**Title:** The contribution of violence to life uncertainty on a global scale

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**Extended abstract with preliminary results:**

Being unable to control the unfolding of the future is a state of uncertainty that has puzzled humans for centuries.1 Any individual making plans must, somehow, consider that he/she does not know the day when death will happen.2 *When will I die?* Is, therefore, a crucial question that shapes individuals’ decisions and their future. Most research on uncertain lifetimes, or lifespan inequality, has focused on how this unpredictability affects individual consumption and distribution of wealth.3-7 While, more recently, research on how social determinants, such as socioeconomic status, education or income, affect lifespan uncertainty has found that socially disadvantaged groups tend to experience higher uncertainty about their lifetime with lower life expectancy.8-13 In contexts of high violence, greater uncertainty in life suggests ineffectiveness of policies to protect individuals and implies a failure of social protection through which violence is spread in a population.14 Our article, therefore, highlights the role of violent environments on life uncertainty.

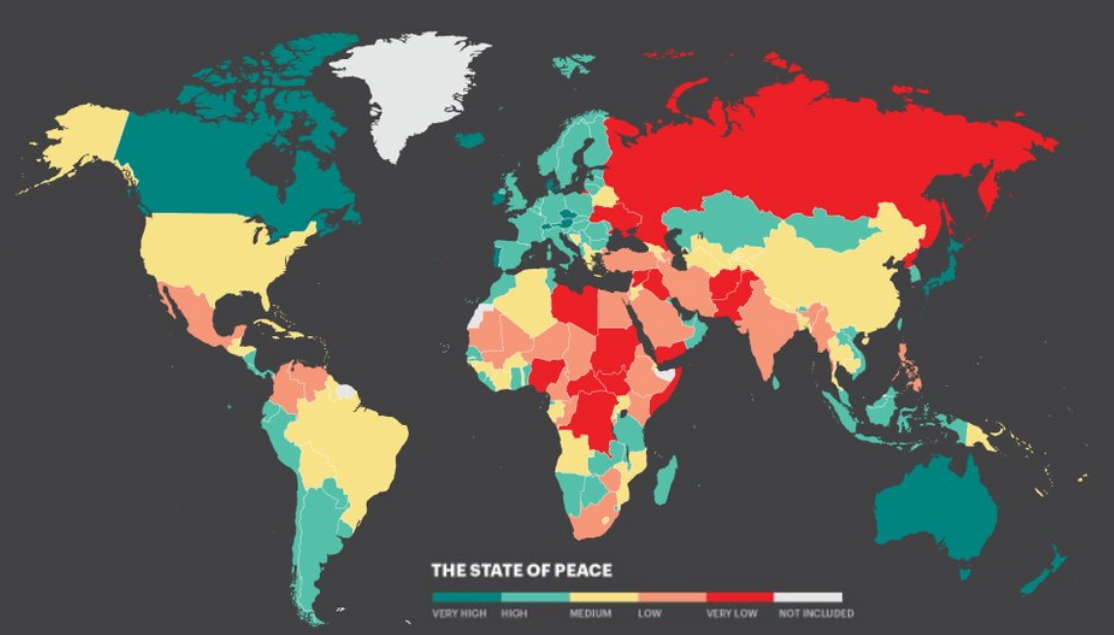
Globally, lifespan uncertainty varies considerably between countries.15-21 Greater uncertainty usually corresponds to those countries with lower life expectancy.19-21 Over time, major decreases in lifespan inequality came about from reducing premature mortality since the 18th century. Particularly from saving lives at infancy, and decreasing infectious diseases and maternal mortality.22 More recently, reduced cancer mortality has helped to make lives more equal in developed countries.22,23 However, detailed knowledge is lacking about whether and how violence makes lifetimes uncertain: a fundamental state of vulnerability. Studies on how violence affects the quality of life often rely on subjective measures.24 Fear of crime depends on how individuals perceive their environment and, therefore, might lead to a mismatch between the real uncertainty and how it is perceived.25 For example, females are more likely to report significant levels of vulnerability, while experiencing lower levels of victimization in periods when violence is inreasing.26 Certainly, this has an immediate effect on quality of life27, causing higher levels of paranoia, anxiety and other mental health issues for individuals,28 while promoting segregation at the population level.26,29 Therefore, a fuller comprehension of the burden of violence on lifespan uncertainty holds potential insights for the consequences it poses on individuals and societies, their behavior in violent environments, and the future of longevity.

