Health security capacities in the context of COVID-19 outbreak: an analysis of International Health Regulations annual report data from 182 countries

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Summary

Background Public health measures to prevent, detect, and respond to events are essential to control public health risks, including infectious disease outbreaks, as highlighted in the International Health Regulations (IHR). In light of the outbreak of 2019 novel coronavirus disease (COVID-19), we aimed to review existing health security capacities against public health risks and events.

Methods We used 18 indicators from the IHR State Party Annual Reporting (SPAR) tool and associated data from national SPAR reports to develop five indices: (1) prevent, (2) detect, (3) respond, (4) enabling function, and (5) operational readiness. We used SPAR 2018 data for all of the indicators and categorised countries into five levels across the indices, in which level 1 indicated the lowest level of national capacity and level 5 the highest. We also analysed data at the regional level (using the six geographical WHO regions).

Findings Of 182 countries, 52 (28%) had prevent capacities at levels 1 or 2, and 60 (33%) had response capacities at levels 1 or 2. 81 (45%) countries had prevent capacities and 78 (43%) had response capacities at levels 4 or 5, indicating that these countries were operationally ready. 138 (76%) countries scored more highly in the detect index than in the other indices. 44 (24%) countries did not have an effective enabling function for public health risks and events, including infectious disease outbreaks (7 [4%] at level 1 and 37 [20%] at level 2). 102 (56%) countries had level 4 or level 5 enabling function capacities in place. 32 (18%) countries had low readiness (2 [1%] at level 1 and 30 [17%] at level 2), and 104 (57%) countries were operationally ready to prevent, detect, and control an outbreak of a novel infectious disease (66 [36%] at level 4 and 38 [21%] at level 5).

Interpretation Countries vary widely in terms of their capacity to prevent, detect, and respond to outbreaks. Half of all countries analysed have strong operational readiness capacities in place, which suggests that an effective response to potential health emergencies could be enabled, including to COVID-19. Findings from local risk assessments are needed to fully understand national readiness capacities in relation to COVID-19. Capacity building and collaboration between countries are needed to strengthen global readiness for outbreak control.

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Introduction

Coronaviruses are RNA viruses that are found widely in humans and other mammals.[1] Even though most human coronavirus infections result in mild diseases, the world has had two major epidemics in the past two decades from two different betacoronaviruses; severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV). Collectively, these two outbreaks have resulted in more than 10 000 cumulative cases, with fatality rates of 10% for SARS-CoV and 37% for MERS-CoV.[2]

In December 2019, China reported to WHO cases of pneumonia of unknown cause occurring in Wuhan, Hubei.[3] Initial patients exhibited clinical symptoms resembling viral pneumonia. The country's capacity to detect cases facilitated early recognition and verification of the pathogen. Viral genetic sequencing of samples indicated a novel coronavirus.[4] The novel virus was named 2019 novel coronavirus (COVID-19) and confirmed to have 75–80% resemblance to SARS-CoV.[2] As of Feb 24, 2020, approximately 80 000 confirmed cases have been reported in more than 28 countries.[5] On Jan 30, WHO declared the outbreak of COVID-19 as a public health emergency of international concern and put in place a series of temporary recommendations.[6] No specific antiviral therapies are available, and efforts to develop antivirals and a vaccine continue. Early indications suggest that bats are the primary reservoir for the virus, given COVID-19's close similarity to bat coronaviruses,[7] and while identification of the zoonotic origin of the virus continues, the public health measures for managing the outbreak rely on existing national and regional preparedness capacities to prevent, detect, verify, assess, and respond in accordance with the International Health Regulations (IHR, 2005).

Since the IHR came into force in 2007, countries have made substantial efforts to strengthen their capacities to

Research in context

Evidence before this study

The outbreak of 2019 novel coronavirus disease (COVID-19) has spread rapidly across many countries in a short space of time. Few studies have highlighted the strength and gaps of national capacities in relation to operational readiness against health emergencies and the state of national International Health Regulations (IHR, 2005) implementation. We searched PubMed using the search terms "operational readiness index" in relation to "IHR", "health security", and "emergency preparedness" for articles published in English, between Jan 1, 2010, and Jan 24, 2020. Our search found zero results on the operational readiness index in relation to IHR.

Added value of this study

Because of the insufficient quality of information that exists about the state of national and regional preparedness capacities, we used data and information from IHR State Party Annual Reporting tool to review existing levels of health security capacities to prevent, detect, respond, and establish enabling functions for an effective response, and operational readiness against public health risks and events, including infectious disease outbreaks.

