Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Tuberculosis, HIV/AIDS and Malaria Health Services in sub-Saharan Africa – A Situation Analysis of the Disruptions and Impact of the COVID-19 Pandemic

Pascalina Chanda-Kapata a,b,*, Francine Ntoumi b,c, Nathan Kapata d, Patrick Lungu e, Luchenga Adam Mucheleng’anga f, Jeremiah Chakaya g, John Tembo h, Cordelia Himwaze i, Rashid Ansumana j, Danny Asogun k, Sayoki Mfinanga l, Peter Nyasulu m, Peter Mwaba n, Dorothy Yeboah-Manu u, AlimuU.N. Zulma p,q, Jean B. Nachega f,s,t

a Ministry of Health, Lusaka, Zambia
b Fondation Congolaise pour la Recherche Médicale (FCRM), Brazzaville, Republic of Congo
c Institute for Tropical Medicine, University of Tübingen, Germany
d National Public Health Institute, Ministry of Health, and UNZA-UCLMS Research and Training Program, Lusaka, Zambia
e University of Zambia, School of Medicine, Department Internal Medicine, Lusaka, Zambia
f Ministry of Home Affairs, Office of the State Forensic Pathologist, and UNZA-UCLMS Research and Training Program, University Teaching Hospital, Lusaka, Zambia
g Department of Medicine, Therapeutics, Dermatology and Psychiatry, Kenyatta University, Nairobi, Kenya
h HERPEZ and UNZA-UCLMS Research and Training Program, University Teaching Hospital, Lusaka, Zambia
i University Teaching Hospital, Department of Pathology and Microbiology, and UNZA-UCLMS Research and Training Program, University Teaching Hospital, Lusaka, Zambia
j Mercy Hospital Research Laboratory, Bo, Freetown, Sierra Leone
k Ambrose Alli University, Ekpoma and Irula Specialist Teaching Hospital, Nigeria
l Mahimbi Medical Research Centre National Institute for Medical Research, Dar es Salaam, Tanzania
m Division of Epidemiology & Biostatistics, Faculty of Medicine, Health Sciences, Stellenbosch University, Cape Town, South Africa
n Lusaka Apex Medical University, Faculty of Medicine, and UNZA-UCLMS Research and Training Project, Lusaka, Zambia
o Noguchi Memorial Institute for Medical Research, University of Ghana, Legon, Ghana
p Center for Clinical Microbiology, Division of Infection and Immunity, University College London, and NIHR Biomedical Research Centre, UCL Hospitals NHS Foundation Trust, London, United Kingdom
q UNZA-UCLMS Research and Training Program Program, Lusaka, Zambia
r Department of Medicine and Division of Infectious Diseases, Stellenbosch University Faculty of Medicine and Health Sciences, Cape Town, South Africa
s Deps of Epidemiology and International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA
t Deps of Epidemiology, Infectious Diseases and Microbiology, University of Pittsburgh Graduate School of Public Health, Pittsburgh, Pennsylvania, USA

A R T I C L E  I N F O

Article history:
Received 8 February 2022
Revised 16 March 2022
Accepted 17 March 2022

A B S T R A C T

Background: The unprecedented and ongoing COVID-19 pandemic has exposed weaknesses in African countries’ health systems. The impact of shifted focus on COVID-19 for the past 2 years on routine health services, especially those for the epidemics of Tuberculosis, HIV/AIDS and Malaria, have been dramatic in both quantity and quality.

Methods: In this article, we reflect on the COVID-19 related disruptions on the Tuberculosis, HIV/AIDS and Malaria routine health services across Africa.

Results: The COVID-19 pandemic resulted in disruptions of routine health services and diversion of already limited available resources in sub-Saharan Africa. As a result, disease programs like TB, malaria and HIV have recorded gaps in prevention and treatment with the prospects of reversing gains made towards

*Author declarations: All authors have a specialist interest in global epidemics of COVID-19, TB, HIV and malaria and One Health. All authors declare no conflicts of interest. The views expressed in this article are entirely those of the authors and do not reflect the views of their respective institutions.

