International comparisons of COVID-19 case and mortality data and the effectiveness of non-pharmaceutical interventions: a plea for reconsideration

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Keywords

Epidemiology; Public Health; Methodology.

Abstract

Making international comparisons of the effectiveness of coronavirus disease 2019 (COVID-19) non-pharmaceutical interventions (NPIs) based on national case and mortality data is fraught with complexity. This article calls for stronger attention to just how extensive is the multifactorial nature of national case and mortality data, and argues that, unless a globally consistent benchmark of measurement can be devised, such comparisons are facile, if not misleading. This can lead to policy decisions and public support for the adoption of potentially harmful NPIs that are ineffective in combatting the COVID-19 pandemic and damaging to mental health, social cohesion, human rights and economic development. The unscientific use of international comparisons of case and mortality data in public discourse, media reporting and policymaking on NPI effectiveness should be subject to greater scrutiny.

Introduction

International comparisons of the effectiveness of coronavirus disease 2019 (COVID-19) non-pharmaceutical interventions (NPIs) have become a common feature of public dialogue and media reporting. The widespread replication by national governments of NPIs against COVID-19, such as border restrictions in contradiction to the World Health Organization's (WHO) International Health Regulations (2005), indicates that such international comparisons may have featured prominently in policymaking (Ritchie et al., 2021). A major risk in the making of such comparisons has been an apparent myopic focus on unelaborated case and mortality raw data, national rankings and what might be referred to as a "league table" mentality. Countries with comparatively low case and mortality rates as reported in published national data have served as paradigms for a "successful" handling of the COVID-19 pandemic in public and media discourse, and likely policymaking. Yet this article argues that national case and mortality data are so multifaceted that they are not accurate indicators of the effectiveness of control measures for COVID-19. International comparisons of published case and mortality data and determining the balance between the pros and cons of policies can be extremely complex. This can lead to the adoption of particular NPIs that are ineffective in combatting COVID-19 and that may even be disproportionately harmful to other considerations including mental health, social cohesion, human rights and economic development.

Variability in National Case and Mortality Data

Case and mortality data reported by national authorities are subject to an extensive array of factors. These can broadly be grouped into five categories: (i) surveillance factors, (ii) classification factors, (iii) virological factors, (iv) ecological factors and (v) political factors.

Surveillance factors

There are a variety of ways in which surveillance factors impact case and mortality data. A greater number of tests conducted will tend to result in a greater number of positive test results. Figures may be adjusted to account for the number of positive cases per one million of the population, for instance, but this will not address the other many variations that are encountered. The frequency of testing will impact the data: more frequent testing, particularly of a previously confirmed positive case, may tend to inflate case incidence data. Where testing is repeatedly and frequently performed on persons who test positive for COVID-19, multiple cases could be attributable to a single infected person (Kanamoto et al., 2020).

Mandatory testing regimes are more likely to detect asymptomatic or mildly symptomatic cases than voluntary testing regimes or testing regimes limited to hospitalized cases. This affects overall case and mortality data. There is evidence that COVID-19 mortality rate is negatively associated with test number. For instance, it has been discovered that one additional test per 100 people was associated with an 8% decrease in mortality rate, even after adjusting for various factors (Liang et al. 2020). If countries using mandatory testing measures detect more asymptomatic cases than those using voluntary testing, then the former will likely have a smaller ratio of deaths than the latter. Additionally, viral test techniques and their correct usage have an important influence. The main tests for COVID-19 include assays for detection of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) nucleic acid or antigen and serological assay for detection of SARS-CoV-2 antibody (Centers for Disease Control and Prevention, 2020). The relative diagnostic accuracy and reliability of those tests will tend to positively or negatively impact case and mortality data. Even within a single testing category, such as reverse transcription polymerase chain reaction (RT-PCR) testing, accuracy and reliability may vary by manufacturer, and different manufacturers often recommend a different number of amplification cycles to determine the presence of SARS-CoV-2. International variations in testing technique, consistent and correct usage, and choice of manufacturer, will therefore impact case and mortality data. To confound the matter further, insufficient assessment of diagnostic performance has been reported (Axell-House et al., 2020), in addition to reported manufacturer inflation of performance characteristics (Fitzpatrick et al., 2020).