Implications of all the available evidence

Our results have implications for prioritising capacity building action in WHO Regions and countries, especially in terms of capacities regarding prevention, detection, response, enabling functions, and operational readiness. The operational readiness index can be used to support WHO, governments, and other international agencies to prioritise their support and implementation of operational readiness capacities for the COVID-19 outbreak.

prevent, detect, and respond to public health emergencies.[8] Countries have been enhancing preparedness through the implementation and regular assessment of IHR national capacities to mitigate the effect of public health emergencies, including the emergence of a novel pathogen.[9,10] Increased understanding of the capacities that countries have to prevent, detect, and respond to public health events has been made possible through the introduction of the WHO IHR monitoring and evaluation framework and application of the framework's components including the State Party annual reporting (SPAR) process and voluntary external evaluation using the Joint External Evaluation tools, after-action reviews, and simulation exercises.[11] The results of these assessments are used to develop national action plans to strengthen IHR capacities for health security. WHO benchmarks for IHR capacities include corresponding actions that can increase a country's emergency preparedness, and are used to strengthen a country's emergency preparedness and health security.[12] We analysed the 2018 SPAR submissions of 182 countries to review health security capacities in light of the COVID-19 outbreak and identified opportunities for further strengthening of IHR implementation.[13,14]

Methods

We analysed 2018 SPAR submissions to review health security capacities on the basis of the following indices: capacities to (1) prevent, (2) detect, (3) respond, (4) enabling function (resources and coordination capacity), and (5) operational readiness. National scores for 18 of the 24 SPAR indicators were applied across the five indices. Six SPAR indicators that were not directly related to our indices and infectious hazard threats, including COVID-19, were excluded.[13]

The SPAR indicators selected for use in each of the five indices are shown in panel 1. Each indicator of the SPAR is scored according to a scale from level 1 to 5, in which level 1 is the lowest capacity and level 5 is the highest.[13] Countries without a score were marked as level 0. Panel 1 shows the rationale for including the indicators as part of the respective indices.

Index development and analysis

For each of the five indices we developed an index score using the following steps: (1) we grouped key indicators from the SPAR submissions according to our five indices;[13] (2) each indicator score was converted to a percentage; (3) we aggregated indicator scores using an arithmetic average:

$$\text{arithmetic average of indicators} = \frac{(C1.3 + C2.2 + C3.1 + \cdots)}{n}$$

(4) we categorised countries on an ordinal scale of levels 1–5 on the basis of the scores of the indices. These five levels are similar to the capacity levels used to assess countries using SPAR (panel 2).[13,14]

Results

We analysed the 2018 SPAR submissions of 182 countries. 2018 SPAR data does not exist for 14 State Parties and therefore could not be included as part of this study.[15] 138 (76%) of 182 countries included were found to have an overall detection capacity at level 4 or 5. 52 (28%) countries had levels 1 or 2 capacities to prevent and 60 (33%) countires had levels 1 or 2 capacities to respond, many of which are classified as low-income and lower-middle-income countries by the World Bank. 81 (44%) countries had level 4 or 5 capacities to prevent, and 78 (43%) countries had level 4 or 5 capacities to respond. 102 (56%) countries had a level 4 or 5 enabling function.

49 (27%) countries had prevent, 34 (19%) had detect, 44 (24%) had respond, 36 (20%) had enabling function,

Panel 1: Selected indicators and rationale for their use

Capacity to prevent

C3.1—collaborative effort on activities to address zoonoses
Evidence suggesting a link to zoonosis.[2,7]

C4.1—multisectoral collaboration mechanism for food safety events
Infectious disease outbreaks can be brought about by gaps in food safety.[2,7]

C9.2—capacity for infection prevention and control and chemical and radiation decontamination
Infection prevention and control at the community and health-care facility level is key for prevention, control and containment of the infection.[16]

C10.1—capacity for emergency risk communications
Reaching out to communities at the local, national, and global levels are essential for prevention, detection, and control of the infection.[17]

C11.1—core capacity requirements at all times for designated airports, ports and ground crossing
Core capacities to prevent, detect, and respond at the points of entry are crucial for prevention and control of infectious disease outbreaks.

Capacity to detect

C5.1—specimen referral and transport system; C5.3—access to laboratory testing capacity for priority diseases
Not all countries will have capacity to test specimens. Therefore, countries should have a system of specimen referral, transportation, and testing of suspected cases.

