Malaria, HIV and TB in the Democratic Republic of the Congo: Epidemiology, disease control challenges and interventions

Luchuo Engelbert Bain and Darja Dobermann
Senior Associate Consultants, A.I.S.E Consulting
29 March 2022

Question

What is the evidence on epidemiology (including demographic and geographic inequalities) and disease control challenges of malaria, HIV and TB in Democratic Republic of Congo (DRC); and on the effectiveness of interventions aimed at preventing, detecting and treating these diseases in DRC?

Contents

---

1. Summary

Malaria, human immune deficiency virus (HIV) and tuberculosis (TB) are leading causes of death and public health threat to millions in Democratic Republic of Congo (DRC). The DRC is the second most malaria affected sub-Saharan African country after Nigeria, with malaria being the leading cause of death in children under 5 years (Lechthaler et al., 2019). The HIV prevalence in the country in the adult population stands at 1%, with extensive variations by region (UNAIDS, 2021c). The DRC is considered a high burden country for TB and HIV infection (Linguissi et al., 2017). This rapid review emphasizes significant elements of the epidemiology of malaria, HIV, and TB in DRC, as well as limitations in prevention, detection, and treatment, and examines a few interventions that aim to address these limitations. Evidence utilised is a mixture of the most recent grey literature NGO (programme reports and related documents) literature supplemented by peer reviewed academic literature from the past five years and national survey data when available. Although the clinical disease aspects of malaria, HIV and TB are well-researched there is less research available on socio-demographic variation, disease control challenges and interventions targeting these in the DRC.

Part I: Epidemiology

Demographic variation: The epidemiological profiles of malaria, HIV and TB are closely related to socioeconomic and sociocultural factors in DRC, with the poor disproportionately impacted largely due to limited access to appropriate care (Ma et al., 2017; Otuli Noël et al., 2020; WHO & ENGAGE TB, 2021). Increasing age, female sex, increasing education and increasing wealth have been identified as individual protective factors against malaria infection (Deutsch-Feldman et al., 2020; Emina et al., 2021). HIV prevalence is seen at higher rates in women, with twice as many young women aged 15-24 years infected (0.4%) as young men of the same age (0.2%) (UNAIDS, 2020). Female sex workers, a key population in the DRC, recorded an HIV prevalence rate eight times the national rate (8.2%), with the majority of cases in those aged 25-34 years old (Kakisingi et al., 2020). The prevalence of TB in DRC is 11% among children aged 0-14 years (CDC, 2021a).

Geographic variation: Research on public health risks of humanitarian crises in DRC highlights that investment policies and provision of public services have been focused more in the south-west regions such as Kinshasa and Lingwala and less in the south and north regions of Kivu where the war is still ongoing (Mitchell et al., 2022; Tworek, 2018; WHO, 2018a). Studies reveal that the malaria prevalence estimates by province ranged from 6.7% in North-Kivu to 58.3% in Bas-Uele (Deutsch-Feldman et al., 2020). The prevalence of congenital malaria in Kisangani was 13.98% contributing to low birth weight of new-borns and perinatal mortality (Otuli Noël et al., 2020). In the case of HIV the opposite pattern is generally seen, with higher prevalence in urban centres; Kinshasa, the capital city of DRC, accounted for an estimated 11%. In Eastern DRC where war is ongoing since 1996, the prevalence of TB/HIV coinfection was estimated to be 8.3% (Baduru et al., 2018; Pour et al., 2020).

