Open Access

Health Capacity and Vulnerability in Context of COVID-19 Outbreak: An Analysis of 185 Countries

Usama Waqar[1], Shaheer Ahmed[2], Daniyal Ali Khan[1]
[1]Medical Student, Aga Khan University Medical College, Karachi, Pakistan
[2]Medical Student, Islamabad Medical and Dental College, Islamabad, Pakistan

ABSTRACT

Background: The coronavirus disease 2019 (COVID-19) pandemic has affected most countries, afflicting severe damage. Mitigation measures to control the pandemic rely heavily on existing health capacity and vulnerability of each country. The health capacity and vulnerability with respect to COVID-19 outbreak for 185 countries was assessed in this study to identify those where capacity-building needs to be prioritized.

Material and Methods: The State Parties Annual Reporting data based on WHO International Health Regulations monitoring and evaluation framework was used to extract an indicator for national health capacity. Another indicator for vulnerability was extracted from INFORM epidemic risk index. These metrics were selected after evaluating their complementarity and availability.

Results: Among 185 countries, 111 (60%) had health capacities at level 4 and 5 with most of them having vulnerability at level 3 and 4. Twenty-two (11.89%) countries had level 2 health capacity in place coupled with moderate to high vulnerability. Among continents, Europe had best while Africa had worst mean functional capacity and vulnerability scores.

Conclusions: The results showed that most countries had sufficient response and reaction capacities to handle the pandemic. However, resources, intensified surveillance, and capacity building should be prioritized in vulnerable countries with ill-equipped national health capacities.

Key words: COVID-19 pandemic, Disease outbreaks, Epidemiology, International Health Regulations

Introduction

In December 2019, an outbreak of viral pneumonia of unknown cause was reported in Wuhan, China, which was identified as a novel coronavirus (2019-nCoV).[1] Coronaviruses are RNA viruses found widely in humans and other mammals.[2] While they are mostly associated with mild diseases, coronaviruses have previously caused two major epidemics: severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV) epidemics.[3]

Following the spread of the novel coronavirus (now called SARS-CoV-2) outside China, the WHO declared the outbreak a pandemic.[4] As of 10th July 2020, 12,102,328 cases of coronavirus disease 2019 (COVID-19) and 551,046 associated deaths have been confirmed worldwide.[5] USA has been hit the hardest with 3,038,325 cases and 131,884 deaths. Meanwhile in China, where the first case was identified, the highest number of new cases diagnosed was on 5th of February 2020.[6]

For each country, the potential to limit and control this pandemic depends upon its ability of rapid identification of suspected cases, case isolation, early diagnosis, contact tracing, and follow-up. However, this is limited by the existing national health capacity and vulnerability to the pandemic. Health capacity is determined by the existing healthcare delivery system, public health infrastructure, and diagnostic infrastructure. National vulnerability is influenced by socioeconomic, demographic, ecological, and political characteristics that can influence the mitigation measures.

The International Health Regulations (IHR) monitoring and evaluation framework is developed by WHO to help countries evaluate and strengthen their capacities to prevent, detect, assess, and respond effectively to potential public health risks and emergencies.[7] It consists of a mandatory annual reporting component and three voluntary components: after-action review, simulation exercise and voluntary external evaluation.[7]

We analyzed the IHR monitoring and evaluation framework to generate an indicator for national health capacity while another indicator was used to assess vulnerability for 185 countries in light of the COVID-19 pandemic.[7]

Material and Methods

WHO provides the State Party Self-assessment Annual Reporting (SPAR) and Joint External Evaluation (JEE) tools to countries for uniform mandatory annual reporting and voluntary external evaluation processes.[8,9] SPAR is based on internal evaluation while JEE combines both internal and external evaluations to promote transparency.[7] However, JEE Mission Reports were only available for 95 WHO member states from 2016 to 2019.[10] SPAR 2019 data was unavailable for 29 member states, and SPAR 2018 was used for 25 of these.[11]

Indicators of health capacity were extracted from SPAR and JEE data (Supplementary Material p 1). Both these metrics assess national health capacity by accounting for physical infrastructure, health delivery system, management capacity, chemical hazards, and radiation hazards.[8,9] INFORM epidemic risk index (IERI) and infectious disease vulnerability index (IDVI) were used to extract indicators for vulnerability.[12,13]

All indicators were rescaled from 0-100 with increasing health capacity and decreasing vulnerability (Table I). A multivariate correlation analysis was performed to identify the most complementary pair of metrics (Figure S1 Supplementary Material p 2). The analysis showed a high correlation between health capacity indicators from SPAR and JEE, and between vulnerability indicators extracted from IVDI and IERI. After reviewing the availability and complementarity of potential pairs, we decided to use the SPAR-IERI pair for capturing health capacity and vulnerability of 185 countries (Supplementary Material p 3).

