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A systematic analysis of worldwide disasters, epidemics and pandemics associated mortality of 210 countries for 15 years (2001–2015)

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ABSTRACT

In recent years, the unprecedented death tolls resulting from epidemics and natural disasters made everyone interested, from the general public to country heads, to know about the mortality rates. The coronavirus issue is the most recent example all over the media, and everyone is talking about corona-induced mortality. The study aimed to estimate the disaster-induced mortality rates at the global level for two hundred and ten countries for fifteen years (2001–2015). Using a retrospective study design, we extracted datasets from two data sources, EM-DAT and UNFPA, in October 2019. The cut-off time for the data download was midnight Central European Time, October 17, 2019. The most noticeable finding in this study is that, against the common prevailing notion, both developed and developing countries equally carry the brunt of disaster-induced mortality.

This study proposes empirical confirmation of the direction and magnitude of any year-over-year correlation of disaster and mortality rates. Furthermore, the analysis of the trend in mortality rate over the past fifteen years concludes it is not linear. However, there are huge variations across the years and the countries. The study is of paramount importance to initiate a debate amongst the concerned policymakers and stakeholders to regularly monitor the disaster-induced mortality rates. So that effective interventions can be devised to decrease the mortality rates.

1. Background

The histories of disasters, pandemics, and outbreaks are as old as human history itself [1]. Throughout recorded history, humankind experienced several disasters, epidemics, pandemics, and outbreaks, most reported in different religious scriptures and limited historical documents [2]. At the time, people did not exactly know why disasters happen, how diseases spread, and how to
prevent or survive pandemics [1]. As science was not studied in the early days of humanity, people often viewed disasters as the acts of gods [3]. This, along with other contributing factors, cemented human’s reliance on religion, a state of the mind where hope forever outlives fear and outwears helplessness caused disasters [4–7]. However, with the advancement of science and technology, people now know that such a phenomenon results from different hazards that exist in nature [8]. Although we cannot prevent disasters in the case of natural hazards, we can mitigate the impact by considering various aspects of disasters, i.e., risk, hazard, and vulnerabilities [8,9].

With this realization, the domain of disaster management emerged in the nineteenth century [10]. Disasters are being classified by different organizations and institutions [11], depending on the nature of onset [12], characteristics, and cause of initiation [13]. While disasters are often mainly grouped into natural and human-made disasters, a wide range of classifications available, ranging from technological, human-made, economic, and hybrid disasters [11]. Definition, classification/types of disaster, are crucial for researchers and aid organizations/agencies to better understand, manage and record disasters, in the absence of which there will be inaccuracy in the data and recording of disaster events [14].

The classification made by Wassenhove [12] is in the context of Supply Chain Management; and have categorized various event with four main attributes based on the mechanism of onset and causes of initiation, i.e., natural or anthropogenic cause. Currently, the definitions, concepts, and terminologies are evolving as the knowledge of disaster management is expanding and entering into other areas.

Generally, the mortality rate is considered a daily routine, and the term is not valued much [19]. However, in recent years, especially during the Coronavirus pandemic, the term mortality rate seems everyone’s business from public to presidents and prime ministers of the countries [15]. Hurricane Maria and the Coronavirus pandemic highlight the mortality rate’s importance. Every concerned person is assessing the progress and needs for intervention by linking it to the magnitude of the mortality rate. The mortality indicates is critical for many reasons [16–18]. The mortality rate signposts the seriousness/magnitude of the issues. It is an infection like Corona, a global pandemic, or disasters like Hurricane Maria, which swept through Puerto Rico in August 2017. Besides, the high mortality rate may ground public outrage and point to government officials’ inabilities to handle the matter appropriately aggressive preventive and management interventions [15]. Furthermore, mortality rates can be used as a benchmark to monitor and evaluate the progress on objectives set by institutions, organizations, countries, regions or even the world [19]. For example, several indicators in the Sustainable Development Goals are linked to the mortality rates [20], which are as follow:

- By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to the global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations;
- By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births;
- By 2030, reduce by one-third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being;
- By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, soil pollution, and contamination.

The number of disasters worldwide has increased roughly four-fold in the past couple of decades, while the number of persons affected by disasters has increased approximately three-fold over the same period [21,22]. Though several public health and disaster-related studies have been published in recent years, until today, a systematic analysis of disaster-induced mortality is missing. There are multiple factors as a result of which global disaster-induced mortality estimates are missing [22], one of which centres on the lack of a benchmark for assessing disaster-induced mortality, which could make it difficult for scholars to systematically compare and contrast studies (e.g., via systematic review studies). In this regard, this study attempts to create a benchmark by estimating disaster-induced global mortality rates for two hundred and ten countries across the globe.