Part II: Disease control challenges

Sectoral challenges – health systems and capacity: There is acknowledgement that institutional, organisational and managerial capacity needs to be built to strengthen the management of the malaria programme in the DRC (U.S. President's Malaria Initiative Democratic Republic of the Congo Malaria Operational Plan FY 2022, 2022). The National TB

Control Program (NTCP) of the DRC faces significant operational, resource and structural challenges. These challenges include limited staffing, limited TB diagnostic methods, crowded facilities and poor infrastructure and resources (Linguissi et al., 2017). The distance between health facilities and communities remains a major challenge, particularly for people in poor communities who cannot afford transportation and for those who can, the consultation fee remains a burden. Reducing economic barriers, such as through a referral voucher that allows for reduced-cost consultations, can be critical in improving access to health services, particularly for people who are experiencing extreme poverty (WHO & ENGAGE TB, 2021). Poor infrastructure, such as inadequate roads and a lack of electricity and water at many health facilities, makes it more difficult to access healthcare services in general (PEPFAR, 2017).

Vertical care challenges: The number of people who are diagnosed with TB is extremely low in DRC, especially among children and people living with HIV (PLHIV). In 2018, it was estimated that 56% of TB cases went undiagnosed and untreated; TB case detection has been stagnant for more than 10 years in DRC (WHO & ENGAGE TB, 2021). TB is the fourth leading cause of death in the DRC, with the highest mortality rate of 47.73% among HIV-infected children compared to 17.02% among HIV-uninfected children (Mukuku et al., 2019). There is a critical need to conduct thorough TB screening among PLHIV (CDC, 2021a).

Surveillance challenges: It is challenging to control epidemics if a large percentage of those infected remain undiagnosed and untreated (WHO & ENGAGE TB, 2021). While surveillance systems are in place for Ebola there is limited evidence of a national level surveillance efforts for HIV, TB or malaria outside of partner funded or supported activities such as the DHS.

Informational challenges and stigma: The level of information regarding malaria, HIV and TB modes of transmission, prevention and treatment still remain low in DRC. The lack of knowledge about TB in the general population and high-risk groups is a major health information challenge to TB control efforts (WHO & ENGAGE TB, 2021). Additionally, stigma due to HIV persists in the DRC and many people still believe that HIV and TB infection is associated with the occult (Carlos et al., 2015; WHO & ENGAGE TB, 2021). Additionally, inadequate knowledge of vertical transmission and underutilization of maternal and child health services contribute to an increase in the incidence of paediatric HIV among antenatal women (Whembolua et al., 2019). Current socio-cultural norms continue to associate HIV disease with negative moral connotations, resulting in stigma and discrimination and lower health care seeking behaviour (The Global Fund, 2018).

Emerging threats to disease management: Increased evidence of malaria vector mosquitoes exhibiting resistance to pyrethroid-based insecticides, the primary insecticides utilized in bed nets and spraying, present a threat to current malaria control strategies (U.S. President's Malaria Initiative Democratic Republic of the Congo Malaria Operational Plan FY 2022, 2022; Wat'senga et al., 2018). Across the DRC mosquito populations vary widely and have different feeding behaviours, biting rates, and vectorial capacity and sensitivity, which influence country transmission dynamics and control strategies, however these are difficult to track without accurate entomological surveying (Janko et al., 2018; Mitchell et al., 2022; Swana et al., 2018). Additionally, there are growing concerns with regard to drug resistance across all three diseases, which is becoming increasing prevalent in low-middle income countries (Falzon et al., 2015; Hamers et al., 2018; WHO, n.d.). Suboptimal treatment of diseases has left gaps open for

genetic mutation which have conferred resistance to commonly used drugs necessitating new control strategies and mitigation plans for increased resistance moving forward.

Part III: Interventions

Enabling environment: The DRC through le "Programme National de Lutte contre le Paludisme (PNLP)", has elaborated a strategic plan 2016-2020 as a major intervention plan to contribute effectively to the reduction of morbidity and mortality to malaria in the general population (Programme National de Lutte contre le paludisme, 2017). In DRC, three key partners lead the HIV epidemic response; the government of the Democratic Republic of Congo (GDRC), the Global Fund (GF) and the US President Emergency Plan for AIDS Relief (PEPFAR). More specifically, PEPFAR efforts are concentrated in three Provincial Health Divisions (PHDs): Kinshasa, Haut-Katanga, and Lualaba.