C6.1—early warning function: indicator-based and event-based surveillance
Reporting from communities, health-care facilities, and points of entry are crucial for prevention and detection of infectious disease outbreaks.

C6.2—mechanism for event management (verification, risk assessment, analysis investigation)
Capacity for verification, risk assessment, and analysis investigation is crucial for the prevention, detection, and control of infectious disease outbreaks.

Capacity to respond

C8.1—planning for emergency preparedness and response mechanism
Response capacity depends on availability of preparedness and response plans and mechanisms and regular testing for functionality and updating them to address gaps.

C8.2—management of health emergency response operations
Any public health events require incident management systems to be followed. Therefore, the capacity to respond effectively to an outbreak depends on strong capacity of emergency operations.

C8.3—emergency resource mobilisation
During response, all types of resources must be mobilised in a timely manner (funds, human resources, and logistics).

C9.1—case management capacity for IHR relevant hazards
Effective response to outbreaks and other health emergencies depends on case management.

C9.2—capacity for infection prevention and control and chemical and radiation decontamination
Capacity for infection prevention and control is needed for effective case management and infection control.

C11.2—effective public health response at points of entry
Any suspected case detected at points of entry needs to be managed effectively, otherwise the risk of transmission across borders remains high.

Enabling function index

C1.3—financing mechanism and funds for timely response to public health emergencies
Availability and accessibility of financing mechanisms is essential for prevention, detection, and control of infectious disease outbreaks.

C2.2—multisectoral IHR coordination mechanisms
Multisectoral coordination and action is needed to manage public health events including infectious disease outbreaks.

C7.1—human resources for the implementation of IHR capacities
During emergencies, different skillsets, surge capacity, and timely mobilisation of health-care workers are needed to prevent, detect, and control events.

C8.3—emergency resource mobilisation
During response, all types of resources must be mobilised to manage events.

C9.3—access to essential health services
Access to the essential health services are needed to prevent, detect, and control infectious disease outbreaks. Continuity of essential health services must be ensured during emergencies.[18]

Operational readiness

C1.3; C2.2; C3.1; C4.1; C5.1; C5.3; C6.1; C6.2; C7.1; C8.1; C8.2; C8.3; C9.1; C9.2; C9.3; C10.1; C11.1; and C11.2
These 18 indicators of the SPAR tool[13] have been used to develop an index for operational readiness. The index helps to assess the status of national readiness capacities across each WHO region. A full description of these indicators is given in the appendix. According to WHO, high-level operational readiness to respond to emergencies will allow a timely, effective, and efficient response. Achieving readiness is a continuous process of establishing, strengthening, and maintaining a multisectoral response infrastructure that can be applied at all levels, which follows an all-hazard approach, and which focuses on the highest priority risks. Operational readiness builds on existing capacities to design and set up specialised arrangements and services for an emergency response.[19]

IHR=International Health Regulations.

See Online for appendix

***Panel 2*: Criteria and definitions for levels in this study**

Level 1: ≤20%
Very little functional capacity is in place to prevent and control the risk or event.

Level 2: ≤40%
Little functional capacity available on an ad-hoc basis with the support of external resources.

Level 3: ≤60%
The country is functionally capable at the national level; however, effectiveness is low at the subnational levels.

Level 4: ≤80%
The country is functionally capable of dealing with various events at the national and subnational levels.

Level 5: >80%
The country's functional capacity is well advanced and sustainable at all levels of health systems.

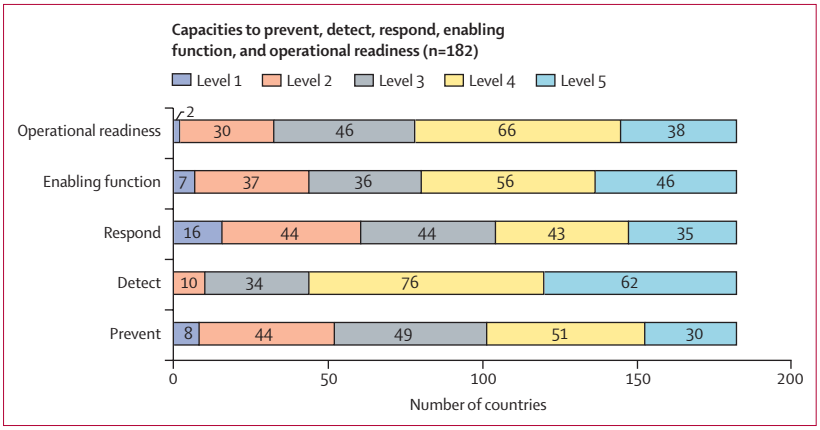

Figure 1: **Number of countries according to capacities to prevent, detect, respond, enabling function, and operational readiness**
Level 1 represents the lowest capacity and level 5 the highest.

