Spike in Hungarian Mortality Rates from Chernobyl?

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Abstract

An unusual spike in mortality rates derived from Hungarian population data is found for persons between ≈20 and 30 years of age during the years 2006 to 2011. It is unlikely to be a result of an epidemic of suicide, or from migration. If due to delayed effects of the 1986 Chernobyl disaster, then ≈50,000 premature deaths are implied in Hungary alone.

Introduction

In a recent paper,[1] I derived mortality rates of 5 countries for the 2010-2015 epoch based upon publicly available population data[2]. The countries chosen for the study were the USA, Iceland, China, Japan, and Hungary. Unique among these countries, and among several countries subsequently examined, is a spike in mortality found in the Hungarian data. It emerges in the 2006-2011 epoch, peaks in the 2010-2015 epoch, and persists at least until the 2011-2016 epoch (see Fig. 1).

A closer examination of the unusual spike in the Hungarian mortality rates is made here. After discounting suicide and migration as causes, enhanced mortality due to the delayed onset of disease from the Chernobyl accident seems to provide the simplest explanation for the mortality spikes. The number of premature deaths in Hungary that resulted from this event is estimated. A two-population model, in which ionizing radiation shortens telomere length, could explain the evolving mortality spike within the context of the telomere-loss model. It cannot, however, be ruled out that the spikes are a feature of the data collection techniques used by Hungarian demographers.

Derivation of mortality rates

Let $N_i(t)$ represent the number of residents at time *t* in a given country, with the index *i* denoting age cohort and sex. As the cohort ages through time period Δt, $N_i(t)$ changes as a result of mortality and migration. The causes of mortality are manifold: homicide, suicide, plague, disease, famine, war, and "natural" death. Migration involves both immigration into a country, which acts as a negative mortality in the rate calculations, and emigration from a country, which acts as a positive mortality.

The mortality rates are derived from the population data through the expression $\nu_M(t)[yr^{-1}] = -\ln\left[\frac{N_{i+1}(t+\Delta t)}{N_i(t)}\right]/\Delta t$, where Δt = 5 yrs for the publicly available 5-year population data.[2] Fig. 1 shows results for the Hungarian mortality rates obtained through this technique. The mortality-rate spike reaches values of 0.01-0.02 yr^{-1} for 20-30 year-old male and female Hungarians during the period 2006 -2011, This implies that the probability that a 20 year old Hungarian in

2007 would survive to 2011 is $\approx \exp(-\nu_M \Delta t) \approx \exp(-0.01 * 4\text{yrs}) \approx 96\%$, or that such a person would have a roughly 4% chance of dying during these 4 years.