Integrated care: There has been emphases on aligning HIV and TB programmes for effectiveness, however, there are persistent financial and operational challenges that need to be effectively addressed to improve patient care and outcomes (Linguissi et al., 2017). The most evidence of integrative care can be seen in the space of malaria and ANC (Becker-Dreps et al., 2009; Brooks et al., 2017), although generally on a study level as opposed to national level.

Surveillance: PEPFAR is re-enforcing an index testing program particularly for men to ensure sexual contact partners of newly diagnosed women are tested by offering the full menu of partner notification services at facility and community level (PEPFAR, 2020). Efforts are also made by PEPFAR to maintain high rates of HIV testing among all presumptive and diagnosed TB patients both at health centers and community level (PEPFAR, 2020). WHO has established contact tracing for the improvement of TB prevention and control for affected households by identifying people with TB, especially in children and PLHIV. A targeted strategy was implemented in collaboration with the health centres (WHO & ENGAGE TB, 2021).

Education and communication: The International Union Against Tuberculosis and Lung Disease (The Union) implemented the Challenge TB project, funded by the United States Agency for International Development (USAID), from April 2015 to March 2019, in collaboration with local community organizations, to increase TB awareness, detection and improve TB services at the community level. The Union supported the nongovernmental organization Fondation Femme Plus (FFP) for implementation in 12 health zones in two provinces, Maniema and Kasa-Central (WHO & ENGAGE TB, 2021).
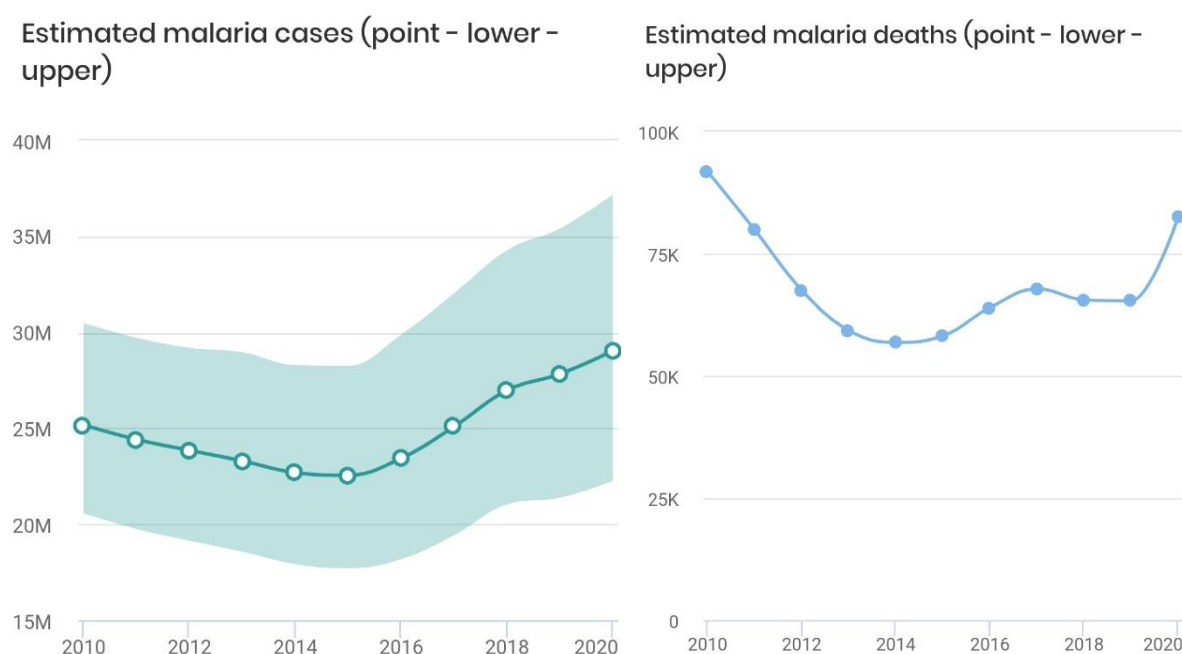
2. Epidemiology