and 46 (25%) had operational readiness capacities at level 3. 44 (25%) countries had enabling functions at levels 1 or 2 and require external support. 32 (18%) countries had operational readiness capacities at levels 1 and 2, and 104 (57%) had good operational readiness (66 [36%] at level 4 and 38 [21%] at level 5).

Prevention capacity

52 (28%) countries had a low capacity to prevent a public health event, including an infectious disease outbreak (eight [4%] at level 1 and 44 [24%] at level 2; figure 1). 81 [45%] countries had a robust prevention capacity (51 [28%] at level 4 and 30 [17%] at level 5) and 49 (27%) of countries had moderate prevention capacities (level 3).

Detection capacity

138 (76%) countries had robust detection capacities (76 [42%] at level 4 and 62 [34%] at level 5; figure 1). 34 (19%) countries' capacities were at level 3, indicating moderate development. Only ten (5%) countries had level 2 capacities, and none at level 1, for the detection of an infectious disease outbreak.

Respond capacity

60 (33%) countries had low capacities to respond to a public health event, including an infectious disease outbreak (16 [9%] at level 1 and 44 [24%] at level 2; figure 1). 44 (24%) countries were at a level 3 capacity to respond, and 78 (43%) countries had high capacities to respond (43 [24%] at level 4 and 35 [19%] at level 5).

Enabling function

44 (24%) countries were categorised in the lowest levels (seven [4%] at level 1 and 37 [20%] at level 2) for enabling function. 102 (56%) countries (56 [31%] at level 4 and 46 [25%] at level 5) had the highest levels of resources and the highest levels of collaboration or coordination to prevent, detect, and respond to an event. 36 (20%) countries were at level 3.

Operational readiness capacity

32 (18%) countries had low operational readiness capacities (two [1%] at level 1 and 30 [17%] at level 2; figure 1). 104 (57%) countries were operationally ready to prevent, detect, and control an event (66 [36%] at level 4 and 38 [21%] at level 5). 46 (25%) countries' operational readiness capacities were at level 3.

Operational readiness capacity by WHO regions

Wide variation exists in the capacity for operational readiness across regions (figure 2). 21 (45%) of 47 the countries in the WHO African Region and five (22%) of 23 countries in the WHO Western Pacific Region had low capacities for operational readiness. Across all regions, 104 (57%) of 182 countries had operational readiness capacities at level 4 (66 [36%]) and level 5 (38 [21%]). No countries were at level 5 for operational readiness in the African and South-East Asia regions. 46 (25%) of all countries had an operational readiness capacity at level 3.

Discussion

We found that countries varied widely in terms of their capacity to prevent, detect, and control outbreaks, with about half the countries reporting operational readiness capacities to respond to public health emergencies. We used the 2018 SPAR data, which is self-reported by countries to represent their capacity levels; the data are not independently verified. The inclusion of additional data sources from external IHR monitoring and assessment exercises was excluded from this study because countries are assessed across multiple years.[20] For instance, over 100 countries have implemented joint external evaluations to date, which have been carried out between 2016 and 2019.[20] The SPAR data that we used reflects the capacity of countries in 2018 only. Although

the use of independently verified data would be useful (eg, external assessments such as joint external evaluations) for a review of this nature, this limitation is minimised by the fact that SPAR data has been shown to correlate strongly with externally evaluated data such as the Joint External Evaluation results.[21]

Several factors affect the emergence and spread of an infectious disease outbreak within countries and between regions, including the strength of IHR capacities at the national and subnational levels, adherence to infection prevention and control measures, climate-related pressures, and the density of populations.[8,16,22] When an outbreak is caused by an airborne pathogen, population density or crowding is known to directly affect spread of infection.[22] Analysis of other risk variables associated with tackling an infectious disease outbreak and managing health emergencies would benefit understanding of existing country capacities, including vulnerabilities due to socioeconomic conditions, comorbid conditions, and lack of health infrastructure, which we did not take into account.