The methodology employed for extraction and selection of indicators for health capacity and vulnerability in this study was influenced by the methodology of Marius and colleagues.[14]

Results

111 (60%) out of 185 included countries were found to have a health capacity at level 4 or 5. Among these, Canada, Malaysia, and Russia had the highest health capacity (SPAR = 99.22; Figure 1) with moderate to low vulnerability (53, 53, and 55 respectively). The remaining 108 members states mostly had vulnerability at level 3 and 4 (48 and 51 countries respectively) while 9 countries were found to have vulnerability at level 2.

Table I: Criteria for defining levels in this study			
Level	Indicator Score	Health Capacity	Vulnerability
1	≤20	Very low	Very high
2	≤40	Low	High
3	≤60	Moderate	Moderate
4	≤80	High	Low
5	>80	Very high	Very low

22 (11.89%) countries had health capacity at level 2 with 19 of them having vulnerability at level 2 and 3. Bosnia and Herzegovina, Equatorial Guinea, and Gabon were found to have vulnerability at level 4 among these 22. Central African Republic had the lowest health capacity at level 1 with a level 2 vulnerability (SPAR = 17.78; IERI = 24). None of the countries included were found to have vulnerability at level 1 or 5.

Among the worst-hit countries (confirmed cases ≥200,000), most countries had health capacity at level 4 or 5 and vulnerability at level 3 and 4. Exceptions included Pakistan and Peru in terms of health capacity (level 3; 44.11 and 49.00 respectively) and India and Turkey in terms of vulnerability (level 2; 34 and 40 respectively). In the least hit group (cases ≤5,000), most countries had health capacity and vulnerability at levels 3 and 4.

Among the continents, Europe had the highest mean SPAR and IERI scores while Africa had the lowest (Table II). Figure 2 represents a comparison between the health capacity and vulnerability among the six continents.

Discussion

COVID-19 pandemic has brought unprecedented disasters with over half a million associated deaths and severe economic recession. With vaccine expected no earlier than 2021, its management, control and prevention are the only methods available to mitigate the crisis. Rapid identification of suspected cases, isolation, diagnosis, contact tracing, and follow-up are crucial to break the lines of transmission and limit further spread. This has proved to be a public health challenge for all countries and is even worse for those with high vulnerabilities and limited functional health capacities.

We found that most countries had adequate SPAR health capacity scores with moderate to low vulnerability to respond to the COVID-19 pandemic. However, our results should be interpreted carefully. These health capacity scores often corresponded to different contributions to mean SPAR indicators, reflecting different aspects of a country's functional health capacity. For example, Brazil and Israel both had same health capacity score (83.67). Brazil had a score of 100 in surveillance capacity and 40 in Health Service Provision while Israel scored 80 in surveillance and 100 in Health Service Provision. Another limitation in this study was the use of self-reported SPAR data from 2018 and 2019 which lacked an independent verification from external evaluation processes. The use of joint external evaluation data would have been useful in this case, but it was available for a limited number of countries only.

