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Review Article

Understanding the concept of Deaths per Million and its implication in the control of disease outbreaks: A data-based review

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COVID-19 pandemic has motivated many nations into innovative ideas on how to survive, pending when nations across the world has attained herd immunity via the vaccination of all her citizens. Despite the standard protocols of the World Health Organisation (WHO) such as wearing of masks, maintaining a minimum distance of 1 metre, avoiding crowded areas, and using hand sanitisers. Some countries like Nigeria chose to boost their immunity against the virus by using both Ascorbic acid tablets and vitamin C rich foods such as Garcinia kola, Guava, Paw-paw (1, 2) and others. While countries like the United Kingdom and the United states preferred vitamin D supplement (3,4). Assessing the success of the public health measures put in place by these nations has become a herculean task especially as there is no effective index to determine that.

According to the WHO definition, Case fatality ratio **(CFR)** is the proportion of individuals diagnosed with a disease who die from that disease (5). Thus, it estimates the severity among detected cases:

$$Case\ Fatality\ ratio\ (CFR, in\%) = \frac{Number\ of\ deaths\ from\ disease}{Number\ of\ confirmed\ cases\ of\ disease} \times 100$$

Attempts to use this index may not be very feasible, considering its definition and designation. Thus, the mortality rate, which is defined as the number of deaths from a specific cause per 100,000 of the population of a state or a country per annum, was brought into this context (6). This can be mathematically represented as:

M = (D/P) x100,000.

Where D is number of deaths, and P is the population size of the country,

This may not be feasible, as some disease outbreaks may persist beyond a year, as is the current case of the pandemic. Hence, the term *deaths per million* (DPM) may be more appropriate. This could be a reason why the WHO via her situation report room introduced the deaths per million, a term which might be relatively new to neophytes in Public health. Thus, the need to critically analyse this term as a concept via available data from the situation report room of the WHO, using the COVID-19 pandemic as a case study.
The period under review is from 1st January 2020 to 31st December 2020. This is to access the efficacy of the public health measures of some selected countries using the available index of deaths per million, case fatality ratio and mortality rate to know the term that is best fit for the pandemic.

Table-1: Total population and total number of cases per selected countries between January and June 2020

COUNTRIES	TOTAL POPULATION	TOTAL NUMBER OF CASES	TOTAL NUMBER OF DEATHS	MORTALITY RATE	CASE FATALITY RATIO	DEATHS PER MILLION
AUSTRALIA	25,203,198	7 641	104	0.412	1.361	4.126
BRAZIL	211,049,527	1 274 974	55 961	26.516	4.389	265.156
CHINA	1,433,783,686	85 190	4 648	0.324	5.456	3.241
INDIA	1,366,417,754	528 859	16 095	1.178	3.0433	11.779
NIGERIA	200,963,599	24 077	558	0.278	2.317	2.777
RUSSIA	145,872,256	634 437	9 073	6.220	1.430	62.198
U.S. A	329,064,917	2 452 048	124 811	37.930	5.090	379.290
U. K	67,530,172	310 254	43 514	64.436	14.025	644.364
S/ AFRICA	58,558,270	131 800	2 413	4.121	1.831	41.207

Table-1: A table showing the respective population of countries according to the statistics from the United Nations with their MR, CFR and DPM as of 28 June 2020. Case Fatality Ratio (CFR) and Deaths Per Million (DPM) of the exceptional nations with the biggest populace of their continents. India and China had been added, due to the fact apart China being the domicile of the index case, India is subsequent in demography. The UK and South Africa had been added, because of the emergence of a 2d version in those countries (7,8).

Table-2: Total population and total number of cases per selected countries between July and December 2020

COUNTRIES	TOTAL POPULATION	CUMULAT. NUMBER OF CASES	CUMULAT. NUMBER OF DEATHS	MORT ALITY RATE	CASE FATALITY RATIO	DEATHS PER MILLION
AUSTRALIA	25,203,198	28 296	908	3.603	3.209	36.027
BRAZIL	211,049,527	7 448 560	190 488	90.257	2.557	902.575
CHINA	1,433,783,686	96 324	4 777	0.333	4.959	3.332
INDIA	1,366,417,754	10 187 850	147 622	10.804	1.449	108.036
NIGERIA	200,963,599	83 576	1 247	0.620	1.492	6.205
RUSSIA	145,872,256	3 050 248	54 778	37.552	1.796	375.520
U.S. A	329,064,917	18 648 989	328 014	99.681	1.759	996.806
U. K	67,530,172	2 256 009	70 405	104.257	3.120	1,042.571
S/ AFRICA	58,558,270	994 911	26 521	45.290	2.666	452.899

Table-2: A table showing the respective population of countries according to the statistics from the United Nations with their MR, CFR and DPM as of 27 December 2020. Case Fatality Ratio (CFR) and Deaths Per Million (DPM) of the exceptional nations with the biggest populace of their continents. India and China had been added, due to the fact apart China being the domicile of the index case, India is subsequent in demography. The UK and South Africa had been added, because of the emergence of a 2d version in those countries (8,9).

Discussion

A case study of the trend in this pandemic gives a clue as to why the World Health Organisation adopted the term Deaths Per Million (DPM) during a pandemic. The CFR of 2.317 (see table 1), presents Nigeria as a country with many deaths higher than that of Russia, whose CFR is 1.430 and Australia whom theirs is at 1.361 (see table 1). However, in reality, Nigeria is known to be having fewer deaths than Russia and Australia. This scenario indicates that though CFR could be used to determine death rates from diagnosed cases of a disease; it may not be the most appropriate tool during or after a pandemic, especially in an African setting due to some factors which include laboratory testing capacity, making the mortality rate or DPM a preferred index (5). However, the mortality rate, which is the number of deaths from a specific cause per 100,000 of the population of a state or a country may not apply to this situation until after a period of time, say a year (6). This makes DPM, a more appropriate tool. DPM could be described as the number of deaths triggered at any time by a pandemic's aetiology per 1,000,000 population of a country. DPM as an index gives leeway in monitoring the efficiency of the control measures implemented by countries during a pandemic. It helps to decipher when and where there would be a need for a total or partial lockdown during a disease outbreak. It also helps to verify the progress made in saving lives, despite its limitation of only providing an estimate.

In the both tables, one would think that the Deaths per million and the Mortality rate are the same index or that they provide the same information. However, the definition of the Mortality rate presents a challenge in its use. Mortality rate which may be defined as the number of deaths from a specific cause per 100,000 of the population of a state or a country per annum may not be appropriate in the case of a pandemic, except if this definition is reviewed (6). Hence the DPM may be the most appropriate considering its flexibility of use. In line with this, we advocate the use of the term *estimated mortality rate* in place of DPM, considering rare situations this term may be applied.

Conclusion

The DPM of 6.205 as seen in table 2 presents Nigeria as one of the countries with the least number of deaths compared to her CFR of 1.492; this presents a better picture of the pandemic. Hence, it is safe to suggest that CFR be used to evaluate the testing capacity of countries and DPM be used to check the efficacy of the control measures.

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DECLARATION OF INTEREST
The authors declare no competing interests.

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