Incidence of disease

Malaria: Malaria is endemic country-wide in the DRC, and it is the leading cause of death, particularly among children under the age of five. Globally, between 2000 and 2019, the number of cases per 1000 people at risk dropped from 368 to 222; mortality rates dropped from 30 to 13 per 100 000 people at risk; and overall malaria deaths dropped from 896,000 to 558,000. (WHO, 2021c). However, data indicates global increases in malaria mortality rates and deaths for 2020, with an estimated 68% of the estimated additional deaths due to service disruptions caused by the COVID-19 pandemic (WHO, 2021c – see Figure 1). Among the four countries accounting for

just over half of all malaria deaths globally, in 2020, DRC had the second highest mortality at 13% compared to 32% in Nigeria (WHO, 2021c). The burden of malaria in the DRC is one of the highest in the world, it had the second highest number of malaria case in the WHO Africa Region, with an estimated 29 million (22.6 million confirmed) cases in 2021 accounting for 12% of cases worldwide and 18,600 deaths(WHO, 2021c).

The incidence of malaria in DRC in children that are under-five years was 25% accounting for an estimated 11% of the global malaria burden, 40% of outpatient visits, 38% of overall morbidity and 40% of overall mortality (Emina et al., 2021; Lechthaler et al., 2019; WHO, 2020). The 2017-18 Multiple Indicator Cluster Survey (MICS) showed malaria parasite prevalence in children 6-59 months to be 38% for Rapid Diagnostic Tests (RDTs) and 31% for microscopy tests, an increase of 7% and 8%, respectively from the most recent 2013-2014 Demographic and Health Surveys (DHS) data (UNICEF, 2018)

Figure 1. Estimated malaria cases and deaths in the DRC, 2010-2020

Source: World Malaria Report 2021 reproduced under CC BY-NC-SA 3.0 IGO

HIV: HIV remains across the DRC with an estimated prevalence around 0.7% for adults aged 15-49 years old, with the highest prevalence recorded among women aged 15-49 years (1.1%) compared to men of the same age (0.4%). A recent study reported the prevalence of HIV as high as 11% in Kinshasa with the highest prevalence recorded among women aged 45-54 years (Pour et al., 2020). There are an estimated half a million people living with HIV in the DRC, of which only approximately 75% know their status (UNAIDS, 2020). Only 57% of HIV infected persons are on treatment (ONUSIDA, 2021).
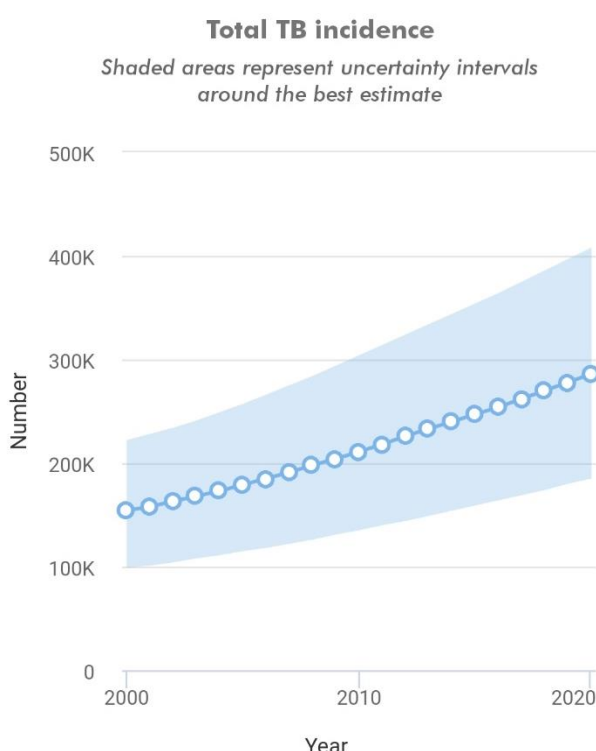
Until recent the number of new HIV infections and AIDS-related deaths has been with reductions of 32% and 52%, respectively, between 2010 and 2016 (Programme National Multisectoriel de Lutte contre le Sida (PNMLS), 2017; The Global Fund, 2018). However, the COVID-19 pandemic has placed extra stress on the health system and about 123,000 to 293,000 new HIV infections

