Software. 2017; Available from: https://surveillance.cancer.gov/joinpoint/ (accessed 01/08/2017)

18. Thomson, S., J. Figueras, T. Evetovits, M. Jowett, P. Mladovsky, A. Maresso, J. Cylus, M. Karanikolos, and H. Kluge, Economic crisis, health systems and health in Europe. Impact and implications for policy. European Observatory on Health Systems and Policies Series. 2015: Open University Press.
19. Pechholdova, M., Sepsis-related mortality in the Czech Republic: multiple causes of death analysis. Epidemiol Mikrobiol Imunol, 2017. 66(2): p. 73-79.
20. Ilic, M. and I. Ilic, Gender disparities in mortality from infectious diseases in Serbia, 1991-2014: a time of civil wars and global crisis. Epidemiol Infect, 2016. 144(12): p. 2473-84.
21. Suhrcke, M., D. Stuckler, J.E. Suk, M. Desai, M. Senek, M. McKee, S. Tsolova, S. Basu, I. Abubakar, P. Hunter, B. Rechel, and J.C. Semenza, The impact of economic crises on communicable disease transmission and control: a systematic review of the evidence. PLoS One, 2011. 6(6): p. e20724.
22. Barlow, P., A. Reeves, M. McKee and D. Stuckler, Austerity, precariousness, and the health status of Greek labour market participants: Retrospective cohort analysis of employed and unemployed persons in 2008-2009 and 2010-2011. J Public Health Policy, 2015. 36(4): p. 452-68.
23. Kentikelenis, A., M. Karanikolos, A. Reeves, M. McKee and D. Stuckler, Greece's health crisis: from austerity to denialism. Lancet, 2014. 383(9918): p. 748-53.
24. Kondilis, E., S. Giannakopoulos, M. Gavana, I. Ierodiakonou, H. Waitzkin and A. Benos, Economic crisis, restrictive policies, and the population's health and health care: the Greek case. Am J Public Health, 2013. 103(6): p. 973-9.
25. Simou, E. and E. Koutsogeorgou, Effects of the economic crisis on health and healthcare in Greece in the literature from 2009 to 2013: a systematic review. Health Policy, 2014. 115(2-3): p. 111-9.
26. Rachiotis, G., D. Stuckler, M. McKee and C. Hadjichristodoulou, What has happened to suicides during the Greek economic crisis? Findings from an ecological study of suicides and their determinants (2003-2012). BMJ Open, 2015. 5(3): p. e007295.
27. Economou, C., Greece: Health system review. Health Syst Transit, 2010. 12(7): p. 1-177, xv-xvi.
28. Karanikolos, M. and A. Kentikelenis, Health inequalities after austerity in Greece. Int J Equity Health, 2016. 15: p. 83.
29. Vlachadis, N., N. Vrachnis, E. Ktenas, M. Vlachadi and E. Kornarou, Mortality and the economic crisis in Greece. Lancet, 2014. 383(9918): p. 691.
30. Laliotis, I., J.P.A. Ioannidis and C. Stavropoulou, Total and cause-specific mortality before and after the onset of the Greek economic crisis: an interrupted time-series analysis. The Lancet Public Health, 2016. 1(2): p. e56-e65.