The information and data from these exercises should be analysed to build and inform readiness and response plans for preventing and controlling health emergencies including the outbreak of COVID-19. The analyses of the operational readiness index have been used to support the development of a draft WHO strategic preparedness and response plan for COVID-19.[23] These findings must be triangulated with the latest risk assessments available for COVID-19 and other assessments such as Joint External Evaluations, after-action reviews, simulation exercises, and others to understand the capacity level of countries and to implement priority actions at the national and subnational levels.[19,23] The WHO Secretariat is working on the development of a preparedness dashboard to provide real-time information that is based on these capacity assessments. Another limitation is related to the method being based on a deterministic approach; therefore, proportionate or inverse interactions among variables could not be shown.[24]

An effective way of managing airborne infections is applying evidence-based public health prevention strategies.[16,17,22] This method includes scaling up public awareness of behaviours such as hand hygiene and respiratory etiquette, communicating and engaging with local communities about the risks of the outbreak, and putting in place effective public health response measures.[17,25,26] National points of entry should also have the capacity to prevent, detect, and respond to potential threats in line with the IHR. Many countries have low capacities for preventing the occurrence and spread of outbreaks, such as measles, influenza, Ebola virus.[27,28] Therefore, enhancing national preparedness capacities in line with the gaps identified in this study should incorporate action to strengthen points of entry.

Many countries have made substantial progress in developing effective levels of disease detection, which involves strengthening surveillance and laboratory capacities. The application of lessons learned from previous infectious disease emergencies including the 2002 SARS-CoV, 2009 H1N1 influenza pandemic, MERS-CoV, Ebola virus, and Zika virus outbreaks, have helped to strengthen countries' capacities to effectively detect and verify suspect cases.[5,8,28,29] The early detection of COVID-19 in China and the development of laboratory reagents for testing and genetically sequencing the novel virus are key steps that have supported the early response.[29] We showed that 76% of countries have robust detection capacities in place, which will enable early detection and verification of potential outbreaks when they occur.

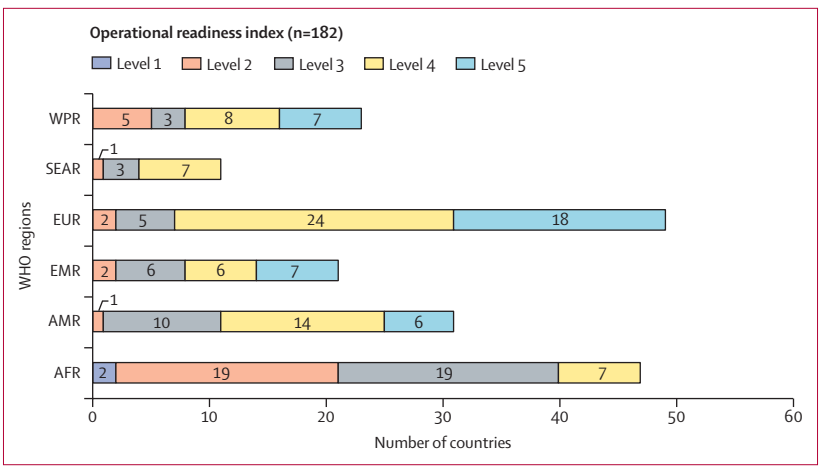

Figure 2: **Operational readiness index by WHO regions**
Level 1 represents the lowest capacity and level 5 the highest. WPR=Western Pacific region. SEAR=South-East Asia region. EUR=European region. EMR=Eastern Mediterranean region. AMR=Region of the Americas. AFR=African region.

A country's response capacity depends on the strength of its emergency preparedness and the regular testing and updating of national plans and capacities.[30] An effective response to an outbreak depends not only on the availability of adequate human resources and financing, but also on the ability to manage emergency logistics (including the handling of supply chains for essential products that are required during an emergency). Our findings show that many countries need support to achieve these capacities and increased support should be provided as a global priority action to strengthen health security. Our findings on operational readiness capacities and enabling function, which are low in many low-resource countries, underline the importance of increasing investments in scaling up IHR capacities, as described in the 2019 annual report of the Global Preparedness Monitoring Board.[8]

Another challenge underpinning low national preparedness capacities is insufficient investment in human capital and poor continuity planning.[18,31,32] The world needs to increase investment in anthropologists, data scientists, communication specialist, educationists, and economists, who are all essential in providing necessary support for the control of infectious disease outbreaks.[12,31,32] The important role these specialists play in responding to outbreaks,

including Ebola virus, MERS-CoV, cholera, and measles are well documented, and a key lesson from these public health emergencies has been to ensure that these skillsets are developed further.[32] Our data reinforce this notion, given the low capacities that many countries have to prevent and respond to health emergencies and infectious disease outbreaks effectively.

