Multi-morbidity at death and the US disadvantage in life expectancy

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Short abstract

The US experiences a significant shortfall in life expectancy compared to peer countries. The literature indicates that a similar disadvantage affects morbidity and, more generally, the prevalence of risk factors for major diseases within the US population. In this study, we assess the impact of multi-morbidity at death on the life expectancy gap between the US and three other high-income countries with comparable data, namely France, Italy and Spain. The study relies on an analysis of the multiple cause-of-death information available on all death certificates for a single year (2017), used to classify morbid processes leading to death into three categories: simple, multi-morbid, and ill-defined. The results show disproportionately high rates of multi-morbid processes among working age adults in the US compared with the other three countries, particularly among men for whom these rates are up to 5 times higher around ages 25-30 years compared with France and Italy, and nearly 25 times higher compared to Spain. Multi-morbid processes contribute 43% of the US gap in life expectancy at birth with Italy, 57% with France, and 64% with Spain. The prevalence of multi-morbid processes in the US indicates that structural factors are most likely at play in this disadvantage in mortality and no magic bullet will easily enable the country to catch up to its peers. The study further demonstrates the value of studying the prevalence of multi-morbidity at the time of death as a complement to the analysis of multi-morbidity within the living population, especially for international comparisons.

Extended abstract

The US experiences a significant shortfall in life expectancy compared to peer countries (National Research Council, 2011 and 2013; Barbieri, 2021). The literature indicates that a similar disadvantage affects morbidity and, more generally, the prevalence of risk factors for major diseases within the US population (Murray *et al*., 2013; Salive, 2013). In this study, we demonstrate the value of multiple cause-of-death data to measure multi-morbidity in a comparative setting. Our more specific goal is to assess the impact of multi-morbidity at death on the life expectancy gap between the US and three other high-income countries with comparable data, namely France, Italy and Spain.

Data and method

The study relies on an analysis of the multiple cause-of-death information available on all death certificates in the national vital statistics systems of the US, France, Italy and Spain for 2017 (last data point available for all study countries). Multiple causes of death include all the causes listed in Part 1 and

Part 2 of the death certificate. The standard death certificate form recommended by the WHO and used by most high-income countries, including those in this study, distinguishes between the medical causes involved in "the sequence of morbid conditions, lesions or poisoning that led directly to death" reported in Part 1, and those in Part 2, which are excluded from the sequence reported in Part I but contributing to death, often designated as the associated or contributing causes.

Following an approach developed by Grippo *et al*. (2020), all deaths in our study are classified into one of three morbid processes, namely simple causal processes, multi-morbid processes, and ill-defined processes. Simple processes characterize deaths with a single originating cause (either a single cause listed on the certificate or a sequence of causes deriving from the same originating condition). Multi-morbid processes characterize deaths with at least two originating causes (where neither one can be the consequence of the other) or with one originating cause but at least one contributing cause in Part 2. Ill-defined processes characterize deaths with no specific causes listed on the death certificate. From the tabulation of deaths in each country by five-year age group, sex, and morbid process, we calculated the corresponding age-specific death rates using exposures from the Human Mortality Database (HMD, 2023) series for each of the four countries, as well as age-standardized death rates with the US exposures from the HMD as the reference. In the HMD, exposures are derived from the annual population estimates in each country (see the HMD Methods Protocol for more details – Wilmoth *et al*., 2017). The rates are used to determine the contribution of each type of morbid process to the difference in life expectancy between the US and each of the three comparison countries using a decomposition method proposed by Pollard (Pollard, 1988). We also estimated the total and average number of years of life lost by the United States, overall and separately from all simple causal processes and all multi-morbid processes compared to the other three countries. To do so, we first estimated the distribution of excess deaths in the US by sex and age group (applying the age- and sex-specific death rates of each comparison country to the US population in turn and taking the difference between the actual and the estimated death counts), then multiply each death by the number of expected years of life at the corresponding age in the comparison country lifetable, adding up all of those years to estimate the total number of years of life lost to the US, and dividing by the overall number of excess deaths to estimate the average number of years lost for each excess death.