## CHAPTER 5. SUPPLEMENTARY DATA

**Appendix 1.** List of amenable causes of deaths

| Amenable causes of death | Age | ICD-10 code |
|---|---|---|
| **Infectious diseases** | | |
| Intestinal infections | 0-14 | A00-09 |
| Tuberculosis | 0-74 | A15-19, B90 |
| Other infections (tetanus, diphtheria septicaemia, poliomyelitis) | 0-74 | A36, A35, A80 |
| Whooping cough | 0-14 | A37 |
| Measles | 1-14 | B05 |
| | | |
| **Treatable cancers** | | |
| Colon and rectum | 0-74 | C18-21 |
| Skin | 0-74 | C44 |
| Breast | 0-74 | C50 |
| Cervical and uterus | 0-44 | C53-55 |
| Testis | 0-74 | C62 |
| Hodgkin's disease | 0-74 | C81 |
| Leukaemia | 0-44 | C91-95 |
| | | |
| **Diabetes** | 0-49 | E10-14 |
| **Ischaemic heart disease (50% of deaths)** | 0-74 | I20-25 |
| **Cerebrovascular disease** | 0-74 | I60-69 |
| | | |
| **Respiratory diseases** | | |
| Influenza | 0-74 | J10-11 |
| Pneumonia | 0-74 | J12-18 |
| Other respiratory conditions | 1-14 | J00-09, J20-99 |
| | | |
| **Digestive diseases** | | |
| Peptic ulcer | 0-74 | K25-27 |
| Appendicitic | 0-74 | K35-38 |
| Abdominal hernia | 0-74 | K40-46 |
| Cholelithiasis and cholecystitis | 0-74 | K80-81 |
| | | |
| **Perinatal deaths** | 0-74 | P00-96, A33 |
| | | |
| **Other amenable conditions** | | |
| Diseases of thyroid | 0-74 | E00-07 |
| Epilepsy | 0-74 | G40-41 |
| Chronic rheumatic heart disease | 0-74 | I05-09 |
| Hypertensive disease | 0-74 | I10-13, I15 |
| Nephritis and nephrosis | 0-74 | N00-07, N17-19, N25-27 |
| Benign prostatic hyperplasia | 0-74 | Y60-69, Y83-84 |
| Misadventures to patients | 0-74 | O00-99 |
| Maternal deaths | 0-74 | Q20-28 |
| Congenital cardiovascular anomalies | 0-74 | |

Source: Adapted from Nolte and McKee[7]

**Appendix 2.** Joinpoint regression results for 28 EU member states, 2000-15 (or latest available)

| | | Males | | | Females | | |
|---|---|---|---|---|---|---|---|
| Country | Cause | No of joinpoints | Segments | APC | No of joinpoints | Segments | APC |
| Austria | amenable | 1 | 2000-2005 | -6.8* | 1 | 2000-2008 | -4.7* |
| | | | 2005-2014 | -3* | | 2008-2014 | -1.9* |
| | other | 0 | 2000-2014 | -1.7* | 1 | 2000-2007 | -1.7* |
| | | | | | | 2007-2014 | -0.1 |
| Belgium | amenable | 0 | 2000-2014 | -3.9* | 0 | 2000-2014 | -3* |
| | other | 2 | 2000-2006 | -2.9* | 2 | 2000-2006 | -1.9* |
| | | | 2006-2012 | -0.7 | | 2006-2012 | 0.6 |
| | | | 2012-2014 | -3.3 | | 2012-2014 | -2.6 |
| Bulgaria | amenable | 0 | 2000-2013 | -2* | 0 | 2000-2013 | -2.8* |
| | other | 1 | 2000-2011 | -0.8* | 2 | 2000-2007 | -2.4* |
| | | | 2011-2013 | -3.4* | | 2007-2011 | -0.6 |
| | | | | | | 2011-2013 | -4.8* |
| Croatia | amenable | 0 | 2000-2015 | -3.7* | 1 | 2000-2002 | -13.8* |
| | | | | | | 2002-2015 | -2.9* |
| | other | 1 | 2000-2002 | -12.7* | 1 | 2000-2002 | -11.5* |
| | | | 2002-2015 | -2.1* | | 2002-2015 | -1.8* |
| Cyprus | amenable | 0 | 2004-2014 | -4* | 0 | 2004-2014 | -4.3* |
| | other | 0 | 2004-2014 | -2.9* | 0 | 2004-2014 | -4.6* |
| Czech Republic | amenable | 1 | 2000-2011 | -3.8* | 0 | 2000-2015 | -4* |
| | | | 2011-2015 | -2.1* | | | |
| | other | 0 | 2000-2015 | -2* | 0 | 2000-2015 | -1.6* |
| Denmark | amenable | 1 | 2000-2003 | -0.4 | 2 | 2000-2002 | -1.3 |
| | | | 2003-2014 | -5.3* | | 2002-2010 | -4.5* |
| | | | | | | 2010-2014 | -6* |
| | other | 0 | 2000-2014 | -2.5* | 0 | 2000-2014 | -2.7* |
| Estonia | amenable | 0 | 2000-2014 | -4.5* | 2 | 2000-2005 | -6.5* |
| | | | | | | 2005-2012 | -4.5* |
| | | | | | | 2012-2014 | 0 |
| | other | 2 | 2000-2007 | -1.2* | 2 | 2000-2007 | -2.2* |
| | | | 2007-2010 | -7.9* | | 2007-2010 | -6.6 |
| | | | 2010-2014 | -2.2 | | 2010-2014 | -2.1 |
| Finland | amenable | 1 | 2000-2006 | -5.1* | 0 | 2000-2014 | -3.6* |
| | | | 2006-2014 | -3.7* | | | |
| | other | 1 | 2000-2008 | -1.1* | 0 | 2000-2014 | -1* |
| | | | 2008-2014 | -2.7* | | | |