2. Methodology

The estimations of mortality rates resulting from natural hazards are not well studied and understood. Reliable data in the context of disaster-induced mortality rarely existed [22,23]; therefore, disaster-induced mortality rates estimation is difficult to accomplish. Unlike in developing countries, the population census data are often available, accessible, and well-maintained in developed countries. However, disaster-induced deaths records are rarely available even in developed countries. In this regard, establishing a benchmark for disaster-induced mortality and initiating a debate amongst policymakers and global health practitioners is essential. Overall, this estimate the disaster-induced mortality rates at the global level for the two hundred and ten countries across the world. In this regard, a retrospective study was undertaken with the following study protocols:

i. Defining Disaster-Induced Death

To calculate the disaster-induced mortality rate, the first thing that needs to be determined is the definition of disaster-induced deaths. Till today, there is no universally agreed definition of disaster-induced death as there are many medico-legal aspects that vary from country to country, and even within the same country from organization to organization, it difficult to set a commonly accepted definition. This is a global study aiming to estimate disaster-induced mortality for all countries worldwide. Furthermore, this study is not based on individual countries’ databases but rather on the datasets compiled and maintained by the EM-DAT. So, the definition set to conduct this study is the same as defined by the EM-DAT, i.e., “Number of people who lost their lives because the event happened” [21]. EM-DAT defines the event of a disaster if it fulfils the following criteria:
For a disaster to be entered into the EM-DAT database, at least one of the following criteria must be fulfilled [21]:

- Ten (10) or more people reported killed
- Hundred (100) or more people reported affected
- Declaration of a state of emergency
- Call for international assistance

ii. Study design

This study adopts a retrospective study design.

iii. Datasets used

- For disaster-induced mortality, the EM-DAT database is used [24].
- For population estimates, the UNFPA database is used [25].

iv. Study area

The objective of this study is to estimate the disaster-induced mortality rates for all the countries in the world. However, the final analysis includes two hundred and ten countries. To calculate the mortality rate, we need to know two variables: the number of deaths and the population.

v. Study scope

This study focused on disasters that occurred in the fifteen years between January 2001 and December 2015.

2.1. Data collection & data analysis timeline

Data analyses were carried out from October 17, 2019, to November 30, 2019. The cut-off time for the data download was midnight Central European Time, October 17, 2019. This time was purposely chosen to complete the downloading of data by assuming that both databases are maintained in Europe, so at this specific time, no more data updating will be in progress.

vi. Case-Scenario for the analysis

The study adopted a five-year time frame scenario. The scenario includes data compilation for time-interval of first from 2001 to 2005, second from 2006 to 2010, and third from 2011–2015.

vii. Process undertaken

a) In the first step, the population data were yearly compiled from 2001 to 2015 using the UNFPA database.

b) In the second step, we categorized the yearly data into three groups of five years each, i.e., 2001–2005, 2006–2010, and 2011–2015. The exact process was applied to the dataset on disaster-induced deaths; the only difference is that the data was extracted from EM-DAT.

c) The third step calculated the mortality rate using the following formula.

\[
\frac{dy}{dx} = \frac{TND}{TNP} \times 1,000,000
\]

whereas

- \( DIM \) = Disaster-Induced Mortality
- \( TND \) = Total number of deaths of five years
- \( TNP \) = Cumulative total mid-year population of five years

d) After calculating the disaster-induced mortality rate for each country per five-year compilation, data visualization of the findings at a global level was carried out.

Ethical approval

The study was approved by the IRB Office of the Asian Institute of Technology, Thailand (Ref# 02/2017).

3. Results and discussion

The findings of this study show that from 2001 to 2015, a total of 1,356,831 (1.35 million) people died due to disasters. The number of deaths varies from country to country and continent to continent. The number of fatalities is limited to the absolute number, but the same variation exists if the mortality rate is normalized to per million population. The study results revealed interesting findings, which are discussed systematically in the following sections.
3.1. No country is immune to disaster risk

This study created four scenarios to capture an accurate picture of disaster-induced mortality. First, an annual mortality rate was calculated for each country for a time window of fifteen years (2001–2015). However, it is a well-established fact that the nature of the onset of different types of disasters varies; like some disasters are low probability events but high consequences in terms of injuries and deaths such as earthquakes, while others are high probability events but profound consequences in terms of injuries and deaths such as floods [26,27]. So it is evident that low-probability and high consequences events that happen once may not happen in the next couple of years. Stakeholders, especially policymakers, may assume that the earthquake is not a problem. It does not contribute to mortality by justifying that the region did not have any earthquake-induced deaths in the last nine years. To explain and make the stakeholders realize the existence and magnitude of the problem, this study proposes a step ahead and calculated mortality rates for five-year window time as 2001–2005, 2006–2010, and 2011–2015. The time-window-based analysis in this study concluded exciting findings, visualized in Fig. 1, Fig. 2, and Fig. 3. It is pertinent to mention that almost every country globally has its share of disaster-induced mortality, whether developed or developing (see Fig. 4).