are expected between 2022 and 2023, as well as 69,000 to 148,000 additional AIDS related deaths within the same period (UNAIDS, 2021c). Antiretroviral coverage stands at 72% and 52% among men and women respectively.

The prevalence of HIV infection among under five years children was 20.95%, which contributes to a 30% increase in mortality for these children (Mukuku et al., 2019). The DRC has a mother-to-child transmission (MTCT) rate of 29% and it is among the 19 countries targeted by the UNAIDS Global Plan to eliminate MTCT of HIV (Whembolua et al., 2019). Unfortunately, treatment coverage and prevention of mother-to-child transmission (PMTCT) remains suboptimal with only 39% of eligible women receiving antiretroviral therapy (ART) for PMTCT in 2020 (UNAIDS, 2020; Whembolua et al., 2019). This treatment coverage has only increased 6% since 2013, contributing to an estimated additional 7,400 new paediatric cases of HIV (UNAIDS, 2020; Whembolua et al., 2019).

TB: The incidence of TB in DRC is on the rise with 319 cases per 100,000 population (WHO, 2021b). According to a recent report by WHO and CDC, the estimated TB mortality rate is 60 per 100,000 population. The prevalence of TB in DRC is 11% among children aged 0-14 years and the detection rate in children from birth to five years, living in the same household as a parent with TB is very low (CDC, 2021a). Even with the increasing incidence trend the total number of TB deaths between 2015 and 2020 has decreased by 25% (WHO, 2021b).
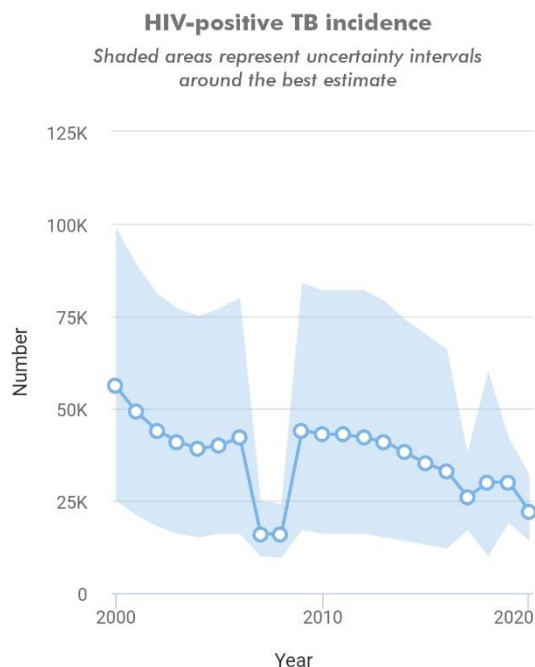
Figure 2. Total TB incidence in the DRC, 2000-2020

Source: WHO estimates, Global Tuberculosis Report 2021 reproduced under CC BY-NC-SA 3.0 IGO

Malaria/HIV: The incidence of malaria in the DRC remains very high and is of public health concern. Due to the high incidence of both malaria and HIV infections, co-infection with malaria/HIV is likely to occur (Mahittikorn et al., 2021). Malaria/HIV co-infection have been linked to negative outcomes in pregnant women and their babies. Adults who are HIV-positive have a higher risk of developing severe malaria and nearly all malaria/HIV co-infected patients develop anaemia (Mahittikorn et al., 2021). A 2020 study reported an 88.9% prevalence of malaria in children under five years and malaria/HIV co-infection accounted for 29.2% of those. In children aged greater than 12 months, HIV prevalence was reported to be 29.3%, 6.8% had undernutrition and HIV and 4.3% had undernutrition, HIV and malaria (Jacques et al., 2020). The overall mortality rate was 18.4%, which was reported to be higher in children with malaria/HIV co-infection at 39.6%. A recent study reported the pooled prevalence of severe malaria in patients with Plasmodium spp. and HIV co-infection to be 42.0% (Mahittikorn et al., 2021).