**Appendix 2.** Joinpoint regression results for 28 EU member states, 2000-15 (or latest available) (*continued*)

| | | Males | | | Females | | |
|---|---|---|---|---|---|---|---|
| Country | Cause | No of joinpoints | Segments | APC | No of joinpoints | Segments | APC |
| France | amenable | 0 | 2000-2013 | -3.6* | 0 | 2000-2013 | -2.6* |
| | other | 1 | 2000-2007 | -2.7* | 2 | 2000-2003 | -0.7 |
| | | | 2007-2013 | -1.6* | | 2003-2006 | -3.1* |
| | | | | | | 2006-2013 | -0.8* |
| Germany | amenable | 1 | 2000-2011 | -4* | 1 | 2000-2010 | -3.4* |
| | | | 2011-2014 | -1.8 | | 2010-2014 | -1.7* |
| | other | 1 | 2000-2007 | -2.8* | 1 | 2000-2007 | -2.1* |
| | | | 2007-2014 | -1* | | 2007-2014 | 0 |
| Greece | amenable | 1 | 2000-2010 | -2.9* | 1 | 2000-2010 | -3.5* |
| | | | 2010-2013 | 0 | | 2010-2013 | 0.1 |
| | other | 0 | 2000-2013 | -1.2* | 1 | 2000-2006 | -3.1* |
| | | | | | | 2006-2013 | -0.2 |
| Hungary | amenable | 0 | 2000-2015 | -2.8* | 1 | 2000-2007 | -3.7* |
| | | | | | | 2007-2015 | -2.2* |
| | other | 1 | 2000-2008 | -1.3* | 0 | 2000-2015 | -1.4* |
| | | | 2008-2015 | -3.3* | | | |
| Ireland | amenable | 0 | 2000-2013 | -5.6* | 1 | 2000-2002 | -9.5* |
| | | | | | | 2002-2013 | -4.1* |
| | other | 0 | 2000-2013 | -3* | 1 | 2000-2006 | -3.3* |
| | | | | | | 2006-2013 | -1.6* |
| Italy | amenable | 0 | 2006-2012 | -2.1* | 0 | 2006-2012 | -1.8* |
| | other | 1 | 2006-2010 | -2.7* | 0 | 2006-2012 | -0.9* |
| | | | 2010-2012 | -0.7 | | | |
| Latvia | amenable | 1 | 2000-2006 | -0.7 | 1 | 2000-2005 | -1.1 |
| | | | 2006-2014 | -4.2* | | 2005-2014 | -3.8* |
| | other | 1 | 2000-2006 | 0.3 | 1 | 2000-2006 | 0.4 |
| | | | 2006-2014 | -3.5* | | 2006-2014 | -3.4* |
| Lithuania | amenable | 2 | 2000-2007 | 2.4* | 1 | 2000-2007 | 0 |
| | | | 2007-2010 | -5.4 | | 2007-2015 | -3.3* |
| | | | 2010-2015 | -1.1 | | | |
| | other | 1 | 2000-2007 | 1.6* | 2 | 2000-2007 | 1.4* |
| | | | 2007-2015 | -3.5* | | 2007-2010 | -5.6 |
| | | | | | | 2010-2015 | -1.5* |
| Luxembourg | amenable | 0 | 2000-2014 | -4.4* | 0 | 2000-2014 | -3.8* |
| | other | 0 | 2000-2014 | -3.2* | 0 | 2000-2014 | -2.2* |
| Malta | amenable | 0 | 2000-2014 | -4.8* | 0 | 2000-2014 | -4.4* |
| | other | 0 | 2000-2014 | -2.7* | 0 | 2000-2014 | -2.6* |