Most of the countries (18 out of 23) with insufficient functional health capacities and moderate to high vulnerability were found to be in Africa. Africa also has some of the poorest countries in the world, and
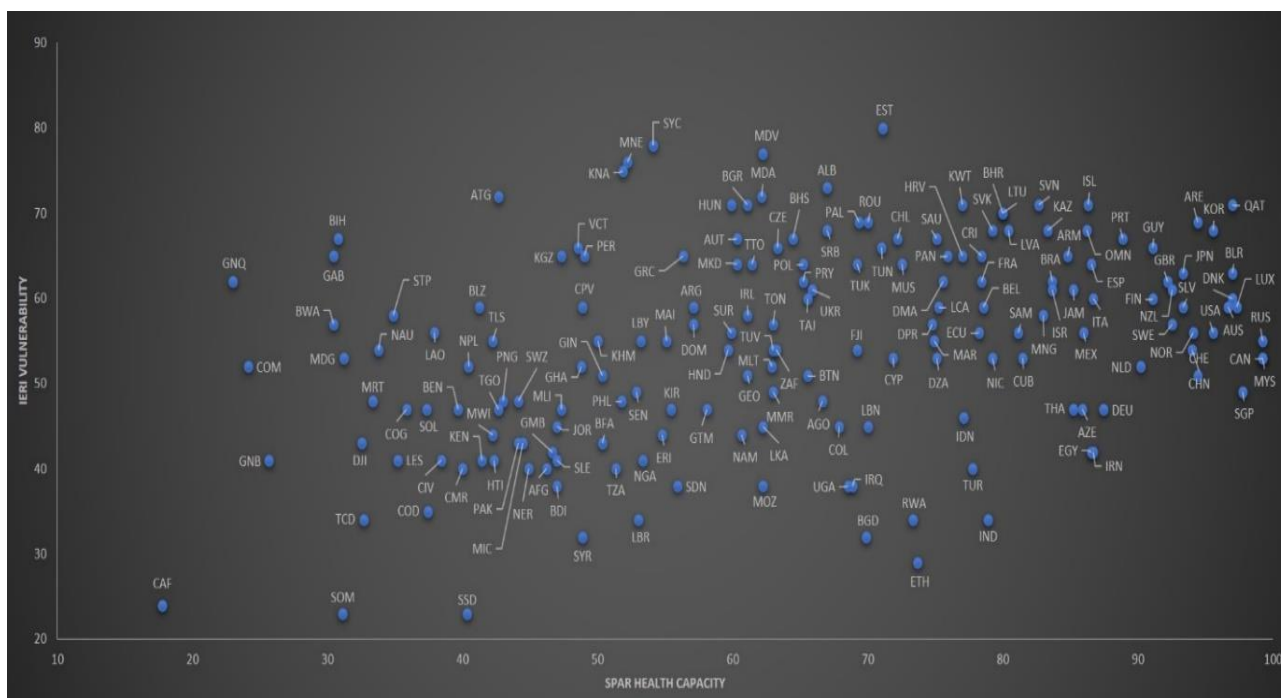
Figure 1: SPAR capacity and IERI vulnerability of 185 countries

AFG=Afghanistan. ALB=Albania. DZA=Algeria. AGO=Angola. ATG=Antigua and Barbuda. ARG=Argentina. ARM=Armenia. AUS=Australia. AUT=Austria. AZE=Azerbaijan. BHS=Bahamas. BHR=Bahrain. BGD=Bangladesh. BLR=Belarus. BEL=Belgium. BLZ=Belize. BEN=Benin. BTN=Bhutan. BIH=Bosnia and Herzego vina. BWA=Botswana. BRA=Brazil. BGR=Bulgaria. BFA=Burkina Faso. BDI=Burundi. CPV=Cabo Verde. KHM=Cambodia. CMR=Cameroon. CAN=Canada. CAF=Central African Republ ic. TCD=Chad. CHL=Chile. CHN=China. COL=Colombia. COM=Comoros. COG=Congo. CRI=Costa Rica. CIV=Côte d'Ivoire. HRV=Croatia. CUB=Cuba. CYP=Cyprus. CZE=Czech Republic. DPR=Democratic People's Republic of Korea. COD=Democratic Republic of the Congo. DNK=Denmark. DJI=Djibouti. DMA=Dominica. DOM=Dominican Republic. ECU=Ecuador. EGY=Egypt. SLV=El Salvador. GNQ=Equatorial Guinea. ERI=Eritrea. EST=Estonia. SWZ=Eswatini. ETH=Ethiopia. FJI=Fiji. FIN=Finland. FRA=France. GAB=Gabon. GMB=Gambia. GEO=Georgia. GRC=Greece. DEU=Germany. GHA=Ghana. GTM=Guatemala. GIN=Guinea. GNB=Guinea-Bissau. GUY=Guyana. HTI=Haiti. HND=Honduras. HUN=Hungary. ISL=Iceland. IND=India. IDN=Indonesia. IRN=Iran. IRQ=Iraq. IRL=Ireland. ISR=Israel. ITA=Italy. JAM=Jamaica. JPN=Japan. JOR=Jordan. KAZ=Kaz akhstan. KEN=Kenya. KIR=Kiribati. KOR=Republic of Korea. KWT=Kuwait. KGZ=Kyrgyzstan. LAO=Lao People's Democratic Republic. LVA=Lat via. LBN=Lebanon. LES=Lesotho. LBR=Liberia. LBY=Libya. LTU=Lithuania. LUX=Luxembourg. MDG=Madagascar. MWI=Malawi. MYS=Malaysia. MDV=Maldives. MLI=Mali. MLT= Malta. MAI=Marshall Islands. MRT=Mauritania. MUS=Mauritius. MEX=Mexico. MIC=Federated States of Micronesia. MDA=Republic of Moldova. MNG=Mongolia. MNE=Montenegro. MAR=Morocco. MOZ=Mozambique. MMR=Myanmar. NAM=Namibia. NAU=Nauru. NPL=Nepal. NLD=Netherlands. NZL=New Zealand. NIC=Nicaragua. NER=Niger. N GA=Nigeria. MKD=North Macedonia. NOR=Norway. OMN=Oman. PAK=Pakistan. PAL=Palau. PAN=Panama. PNG=Papua New Guinea. PRY=Paraguay. PER=Peru. PHL=Philippines. POL=Poland. PRT=Portugal. QAT=Qatar. ROU=Romania. RUS=Russian Federation. RWA=Rwanda. KNA=Saint Kitts and Nevis. LCA=Saint Lu cia. VCT=Saint Vincent and the Grenadines. SAM=Samoa. STP=Sao Tome and Principe. SAU=Saudi Arabia. SEN=Senegal. SRB=Serbia. SYC=Seychelles. SLE=Sierra Leone . SGP=Singapore. SVK=Slovakia. SVN=Slovenia. SOL=Solomon Islands. SOM=Somalia. CHE=Switzerland. ZAF=South Africa. SSD=South Sudan. ESP=Spain. LKA=Sri Lanka. SDN=Sudan. SUR=Suriname. SWE=Sweden. SYR=Syrian Arab Republic. TAJ=Tajikistan. TZA=United Republic of Tanzania. THA=Thailand. TLS=Timor-Leste. TGO=Togo. TON=Tonga. TTO=Trinidad and Tobago. TUN=Tunisia. TUR=Turkey. TUK=Turkmenistan. TUV=Tuvalu. UGA=Uganda. UKR=Ukraine. ARE=United Arab Emirates. GBR= United Kingdom of Great Britain and Northern Ireland. USA=United States of America. URY=Uruguay. UZB=Uzbekistan. VAN=Vanuatu. VEN=Venezuela. VNM=Viet Nam. YEM=Ye men. ZMB=Zambia. ZWE=Zimbabwe