TB/HIV: Despite some progress, TB remains the number-one killer of people living with HIV in the DRC (WHO & ENGAGE TB, 2021). There has been a shift in the percent of TB patients with known HIV status from approximately 50% in 2015 to 75% in 2020 (WHO, 2021b). WHO estimates indicate that 12% of TB positive people were living with HIV in 2018 and 40% of people living with HIV were receiving TB treatment in 2017, up from 22% in 2015 (WHO & ENGAGE TB, 2021). 88% of HIV-positive TB patients are on ART (WHO, 2021b).

A study in DRC was conducted across 241 clinics to analyse variation in TB/HIV co-infection and risks of negative outcomes among patients with TB/HIV co-infection compared to those without coinfection. It was shown that the proportions of patients with TB/HIV co-infection were 4.5% in men and 3.3% in women; TB/HIV co-infection increased the risk of death and loss to follow up treatment and TB/HIV co-infection decreased the odds of viral load suppression (Shah et al., 2021). In another study data of 1368 patients were noted from three TB Health Centers for Diagnosis and treatment (HCDT) in Lubumbashi health zone and among them 334 cases of TB/HIV co-infections were recorded and the man/women sex ratio was 1.70. In this study, 51 cases of deaths were recorded among which 23 (45.10%) were HIV-positive while 28 (54.90%) were HIV-negative (Wa Ilunga et al., 2018). In Butembo town, the prevalence of TB/HIV co-infection was reported to be 18.3%, with female patients at highest risk of developing TB/HIV coinfection in this context (Baduru et al., 2018). Data on co-infection in children and adolescents is sparse and their knowledge of their own status and adherence to treatment is at the mercy of their caregivers (Shah et al., 2021).

Figure 3. Estimated HIV-positive TB case incidence in the DRC, 2000-2020

Source: WHO estimates, Global Tuberculosis Report 2021 reproduced under CC BY-NC-SA 3.0 IGO

Demographic variation

Socioeconomic status

In the DRC, despite its vast land and abundant natural resources, 63% of the population remains impoverished, and economic inequality among the population is widening (JICA, 2017). Malaria and poverty have a strong ecological link that makes them mutually amplifying. Due to limited access to health care, the poor suffer disproportionately more from malaria-related morbidity and mortality than the general population (Ma et al., 2017).

Protective/Risk factors: The prevalence of malaria in children of mothers with no education, primary school, and beyond primary was 30%, 17%, and 15%, respectively (Ma et al., 2017). Wealthier households have significantly lower odds of malaria, potentially owing to the construction of their houses (Carrel et al., 2021). Additionally, larger household size and absence of periodic WASH interventions coupled with inappropriate water sources were associated with an increase in malaria prevalence (Carrel et al., 2021; Ngatu et al., 2019).

Some similar associations have been noted for HIV, with those presenting as HIV-positive to be more likely to have a low-socioeconomic status, no education, and misinformation about HIV transmission (e.g. it is transmitted by sorcery) in one study (Carlos et al., 2015). However, data from the two most recent DHS surveys, 2007 and 2013-2014 negates this. Data from the 2007 DHS originally showed the highest HIV prevalence in women with higher than secondary education (3.2%), whereas for men the highest prevalence was seen in those with secondary

education (1.2%) (DHS, 2008). Though by the 2013-2014 DHS survey this trend was no longer visible with prevalence fairly evenly distributed across education levels (DHS, 2014). Again, unlike in malaria, among women, HIV prevalence tends to increase with increasing household wealth, but stays fairly stable regardless of household wealth for men (DHS, 2014).