Here we unify lifetime uncertainty with violence and pose four questions aimed at filling this knowledge gap: How uncertain lifetimes are in the most dangerous countries in the world, compared with peaceful nations, for males compared with females, and what is the contribution of violent deaths to the observed differences? To answer these questions, we use mortality data from 163 nations from the Global Burden of Disease Study (GBD) by sex (3072 life tables),30 and information on levels of violence from the Global Peace Index for the period 2008-2017.

**Uncertainty and violence around the globe**

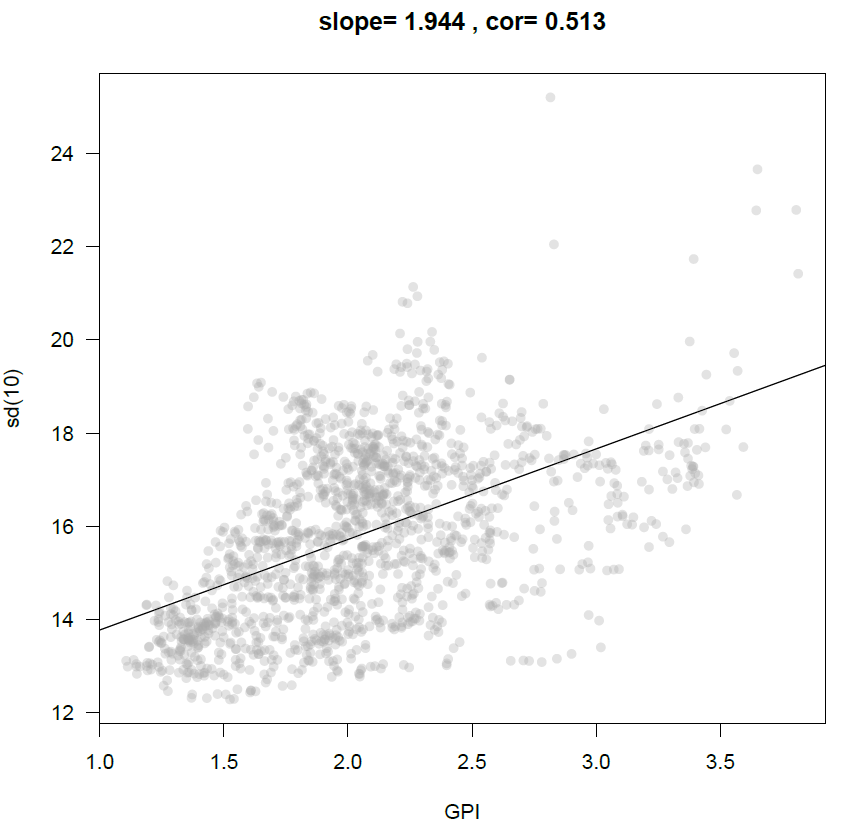
To estimate lifetime uncertainty, we selected countries based on the Global Peace Index (GPI).31 This index ranks the peacefulness of 163 (99.7% of the global population) countries based on three domains: 1) Ongoing domestic and international conflict, 2) societal safety and security, and 3) militarization. It is constructed with 23 indicators of violence, such as number and duration of internal conflicts, level of perceived criminality in society, and homicide rates.31 Europe has consistently been the most peaceful region in the world over the last decade. While the Middle East and North Africa (MENA) are in the other side of the spectrum as the most violent regions,31 and Latin America with highest homicide rates in the world (Figure 1).32 We compare the 25 most violent countries according to the 2017 GPI, with the set of countries that ranked in the top-10 most peaceful nations in the period 2008-2017. For example, Iceland, New Zealand, Austria, Portugal and Denmark ranked among the most peaceful countries in the world. Syria, Afghanistan, South Sudan, Iraq and Somalia, on the other hand, showed the least peaceful levels in 2017.