Corresponding author. Dr Pascalina Chanda-Kapata, Ministry of Health, Lusaka, Zambia. Mobile phone: +260977879101

E-mail addresses: pasczykapat@gmail.com (P. Chanda-Kapata), fntoumi@fcrm-congo.com (F. Ntoumi), nkapata@gmail.com (N. Kapata), lungupatrick99@gmail.com (P. Lungu), luchengam@gmail.com (L.A. Mucheleng’anga), chakaya.jm@gmail.com (J. Chakaya), john.tembo@gmail.com (J. Tembo), cordeliahimwaze@gmail.com (C. Himwaze), rashidansumana@gmail.com (R. Ansumana), asogun2000@yahoo.com (D. Asogun), gsmfinanga@yahoo.com (S. Mfinanga), pnyasulu@sun.ac.za (P. Nyasulu), phmwaba2005@gmail.com (P. Mwaba), Dyebboh-Manu@noguchi.ug.edu.gh (D. Yeboah-Manu), s.zulma@ucl.ac.uk (A. Zulma), jbn16@pitt.edu (J.B. Nachega).

https://doi.org/10.1016/j.ijid.2022.03.033
1201-9712/© 2022 The Author(s). Published by Elsevier Ltd on behalf of International Society for Infectious Diseases. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)
Introduction

The ongoing unprecedented and devastating COVID-19 pandemic continues to claim lives, disrupt and divert resources from health systems and have a negative impact on the mental and physical health of peoples across the world. As of 7th February 2022, COVID-19 accounted for 396,254,535 cases and 5,759,785 deaths globally, with Africa reporting 11,196,707 cases and 241,826 deaths (Worldometers, 2022). Since the beginning of the COVID-19 pandemic two years ago, African countries had to divert resources from other competing priorities to tackle this new WHO declared global public health emergency of international concern (WHO, 2020a; Ivers and Walton, 2020). The COVID-19 pandemic has also exposed weaknesses in health systems such as inadequate infrastructure, low numbers of health care workers, inadequate community engagement and gaps in health system leadership (Chapman and Veras-Estévez, 2021). Routine health services in Africa, especially those for other killer infectious diseases such as Tuberculosis (TB), HIV/AIDS and Malaria, were affected greatly, resulting in slowing progress in achieving control programs targets (Ivers and Walton, 2020). In this article, we reflect on some of the COVID-19 related disruptions on TB, HIV/AIDS and Malaria routine health services in Africa, and on gaps in health systems and lessons learnt.

Tuberculosis

The pandemic response measures such as lockdowns reduced access to key health services like TB diagnosis and treatment. Globally, COVID-19 led to a 29 % decline in the TB detection rates in 2020 (The Global Fund, 2021a). Reductions in sputum samples received for TB diagnosis were in part due to people shunning health facilities and health workers prioritised COVID-19 over other conditions (Afum et al, 2021; Alene et al, 2020). Country level declines for TB notifications ranged from 41% in South Africa to 25% in India, highlighting major disruptions in high TB burden countries (McQuaid et al, 2021). The African region has 17 countries, which have the highest burden of TB. New TB diagnosis notifications and screening programs declined in part due to a reduction in numbers of health workers, limited access to facilities, and data reporting lapses thus affecting treatment access. The World Health Organisation (WHO) states that in 2020, of the 10 million people who developed TB, only 5.8 million cases were detected globally, leaving 4.2 million undetected and a pool for further transmission in communities (WHO, 2021a). These cases of undetected TB will no doubt continue to rise in the near future. Furthermore, the number of people dying from TB increased both among HIV negative (from 1.2 Million in 2019 to 1.3 Million in 2020) and among HIV positive (from 209,000 in 2019 to 214,000 in 2020) individuals (WHO, 2021a). The underlying determinants of TB are poverty, undernutrition and stress and numbers of TB cases will rise further in Africa while untreated TB could kill more than half of those with disease (Tiemersma et al, 2011). Additionally, TB/COVID-19 coinfection appears to triple mortality compared with TB mono infection (Tamuzi et al, 2020; Kouapaei et al, 2021). The poor and malnourished are likely to have undiagnosed TB because of health services disruptions and stigma due to COVID-19, this has further led to an increase in TB incidence and mortality which is disproportionately higher among the low-income communities (Saunders and Evans, 2020). However, how many African countries have data on TB and COVID-19 infection? Larger cross-continental studies are required to define accurately the trends of undiagnosed and new TB cases, MDR/XDR-TB and impact of TB/COVID-19 co-infections on management outcomes. Associated risk factors for mortality also need to be defined (Matos et al, 2021). The disruptions to pharmaceutical supply chains and national TB programs require urgent attention (Inzaule et al, 2021).