3.2. The high disaster-induced mortality rate is not confined to a specific geography

The figures for disaster-induced mortality rates are not the same for all the countries. This study finds out that during 2001–2005 the highest mortality rates were recorded in Sri Lanka, 371.9 per million, Indonesia 153.5 per million, Haiti 127.9 per million, Niue 113.7 per million, and Pakistan 101.9 per million respectively. While during the next five years, 2006–2010, Haiti’s highest mortality rates recorded 4749.10 per million, Myanmar 560.1 per million, Samoa 155.8 per million, American Samoa 119.1 per million, and Russia 78.2 millions respectively. Similarly, during 2011–2015, the top five countries with higher mortality are Liberia 224.5 per million, Sierra Leone 123.8 per million, Dominica 82.8 per million, Nepal 72.3 per million, and Guinea 40.3 per million, respectively. The top five countries with the highest mortality rates in all three-time windows shows that only one country, Haiti, appears twice. In contrast, a different set of countries suffered the highest mortality rate every other time. The details can be seen in Table 1.

The analysis of this study normalizes the mortality rate per million of the country’s population. However, the difference is still very high. When viewed through absolute numbers, the situation is bleak and worrisome. When a disaster hits an area, the existing infrastructure in that area can be a deciding factor in whether or not the situation will lead to mass casualties or not. Roads, for example, can provide access to quickly supply relief aid such as medicine and/or medical human resources to the affected communities; but if roads are destroyed, entire regions can be cut off not only from the support of relief but also evacuation of injured and vulnerable population such as pregnant women, newborn and elderly people. The findings of this study confirm this assumption. In all three time periods, the top-five highest mortality rates included only the developing countries. However, if the list of countries with the highest disaster-induced mortality rate extended to the top 20, some developed countries like Spain, Japan, and Luxembourg would be...
included. Besides developed and developing country factors, the disaster-induced mortality is determined by many other factors, such as population density of the affected country, existing capacity to respond immediately to disasters, underlying vulnerabilities such as poverty, and people living in vulnerable areas, etc.

3.3. The trend of mortality is not linear in space and time

The finding of this study reveals that in the fifteen years (2001–2015), a total of 1,356,831 (1.35 million) people died due to natural disasters. The number of deaths variestemporally and spatially. From 2001 to 2005, the disaster-induced mortality rate for the world was 16.02 per million, which increased to 43.20 per million between 2006 and 2010, and 6.58 per million during 2011–2015. It is worth mentioning that aftermath of the Indian-Ocean Tsunami in 2004, globally almost every country and related international bodies initiated disaster risk reduction strategies such as the United Nations International Strategies for Disaster Risk (UNISDR) Hyogo Framework of Actions and Sendai Framework for Disaster Risk Reduction, with the objectives to reduced disaster-induced mortality and economic losses.

In January 2005, one hundred sixty-eight countries’ governments adopted a 10-year plan to make the world safer from natural hazards at the World Conference on Disaster Reduction, held in Kobe, Hyogo, and Japan. The Hyogo Framework for Action (HFA) was the global blueprint for disaster risk reduction efforts between 2005 and 2015. Its goal was to reduce disaster losses by 2015 substantially - in lives and the social, economic, and environmental assets of communities and countries. However, soon after HFA came into action, the world was struck by major disasters such as China’s Sichuan Earthquake of 2008, Pakistan’s Earthquake of 2008 (85,000 deaths), The 2010 Haiti Earthquake (250,000 deaths), Cyclone Nargis Myanmar (138,371 deaths), and Cyclone Sidr Bangladesh and India (15,000 deaths), etc. This disaster revealed to the world that instead of reducing the disaster-induced losses under various frameworks, the mortality increased by almost 250%, from 16.02 death per million people to 43.20 deaths per million people. The same findings concluded with time-series analysis based on the annual mortality rate. More extreme events of this increased number of deaths can be attributed to more climate-induced events, expected to rise if carbon emissions are not controlled.

The trend in mortality rate over the past 15 years is not linear, but there are huge variations across the years and the countries. The disaster-induced mortality can be best estimated if observed in five or ten-year scenarios instead of the annual mortality rate. Most disasters, epidemics, and pandemics are low-probability and high magnitude events. This means that even if the policymakers are presented with the annual disaster-induced mortality rates, they might not be convinced to allocate the required budget for disaster risk reduction. This study proposes that the five-year cumulative disaster-induced mortality rate be used instead of annual mortality rates. This may help policymakers, decision-makers, politicians, and related stakeholders realize the magnitude of the disaster impact in an absolute sense.
4. Conclusion

This study presented the disaster-induced mortality rates for two hundred and ten countries across the globe with the best possible data that exist at the moment. The study concluded that almost every country globally has its fair share disaster-induced mortality, though the magnitude varies from country to country. However, the existing data sets have several limitations, such as a lack of standardization in collecting the data, missing data, and inconsistent reporting and compilation. Disaster-induced mortality needs a more holistic understanding. To calculate precisely, accurate disaster-induced mortality rates and population data is needed with maximum disaggregated data such as gender, age, and disaster cause-specific like floods, heatwaves, earthquakes, epidemics, etc. All such data should be reported on a universally agreed reporting system and collected and officially endorsed by the respective country governments.

