The Crespo scale: categorising 'dangerous' animal species with two quantifiable factors

Abstract:

Throughout our history, humanity and the kingdom *Animalia* have been inconflicts with both sides sharing countless casualties as the outcome. Among animals, adult female mosquitoes of the *Anopheles* genus are infamously labelled the deadliest to humans in terms of the number of deaths they cause each year. In this scientific paper, an analysis is given over what other direct and indirect factors can be considered when classifying a species of animal as 'dangerous'. It discusses and concludes exactly why they make it more of a danger to human health and safety than others. This is done utilising a brand-new, categoric scale —which has been colloquially referred as the "Crespo scale" — created and designed to categorise all animal species from categories 1–5. One posing the least danger and five the most. The categorisation is performed by examining factors relevant to the animals themselves, which include the estimated Population Size (PS) and Mortality Rate (MR). I hypothesise that species possessing a larger PS and a higher MR will be placed further up on the scale and thus are more likely to be a threat. Ultimately, both PS and MR are quantifiable factors that can be used to measure and categorise a species' threat level in a less biased and more accurate, consistent way. However, the factor of MR can often be indirectly influenced by human-related factors that apply to the human development of a country and its general populace.

Keywords: Dangerous, Fatalities, Mortality Rate, Population Size, Probability, Threat

Introduction

As the human population continues to grow and be an ever-present strain on the remaining stretches of wilderness, encounters with wild animals continue to increase. This in turn is causing human-wildlife conflicts (e.g. animal attacks, damage to crops, and disease outbreaks) to be critical problems around the globe. The Crespo scale is a scale that ranks the 'danger' of an animal species based on how much of a threat it poses towards a random individual within a given country. It does so by determining the probability of said random individual becoming a fatality due to a fatal encounter (e.g. mauling, envenomation, or contraction of disease). It was created and designed to act as a reliable scientific method to categorise various species and the threat level they present. Even though it's not the first attempt to rank this, it is one of the few available online to do so using solely numerical and therefore universal measurements; not measured based on personal biased beliefs and opinions.It's also somewhat distinct from most other rankings in that it's measured using more than one factor aside from the number of yearly deaths alone. With that said, the main justification for just using two factors is that ~~certain~~ some characteristics associated with 'dangerous' animals such as aggression and/or territoriality currently have no accurate scientific measurement and therefore cannot ranked to any degree of reliability. The intended purpose for the Crespo scale is to be adopted as a future comprehensive guide for recording and categorising a specific species within a specific country. A guide that could help direct experts; this in turn could help them decide which species in which countries should be considered a priority to prevent further conflicts and loss of human life. One example would be mosquitoes from the *Anopheles* genus. In2022, the World Health Organisation (WHO) estimated they caused over 608,000 deaths worldwide *via* the transmission of *Plasmodium*: theprotozoa responsible for malaria in humans.[1].Though, the countries that account for the most fatalities are the following: Nigeria, the Democratic Republic of the Congo, Tanzania, and Niger.[1]. As such, epidemiologists and other public health specialists can then prioritise their efforts to create relevant risk assessments on the inhabitants of those specific countries and take appropriate preventative measures to reduce the annualnumber of fatalities more effectively.

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***Table .1** Definitions of Key Terminology.*

Term:	**Definition:**
Envenomation	The process in which venom is injected into a victim through the bite, spine, or sting of a venomous animal.
Gross National Income (GNI) per capita	The dollar value of a country's final income in one year divided by its total population.
Human Development Index	An index that measures and ranks the development of a country using different indicators which include life expectancy at birth, expected years of school, mean years of schooling, and GNI per capita.
Mortality Rate	The estimated number of deaths (either generally or from a specific reason/s) within a particular population number and per unit of time (e.g. per year).
Population Size	The estimated number of mature individuals in the global population of a species in total, wild or feral.
Territoriality	The extent to which an animal claims and defends an area from members of its own species and those of others. Animals who defend their territory more aggressively are more territorial and thus have higher territoriality.
Transmission	The passing of a pathogen that causes disease from one infected individual/group to another.
Vector	Any living agent that carries an infectious pathogen and can transmit it to another organism.