HIV/AIDS

According to Global Fund, the world recorded a 41% reduction in HIV testing, 37% decline in referrals for diagnosis and treatment in 2020 versus 2019 (The Global Fund, 2021a). Modelling estimates by Jewell and colleagues (2020) showed that disruptions in the supply of antiretroviral drugs (ART) would lead to negative impacts on HIV/AIDS trends. Disruptions in the supply of condoms among 50% of the population were projected to increase new infections by 1.19 times, general disruption to services would lead to a 1.06-fold increase in HIV deaths (Jewell, 2020). Information from simulation models also predicted an additional 0.002 -0.15 COVID-19 deaths per 10,000 clients if HIV services were maintained while averting 19-146 HIV deaths per 10,000 clients, showing that it was beneficial to continue HIV services (Stover et al, 2021). COVID-19 has resulted in disruptions of services both for those needing ART and for prevention activities (Holtzman et al, 2022). However, in South Africa, the impact of the 2020 national COVID-19 lockdown on HIV testing and treatment in KwaZulu-Natal, where 1.7 million people are living with HIV, showed that ART treatment provision was generally maintained during the lockdown, but HIV testing and ART initiations were heavily impacted (Dorward et al, 2021). The lessons learned from maintenance of ART provision which can be extended to other areas of service delivery include prioritising essential health services at all times, integrated health service delivery, multi-month prescriptions for chronic medications and ongoing sensitisation of patients and care givers. National HIV programs in collaboration with WHO and local non-governmental organization need to make pivotal health system changes to help maintain essential health services, including expanding testing and
treatment initiation during ongoing COVID 19 surges in low- and middle-income countries.

Malaria

The World Health Organisation (WHO) estimated that 241 million malaria cases and 627,000 malaria deaths occurred globally in 2020, an increase of 14 million cases and 69,000 deaths compared to 2019, with 47,000 deaths specifically due to COVID-19 related disruptions of malaria prevention, diagnosis, and treatment services (WHO, 2021b). In the African region, death increased by 12% between 2019 and 2020 (WHO, 2021b). Models project a grim picture for Africa, and anticipate that the 2021 situation may not be any better (WHO, 2021b; Weiss et al., 2021). While the scale up of Artemisinin-based combination therapy (ACTs) and Rapid Diagnostic Tests (RDTs) improved testing and treatment for malaria, the emergence of pyrethroid resistance stagnated malaria prevention efforts leading to WHO recommending use of nets containing the synergist piperonyl butoxide (WHO, 2021b; Lindsay et al., 2021). Additionally, climate change factors and mobility are expected to re-introduce malaria to areas known to be malaria free (Celia et al., 2019). Late heating due to distance to health facilities impedes early access to appropriate treatment (Bannister-Tyrrell et al., 2017). Thus, the stagnation in malaria indicators requires further exploration (Lindsay et al., 2021). The COVID-19 pandemic started while progress in malaria control and elimination had plateaued. COVID-19 exacerbated a trend that began about 2015, with improvements in other regions, but progress against malaria stalled in Africa where the malaria incidence is off track by 40% for cases and 42% for mortality rate (WHO, 2021b). The biggest increases in burden caused by disruptions due to COVID-19 occurred in the moderate and high malaria transmission countries in Africa.

Worst-case scenarios projected that the COVID-19-related disruptions to malaria control in Africa could double malaria deaths from 2020 and much more thereafter (Weiss et al., 2021). It has also been shown that even moderate service disruption to malaria services (diagnosis, treatment bed-nets distributions, chemo-prevention for pregnant women and children living in Sahelian areas) may have dramatic consequences (WHO, 2021b). For countries in Africa, there are cross-country variations in the COVID-19 related impact. For example, Uganda reported a slight decline in patients tested for malaria because of disruptions in the global supply chain while the case load remained similar to pre-COVID times (Namuganga et al., 2021). In Zimbabwe, however, both malaria cases and deaths increased when comparing 2019 and 2020 using data from all public and private health facilities (Gavi et al., 2021). However, the data sources were different making it difficult for cross country comparisons. Countries need to take on the challenge of tailoring the response to infectious diseases using locally generated data to be on course to attain the 2030 global malaria targets (WHO, 2021b). The need for more resources is key as some of the reported reduction in funding levels was due to diversion of local and external resources to respond to the COVID-19 pandemic. Malaria service disruptions in the early days of the pandemic, though moderate, were anticipated to cause more deaths (WHO, 2020b).