Ethics approval and consent to participate

The study is based on secondary data and was exempted from ethical approval by IRB.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analyzed during this study are included in this manuscript and its supplementary information files.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.
Fig. 4. Heatmap visualizing annual mortality rates globally for each country (2001–2015) (The lighter the colour, the lower the mortality rate; the darker the colour, the higher the mortality). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Source: Author own work (High-quality image can be seen via https://bit.ly/2WBWxMA)
| Country              | Population  | Deaths  | Mortality rate per 1,000,000 |
|----------------------|-------------|---------|-----------------------------|
|                      | 2001–2005   | 2006–2010 | 2011–2015 | 2001–2005 | 2006–2010 | 2011–2015 |
| Afghanistan          | 115,201,014 | 136,611,771 | 158,631,759 | 5305 | 2463 | 1637 |
| Albania              | 15,529,368  | 14,973,049  | 14,609,803  | 15 | 0 | 6 |
| Algeria              | 162,110,246 | 174,522,103 | 191,708,808 | 3394 | 238 | 97 |
| American Samoa       | 294,405     | 285,447    | 276,831     | 6 | 34 | 0 |
| Angola               | 91,177,542  | 108,938,184 | 130,092,826 | 534 | 3615 | 598 |
| Anguilla             | 60,062      | 66,747     | 71,449      | 0 | 0 | 0 |
| Antigua and Barbuda  | 436,126     | 462,402    | 489,118     | 0 | 0 | 0 |
| Argentina            | 191,544,442 | 201,934,799 | 212,692,823 | 106 | 90 | 127 |
| Armenia              | 15,084,229  | 14,565,671 | 14,474,182  | 1 | 0 | 0 |
| Australia            | 98,628,028  | 106,721,867 | 115,726,601 | 40 | 594 | 163 |
| Austria              | 40,878,467  | 41,714,958 | 46,917,844  | 0 | 3 | 5 |
| Azerbaijan           | 41,823,141  | 44,133,271 | 46,917,844  | 13 | 1 | 34 |
| Bahamas              | 1,579,813   | 1,742,522  | 1,884,854   | 0 | 0 | 0 |
| Bahrain              | 1,345,686   | 1,530,856  | 1,721,056   | 33 | 8 | 1 |
| Bangladesh           | 678,166     | 743,916,819 | 787,816,426 | 3076 | 6398 | 734 |
| Barbados             | 1,361,521   | 1,386,547  | 1,412,297   | 1 | 0 | 0 |
| Belarus              | 48,718,592  | 47,578,548 | 47,389,755  | 42 | 5 | 6 |
| Belgium              | 52,129,939  | 53,895,604 | 55,755,246  | 1184 | 947 | 418 |
| Belize               | 1,345,686   | 1,530,856  | 1,721,056   | 33 | 8 | 1 |
| Benin                | 37,524,111  | 43,512,568 | 50,057,077  | 435 | 139 | 11 |
| Bermuda              | 321,998     | 322,839    | 313,916     | 4 | 0 | 0 |
| Bhutan               | 3,116,354   | 3,502,235  | 3,822,272   | 23 | 1 | 1 |
| Bolivia              | 44,053,290  | 48,001,623 | 52,004,475  | 289 | 227 | 338 |
| Bosnia-Herzegovina   | 18,889,155  | 18,785,712 | 18,044,027  | 4 | 6 | 30 |
| Botswana             | 9,024,409   | 9,739,751  | 10,646,931  | 0 | 0 | 12 |
| Brazil               | 912,039,659 | 964,710,343 | 1,011,831,544 | 602 | 1014 | 1168 |
| Virgin Island (UK)   | 110,322     | 127,911    | 145,167     | 0 | 0 | 0 |
| Brunei Darussalam    | 1,765,054   | 1,896,800  | 2,028,723   | 0 | 0 | 0 |
| Bulgaria             | 39,027,540  | 37,562,859 | 36,332,278  | 42 | 48 | 64 |
| Burkina Faso         | 63,344,807  | 73,517,240 | 85,422,444  | 4572 | 4137 | 28 |
| Burundi              | 34,855,251  | 41,083,136 | 48,054,464  | 216 | 45 | 204 |
| Cape Verde Island    | 2,298,200   | 2,458,303  | 2,601,502   | 0 | 9 | 0 |
| Cambodia             | 64,223,904  | 69,430,639 | 75,125,869  | 108 | 216 | 623 |
| Cameroon             | 82,650,511  | 94,604,965 | 108,332,971 | 171 | 662 | 779 |
| Canada               | 158,210,824 | 167,028,462 | 176,249,259 | 68 | 9 | 22 |
| Netherlands Antilles | 81,053,818  | 82,911,590 | 84,310,636  | 969 | 1007 | 3 |
| Cayman Islands       | 230,003     | 264,226    | 291,608     | 2 | 0 | 0 |
| Central African Rep  | 19,904,426  | 21,675,699 | 22,527,714  | 380 | 8 | 18 |
| Chad                 | 46,794,954  | 55,721,154 | 65,706,226  | 483 | 494 | 665 |
| Chile                | 78,988,988  | 83,286,217 | 87,305,564  | 89 | 607 | 231 |
| China P Rep          | 6,643,059,322 | 6,836,854,498 | 7,029,299,208 | 6049 | 100,225 | 5057 |
| Hong Kong (China)    | 33,894,726  | 34,707,589 | 35,761,049  | 303 | 3 | 0 |
| Macau                | 2,301,136   | 2,573,773  | 2,877,534   | 0 | 0 | 0 |
| Taiwan (China)       | 6,643,059,322 | 6,836,854,498 | 7,029,299,208 | 6049 | 100,225 | 5057 |
| Colombia             | 210,723,348 | 246,446,116 | 236,651,710 | 621 | 1169 | 677 |
| Comoros              | 2,917,433   | 3,288,218  | 3,708,746   | 1 | 31 | 4 |
| Congo                | 17,549,187  | 20,574,451 | 23,764,235  | 193 | 301 | 374 |