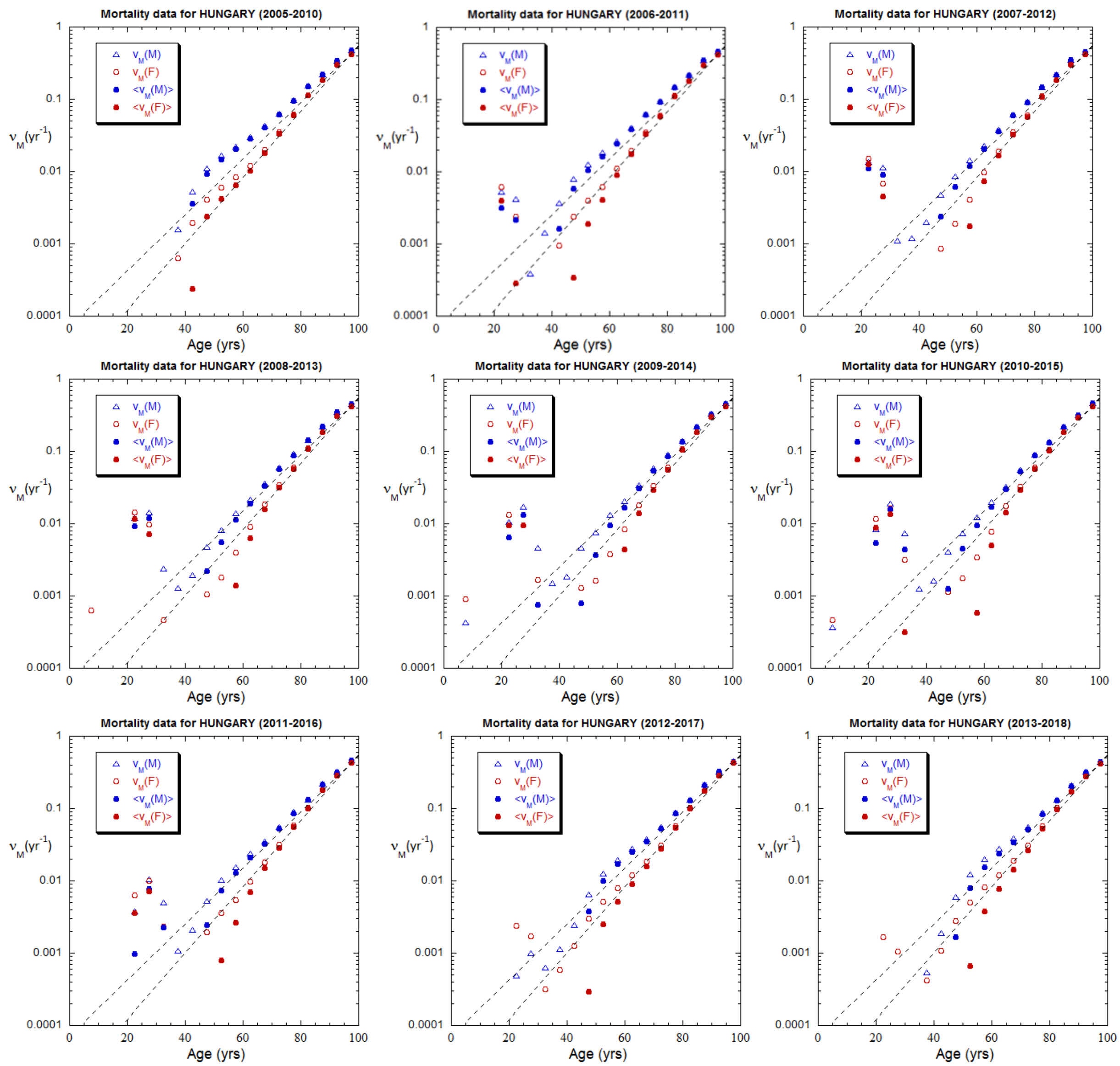

Figure 1. Hungarian male and female mortality rates derived from UN population data (open symbols), and normalized population data (closed symbols), as described in Ref. 1. The rates are calculated at the epochs given in the labels. The dashed lines show best fit power laws by eye to the old-age male and female mortality rates derived for the 2010-2015 epoch.

The spikes are found in both the male and female mortality rates, and are largely unaffected by renormalization to total population, at least until the 2012-2017 epoch. Note further that the peak of the mortality spike tends to increase with time, as if the same age cohort is suffering from enhanced mortality as it ages. Most remarkable is that the age cohort that suffered the enhanced mortality are those Hungarians born or those very young during the years from 1980 to 1990.

That decade saw, of course, the Chernobyl disaster. Whether radioactive fallout from Chernobyl was the cause of this enhanced mortality must contend with alternate explanations, for example, an epidemic of suicides or a scourge in the population such as occurred with the opioid crisis in the United States (which is not to say that Hungary saw any such devastation, only that such possibilities should be kept in mind). Further complicating this issue is that the positive mortality spikes are accompanied by small negative mortality features for the younger age groups, as seen in the animations[3] of the mortality rates on a linear scale. Also important is the impact of migration.

Until these issues are fully resolved, an explanation implicating Chernobyl must remain hypothetical. We address some of these issues below.

Suicide

World Bank data for male and female Hungarian suicides for the years from 2000 to 2019 are given in Ref. 4. The total (male plus female) rate varies from 33.0 per 10^5 Hungarians in 2000 to 16.6 per 10^5 Hungarians in 2019, with the male suicide rate being ~3.5-4 times larger than the female rate. The rate displays a smooth, almost monotonic decline between 2000 and 2019, with a plateau at about 25 per 10^5 Hungarians per year in the years from 2006-2012.

The suicide data are unfortunately not age-stratified. But even if the suicides were overwhelmingly by 20-30 year-old Hungarians, who represent ~15% of all Hungarians in this time frame, the implied mortality rate is $\sim 7 \times 25/10^5$ yr^{-1} ~ 0.002 yr^{-1}. Besides being nearly an order of magnitude smaller than the mortality spikes, the smoothness of the rates with time and the large differences between male and female suicide rates, which are not seen in the mortality rates of Fig. 1, means that an epidemic of suicide as a cause of the mortality spikes can be ruled out.

Migration

The statistica.com website[5] gives data for Hungarian immigration, emigration and net migration for the years 2006 - 2021. The data are not stratified by age, but in every one of these years immigration exceeds emigration, implying a net positive addition to the population of Hungary. As noted previously, this would show up in the population data as a negative mortality, so that the appearance of mortality spikes would require an even larger number of deaths in the Hungarian population than obtained under the assumption of no migration.

Specifically, in the 5 years from 2010 to 2014 (inclusive), a net migration of 52,539 persons into Hungary is reported, implying an average number of new arrivals of ~10,500 yr^{-1} during this period. In contrast, the population of Hungary declined by 142,579 persons during the same period, giving an average decrease of 28,500 yr^{-1}. This is largely due to an aging population, as the Hungarian birthrate[6] is roughly constant during this time—indeed, slightly rising—with a value of 9.2 births per 1000 persons per year. For a Hungarian population of ~10^7 people, this implies that the mean birthrate is ~9,000 yr^{-1}.

An indirect check on Hungarian migration can be made from the migrant stock of the country, namely, the number of people residing in a given country that were born in another country. An age-stratified table of the migrant stock for 5-year age cohorts and sex is given by Unicef in Ref. 7 for the years 1990, 2000, and 2013. For persons younger than 40 years of age, the migrant stock decreases between 1990 and 2000 but increases between 2000 and 2013. In particular, the migrant stock of people between 20 and 30 years of age roughly doubles between 2000 and 2013.