Re-invigorating Health Systems Disruptions by COVID-19

COVID-19 has resulted in variable disruptions on health systems, social services, and economic activity (UNSDG, 2020) [Table 1]. Furthermore, global disruptions to the supply chains affected the availability of essential medicines and supplies amidst a limping global health system (Amino et al., 2021). Disruptions in sub-Saharan Africa are expected to be disproportionately higher than other world regions due to relatively weak health service infrastructures, low clinician to population ratio, limited laboratory capacity, and a higher burden of other infectious diseases (El-Sadr and Justman, 2020). With the advent of COVID-19 however, even the available equipment and staff were repurposed as countries had to respond to the pandemic (Nyaruhirira et al., 2022, Ivers and Walton, 2020). As a result, outpatient consultations declined, childhood immunisations were disrupted, infectious disease programs limped, and the global burden and mortality estimates for both COVID-19 and other conditions have continued to soar (Shapira et al., 2021; Holtzman et al., 2022). Mathematical models predicted higher mortalities in high TB burden countries with major disruptions to provision of antiretroviral treatment (Hogan et al., 2020). Model projections showed that assuming a 75% disruption in malaria control interventions could lead to reduced testing rates and consequently declined numbers of those on treatment (Weiss et al., 2021). Weaknesses in the quality and scope of pediatric and critical care services in Africa have resulted in a high in-hospital mortality (8.3%) among African children with COVID-19, contrasting with about 1% in high-income countries (1%) (Nachega et al., 2022). The COVID-19 pandemic will continue to negatively affect the HIV, TB and Malaria Control Programs until such a time that the pandemic is contained (Holtzman et al. 2022; Weiss et al. 2021). The Global Fund to fight AIDS, Tuberculosis and Malaria (GFATM) has indicated that COVID-19 will likely reverse decades of progress made in mitigating the impact of TB, HIV and Malaria (The Global Fund, 2021b). Further research is required to establish the impact of COVID-19 preventive measures on infectious disease transmission patterns in Africa and beyond.

The COVID-19 pandemic associated economic recession has negatively affected each individual household through reduction of income and rise in unemployment rates (Gondwe, 2020). Under scoring the need for countries to strengthen social security systems as part of safeguarding the well-being of citizens. Unfortunately, at macroeconomic level, most African countries had to divert resources from essential services and acquired more debt in order respond to the COVID-19 fight, coupled with a shrinking fiscal space due to slowed economic activities, there are limited options to finance an ever growing health and social security need (Gondwe, 2020; Holtzman et al., 2022). Global solidarity is thus required to enable sustainable, rights-based approach to investments for the fight against TB, HIV and Malaria, amidst health security threats.

Given the foregoing COVID-19 pandemic, policy makers should align their plans in such a manner as to ensure that additional resource allocation and investment go into health system strengthening. Cross-country studies are required to generate granular country level surveillance data as well as on comorbidities, outcomes and costing to guide current and future COVID-19 related investments. National and international funding agencies should prioritise activities that will provide epidemiological, molecular diagnostics and surveillance programs to strengthen the countries early warning systems. Frontline health workers should utilise the point of care tests to guide their clinical management decision-making to optimise appropriate COVID-19 care. The inequities in COVID-19 vaccine rollout has taught the world that urgent investment in vaccine manufacturing hubs in Africa must be a priority and expanded to prepare for the current and future pandemics (Inzaule et al, 2021; Loembé and Nkengasong, 2021; Nachega et al 2021). When it appeared that the COVID-19 was somewhat contained, the ‘leaving behind’ of those needing routine services has regressed progress made and it is anticipated that countries will have to innovate and collaborate more to get back on track. Therefore, innovations, collaborations, human rights, and science are critical now more than ever. Improvements in domestic and external investments are required to ensure uninterrupted
access to a wide range of services for all (WHO, 2020b). Innovations are also key in-service delivery including use of technological approaches to improve data or information flow, deliver essential medical supplies, e-learning, disease surveillance and supportive supervision (Maharana et al., 2021). As an example, the novel RTS,S which was found to save 1 life for every 200 children vaccinated, reduction of malaria cases by 40% and significant reduction in deadly severe malaria can be delivered through the existing platform for childhood vaccination that reaches more than 80% of children (WHO, 2021b). Practical recommendations to help maintain access to high quality HIV and TB health services in the COVID-19 era include embracing community-based differentiated service delivery models, less frequent visits to a health facility with less frequent medication pick-ups, expansion of mental health strategies, offering opportunities to build back better, and an improved focus on people centered care.