Classification factors

National differences in classification of case and mortality data are considerable. The definition of cases differs from country to country; some include presumptive cases, whereas others recognise only cases confirmed by RT-PCR testing (Jamison et al., 2020). Some countries, such as the UK, include asymptomatic positive test results in their case incidence data, with a case defined as a person with one or more specimen tests which proves positive for the presence of SARS-CoV-2, including positive results not confirmed by a laboratory (UK Government, 2021a). Other countries, such as China, have excluded such results from their case incidence data (Cyranoski, 2020). This would tend to inflate UK case incidence data relative to the Chinese data.

Similarly, the methodology for compiling mortality data will tend to positively or negatively impact the published mortality rate in a given country. Definitive criteria may include COVID-19 as the sole or principal certified cause of death, COVID-19 mentioned on the death certificate but without a requirement that it be the sole or principal cause of death, or excess mortality adjusted for non-COVID-19 deaths. Excess mortality refers to the number of deaths from all causes during a crisis, above and beyond "normal" conditions. It is a more comprehensive measure of the overall impact of the pandemic on mortality than the confirmed COVID-19 death count alone. It reflects not only confirmed COVID-19 deaths, but also COVID-19 deaths that were misclassified, as well as deaths from other causes that are attributable to the pandemic. However, a notable limitation of excess mortality comparisons is that many countries, especially low- and middle-income countries, do not have statistical agencies and infrastructural frameworks sufficient to reliably monitor and report the incidence of death on a daily, weekly, or even monthly basis (Checchi and Roberts, 2005).

Classification methodologies vary in terms of causation requirements and can skew the data either positively or negatively. The main UK classification for a COVID-19 death was the death of a person within 28 days of that person's first positive COVID-19 test (UK Government, 2021b). There was no strict requirement for causation between COVID-19 infection and death, thus including patients already severely or terminally ill with other diseases, patients with significant comorbidities and patients that died of unrelated reasons but who carried SARS-CoV-2, even asymptomatically. This crude measure is notoriously over-broad. It should also be noted that national classification methodologies can change over time (Raleigh, 2020), and can also vary on a sub-national level (Tsang et al., 2020).

Classification can also be influenced by systematic factors such as national medical standards, practices and consistency. COVID-19 infections may be undiagnosed, misdiagnosed and attributed to other diseases with similar clinical presentation such as influenza (World Health Organization, 2020), such that gaps between observed increases in all-cause mortality and reported COVID-19 mortality may widen (Jamison et al., 2020). Conversely, suspected COVID-19 cases may be misdiagnosed and attributed to COVID-19 instead of other diseases with similar clinical presentation, such as influenza or pneumonia (Budhram, Kobza and Mohammed, 2020), such that reported COVID-19 mortality may be overstated.

Virological factors

SARS-CoV-2 has developed many thousands of different variants (Koyama, Platt and Parida, 2020). Among the more widely reported variants thus far are the B.1.1.7 variant first detected in the UK, the B.1.351 variant first detected in South Africa, the B.1.617.2 (commonly known as "Delta") variant first detected in India, and the P.1 variant first detected in Brazil and Japan. Yet these variants are reported to be more or less transmissible than other variants of SARS-CoV-2, which likely affects case incidence; and/or be more or less virulent, which likely affects mortality. For example, the B.1.1.7 variant estimated to have first emerged in the UK in September 2020 and likely more prevalent in the UK was reportedly 74% more transmissible than the original (probably zoonotic) SARS-CoV-2 (Volz et al., 2021), which may tend to inflate UK case incidence relative to data in countries where less transmissible variants are prevalent. Moreover, the variants are unequally distributed around the world and their presence and prevalence will vary over time, with the B.1.617.2 and B.1.1.7 variants presently more widely distributed around the world than, for example, the P.1 variant, in turn more widely distributed than more localised variants such as B.1.1.30 or B.1.1.31 (O'Toole et al., 2021). The unequal distribution of more or less transmissible and virulent variants will tend to skew case and mortality data, further complicating international comparisons as a basis for NPI decision-making.