Material and methods

Scale Categories:

The scale has a categorical structure, ranking in categories 1–5 with category one presenting the lowestlevel of threat and five the highest. Species in category one are considered Low Danger, those in category two Moderate Danger, category three Considerable Danger, category four High Danger and category five Very High Danger. Categories one and two both present the leastdanger, whereas categories three to five present the most. Categories 1–2 are considered to be insignificant threats. On the other hand, categories 3–5 are all deemed significant threats. This is due to the overall likelihood of a random individual out of the global human population becoming a fatality by a species from category one or two. The likelihood of which is much smaller compared to species from the higher categories. It's important to emphasise, however, that just because a species is placed in categories one or two does not necessarily mean it is safe to approach and interact with. Care and caution should still be taken under all circumstances with any wild animal.

Scale Factors:

It has been predicted that with the majority of animal species, the exact extent of danger they pose towards a random human can be judged based on two distinct factors: Population Size (PS) and Mortality Rate (MR). PS accounts for the probability of a random individual encountering a species in a specific country. Meanwhile, MR accounts for the probability of that random individual out of the global human population becoming a fatality from that species. MR is calculated by dividing the approximate current global human population (which has been rounded to the nearest whole billion: eight billion)[2] by the maximum estimated number of fatalities caused by an entire species annually.This excludes captive and domesticated animals. For instance, in some years, up to 300 people can be mortally wounded every year from attacks by Asian elephants (*Elephas maximus*) in India alone[3]. 8 billion/300 = ~26.6 million, which means that about one person out of 26.6 million or 1/26.6 million has a fatal attack by Asian elephants. As of this paper's publication, the MR is calculated using a steady eight billion as the approximate current global human population for now. But because the global human population is in a constant state of growth the MR factor of the Crespo scale would have to be updated daily for future records. The reason/s why the scale is measured with the two factors of MR and PS is first because when a species possesses a larger population, it has a higher probability of encountering people inside or outside of its natural environment. More abundant species often live closer to urban environments (e.g. cities, towns, villages, etc). Brown rats (*Rattus norvegicus*) are one of the most widespread of all terrestrial vertebrates with a global population that numbers in the billions. In just the UK, the minimum pre-breeding population is 6.5 million according to the Mammal Society. That does not include urban settings such as factories, rubbish tips, and sewers[4]. Their abundance is not exclusive to the UK, though, as they have become a common pest in almost every single country in the world. Such an expansive populationallows them and other rodent species to directly and/or indirectly transmit over 30 zoonotic diseasesonto humans[5] such as Hantavirus Pulmonary Syndrome (HPS) and Leptospirosis. It's these zoonotic diseases — coupled with their copious numbers and global range— which make brown rats a far dangerous species than most people expect. Leptospirosis on its own claims roughly 58,900 lives every year[6]. So the scale makes it apparent that the larger the population of a species, the greater the probability of encounters between them and humans. Occasionally, these encounters can result in fatality. Another instance of this is lions (*Panthera leo*) and tigers (*Panthera tigris*). Although both big cat species have a history of attacking, killing, and on rare occasions consuming humans, lions perform these acts at a higher frequency per year than tigers do. One explanation for this is the wild lion population has an estimated 23,000-39,000 mature individuals[7]; the wild tiger population has only 2,600-4,000[8]. Being the more common species of the two, lions are responsible for more fatalities annually than tigers. According to Smithsonian, the government of India reported an average of 34 deaths caused by tigers each year between 2015 and 2018[9]. Meanwhile, in a separate article, Smithsonian states that “it’s not uncommon for them [lions] to kill more than 100 people a year in Tanzania alone”[10]. So besides being potential vectors for zoonotic diseases, an aggressive, predatory and/or territorial nature can be an alternative cause for a species to have a higher MR.