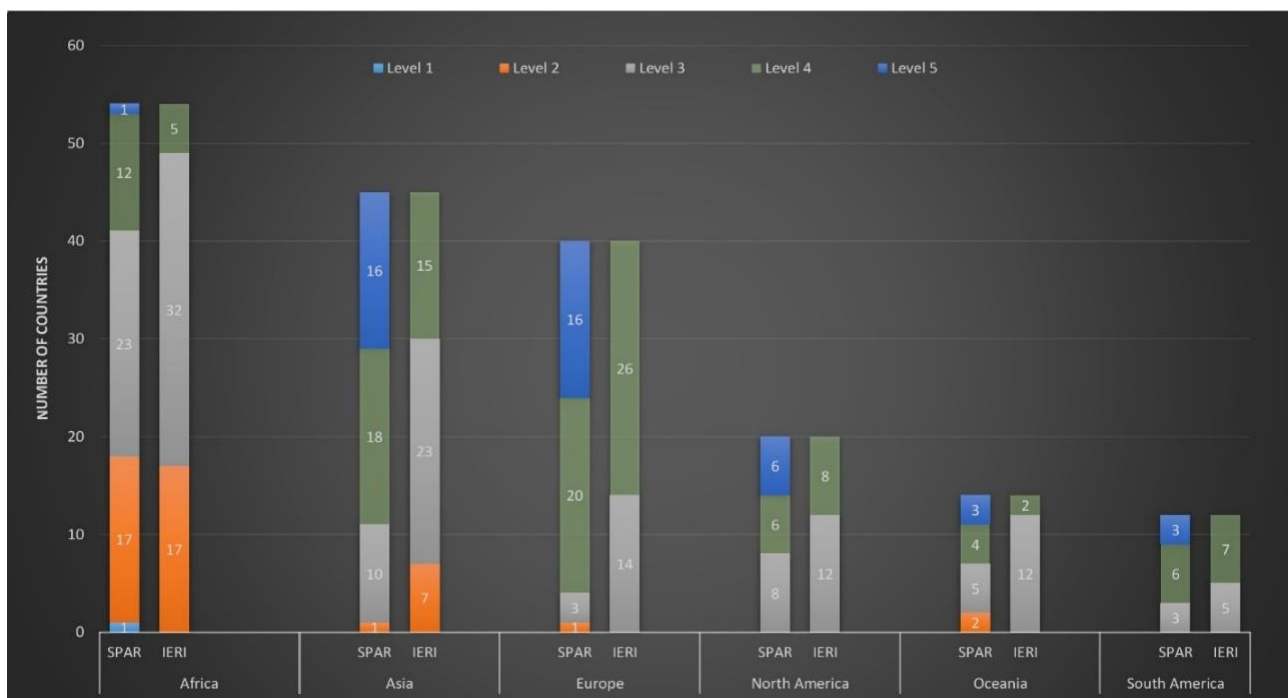| Table II. Mean SPAR health capacity and IERI vulnerability of the continents			
Continent	**Countries included**	**Mean SPAR**	**Mean IERI**
Africa	54	48.24 ± 15.43	45·35 ± 10.78
Asia	45	71.67 ± 17.79	53.93 ± 11.77
Europe	40	75·20 ± 15.06	63.50 ± 7.37
North America	20	69.56 ± 18.01	59.00 ± 7.89
Oceania	14	60.32 ± 19.27	54.43 ± 6.44
South America	12	70.29 ± 12.30	60.42 ± 5.91