No data focused on the DRC could be found with regard to protective/risk factors related to TB.

Age-based variation

With regard to age, there is increasingly conflicting evidence on where the highest burden of malaria disease is concentrated. Historically it has been assumed that children under 5 carry a disproportionate burden of malaria in the DRC, with 40% of deaths attributed to malaria (Brooks et al., 2017; Dolan et al., 2019). One study on malaria infection among children in DRC found that children under five years are more likely to develop malaria infection with increased infection observed among children sleeping in the same bedroom (Ma et al., 2017). However, there is evidence that older children and adolescents may bear the highest burden, also including asymptomatic diseases. Reanalysis of PCR data from the 2013-2014 DHS and additional data from an on-going longitudinal study showed that adolescents aged 10 to 14 years old had the highest malaria prevalence followed by 5 to 9 year old children (Deutsch-Feldman et al., 2021). Similarly, other research has demonstrated an increase in malaria prevalence between the ages of 5 to 15 years old, potentially owing to a decrease in use of bed nets and increased time outside in the evenings (Carrel et al., 2021; Mwandagalirwa et al., 2017).

In a 2014 study, children account for just under 10% of overall TB incidence with the majority of cases seen in adults age 15-44 years old (Loukia et al., 2016). Data for 2020 echoes this with approximately 13% of TB incidence in children 0-14 years old (WHO, 2021b). For HIV, the infection rate increases with age, regardless of gender (DHS, 2014). The prevalence of HIV infection among under five years children was 20.95% with the highest mortality rate observed in HIV-infected children (47.73%) compared to HIV-uninfected children (17.02%) (Mukuku et al., 2019).

Co-infection and age have also shown an interaction. The mortality rate increases among children co-infected with malaria/HIV (39.6%) compared to children only infected by HIV (12.2%); and 29% of children with a high parasite load have malaria/HIV coinfection (Jacques et al., 2020).

Gender and key populations

Adolescent girls and young women face legal and sociocultural limitations to HIV services, including a law that sets the legal capacity age at 18 years old, which includes independent access to HIV and other sexual and reproductive health services. As a result, those who are sexually active face significant stigma from health care providers, as well as occasional refusals to provide needed services (The Global Fund, 2018). Many children under 18 will avoid going to health facilities if parental consent is required rather than share confidential information about their sexual health needs with their parents. Survivors of sexual and gender-based violence, particularly those who are HIV-positive, face high levels of stigma and shame within their families and communities, which has a negative impact on service uptake and retention for those in need of ART (The Global Fund, 2018).

In 2016, there were 381,187 HIV-positive people in the country, with 224,673 (59%) of them being women (The Global Fund, 2018). By the end of 2021, the pandemic and the impact of anti-coronavirus measures are expected to have pushed 47 million girls and women globally into extreme poverty. Making HIV-positive young women even more vulnerable, disrupting vital sexual and reproductive health services, increasing domestic violence and undoing more than a decade of progress in the fight against HIV and TB (The Global Fund, 2021; Cordaid, 2020).