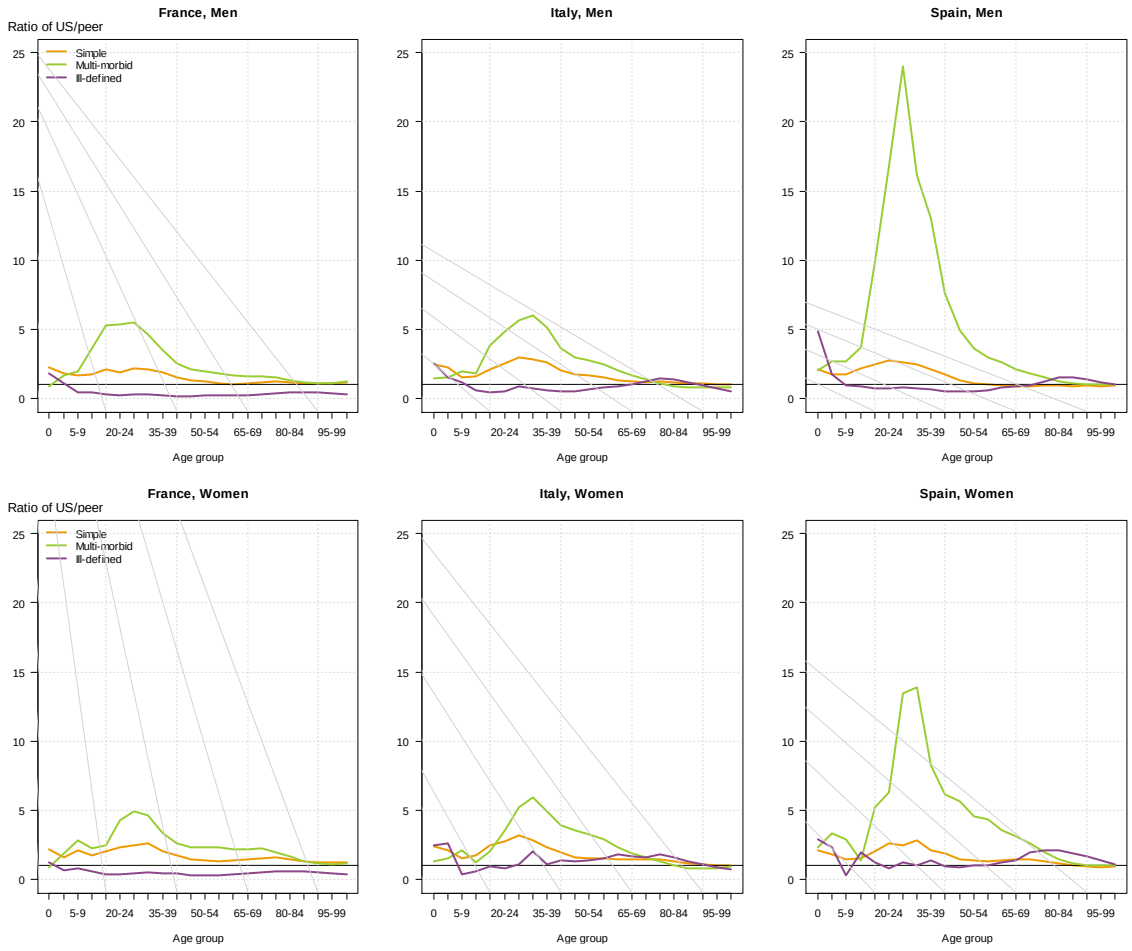
Results

At 78.7 years for both sexes combined (76.2 years for men and 81.2 years for women), life expectancy at birth was much lower in the United States than in the other three countries (82.5 in France, 82.7 years in Italy, and 83.0 years in Spain for both sexes combined) in 2017. The difference reached 3.8 (compared with France), 4.0 (Italy) and 4.3 (Spain) years for both sexes combined (3.2, 4.2, and 4.1 years for men, and 4.1, 3.6, and 4.5 years for women, respectively).