Figure 2: Comparison of SPAR and IERI among the continents

the healthcare infrastructure there requires significant improvements to be self-sufficient against pandemics like COVID-19.[15] Similarly, 9 out of 10 countries with least number of doctors per 10,000 population are based in Africa. It also has the 10 countries with least health expenditure per capita.[16] Hence, efforts are being made to assist Africa during the pandemic. An African task force for coronavirus preparedness and response (AFTCOR) has been established to help with diagnoses, surveillance, prevention and control, treatment, risk communication, and supply chain management.[17] These capacity-building efforts might have contributed to the effectiveness of African countries to respond and should be prioritized for other high-risk areas as well.

We found that the SPAR and IERI scores are linked to the wealth of the countries. High-income countries, i.e. Oman and Qatar, etc., often had better functional health capacity with less vulnerability while the contrary was true for most low-income countries. This is important because the outbreak in the worst-hit countries has highlighted that COVID-19 can rapidly strain existing hospital capacity and require significant investments to maintain the required capacity.[18] A potential exacerbation of outbreak would require development of more quarantine facilities, ventilators, and other health infrastructure which can be an added challenge for these resource-limited countries.

However, it was found that high-income countries with high SPAR and IERI scores have been mostly hit harder by the pandemic than those with low scores. Europe has been affected worst and earliest while the least-affected are African countries. This can be explained by different case importation risks for Africa and Europe (1% vs 11%, respectively).[14] Having learned from Ebola, African countries started issuing recommendations to avoid travel to China following case importations in Europe along with other measures to strengthen their preparedness.[19] However, cases are still increasing in some resource-limited countries, i.e. Pakistan. Resource investment in preventative measures like Africa should be prioritized to avoid a potential exacerbation in these

vulnerable countries with inadequate functional health capacities.

Another underlying factor which might have contributed to the difference between high-income and low-income countries could be their experience with previous outbreaks. Low-income countries often experience relatively more outbreaks, making them battle-hardened. According to WHO, 265 outbreaks were reported between 2018 and 2020, out of which only 8 were in Europe (5 in France, 2 in Netherlands, and 1 in the UK).[20]

The COVID-19 pandemic requires extensive coordinated efforts at the global, national, and subnational levels to allow countries to respond and control the outbreak. Our findings should be triangulated with other risk assessments available for COVID-19 to help inform prioritization for intensified support in terms of deployment of resources and assistance in developing response and reaction capacities. Countries with limited capacities can also use these findings to invest resources in capacity-building efforts to be better prepared for any future public health emergency.

Limitations: SPAR data was self-reported and lacked external verification. The use of JEE would have been more transparent as it employs external evaluation processes. However, JEE data was only available for 95 countries, so it could not be used. Another limitation was the unavailability of SPAR 2019 data for 29 countries, and we relied on SPAR 2018 for 25 of these. These included Antigua and Barbuda, Belarus, Belize, Bulgaria, Cook Islands, Estonia, Fiji, Finland, Haiti, Iran, Italy, Kiribati, Malaysia, Marshall Islands, Montenegro, Nauru, New Zealand, Papua New Guinea, Samoa, San Marino, Solomon Islands, Somalia, Tonga, Tuvalu, and Vanuatu.