In HIV, innovative examples of home delivery models exist from Africa (Nigeria, Indonesia, Laos, Nepal, and) where ART was delivered using existing community networks or private courier to avoid interrupted service delivery during the pandemic (Hoke et al., 2021). Another good example of utilising the local context to ensure continued supply of essential medicines for PL HIV. The future pandemics should find a more just, prepared, and strong health system if the lives are to be saved by prioritizing the continuity of essential services amid the COVID-19 pandemic remains crucial (Gavi et al., 2021). The One Health approach provides valuable platform to effectively prepare and respond to zoonotic health threats through a multisectoral human-environmental-animal health approach (Ung et al., 2021; Zumla et al., 2016). It is important that other infectious diseases which also impact a high burden on health services in Africa are not sidelined by COVID-19 epidemic (Kapata et al., 2020).

### Table 1

| Issue | COVID-19 related impact | Projections for 2021/2022 |
|-------|-------------------------|-------------------------|
| Tuberculosis -global (WHO, 2021a) | • >100,000 TB deaths among HIV negative (+100000) and HIV positive (+5000) | |
| Malaria - global (WHO, 2021b) | • 14 million more cases in 2020 compared to 2019  
• 69,000 more deaths; 47 000/69,000 malaria were linked to disruptions in the provision of malaria prevention, diagnosis and treatment during the pandemic. | |
| HIV/AIDS – Model estimates (Jewell et al, 2020) | • Assuming disruption for 50% of the population over a 1 year period:  
  o 1•06 times increase in HIV-related deaths;  
  o 1•19 times increase in new HIV infections | |
| Financing/resources – Foreign and domestic | • Diverted and redirected to COVID-19 response | |
| Economic performance – Africa (Gondwe, 2020 [https://unctad.org/system/files/official-document/aldcmsic2020d1_en.pdf]) | • Overall 1.4% decline in GDP  
  o Smaller economies facing contraction of up to 7.8% | |
| Health services utilisation -Africa (Tessema et al, 2021) | • Reduced service utilisation  
• Repurposing of services and facilities | |
| Health service disruptions – Selected African countries (Shapira et al, 2021) | • >= 1 month, OPD 10-25% decline,  
• Variations in patterns of service disruptions across countries | |
Further, innovations in financing are key to improve financing levels to support full implementation of prioritised activities. For example, the GFATM has used different innovations to raise up to USD50 billion as of June 2021 to support both programs and health system strengthening (The Global Fund, 2021b). The GFATM has also made available funding for both country and regional grants, increased the role of both domestic and private sources of financing while maintain transparency and accountability. The Fund continues to be responsive to emerging needs by providing ‘above allocation’ funding either to support country attainment of strategic targets or pandemic related responsive mechanism to avoid disruption to TB, HIV and malaria services (The Global Fund, 2021b).

In conclusion, the ongoing COVID-19 pandemic has disrupted health services generally and led to diversion of resources away from tuberculosis, HIV and malaria services at various levels. There is an urgent need to address this by strengthening health systems, providing needed financial resources, renewed political leadership and foster collaborations. Evidence-based cost-effectiveness interventions need to be scaled-up and include community-based differentiated service delivery models, less frequent visits to a health facility with less frequent medication pick-ups, expansion of mental health strategies, offering opportunities to build back better, and an improved focus on people centered care. Finally, innovations in service delivery and technological adaptations remain critical as countries aim to limit disruptions to routine services.

Transparency declaration
This article is part of a supplement entitled Commemorating World Tuberculosis Day March 24th, 2022: “Invest to End TB. Save Lives” published with support from an unrestricted educational grant from QIAGEN Sciences Inc.

Conflict of Interest
All authors have no conflicts of interest to declare.