**Appendix 2.** Joinpoint regression results for 28 EU member states, 2000-15 (or latest available) (*continued*)

| | | Males | | | Females | | |
|---|---|---|---|---|---|---|---|
| Country | Cause | No of joinpoints | Segments | APC | No of joinpoints | Segments | APC |
| Netherlands | amenable | 1 | 2000-2008 | -5.4* | 0 | 2000-2015 | -3.3* |
| | | | 2008-2015 | -3.6* | | | |
| | other | 2 | 2000-2002 | -2.1 | 2 | 2000-2003 | -0.2 |
| | | | 2002-2008 | -3.9* | | 2003-2007 | -3.5* |
| | | | 2008-2015 | -1.8* | | 2007-2015 | -0.4* |
| Poland | amenable | 1 | 2000-2012 | -2.9* | 2 | 2000-2002 | -5.2* |
| | | | 2012-2014 | -7.1* | | 2002-2012 | -3.1* |
| | | | | | | 2012-2014 | -5.1* |
| | other | 2 | 2000-2002 | -2.6 | 1 | 2000-2002 | -3.7 |
| | | | 2002-2007 | -0.4 | | 2002-2014 | -1* |
| | | | 2007-2014 | -2.3* | | | |
| Portugal | amenable | 0 | 2007-2014 | -4.5* | 0 | 2007-2014 | -2.5* |
| | other | 1 | 2007-2014 | -3.3* | 1 | 2007-2012 | -2.8* |
| | | | | | | 2012-2014 | 5.6* |
| Romania | amenable | 1 | 2000-2002 | 3.5 | 1 | 2000-2002 | 2.2 |
| | | | 2002-2015 | -3.2* | | 2002-2015 | -4* |
| | other | 0 | 2000-2015 | -1.5* | 0 | 2000-2015 | -2.1* |
| Slovakia | amenable | 1 | 2000-2009 | -2.8* | 0 | 2000-2014 | -3.4* |
| | | | 2009-2014 | -4.5* | | | |
| | other | 2 | 2000-2003 | -2.5* | 1 | 2000-2007 | -0.7* |
| | | | 2003-2006 | 0.2 | | 2007-2014 | -2.7* |
| | | | 2006-2014 | -2.8* | | | |
| Slovenia | amenable | 0 | 2000-2015 | -4.5* | 1 | 2000-2013 | -4.2* |
| | | | | | | 2013-2015 | 0.7 |
| | other | 0 | 2000-2015 | -3.6* | 0 | 2000-2015 | -2.9* |
| Spain | amenable | 0 | 2000-2014 | -3.3* | 0 | 2000-2014 | -3.2* |
| | other | 1 | 2000-2003 | -1.7* | 0 | 2000-2014 | -1.9* |
| | | | 2003-2014 | -2.8* | | | |
| Sweden | amenable | 1 | 2000-2011 | -4.1* | 0 | 2000-2015 | -2.9* |
| | | | 2011-2015 | -1.8* | | | |
| | other | 2 | 2000-2004 | -1.3* | 0 | 2000-2015 | -1.2* |
| | | | 2004-2013 | -2.3* | | | |
| | | | 2013-2015 | 0.4 | | | |
| United Kingdom | amenable | 0 | 2001-2013 | -4.9* | 0 | 2001-2013 | -4.2* |
| | other | 0 | 2001-2013 | -2.2* | 0 | 2001-2013 | -1.6* |

* Significant at p<0.05