(continued on next page)
| Country            | Population 2001–2005 | Deaths 2001–2005 | Mortality rate per 1,000,000 |
|--------------------|-----------------------|------------------|-----------------------------|
| **Cook Island**    | 95,404                | 0                | 0                           |
| **Costa Rica**     | 20,620,852            | 29               | 1.4                         |
| **Cote D’Ivoire**  | 88,420,065            | 313              | 3.5                         |
| **Croatia**        | 21,954,822            | 795              | 36.2                        |
| **Cuba**           | 56,200,619            | 32               | 0.6                         |
| **Cyprus**         | 4,968,879             | 6                | 0.6                         |
| **Korea Dem P Rep**| 358,829,876           | 833              | 2.3                         |
| **Denmark**        | 26,942,294            | 5                | 0.5                         |
| **Djibouti**       | 3,791,553             | 3                | 0.3                         |
| **Cote D’Ivoire**  | 31,991,553            | 51               | 13.5                        |
| **Croatia**        | 29,964,822            | 3                | 1                           |
| **Cuba**           | 18,677,685            | 0                | 0                           |
| **Cyprus**         | 6,866,583             | 0                | 0                           |
| **Korea Dem P Rep**| 362,886,081           | 872              | 2.4                         |
| **Denmark**        | 4,068,708             | 34               | 8.3                         |
| **Djibouti**       | 937,024               | 0                | 0                           |
| **Cote D’Ivoire**  | 1,241,439             | 13               | 64.7                        |
| **Croatia**        | 6,652,145             | 1                | 7.7                         |
| **Cuba**           | 43,655,017            | 10               | 9.0                         |
| **Cyprus**         | 52,801,726            | 645              | 12.1                        |
| **Korea Dem P Rep**| 46,871,354            | 943              | 23.1                        |
| **Denmark**        | 302,806,932           | 19,581           | 10.7                        |
| **Cote D’Ivoire**  | 593,528,924           | 574              | 1.6                         |
| **Korea Dem P Rep**| 35,099,048            | 34               | 0.9                         |
| **Denmark**        | 1,214,939             | 0                | 0                           |
| **Cote D’Ivoire**  | 6,252,225             | 7                | 0.8                         |
| **Cote D’Ivoire**  | 511,929               | 40               | 78.1                        |
| **Cote D’Ivoire**  | 2,170,207             | 1                | 0.5                         |
| **Cote D’Ivoire**  | 787,791               | 2                | 2.5                         |
| **Cote D’Ivoire**  | 62,527,225            | 1731             | 27.7                        |
| **Cote D’Ivoire**  | 53,201,726            | 645              | 12.1                        |
| **Cote D’Ivoire**  | 37,580,602            | 34               | 9                           |
| **Cote D’Ivoire**  | 44,886,434            | 5699             | 127                         |
| **Cote D’Ivoire**  | 35,167,622            | 111              | 3.2                         |
| **Cote D’Ivoire**  | 50,705,379            | 140              | 2.8                         |
| **Cote D’Ivoire**  | 1,442,271             | 0                | 0.2                         |
| **Cote D’Ivoire**  | 5,239,567,266         | 1,180,851,220    | 1.5                         |
| **Cote D’Ivoire**  | 1,102,887,154         | 1,180,851,220    | 1.5                         |
| **Cote D’Ivoire**  | 53,201,726            | 49,021           | 8.8                         |
| **Cote D’Ivoire**  | 343,931,368           | 28,393           | 82.6                        |
| **Cote D’Ivoire**  | 128,143,609           | 140              | 2.8                         |
| **Cote D’Ivoire**  | 20,276,854            | 0                | 0                           |
| **Cote D’Ivoire**  | 31,790,131            | 0                | 0                           |
| **Cote D’Ivoire**  | 13,588,418            | 36               | 2.7                         |