Factor Numbers:

The numbers presenting the two factors are divided or multiplied — depending on if they’re read upwards or downwards — each to equal a maximum number of five ‘points’, known as Degrees of Threat (DoTs). One DoT is Very Unlikely (freak event), two DoTs is Unlikely (highly unusual circumstance), three DoTs is Possible (unusual circumstance), four DoTs is Likely (infrequent occurrence), and five DoTs is Highly Likely (common occurrence). They are then multiplied together to get a total. The maximum number of DoTs is 25. It is the total number of DoTs that will determine which category a specific species is placed in. Both PS and MR are divided/multiplied logarithmically, always increasing or decreasing by 10.

***Table .2** DoTs Point System.*

Population Size (PS):	**X**	**Mortality Rate (MR):**
1,000,000–9,999,999< = 5 DoTs	X	1/99,999–1/10,000> = 5 DoTs
100,000–999,999 = DoTs	X	1/999,999–1/100,000 = 4 DoTs
10,000–99,999 = 3 DoTs	X	1/9,999,999–1/1,000,000 = 3 DoTs
1,000–9,999 = 2 DoTs	X	1/99,999,999–1/10,000,000 = 2 DoTs
0–999 = 1 DoT	X	<1/100,000,000 = 1 DoT

***Table .3** Total DoTs Numbers & Category Types.*

Total Number of DoTs:	**Category:**
21–25 DoTs	Category 5 (**Very High Danger**) - Significant threat
16–20 DoTs	Category 4 (**High Danger**) - Significant threat
11–15 DoTs	Category 3 (**Considerable Danger**) - Significant threat
6–10 DoTs	Category 2 (**Moderate Danger**) - Insignificant threat
0–5 DoTs	Category 1 (**Low Danger**) - Insignificant threat

Results

***Table .4.** The Five Categories (with examples).*

Likelihood (PS): > Likelihood (MR): v	**1 DoT Very Unlikely (freak event)**	**2 DoTs Unlikely (highly unusual circumstance)**	**3 DoTs Possible (unusual circumstance)**	**4 DoTs Likely (infrequent occurrence)**	**5 DoTs Very Likely (common occurrence)**

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1 DoT Very Unlikely (freak event)	**Category 1**	**Category 1** Tiger (in India)[8, 9]	**Category 1** Sloth bear (in India)[11, 12]	**Category 1** American black bear (in Canada)[13, 14]	**Category 1** American alligator(in USA)[15, 16]&Asian giant hornet (in Japan)[17]
2 DoTs Unlikely (highly unusual circumstance)	**Category 1**	**Category 1**	**Category 2** Nile crocodile (Unknown)[18, 19], Asian elephant (in India)[20, 3] & Lion (in Tanzania)[7, 10]	**Category 2**	**Category 2** *Ascaris lumbricoides* (in Philippines)[21],*Chironexfleckeri* (in Philippines)[22]&*Tityusserrulatus* (in Brazil)[23]
3 DoTs Possible (unusual circumstance)	**Category 1**	**Category 2**	**Category 2** Hippopotamus (Unknown) [24, 25]	**Category 3**	**Category 3** *Lutzomyia longipalpis* (in Brazil)[26]&*Triatoma infestans*(in Brazil)[27]
4 DoTs Likely (infrequent occurrence)	**Category 1**	**Category 2**	**Category 3**	**Category 4**	**Category 4** *Russell's viper* (in India)[28], *Schistosoma spp.* (in Nigeria)[29]& *Taenia solium*(Unknown)[30]
5 DoTs Very Likely (common occurrence)	**Category 1**	**Category 2**	**Category 3**	**Category 4**	**Category 5** *Anopheles gambiae* (in Nigeria)[1]