Ecological factors

Case and mortality data will tend to be impacted by the local prevalence of comorbidity factors. Obesity, for example, may be one of the major comorbidities associating with COVID-19 mortality, with it being reported that COVID-19 patients with obesity were more severely affected and had a worse clinical outcome than COVID-19 patients without obesity (Yang, Hu and Zhu, 2021). However, obesity is unequally distributed among national populations. Yet among the adult populations with the highest prevalence rates of obesity are several island nations where NPIs focused on more intrusive border and quarantine measures are potentially easier to implement or yield greater impact on case incidence data, such as Nauru (60.7%), Cook Islands (55.3%), Tuvalu (51%), Marshall Islands (52.4%) and Tonga (45.9%). Conversely, among the adult populations with the lowest prevalence rates of obesity are a number of developing countries where testing and reporting regimes may be less adequately resourced, such as Vietnam (2.1%), Timor-Leste (2.9%), Bangladesh (3.4%), Cambodia (3.5%) and Ethiopia (3.6%) (World Health Organization, 2017). In each situation, potentially adverse factors may be at work on case and mortality data.

The local prevalence of pre-existing immunity to COVID-19 may be unequally distributed among countries. This includes the prevalence of pre-existing T cell reactivity (Doshi, 2020) and other innate resistance or cross-protection from exposure to seasonal coronaviruses (Lourenço et al., 2020). Pre-existing immunity to COVID-19 infection will tend to negatively impact case and mortality rates in comparison with rates in countries with relatively less such immunity. This further confounds national comparisons of case and mortality data. Moreover, it is suspected that COVID-19 is seasonal in whole or in part, with factors such as temperature and maximum daily ultraviolet light affecting infection incidence (Merow and Urban, 2020). This would caution against crude comparisons of data between countries with latitudinal, hemispheric and climactic differences, in addition to economic disparities (Broadbent et al., 2020).

In addition, infrastructural and demographic factors will be relevant to local epidemiology. Higher population density (Bhadra, Mukherjee and Sarkar, 2021) and connectivity (Hamidi, Sabouri and Ewing, 2020) may tend to exacerbate infection rates and mortality. Older persons appear to be at greater risk of severe COVID-19 and requiring hospitalization if infected (Clark et al., 2020), thus tending to inflate case and mortality rates in countries with older populations.

Political factors

Bureaucratic and infrastructural disparities will likely affect the accurate, efficient, complete and timely gathering and reporting of case and mortality data. This is in itself multifactorial, but less developed countries may under-report case and mortality data due to sub-optimal bureaucracies and infrastructures. Differing national, regional and local testing policies may also tend to affect case incidence data, such as the existence and form of mandatory testing regimes and any financial incentives for testing (Government of the Hong Kong Special Administrative Region, 2020; Lee, Kwak and Kim, 2021). Local social and cultural variations may also affect compliance behaviours and affect case incidence rates (Dryhurst et al., 2020).

Polity type may also affect case and mortality data in multifaceted ways. More authoritarian, autocratic and closed regimes may tend towards greater corruption, concealment and statistical manipulation, and less transparency, relative to more democratic, competitive and open regimes. Even though there is evidence of global inclinations towards authoritarianism in the adoption of COVID-19 NPIs (Thomson and Ip, 2020a), there are diverse governmental models practised throughout the world. The ability of well-resourced authoritarian regimes to mobilize resources and populations quickly to combat the outbreak of infectious diseases is tempered by information politics in such regimes which can undermine a rapid response to those outbreaks (Kavanagh, 2020). Authoritarian and semi-authoritarian governments tend to manipulate information and stifle dissent in an effort to convince populations of their competence (Guriev and Treisman, 2019), behaviours that are not conducive to good pandemic management.