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| Country                  | Population| Deaths |
|-------------------------|-----------|--------|
| Japan                   | 640,243,323 | 573 |
| Jordan                  | 27,127,450  | 5  |
| Kazakhstan              | 76,305,314  | 54  |
| Kenya                   | 170,789,562 | 434 |
| Kiribati                | 444,963    | 0   |
| Kuwait                  | 10,906,868 | 0   |
| Kyrgyzstan              | 25,078,655 | 90  |
| Lao P Dem Rep          | 27,910,128 | 2   |
| Latvia                  | 11,572,782 | 36  |
| Lebanon                 | 18,434,279 | 0   |
| Lesotho                 | 9,589,635  | 1   |
| Libya                   | 15,607,872 | 29  |
| Libyan Arab Jamah       | 28,081,480 | 0   |
| Lithuania               | 17,058,093 | 20  |
| Luxembourg              | 2,240,907  | 170 |
| Madagascar              | 86,444,911 | 1301|
| Malawi                  | 61,762,010 | 1939|
| Malaysia                | 123,419,923| 143 |
| Maldives                | 1,512,836  | 102 |
| Mali                    | 60,127,984 | 186 |
| Marshall is             | 260,586    | 0   |
| Martinique              | 1,970,037  | 0   |
| Mauritania              | 14,794,617 | 89  |
| Mauritius               | 6,042,403  | 3   |
| Mexico                  | 528,530,940| 359 |
| Micronesia Fed States   | 533,737    | 48  |
| Mongolia                | 12,355,999 | 34  |
| Montenegro              | 3,072,187  | 0   |
| Montserrat              | 22,774     | 0   |
| Morocco                 | 149,238,492| 759 |
| Mozambique              | 98,680,789 | 348 |
| Myanmar                 | 237,949,429| 396 |
| Namibia                 | 9,923,702  | 136 |
| Nepal                   | 124,628,478| 1257|
| Netherlands             | 81,053,818 | 969 |
| New Caledonia           | 1,124,723  | 2   |
| New Zealand             | 20,109,001 | 6   |
| Nicaragua               | 26,202,394 | 54  |
| Niger                   | 63,380,309 | 2120|
| Nigeria                 | 860,435,771| 2120|
| Niue                    | 8796       | 1   |
| Northern Mariana is     | 334,980    | 3   |
| Norway                  | 22,869,848 | 23  |
| Oman                    | 11,970,347 | 37  |
| Pakistan                | 738,648,948| 75,234|
| Palau                   | 98,388     | 0   |
| Panama                  | 16,048,129 | 26  |
| Papua New Guinea        | 30,065,418 | 198 |

Table 1 (continued)