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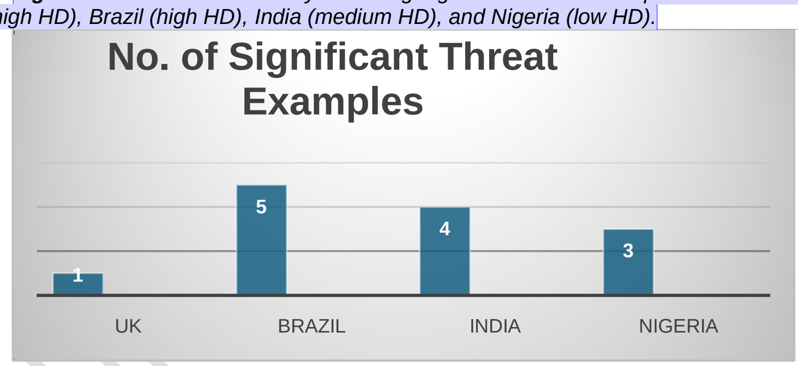
Discussion

It's important to note that Table 4 is not a complete representation of the scale that displays every animal species that can be categorised. Rather, it only displays those which enough relevant and reliable data could be sourced for. Neither is it necessarily a perfect representation. In particular, the taxonomic specificity of the examples displayed is not always consistent. 16 of the 17 examples are specified as species. The one remaining exceptionis classified as a genus: *Schistosoma*. The reason for this is that some zoonotic diseases are caused/transmitted by a single species such as the human roundworm *Ascaris lumbricoides* with ascariasis [20]. Others can be caused/transmitted by a few species but usually by one primary species in a particular region such as thesandfly*Lutzomyia longipalpis*with Leishmaniasis in the Americas [25]. Schistosomiasis, though, is caused by

Schistosoma trematodes(commonly known as blood flukes) and can be caused/transmitted by several species. In Nigeria, schistosomiasis iscaused by two main species: *Schistosomahaematobium*and *Schistosomamansoni*.[31]. It can also be caused by *Schistosoma intercalatum* and *Schistosoma mekongi*, although cases of this arerarer.[32].As such it's difficult to determine which, if any, is the main species responsible for the most annual cases and deaths in Nigeria.

One observed pattern that's worth noting is all the examples for categories 3–5 (i.e. the examples for significant threats) in Table .4 are naturally found in one or several developing countries. The Human Development Index (HDI) is an index that measures and grades the development of a country using different indicators.[33]. These indicators include life expectancy at birth, expected years of school (for children of school entering age), mean years of schooling (for adults above the age of 25), and Gross National Income (GNI) per capita.[33]. The lower these indicators are, the less developed a country is. The HDI scores each country a number of points from 0-1. A value of 0.550 or less is classed as low human development, 0.550-0.699 is medium, 0.700-0.799 is high and 0.800 or greater is very high.[33]. All 10 of the significant threat examples occur in at least one low-ranked country: *Anopheles gambiae*,*Lutzomyia longipalpis,*Russell's viper (*Daboia russelii*),*Schistosoma spp.*, *Taenia solium*, and *Triatoma infestans* [34, 35, 36, 37, 38 &39].

Fig .1 *The number of naturally occurring significant threat examples in the United Kingdom (very high HD), Brazil (high HD), India (medium HD), and Nigeria (low HD).*