Consistent with the literature, mortality in the United States was particularly high for working age adults in general, and for young adult males especially (Harris, Majmundar, and Becker, 2021; Ho, 2013; Ho and Preston, 2010). Infant mortality alone contributed from 0.6 year to over one year to these differences, depending on the comparison country. However, the gap in life expectancy at age one still reached 3.6, 3.8 and 4.1 years, respectively (3.1, 4.0, and 3.9 for males and 4.0, 3.4, and 4.2 years for females). The results of our analysis show that between age 15 (below which most of the US disadvantage is attributable to simple processes) and 85 years (after which the US exhibits an overall mortality advantage), multi-morbid processes contributed disproportionately to excess mortality in this country

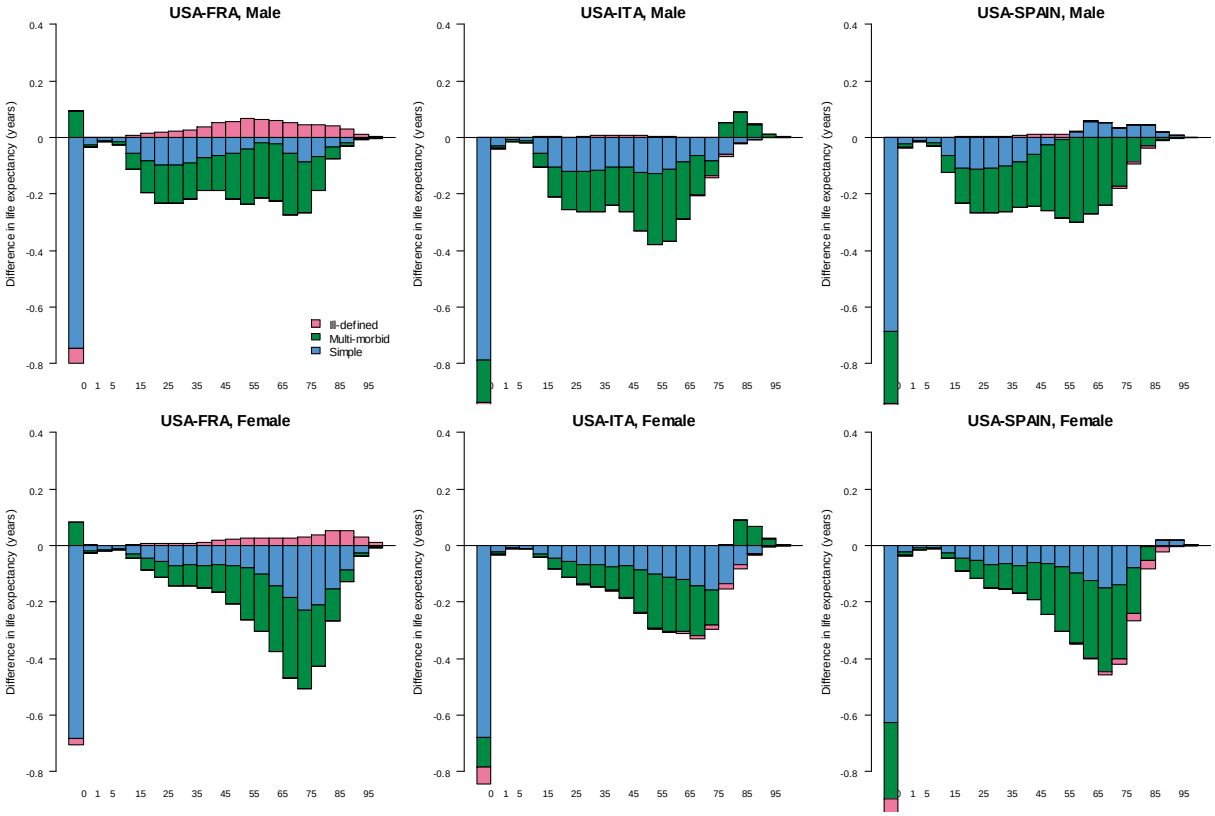
(Figure 1). For instance, at ages 25-29, in the middle of the range (20 to 35 years) when male excess mortality in the US reached its peak, the age-specific death rate from multi-morbid processes was 80 per 100,000 compared with 3 in Spain and 14 in France and Italy. The corresponding rate for simple morbid processes is higher, at 90 per 100,000 but closer to that in the three other countries (i.e., 34 in Spain, 42 in France, and 30 in Italy).