| Country                  | Deaths |
|-------------------------|--------|
| Japan                   | 642,607,285 | 419 |
| Jordan                  | 32,620,751  | 0   |
| Kazakhstan              | 80,116,531  | 45  |
| Kenya                   | 195,873,731 | 224 |
| Kiribati                | 492,231    | 0   |
| Kuwait                  | 13,350,030  | 0   |
| Kyrgyzstan              | 26,341,862  | 90  |
| Lao P Dem Rep          | 30,249,643  | 2   |
| Latvia                  | 10,859,779  | 36  |
| Lebanon                 | 20,775,160  | 0   |
| Lesotho                 | 10,007,639  | 1   |
| Libya                   | 18,311,416  | 29  |
| Libyan Arab Jamah       | 30,195,068  | 0   |
| Lithuania               | 16,070,964  | 20  |
| Luxembourg              | 2,429,549   | 170 |
| Madagascar              | 100,031,021 | 29  |
| Malawi                  | 71,423,162  | 24  |
| Malaysia                | 135,898,152 | 143 |
| Maldives                | 1,727,507   | 102 |
| Mali                    | 70,722,568  | 186 |
| Marshall is             | 261,179     | 0   |
| Martinique              | 1,983,363   | 0   |
| Mauritania              | 17,056,690  | 89  |
| Mauritius               | 6,193,281   | 3   |
| Mexico                  | 568,414,702 | 359 |
| Micronesia Fed States   | 522,816    | 48  |
| Mongolia                | 13,158,752  | 34  |
| Montenegro              | 3,105,658   | 0   |
| Montserrat              | 24,510      | 0   |
| Morocco                 | 158,091,618 | 759 |
| Mozambique              | 114,328,076 | 348 |
| Myanmar                 | 247,454,398 | 396 |
| Namibia                 | 10,552,234  | 136 |
| Nepal                   | 132,395,564 | 1257|
| Netherlands             | 82,916,580  | 969 |
| New Caledonia           | 1,218,800   | 2   |
| New Zealand             | 21,391,907  | 6   |
| Nicaragua               | 27,971,127  | 54  |
| Niger                   | 76,268,418  | 54  |
| Nigeria                 | 752,358,950 | 2120|
| Niue                    | 8218        | 1   |
| Northern Mariana is     | 288,730     | 3   |
| Norway                  | 23,877,185  | 37  |
| Oman                    | 13,929,169  | 37  |
| Pakistan                | 818,681,332 | 37  |
| Palau                   | 101,168     | 0   |
| Panama                  | 17,584,587  | 26  |
| Papua New Guinea        | 33,941,067  | 56  |