Immigration statistics reported in Ref. 8 show a 23.52%, 19.04%, and 2.98% increase for the migrant stock during the epochs 2000-2005, 2005-2010, and 2010-2015, respectively. The migrant stock decreased by 7.84% from 1995-2000. These trends are consistent with Ref. 5.

A direct comparison between data on migrant stocks and migrant arrival numbers is not possible without having age-stratified data for each year. For example, the population of the migrant stock changes due to migration but declines due to mortality in an age-dependent fashion. Nevertheless, the cited data all support an increase in the number of migrants younger than about 30 years of age to Hungary during the period from 2000-2013. This makes it difficult to attribute the mortality spikes to migration without extreme fine tuning.

Data

This analysis is based on population data for 5 year age cohorts.[2] Similar analyses for Slovakia, Belarus, and Ukraine itself show enhanced mortality for persons younger than about 40 years of age, but nothing like the spikes found in the Hungarian mortality rates (see animations in Ref. 3). A better analysis could be performed using 1-year population data, and surely exists as seen in population pyramids displayed for various counties, including Hungary, on Wikipedia. A request to the United Nations Population Division for the 1-year population data has gone unanswered.

The population data has been accepted at face value. There remains the possibility that an adjustment to the Hungarian population data was made that subtracted a large number of young Hungarians from the 2006-2011 data. An explanation for such an extreme alteration would have to be made, though this would call into question the reliability of any UN population data.

Chernobyl

The explosion of the Chernobyl reactor Unit 4 on April 26, 1986 near the now abandoned town of Pripyat in the Ukrainian Socialist Republic is the worst nuclear accident in history (though the extent of the Urals nuclear disaster[9] remains unknown). The United Nations officially acknowledged 31 deaths in the immediate aftermath of the explosion and 50 subsequent direct deaths. The actual toll is controversial. According to a 2019 BBC report,[10] Ukrainian registries show that some 600,000 persons were given liquidator status, that is, persons documented to have exposure to radiation from the disaster. Benefits were paid by the Ukrainian government to 36,525 widows of affected men. Of the 298 women working in a processing plant in the northern Ukrainian city of Chernihiv that received wool from contaminated sheep (all of whom received liquidator status), only 10 remained at the plant at the time of the BBC report, with the others either disabled or dead.

Besides the immediately affected area near Chernobyl, the radioactive cloud formed by the Chernobyl explosion was blown in a westward direction. Its extent was however continent-wide, as the radiation from Chernobyl was first detected outside the immediately affected area in Sweden, some 1100 km away.

The distance from Chernobyl to Budapest, the main population center of Hungary, is about 900 km. Human exposure to the radiation plume blown by the prevailing winds is strongly enhanced when the radioactive ions precipitate to the ground. The western Hungarian city of Szombathely, nearly 1100 km from Chernobyl, was subject to heavy rains following two waves of radioactive clouds entering Hungary on April 29 and May 7, 1986.[11] Allegedly, all persons caught in the rain were diagnosed with cancer within a few years, and "…the country [Hungary] was affected by its biggest diarrhea epidemic…"

Thus it does not appear to be far-fetched to suppose that Hungary experienced severe mortality as a consequence of Chernobyl.

Excess Hungarian Mortality

An estimate of the number of premature deaths for young Hungarians during the 2006-2011 period can be determined from the magnitude of the mortality spikes with the assumption of no migration. Given that the data show that migration for this age group during this time frame is positive, this assumption will underestimate the true mortality. "Background" mortalities of 0.001 yr^{-1} – 0.003 yr^{-1} for the young are assumed, which would grossly overestimate historical mortality outside this time frame, and require all suicides to be concentrated in the younger age group, also unlikely.

The number of 2.5-32.5 year-old Hungarians decreases by 60,460 from 2006-2011, whereas it significantly increases at earlier and later times. Including a background mortality rate of 0.003 yr^{-1} implies, using the most conservative assumptions, that Hungary saw at least ≈50,000 premature deaths.

Theoretical interpretation

The immediate effects of enhanced doses of ionizing radiation are well-known: skin burns, an elevated risk of cancer, and fetal brain damage. The longer term effects are less well-known.

In Ref. 1, a toy model for old-age human mortality was proposed based upon telomere shortening. Ionizing radiation has indeed been found to reduce telomere length.[12] If a population of Hungarians were subject to strong doses of ionizing radiation in 1986 that reduced telomere length, this would shorten the time to cell senescence and organism death. The irradiated population would consequently have a shorter life span.

Such a two-population model could reproduce the spikes in Hungarian mortality. Because of the speculative nature of the model, however, I suggest it only as a potential mechanism for the mortality spikes.

Conclusions

The unusual mortality spikes implied by the Hungarian population data could be a consequence of the Chernobyl disaster. If so, then at least 50,000 premature deaths occurred in Hungary. I propose this as the most likely hypothesis---assuming that the population data are reliable. Given the negative implications that this interpretation would have for nuclear energy production, it is important to have confirmation, clarification, or criticism of this result from professional demographers.

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