In the past 5 years, multisectoral coordination and collaboration for health security strengthening has improved substantially. This coordination and collaboration is reinforced by the introduction of voluntary IHR external evaluation processes, including Joint External Evaluations, which have successfully brought multiple sectors together around common plans for national preparedness capacity building.[34] However, we showed that half of the countries analysed have low enabling functions, which means that coordination and collaboration have been insufficient. The COVID-19 outbreak requires a robust mechanism of collaboration and coordination at the global, national, and subnational levels to prevent, detect, and respond effectively.

The availability of essential health services at the community level is highly important for the ability of countries to minimise potential health emergencies during the earliest stages. Access to essential health services is one of the key indicators that contributes to the indices of enabling function and operational readiness. When an outbreak occurs, national health systems should be strong enough to be able to ensure the continued delivery of essential health-care services, including immunisation and maternal health services. Many countries, especially those that are low resource, have insufficient access to essential health services.[34] Expanding access to essential health services in such countries would support the achievement of effective operational readiness, which is insufficient for many countries, as shown in our analysis.

According to WHO, operational readiness for emergencies will allow a timely, effective, and efficient response.[19] Achieving operational readiness is a continuous process of establishing, strengthening, and maintaining a multisectoral response infrastructure that can be applied at all levels, which follows an all-hazard approach, and which focuses on the highest priority risks.[19] Our analysis shows that more than 50% of countries analysed had the highest levels of operational readiness capacities; however, findings must be integrated with findings from local risk assessments to fully understand national readiness capacities in relation to COVID-19.[23]

The findings of our analysis are similar to those of other publications that have assessed health security capacities.[36,37] A study[36] on the assessments of health security capacities in the African Region also found similar variances in the capacity of countries. Using an analysis of results of joint external evaluations, most of the countries of the African Region have been shown to have national capacity levels of between 1 and 3, and none have achieved level 5. This variance in national capacities is similar to our findings on the operational readiness index.[36] A study[37] of systemic resilience based on one composite measure of IHR core capacities to manage cross-border infectious diseases showed that improvement in IHR capacities is associated with a decrease of incidence of cross-border infection in Europe.[37] This level of capacity is also reflected in our study, in which most of the countries of the WHO European Region were level 4 or 5 as per the operational readiness index.[37] Some countries have stronger capacities than others; however, all countries should invest in building greater preparedness against health emergencies.

Assessments of IHR (2005) capacities reveal that advances have been made since 2010 in many countries to better detect potential outbreaks of infectious diseases early and test suspect cases rapidly—eg, the early detection and verification of the novel coronavirus cases by China and other countries.[38] All countries are at risk of COVID-19 and other outbreaks of infectious diseases, and countries vary widely in terms of their capacity to prevent, detect, and control outbreaks COVID-19 is not fully understood, which can further aggravate the situation. Therefore these findings should be combined with the latest risk assessments that are available for COVID-19 and other assessments to understand the existing capacities. The WHO Secretariat is developing the preparedness dashboard (a data visualisation platform that will include a query system) to provide real-time information that is based on various capacity assessments. Despite the gains made in understanding the pathogen, many countries are underprepared to manage cases within their borders. Investments in preparedness urgently need to be scaled up to ensure that vulnerable countries are operationally ready and capable to respond to public health events such as the COVID-19 outbreak.

Many countries are struggling to sustain or develop their national preparedness capacities, primarily because of a lack of resources, competing national priorities, and a high turnover of health-care workers. Only half of the countries analysed in this study have the provision for adequate resources for emergencies, and these countries are mostly either high-income or middle-income countries. Urgent action is needed to ensure that capacities are in place to prevent and manage health emergencies. The outbreak of COVID-19 is another opportunity to review the preparedness of all countries and apply key recommendations from other major public health emergencies to better protect the world against future health emergencies.

Contributors
NK conceptualised the study, analysed the data, and drafted and finalised the manuscript. SC contributed to the concept, draft, and finalising the paper. AO and JX saw drafts and provided input. All authors approved the final version of the manuscript.

Declaration of interests
We declare no competing interests.

Data sharing
The data are publicly available online.[15]

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