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There seems to be a much higher occurrence of species considered significant threats in less developed countries compared to countries that are more developed and therefore score higher on the HDI. All the examples of significant threat in Table 4. have a large PS either due to their widespread global ranges, high reproductive rates, sheer abundance, or a combination of all three. Their MR, however, is the result of other causes. Unlike the insignificant threat examples (i.e. the examples for categories 1–2), most of the significant threat examples are responsible for human fatalities because of either the pathogens they carry or because they themselves are pathogens (e.g. parasites); not necessarily due to aggression or territoriality. The Russell's viper (*Daboia russelii*) being the only exception. Their larger PS, as well as their close association with humans, means they encounter humans much more often. This results in more opportunities for an attack or disease transmission to take place; consequently, more annual fatalities. Particularly in countries less developed, but more populous (e.g. India and Nigeria). One of the crucial dimensions of human development that the HDI considers is education. Expected years of school and mean years of schooling are the indicators used for this dimension [33]. So countries that score lower on the HDI tend to have lower quality of education. Poor education can be an indirect cause for a species to have a higher MR because the public lack adequate knowledge of said species. In such cases, not knowing how a zoonotic disease is transmitted can allow it to spread at more rapid rate; not knowing the symptoms can lead to a person being given a false diagnosis and then improper treatment. The probability of this is greater if the people witnessing the symptoms are not trained medical professionals (e.g. untrained friends and family members). Another dimension that the HDI considers is the standard of living in a country. This dimension uses Gross National Income (GNI) *per capita* as its indicator [33]. As with education, countries that score lower on the HDI tend to have a lower GNI *per capita* even if their annual Gross Domestic Product (GDP) is relatively high. India, for instance, was ranked the fifth wealthiest country in the world with a GDP of around $3.385 trillion U.S. Dollars (USD) in 2022, according to the World Bank [40]. Despite this, India's HDI value in the same year was only 0.644 [33]. The World Bank stated India's GNI *per capita* in 2022 was also quite low at around $2,380 USD *per capita* [41]. Similar to poor education, this poor standard of living can be another indirect cause for a species to have a higher MR. The reason being that when a person is attacked, envenomated or infected, the proper treatment (e.g. surgery, antivenom, antibiotics, etc.) is often inaccessible due to being too costly for most families in less developed countries. The total direct cost of snake antivenom treatment, for example, varies between countries but can get as high as $5,700 USD in India [42]. That equates to ~239.5% of the average citizen's GNI in 2022 and so is simply unaffordable for the majority of the population. Likewise, distance can make treatment more challenging to access due to less developed infrastructure (e.g. public transport routes) and a larger portion of the citizens living in rural areas. This can make travelling to and from a hospital a more time-consuming endeavour. Precious time that can be the difference between life and death for a victim. The result is far more fatalities each year in comparison to countries where the GNI *per capita*, and thus purchasing power, is greater and where infrastructure is more developed as well. According to the Arizona Pest Management Centre at the University of Arizona, there are around 1,000 fatalities from scorpion stings in Mexico each year; the United States has only experienced four fatalities in the last 11 years [43]. The HDI value in 2022 for Mexico was 0.781; the United States scored a value of 0.927 [33]. The GNI *per capita* in 2022 for Mexico was $10,820 USD, while that of the United States was $76,770 USD [41].

***Fig. 2** Human Development Index (HDI) values in 2022 for Mexico and the United States.*

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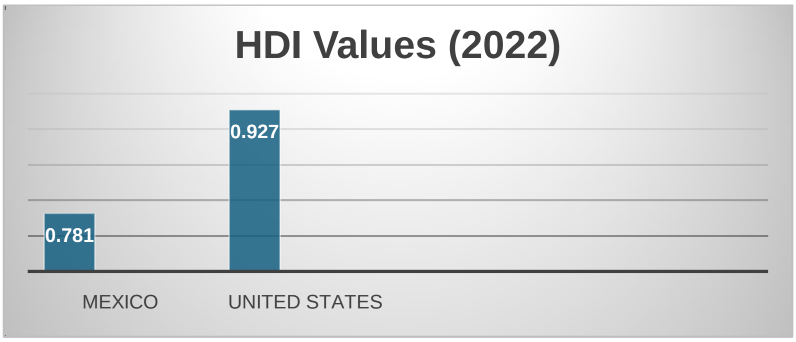

Fig. 3 Gross National Income (GNI) per capita in U.S. Dollars (USD) in 2021 for Mexico and the United States.