Author Contributions
PC-K, FN, NK and AZ conceptualised and drafted the manuscript. PSL, LAM, JC, JT, CH, RA, DA, SM, PN and PM contributed to discussions and provided further inputs in writing the manuscript.

Acknowledgements
P C-K, FN, NK, AZ are co-investigators or collaborators on the Pan-African Network on Emerging and Re-Emerging Infections (PANDORA-ID-NET – https://www.pandora-id.net/) funded by the European and Developing Countries Clinical Trials Partnership the EU Horizon 2020 Framework Programme. AZ, FN, TV and TMC acknowledge support from EDCTP CANTAM-3. Sir Zumla is a Mahathir Science Award and EU-EDCTP Paschal Mucumbi Prize Laureate. FN is coordinator of the Central Africa Clinical research Network, CANTAM (www.cantam.org). PSN is an Investigator on the COVID-19 Africa Rapid Grant Fund. J.B.N. is an infectious disease internist and epidemiologist and Principal Investigator of NIH/FIC grant numbers 1R25TW01217-01; 1R21TW011706-01 435 and 1D43TW010937-01A1. He is also Chairman of the AFREhealth Research Committee, served on the scientific program committee of the American Society of Tropical Medicine and 437 Hygiene (ASTMH), and is a senior fellow alumnus of the European Developing Countries Clinical Trial Partnership (EDCTP).

Funding Source
The authors did not receive any funding for this work.

Ethical Approval Statement
Ethics clearance was not required as the information contained in this Viewpoint was accessed from publicly available information using online searches.