(continued on next page)
| Country            | Population          | Deaths                          | Mortality rate per 1,000,000 |
|--------------------|---------------------|---------------------------------|------------------------------|
|                    | 2001-2005 | 2006-2010 | 2011-2015 | 2001-2005 | 2006-2010 | 2011-2015 | 2001-2005 | 2006-2010 | 2011-2015 |
| Paraguay           | 28,022,419 | 30,233,786 | 32,330,445 | 0          | 57        | 63       | 0          | 1.9       | 1.9       |
| Peru               | 134,684,172 | 143,259,801 | 152,834,696 | 735        | 1804      | 1061     | 5.5        | 12.6      | 6.9       |
| Philippines        | 415,002,059 | 453,802,276 | 492,444,222 | 3291       | 6492      | 13,318   | 7.9        | 14.3      | 27        |
| Poland             | 192,206,035 | 191,644,582 | 191,506,088 | 682        | 629       | 409      | 3.5        | 3.3       | 2.1       |
| Portugal           | 52,424,084 | 53,195,107 | 52,624,466 | 2734       | 89        | 12       | 52.2       | 1.7       | 0.2       |
| Puerto Rico        | 18,924,961 | 18,679,183 | 18,447,726 | 6          | 1         | 2        | 0.3        | 0.1       | 0.1       |
| Korea rep          | 358,829,876 | 367,763,474 | 375,767,955 | 833        | 1003      | 525      | 2.3        | 2.7       | 1.4       |
| Moldova rep        | 20,857,803 | 20,565,340 | 20,358,954 | 1          | 17        | 10       | 0          | 0.8       | 0.5       |
| Reunion             | 3,853,762 | 4,079,669 | 4,251,841 | 0          | 2         | 1        | 0          | 0.5       | 0.2       |
| Slovenia           | 2,417,540 | 2,575,882 | 2,712,342 | 0          | 5         | 0        | 1.9        | 0         | 0         |
| Somalia            | 688,520     | 917,937    | 953,665    | 10         | 143       | 12       | 11.3       | 155.8     | 12.6      |
| Saudi Arabia       | 723,257,233 | 715,802,896 | 717,931,197 | 1499       | 55,975    | 457      | 2.1        | 78.2      | 0.6       |
| Senegal            | 43,356,130 | 48,586,439 | 55,344,884 | 213        | 146       | 21       | 4.9        | 3         | 0.4       |
| Serbia             | 20,857,803 | 20,565,340 | 20,358,954 | 1          | 17        | 10       | 0          | 0.8       | 0.5       |
| Seychelles         | 428,908     | 453,065    | 463,880    | 3          | 0         | 0        | 7          | 0         | 0         |
| Sierra Leone       | 25,993,986 | 30,798,461 | 34,616,061 | 108        | 289       | 4287     | 4.2        | 0         | 0         |
| Singapore          | 21,260,364 | 24,235,308 | 26,791,416 | 134        | 185       | 92       | 1.2        | 1.4       | 0.6       |
| Slovakia           | 26,998,428 | 27,000,736 | 27,124,206 | 5          | 128       | 6        | 0.2        | 4.7       | 0.2       |
| Slovenia           | 9,593,289 | 10,122,460 | 10,325,578 | 290        | 6         | 4        | 29.1       | 0.6       | 0.4       |
| Solomon Island     | 2,234,093 | 2,522,708 | 2,817,644 | 0          | 75        | 69       | 0          | 29.7      | 24.5      |
| South Africa       | 238,127,887 | 252,219,373 | 268,859,921 | 185       | 248       | 95       | 0.8        | 1         | 0.4       |
| South Sudan        | 37,609,892 | 46,325,947 | 55,857,712 | 0          | 0         | 342      | 0          | 0         | 6.1       |
| Spain              | 213,425,329 | 229,381,898 | 233,833,586 | 15,162     | 56        | 36       | 71         | 0.2       | 0.2       |
| Sri Lanka          | 96,084,757 | 99,700,211 | 102,640,409 | 35,736     | 499       | 770      | 371.9      | 5         | 7.5       |
| Tunisia            | 213,684,172 | 214,359,801 | 217,834,696 | 2735       | 1804      | 1061     | 5.5        | 12.6      | 6.9       |
| Uzbekistan         | 9,642,321 | 10,057,562 | 10,472,882 | 0          | 5         | 0        | 1.9        | 0         | 0         |
| Zambia             | 8,000,000 | 8,000,000 | 8,000,000 | 0          | 0         | 0        | 0          | 0         | 0         |
| Zimbabwe           | 2,541,780 | 2,541,780 | 2,541,780 | 0          | 0         | 0        | 0          | 0         | 0         |
| (continued on next page) |          |            |            |            |            |          |            |            |            |
| Country                          | Population | Deaths | Mortality rate per 1,000,000 |
|---------------------------------|------------|--------|-------------------------------|
|                                 | 2001-2005 | 2006-2010 | 2011-2015 | 2001-2005 | 2006-2010 | 2011-2015 |
| Turkey                          | 330,331,592 | 352,466,817 | 379,068,755 | 452 | 230 | 692 | 1.4 | 0.7 | 1.8 |
| Turkmenistan                    | 23,287,862 | 24,711,164 | 26,839,702 | 0 | 0 | 0 | 0 | 0 | 0 |
| Turks and Caicos Island         | 116,813 | 147,002 | 165,348 | 0 | 4 | 0 | 0 | 27.2 | 0 |
| Tuvalu                          | 48,835 | 51,692 | 54,081 | 0 | 0 | 0 | 0 | 0 | 0 |
| Uganda                          | 133,310,136 | 158,492,073 | 187,932,378 | 206 | 901 | 265 | 1.5 | 5.7 | 1.4 |
| Ukraine                         | 238,071,165 | 230,975,699 | 225,582,555 | 9 | 879 | 197 | 0 | 3.8 | 0.9 |
| United Kingdom                  | 298,249,400 | 310,323,132 | 323,116,088 | 338 | 43 | 788 | 1.1 | 0.1 | 2.4 |
| Tanzania Uni Rep                | 186,032,428 | 216,591,629 | 253,405,320 | 82 | 312 | 719 | 0.4 | 1.4 | 2.8 |
| United States                   | 1,450,055,687 | 1,516,514,351 | 1,577,571,413 | 2998 | 1245 | 1863 | 2.1 | 0.8 | 1.2 |
| Virgin Islands (US)             | 541,478 | 534,029 | 526,798 | 0 | 0 | 0 | 0 | 0 | 0 |
| Uruguay                         | 16,630,221 | 16,758,778 | 17,041,504 | 9 | 18 | 0 | 0.5 | 1.1 | 0 |
| Uzbekistan                      | 129,203,572 | 138,660,063 | 150,104,416 | 0 | 0 | 13 | 0 | 0 | 0.1 |
| Vanuatu                         | 995,723 | 1,127,007 | 1,265,951 | 4 | 0 | 23 | 4 | 0 | 18.2 |
| Venezuela                       | 120,337,085 | 140,688,190 | 151,567,731 | 142 | 57 | 17 | 1.1 | 0.4 | 0.1 |
| Vietnam                         | 413,680,598 | 433,729,927 | 457,502,732 | 1242 | 1920 | 500 | 3 | 4.4 | 1.1 |
| Wallis and Futuna               | 73,047 | 69,781 | 62,867 | 0 | 0 | 0 | 0 | 0 | 0 |
| Yemen                           | 97,371,395 | 111,850,238 | 127,901,031 | 218 | 252 | 69 | 2.2 | 2.3 | 0.5 |
| Zambia                          | 57,150,420 | 65,498,387 | 75,839,464 | 222 | 328 | 2 | 3.9 | 5 | 0 |
| Zimbabwe                        | 63,218,130 | 67,909,561 | 75,341,107 | 154 | 4433 | 194 | 2.4 | 65.3 | 2.6 |

Source: Authors own work with the data extracted from UNFPA [24], an EM-DAT [25] on October 17, 2019
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Not applicable

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijdrr.2022.103001.

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