Extensive complicating factors therefore arise in relation to the variegated impact of polity type on the gathering and reporting of COVID-19 case and mortality data. It may be that there is a positive relationship between governmental transparency and the severity of reported data, such that the relative reported "success" of certain countries cannot be taken at face value. It is telling that North Korea and Turkmenistan – among the lowest scoring countries in the Global Democracy Index 2020 (The Economist, 2021) and the outright lowest scoring countries in the 2021 World Press Freedom Index after Eritrea (Reporters Without Borders, 2021) – continue to report zero COVID-19 cases and zero COVID-19 deaths (World Health Organization, 2021a, 2021b). Statements of the kind that "death tolls don't lie" (Mahbubani, 2020) should be subject to far greater contextual scrutiny in serious scientific and policy discourse.

Effect on Policymaking and Public Perception

Public and media discourse has frequently focused on the reputed "success" of particular countries in tackling COVID-19, and on the supposed "failure" of others. Such narratives have been driven by a myopic focus on unelaborated case and mortality data, national rankings and a "league table" mentality. The UK has been repeatedly berated by the public and media for having the "worst COVID-19 death rate in Europe" – yet this may or may not be accurate, not to mention that the UK's position relative to other European countries ostensibly improved in less than a year. It is impossible to make accurate macro international comparisons at least until the pandemic is over. International comparisons of officially reported COVID-19 case and mortality data have palpably driven public discourse, media narratives and policymaking on pandemic management. National authorities have implemented an unprecedented suite of COVID-19 NPIs in apparently uncritical fashion. From border closures to stay-at-home orders, novel and intrusive NPIs have proliferated around the world. Such measures have been adopted even where key aspects of existing preparedness plans were ignored or abandoned, and where, as in the UK, those plans expressly stated that they could be adapted and deployed for scenarios such as an outbreak of severe acute respiratory syndrome with a different pattern of infectivity to influenza (UK Department of Health, 2021).

Yet national case and mortality data are too multifactorial to be a meaningful predictor of NPI effectiveness. Differences in national case and mortality rates can be explained by a plethora of local surveillance, classification, virological, ecological and political factors. Comparatively low case and mortality rates may indicate any number of explanations, from greater local prevalence of pre-existing immunity, or lower population age, to the presence of corruption, or a regulatory response that is out of all proportion to the epidemiological risks of COVID-19. Consider the radically disparate reasons that underlie the comparatively low COVID-19 rates in, for example, Australia, Laos, and the Vatican City. The figures may bear little relation to local use of NPIs, the effectiveness of which should be evaluated on the basis of scientifically rigorous studies alone.

The uncritical commendation of countries with comparatively low case and mortality rates as paradigms of good pandemic management can lead to the imitation of NPIs that are ineffective in containing COVID-19 or are otherwise harmful. Noting how comparatively low are the case and mortality rates in countries with authoritarian political systems (Annaka, 2021), in particular, there is a risk that such comparisons drive public and policy support for the implementation of NPIs that are hostile to civil liberties and human rights. Similarly, though counterintuitive at first glance, the dismissal of countries with comparatively high case and mortality rates as "failures" can lead to other countries declining to emulate their otherwise effective NPIs, or indeed their absence of NPIs. Higher case and mortality rates could be explained by more transparent government, local ecological factors or the use of surveillance and counting methodologies that tend to over-inflate case and mortality data, as much as by failing to implement effective NPIs. There are major risks associated with such facile international comparisons of case and mortality data, which are neither conducive to good pandemic management nor to the protection of health, social cohesion, human rights and economic development, all of which are essential to human wellbeing (Thomson and Ip, 2020b).

Conclusions

The unscientific acceptance of international comparisons of COVID-19 case and mortality data in public discourse, media reporting and policymaking on NPI effectiveness is dangerous. National data are too multifactorial to be a meaningful predictor of the effectiveness and appropriateness of underlying NPIs in the absence of a globally consistent benchmark of measurement, which is extremely difficult to achieve in practice. The use of such data to identify seemingly effective NPIs can lead to the adoption of NPIs that are not only ineffective in combatting COVID-19 but also disproportionately harmful to other important interests from the protection of mental health to human rights. The "numbers game," epitomized in the use of crude international rankings and league tables of case and mortality rates, should be discouraged. Scientifically rigorous studies of NPI effectiveness should drive public discourse, media reporting and policymaking for the better management of the COVID-19 pandemic.

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Ethical approval is not required by the authors' respective institutions for this study.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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