References
Afuom T, Asare P, Asante-Poku A, et al. Diagnosis of tuberculosis among COVID-19 suspected cases in Ghana. PLoS One 2021;16(12) Published 2021 Dec 28. doi:10.1371/journal.pone.0263849.
Alene KA, Wangdi K, Clements ACA. Impact of the COVID-19 Pandemic on Tuberculosis Control: An Overview. Trop Med Infect Dis 2020;5(3):123. doi:10.3390/tropicalmed5030123.
Aminio F, Lambert B, Magia A, et al. A Review of prospective pathways and impacts of COVID-19 on the accessibility, safety, quality, and affordability of essential medicines and vaccines for universal health coverage in Africa. Global Health in 2021;17(42). doi:10.1186/s12992-021-00666-8.
Barnett-Page R, Everard M, Verdonck K, Hausmann-Muela S, Gryspeerds C, Muela Ribera J, Peeters Grietens K. Defining micro-epidemiology for malaria elimination: systematic review and meta-analysis. Malar J 2017;16(1):164 Published 2017 Apr 20. doi:10.1186/s12936-017-1750-9.
Cella W, Baia-da-Silva DC, Mello GC, et al. Do climate changes alter the distribution and transmission of malaria? Evidence assessment and recommendations for future studies. Rev Soc Bras Med Trop 2019;52 PMID: 31800921. doi:10.1590/0085-8519-2019-0359-3.
Chapman HJ, Veras-Estévez BA. Lessons Learned During the COVID-19 Pandemic to Strengthen TB Infection Control: A Rapid Review. Glob Health Sci Pract 2021;9(4):564–77 Published 2021 Dec 21. doi:10.9745/GHS-D-21-00368.
Churcker T, Lissendes N, Griffin JT, et al. The impact of pyrhythm resonance on the efficacy and effectiveness of bednets for malaria control in Africa. Elite 2016;5:e10690 PMID: 27547988; PMCID: PMC5002572. doi:10.5554/ejfe.16090.
Dorward J, Khobane T, Gate K, et al. The impact of the COVID-19 lockdown on HIV care in 65 Sub-Saharan African primary care clinics: an interrupted time series analysis. Lancet HIV 2021;8(3):e158–65 Epub 2021 Feb 4. PMID: 33549666. doi:10.1016/S2213-2600(20)30359-3.
El-Sadr WM, Justman J. Africa in the Path of COVID-19. N Engl J Med 2020;383(3):e11 Epub 2020 Apr 17. PMID: 32302075. doi:10.1056/NEJMp2008103.
Gavi S, Tapera O, Mberikunahje J, Kanyangarara M. Mortalidad and incidence in mortality in Zimbabwe during the COVID-19 pandemic: analysis of routine surveillance data. Malar J 2021;20(1):233. doi:10.1186/s12936-021-03770-7.
Gondwe C. Assessing the Impact of COVID-19 on Africa’s Economic Development. UNCTAD/ALDIC/MISC/2020/3 Accessed 4th February 2022 at https://unctad.org/system/filesofficial-document/aldicms202003_en.pdf.
Hoke T, Bateganya M, Toyo O, et al. How Home Delivery of Antiretroviral Drugs Ensured Uninterrupted HIV Treatment During COVID-19: Experiences From Indonesia, Laos, Nepal, and Nigeria. Glob Health Sci Pract 2021;9(4):798–89 PMID: 34393391; PMCID: PMC8991873. doi:10.5554/gjhs.21-01606.
Holzman CW, Godfrey E, Pelto EN, et al. In Protecting and Leveraging HIV Services in the COVID-19 Response in Africa [published online ahead of print, 2022 Jan 4]. Curr HIV/AIDS Rep 2022;11:1. doi:10.1007/s11904-021-00587-6.
Inzauale SC, Onolua P, Loembe MM, Tebeje YK, Osuna AEO, Nkengasong JN. COVID-19 and indirect health implications in Africa: Impact, mitigation measures, and lessons learned for improved disease control. PLoS Med 2021;18(6) PMID: 34181318; PMCID: PMC8266084. doi:10.1371/journal.pmed.1003666.
Jewell BL, Mudimu E, Stover J, et al. Potential effects of disruption to HIV programmes in sub-Saharan Africa caused by COVID-19: results from multiple mathematical models. Lancet HIV 2020;7(9):e629–40 Epub 2020 Aug 6. PMID: 32771089; PMCID: PMC7462434. doi:10.1016/S2213-2600(20)30211-3.
Kapata N, Bekweimbi C, Ntoumi F, et al. Is Africa prepared for tackling the COVID-19 (SARS-CoV-2) epidemic. Lessons from past outbreaks, ongoing pan-African public health efforts, and implications for the future. Int J Infect Dis 2020;93:233–6. doi:10.1016/j.ijid.2020.03.013.
Lindsay SW, Thomas MB, Kleinschmidt I. Threats to the effectiveness of insecticide treated bednets for malaria control: thinking beyond insecticide resistance. Lancet Glob Health 2021;9(9):e1325–31 Epub 2021 Jun 30. PMID: 34216565. doi:10.1016/S2214-109X(21)00216-3.
Loembe MM, Nkengasong JN. COVID-19 vaccine access in Africa: global distribution, vaccine platforms, and challenges ahead. Immunity 2021;54(7):1353–62 PMID: 34260880; PMCID: PMC8276532. doi:10.1016/j.immuni.2021.06.017.
Marahana A, Amutome M, Sengeh MD, Nkhoesio ED. COVID-19 and beyond: Use of digital technology for epidemic response in Africa. Sci Afr 2021;3:610414. doi:10.1016/j.scafi.2021.e0104.
Matoes R, Fonseca KL, Mereteir S, et al. Mycobacterium tuberculosis Infection Up-Regulates Sialyl Lewis X Expression in the Lung Epithelium. Microorganisms 2021;9:899. doi:10.3390/microorganisms9080899.
McQuaid CF, Vassall A, Cohen T, Fiekert K, White RG. The impact of COVID-19 on TB: a review of the data. Int J Tubere Lung Dis 2021;25(6):436–46. doi:10.5588/ijtld.21.0148.
Nacchega JB, Sam-Agudu NA, Machekano RN, et al. Assessment of Clinical Outcomes Among Children and Adolescents Hospitalized With COVID-19 in 6 Sub-Saharan African Countries. JAMA Pediatr 2022 Published online January 19. doi:10.1001/jamapediatrics.2021.6436.

Nacchega JB, Sam-Agudu NA, Maselka R, et al. Addressing challenges to rolling out COVID-19 vaccines in African countries. Lancet Glob Health 2021;9(6):e746–8 Epub 2021 Mar 10. PMID: 33713633; PMCID: PMC7946417. doi:10.1016/S2214-109X(21)00089-8.

Nyamuririra AU, Scholten JN, Cidado M, Suarez PG. COVID-19 Diagnosis in Low-and-Middle-Income Countries: the big new bull disrupting TB and HIV diagnostic services. J Mol Diagn 2022 [Epub ahead of print] PMCID: PMC8810266. doi:10.1061/jmjddx.2021.12.008.