Conclusion

Countries vary in terms of health capacity and vulnerability to the COVID-19 outbreak with most of them having sufficient functional capacities in place to respond. However, cases are significantly increasing in some vulnerable and ill-equipped countries. Our findings can help policymakers identify the lack of response and reaction capacities in their countries which can lead to urgent capacity-building efforts, improving the effectiveness of pandemic mitigation measures.

Supplementary Material :

https://jimdc.org.pk/index.php/JIMDC/article /view/567/460

References

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med. 2020; 382(8): 727-33. Doi: 10.1056/NEJMoa2001017

2. Richman D, Whitley R, Hayden F. Clinical Virology. Washington, USA: ASN Press; 2016.

3. Petrosillo N, Viceconte G, Ergonul O, Ippolito G, Petersen E. COVID-19, SARS and MERS: are they closely related? Clin Microbiol Infect. 2020; 26(6): 729-734. Doi: 10.1016/j.cmi.2020.03.026

4. World Health Organization. Rolling updates on coronavirus disease (COVID-19). 2020. Available from: https://www.who.int/emergencies/diseases/ novel-coronavirus-2019/events-as-they-happen

5. World Health Organization. Coronavirus disease 2019 (COVID-19) Situation Report-202. 2020. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200809-covid-19-sitrep-202.pdf?sfvrsn=2c7459f6_2.

6. Gourinchas P-O. Flattening the pandemic and recession curves. Mitigating the COVID Economic Crisis: Act Fast and Do Whatever. 2020;31. https://voxeu.org/content/mitigating-covid-economic-crisis-act-fast-and-do-whatever-it-takes

7. World Health Organization. International Health Regulations (2005): IHR monitoring and evaluation

framework. Geneva: World Health Organization; 2018.

8. World Health Organization. International Health Regulations (2005): State Party self-assessment annual reporting tool. Geneva: World Health Organization; 2018.

9. World Health Organization. Joint external evaluation tool: International Health Regulations (2005). Geneva: World Health Organization; 2018.

10. World Health Organization. Joint External Evaluation (JEE) mission reports. Available from: https://www.who.int/ihr/procedures/mission-reports/en/.

11. World Health Organization. Electronic State Parties Self-Assessment Annual Reporting Tool. Available from: https://extranet.who.int/e-spar.

12. Karmen P, Montserrat MF, Luca V, Laura M. Incorporating epidemics risk in the INFORM Global Risk Index. Luxembourg: Publications Office of the European Union; 2018. Doi:10.2760/990429

13. Moore M, Gelfeld B, Okunogbe AT, Paul C. Identifying Future Disease Hot Spots: Infectious Disease Vulnerability Index. Santa Monica, USA: RAND Corporation; 2016.

14. Gilbert M, Pullano G, Pinotti F, Valdano E, Poletto C, Boëlle P-Y, et al. Preparedness and vulnerability of African countries against importations of COVID-19: a modelling study. Lancet. 2020; 395(10227): 871-77. Doi: 10.1016/S0140-6736(20)30411-6

15. Martinez-Alvarez M, Jarde A, Usuf E, Brotherton H, Bittaye M, Samateh AL, et al. COVID-19 pandemic in west Africa. Lancet Glob Health. 2020; 8(5): e631-e632. Doi: 10.1016/S2214-109X(20)30123-6

16. World Health Organization. Global Health Observatory data repository. 2020. Available from: https://apps.who.int/gho/data/?theme=main#ndx-H

17. Nkengasong JN, Mankoula W. Looming threat of COVID-19 infection in Africa: act collectively, and fast. Lancet. 2020; 395(10227): 841-42. Doi: 10.1016/S0140-6736(20)30464-5

18. NEWS AJ. As coronavirus spreads in Europe, hospitals are overwhelmed. Available from: https://www.aljazeera.com/news/2020/03/coronavirus-spreads-europe-hospitals-overwhelmed-200325072333193.html.

19. Monde L. Coronavirus: l'Afrique en état d'alerte. Available from: https://www.lemonde.fr/afrique/article/2020/01/28/coronavirus-l-afrique-sur-ses-gardes_6027538_3212.html.

20. World Health Organization. Emergencies preparedness, response: Disease outbreaks by year 2020. Available from: https://www.who.int/csr/don/archive/year/en/.