**Figure 1. Global state of peace. Source: GPI 2018**



Lifetime uncertainty can be measured with a summary indicator of how similar ages at death are. Multiple indicators exist for this purpose,33 such as the standard deviation or the Gini coefficient of the age-at-death distribution. We chose the standard deviation conditioned to surviving at age 10 to determine how spread ages at death are. The high correlation between these indices suggests that our results would not change significantly by using another index.16,33 Peaceful nations all enjoy low lifetime uncertainty (Figure 2), whereas the most violent countries tend to have higher life uncertainty. Between 2008 and 2017, males living in the most dangerous countries showed a positive association with experiencing higher uncertainty in lifetime (correlation between GPI and life uncertainty is 0.51 for males). Moreover, the strong relationship between uncertainty about life and life expectancy suggests that those countries with high levels of violence experience lower levels of life expectancy than the peaceful nations.16 This is important because life uncertainty is a measure of how the length of life varies and GPI measures the level of peace in a country. In principle, the two indicators could be unrelated to each other: A peaceful country could suffer high life uncertainty while a violent country might display lower mortality and uncertainty in life. The set of countries with the highest life uncertainty could be completely different from the set of countries with the highest levels of violence, but it turns out that they overlap. For females, lifetime uncertainty is lower than for males. This advantage, however, is less associated with the levels of violence (correlation of 0.44). We hypothesize that this difference results from higher mortality at young and working ages for males. This is usually referred to as the ‘young-mortality’ hump and it is an important explanatory factor of sex differences in mortality.34 For example, war related deaths are five times higher for men than for women, and homicide rates in Latin America are 10 times higher for men.35 This highlights the importance of premature mortality on lifetime uncertainty.

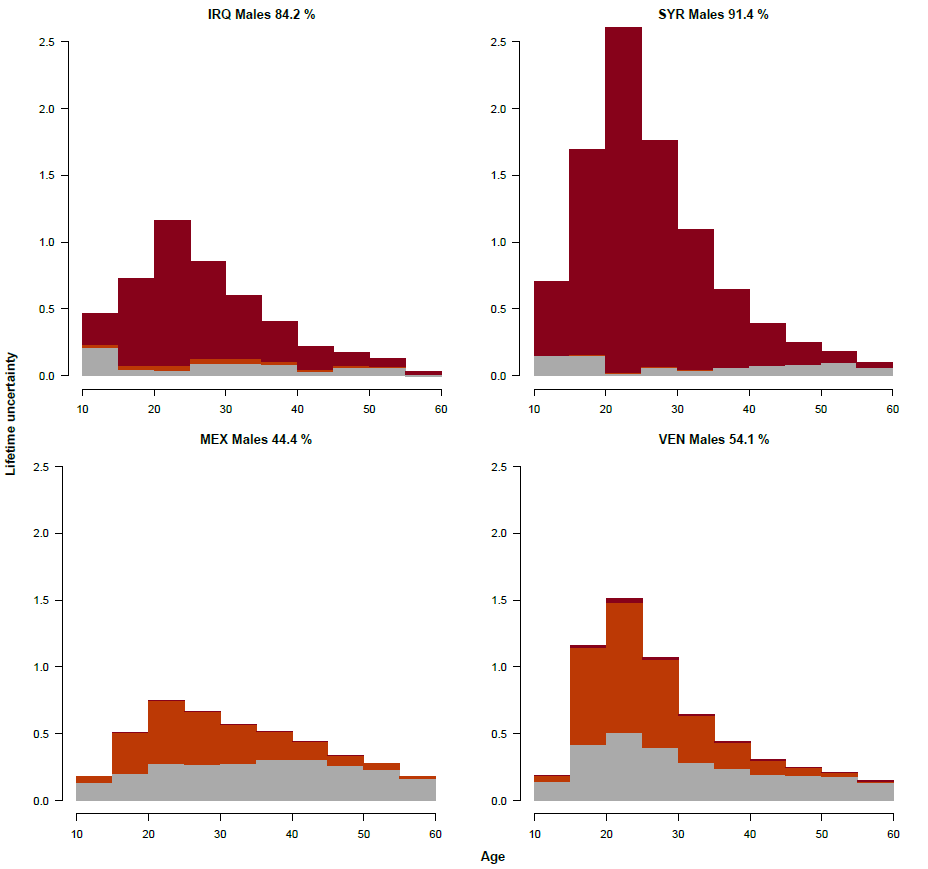
**Figure 2 Level of Violence by lifetime uncertainty for males 2008-2017**



**Contribution of violent deaths to life uncertainty**

The countries with the lowest levels of lifespan uncertainty succeeded not only because of a general lower level of mortality at all ages, but also because their levels of deaths due to war or interpersonal violence are almost inexistent. For example, in Iraq and Syria (Figure 3) war-related deaths make up 84.2% and 91.4% of the difference in lifetime uncertainty with the peaceful region. Most of these additional deaths are concentrated in young ages for males. Similarly, in countries such as Mexico and Venezuela without a declared conflict, homicides explain 44.4% and 54.1% of the difference with the peaceful region.