Figure 1. Excess mortality in the US compared to peer countries by morbid process, each sex



Our analysis indicates that if the mortality rates from multi-morbid processes had been the same in the US as in the comparison countries, the country would have experienced a gap in life expectancy at birth which would have been smaller by 43% compared with Italy (46% for men and 38% for women), by 57% compared with France (64% for men and 50% for women), and by 64% compared with Spain (71% for men and 57% for women) (Figure 2). Excluding infant and child mortality, the gap in life expectancy at age 15 years would have been smaller by 56% (compared with Italy), 87% (France), and 88% (Spain). For males, the percentages are 56% (Italy) and 86% (France and Spain), and for females, 47%, 62% and 65%, respectively.

Figure 2. Contribution of the three morbid processes to the difference in life expectancy at birth between the US and peer countries, each sex



With the mortality rates of France, the US would have experienced 645,071 fewer deaths of both sexes in 2017, the results of 316,358 fewer deaths from simple morbid processes, 475,332 fewer deaths from multi-morbid processes, and 146,619 *more* deaths from ill-defined processes (since France has higher death rates from ill-defined processes than the US). With the mortality rates of Spain, the US would have experienced 656,825 fewer deaths in total, i.e., 100,174 from simple processes, 532,414 from multi-morbid processes, and 24,237 from ill-defined processes. With those of Italy, the US would have experienced 568,886 fewer deaths, i.e., 312,819 from simple morbid processes, 246,112 from multi-morbid processes and 9,956 from ill-defined processes. On average, each of the survivor would have been expected to live an additional 22 years compared with France (26 years for men and 20 years for women), 27 years compared with Spain (31 years for men and 24 years for women), and 30 years compared with Italy (32 years for men and 28 years for women).

Discussion

The prevalence of multi-morbid processes in the US indicates that structural factors are most likely at play in the US disadvantage in mortality and no magic bullet will easily enable them to catch up to their peers. The study suggests that an approach based on the multiple cause-of-death information available on death certificates could be very valuable as a complement to the analysis of multi-morbidity within the living population, especially for international comparisons. In a context of rapidly aging populations and the increasing burden of chronic diseases due to improved survival from cancer, cardiovascular diseases, and other conditions, monitoring the prevalence of multi-morbidity is essential for public

health. Multi-morbidity is associated with increased mortality risks, disability, reduced functional status, poor quality of life, complicated treatment options, and adverse drug events due to incompatibilities (Forman et al., 2018). However, the lack of standard methods for measuring multi-morbidity and the difficulty in carrying out comparative studies over time or across populations have hampered comprehensive analyses due to the diversity of data sources and population samples. The approach we propose overcomes many of these shortcomings as it is based on routinely collected vital statistics based on a standard data collection instrument (the WHO recommended death certificate with all causes of death coded to the International Classification of Diseases), thereby providing widespread, systematic, low cost, and highly comparable information on multi-morbidity at death. In addition to international comparisons, this approach is easily amenable to additional studies of changes in the prevalence of multi-morbidity at death over time or within-population variations by geographic location, race/ethnicity, or social groups.

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