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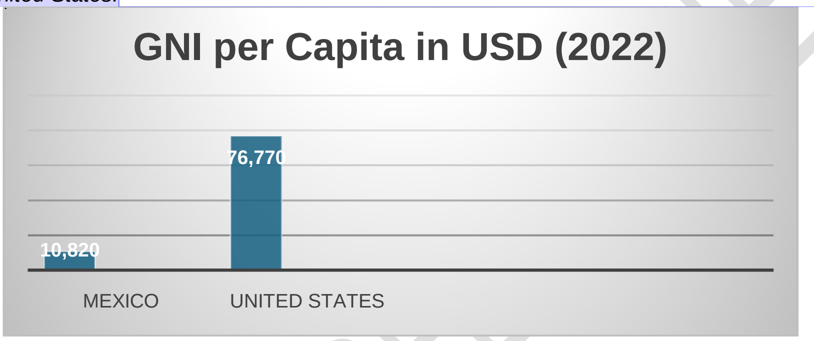

Fig. 4 Estimated human fatalities (per year) in Mexico and the United States.

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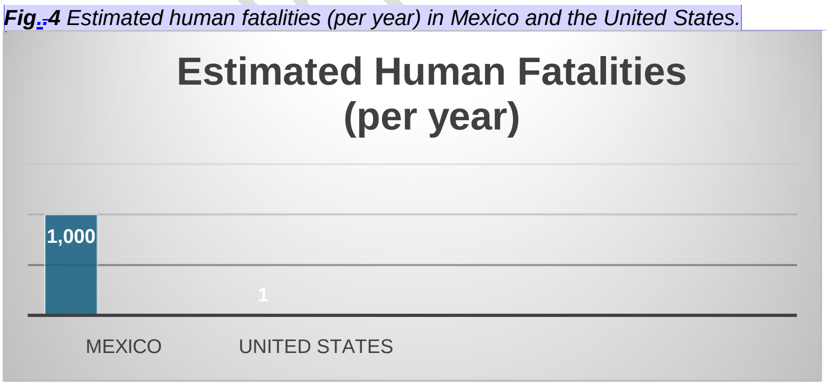

Conclusions

This scientific paper has discussed and explained what factors can cause certain species of animals to be more dangerous to humans than others and how so. To be more precise, it has shown that the MR of a species is dependent on not only what species it is but also where it is. There are two conclusions to end this scientific paper.

The first conclusion is that one of the two factors of the Crespo scale — the MR — can (to a certain extent) be partially dependent on the other. As stated before, species with a larger PS have an overall greater probability of coming into contact with humans: regardless of whether they're encountered inside or outside of their natural environment. This in turn increases the probability of a fatal encounter with a random individual. This seems to be more apparent in species that not only possess a large PS but also live in closer proximity to human settlements in more populous countries. Parasites (e.g. *Ascaris lumbricoides*) and disease vectors (e.g. *Triatoma infestans*) are excellent examples of such species. Their specialised ecology in infecting humans means they're never far from human civilisation; their larger PS means they can infect more people across a wider global range at a much higher frequency per year. As a result, the number of fatalities per year is higher and so the overall MR of these species is higher. Thanks in part to their larger PS.

Finally, the second conclusion is that factors applicable to a species (i.e. its PS and MR) determine which category it should be placed in. However, the factors more related to a country's development (i.e. life expectancy at birth, expected years of school, mean years of schooling, and GNI per capita) can oftenindirectly affect the MR of a species. Thetotal DoTs of a species can increase, decrease, or staystable, depending on the country it's being observed and recorded in. Therefore, the categories that species are placed in can change between countries.Case in point, malaria transmission *via* mosquitoes of the *Anopheles genus* occurs to some degree within most countries in Africa, Latin America, and South Asia[34]. Despite this, 51.9% of all malaria-related deaths are reported in just four countries: Nigeria (26.8%), the Democratic Republic of the Congo (12.3%), Uganda (5.1%), and Mozambique (4.2%)[1].So *Anopheles gambiae*—the most prolific vector for malaria—would be classed as a category five level threat in Nigeria; a category fourin Mozambique.In correlation, these four countries scored 0.548, 0.481, 0.550, and 0.461 on the HDI in 2022[33]. This is not a coincidence. As previously stated, human-related factors regarding human development can influence a species' MR, its DoTs, and thus its respective category.

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