**Figure 3 War related (red) and homicide (orange) contribution to difference in lifetime uncertainty between selected country and RPR**



**Methods & Data [3000]**

**Data.** We used mortality estimates for 163 countries from the Global Burden of Disease Study.30 GBD is an observational epidemiological study widely used to analyze trends in mortality and morbidity from major diseases, injuries and risk factors in a global perspective. These data are provided in 5-year age intervals with the highest interval concentrating deaths above age 85. We focus on three main causes of death related to violence: 1) homicide, 2) other violence (mostly war, state, and terrorist), and 3) all other causes.

To measure the levels of violence (or peacefulness) we use the Global Peace Index (GPI). GPI has been systematically calculated in the period that we study 2008-2017.31 It ranks the 163 countries according to the level of peacefulness. It is based on 23 qualitative and quantitative indicators that measure the state of peace using three domains: the level of societal safety and security, the extent of ongoing domestic and international conflict, and the degree of militarization. It is the most comprehensive index at a global scale and, therefore, a primary source of this study.

**Demographic methods.** To more accurately measure the age-at-death distributions for each country we ungrouped the 5-year age intervals to single ages and distributed the deaths above age 85 with the penalized composite model assuming that deaths follow a Poisson distribution and calculated age-specific mortality rates.36 We constructed life tables for each country, sex, and year following standard demographic techniques.37 From these, lifespan uncertainty conditional on surviving to age 10 were calculated.

To disentangle the effect of violent deaths we calculated life expectancy and lifespan uncertainty in absence of these following the cause-deleted life table methodology.37 Additionally, we decomposed the difference in lifespan uncertainty between violent countries and RPR using the linear integral model for decomposition.38 All procedures were done using the R software,39 and are fully reproducible from the public repository [URL].

**Life span uncertainty indicator.** Several indices, highly correlated, to measure lifespan uncertainty exist.33,40 We chose the standard deviation of longevity conditional on surviving to age 10. This indicator has the advantages of being widely used as dispersion indicator in statistics, easy to interpret, decomposable into age- and cause-specific components, and is expressed in years. In life table notation the standard deviation () is given by

Where and denote the age-at-death density function, life expectancy at age 10, and the open-aged interval (110+ in our case), respectively. We condition to age 10 to capture the onset of violent deaths, which [x%, Tim?] occur over this age, and because infant mortality conceals mortality dynamics of adult ages.41

**Robustness check with life disparity.** All figures were replicated using “life disparity” or average life lost. This indicator has been used in several lifespan inequality studies, including one focusing on homicide mortality. The indices differ in their sensitivity to changes in mortality and in properties and is measured in years, allowing a direct comparison with the standard deviation. While some variations in the levels of lifetime uncertainty were observed, the main results and conclusions of our study are supported.

**Selection of violent countries and construction of the robust peaceful region (RPR).** We focus on the worst and best performers of GPI to compare the burden of violence on lifespan uncertainty. The “Best Performers” category includes all countries that ranked in the top ten over the period 2008-2017: Australia, Austria, Belgium, Canada, Switzerland, Czech Republic, Denmark, Finland, Ireland, Iceland, Japan, Norway, New Zealand, Portugal, Singapore, Slovenia and Sweden. The “Most Violent” category includes the 25 worst performers countries that scored a low or very low level of GPI in 2017. To have more robust comparisons of lifetime uncertainty between violent countries and a peaceful environment, we constructed a “Robust Peaceful Region” based on the best performers of GPI. It was determined by the weighted mean of age-specific death rates by sex of the Best Performers. The weights were constructed according to the instances each country appeared in the top ten.

**Future work:** Describe and apply the results for all countries and for females.

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