Saunders MJ, Evans CA. COVID-19, tuberculosis and poverty: preventing a perfect storm. Eur Respir J 2020;56(1) Published 2020 Jul 9. doi:10.1183/13993003.01348-2020.

Shapira G, Ahmed T, Drouard SHP, Fernandez PA, et al. Disruptions in maternal and child health service utilization during COVID-19: analysis from eight sub-Saharan African countries. Health Policy and Planning 2021, 36(7):1140–1151, https://doi.org/10.1093/heapol/czaa064.

Stover J, Kelly SL, Mudimu E, et al. The risks and benefits of providing HIV services during the COVID-19 pandemic. PLoS One 2021;16(12) PMID: 34941876; PMCID: PMC8699979. doi:10.1371/journal.pone.0260820.

Tamnuti JI, Ayele BT, Shumba CS, et al. Implications of COVID-19 in high burden countries for HIV/TB: A systematic review of evidence. BMC Infect Dis 2020;20:744. doi:10.1186/s12879-020-05450-4.

Tessema GA, Kinfu Y, Dachew BA, et al. The COVID-19 pandemic and healthcare systems in Africa: a scoping review of preparedness, impact and response. BMJ Glob Health 2021;6(12), doi:10.1136/bmjgh-2020-007179.

The Global Fund (2021a). TB Testing in 2020 Drastically due to COVID-19. Accessed 14th January 2022 from https://www.theglobalfund.org/en/news/2021-03-24-tb-testing-in-2020-dropped-drastically-due-to-covid-19/.

The Global Fund (2021b). The Global Fund Results Report. Accessed 25th January 2022 from https://www.theglobalfund.org/en/results/.

Tiemersma EW, van der Werf MJ, Borgdorff MW, et al. Natural history of tuberculosis: duration and fatality of untreated pulmonary tuberculosis in HIV negative patients: a systematic review. PLoS One 2011;6(4):e17601 Published 2011 Apr 4. Ung L, Stothard JR, Phalkey R, et al. Towards global control of parasitic diseases in the Covid-19 era: One Health and the future of multisectoral global health governance. Adv Parasitol 2021;144:1–26 Epub 2021 Oct 11. PMID: 34696842; PMCID: PMC8503781. doi:10.1016/bs.apar.2021.08.007.

United Nations Sustainable Development Group. Policy Brief: Impact of COVID-19 in Africa. Accessed 3rd February 2022 at https://unsg.un.org/sites/default/files/2020-05/Policy-brief-Impact-of-COVID-19-in-Africa.pdf.

Weiss DJ, Bertozzi-Villa A, Rumisha SF, et al. Indirect effects of the COVID-19 pandemic on malaria intervention coverage, morbidity, and mortality in Africa: a geospatial modelling analysis. Lancet Infect Dis 2021;21(1):59–69. doi:10.1016/S1473-3099(20)30700-3.

World Health Organisation (WHO) (2020a). Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19), Accessed 6th February 2022 at https://www.who.int/docs/default-source/coronaviruse-who-china-joint-mission-on-covid-19-final-report.pdf.

World Health Organisation (WHO) (2020b). WHO calls for reinvigorated action to fight malaria. Accessed 14th January 2022 at https://www.who.int/news/item/30-11-2020-who-calls-for-reinvigorated-action-to-fight-malaria.

World Health Organisation (WHO). Global tuberculosis report 2021. Geneva: World Health Organization; 2021a. Licence: CC BY-NC-SA 3.0 IGO. Accessed 14th January 2022 at https://www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2021.

World Health Organisation (WHO) (2021b. World malaria report 2021. Geneva: World Health Organization; 2021. Licence: CC BY-NC-SA 3.0 IGO. Accessed 14th January 2022 at https://www.who.int/teams/global-tuberculosis-programme/reports/world-malaria-report-2021.

Worldometers, COVID-19 COVID-19 PANDEMIC Accessed 7th February 2022 at https://www.worldometers.info/coronavirus/.

Zumla A, Dar O, Kock R, et al. Taking forward a ‘One Health’ approach for turning the tide against the Middle East respiratory syndrome coronavirus and other zoonotic pathogens with epidemic potential. Int J Infect Dis 2016;47:5–9.