Key populations: Key populations (KP) in the DRC include: PLHIV, men who have sex with men (MSM), transgender, female sex workers (FSWs), people who inject drugs (PWID) and prison inmates (The Global Fund, 2018). These populations were selected on the basis of The Global Fund criteria; the populations that the DRC defines as key and vulnerable populations within its national strategic frameworks for the multi-sectoral HIV and TB responses; and the guidance of the DRC Country Coordinating Mechanism (CCM). Although there is insufficient data on the location, typology, and dynamics of key populations and high-risk groups, HIV prevalence among FSWs is estimated at 5.4% in Kinshasa, 7.4% in Lualaba, 8.2% in Lubumbashi and 4.6% in Katanga, with most of the HIV positive FSWs between the age 25-34 years (45.7%) (FHI 360, 2020; Kakisingi et al., 2020)
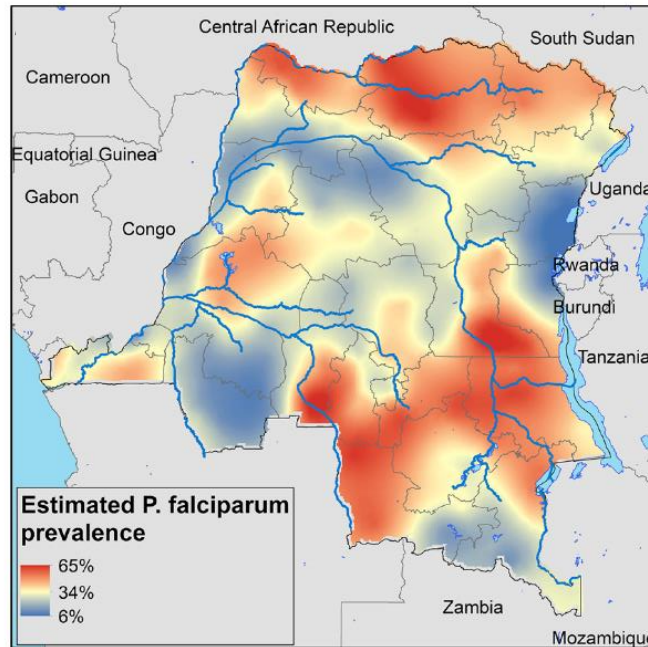
Geographic variation

Regional and state variation

Despite recent improvements in malaria, HIV and TB intervention coverage, the DRC continues to face barriers to accessing preventive and curative malaria interventions, as well as a climate that encourages high transmission rates. Funding constraints, infrastructure issues, and insecurity are all major barriers to achieving the intervention coverage required to protect vulnerable populations (WHO, 2018a).
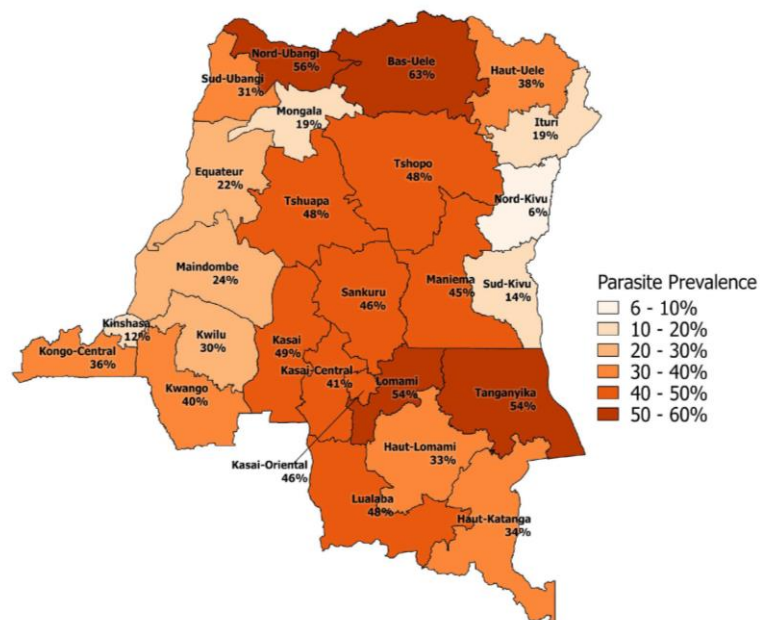
Malaria: Community prevalence estimates range across the DRC from 0 to 76% (see Figure 5) and are associated with several factors (Deutsch-Feldman et al., 2020). In northeast DRC, malaria is the main cause of consultation in 37% of all pathologies and the cause of death in 30% of cases (Otuli Noël et al., 2020). The distribution of malaria prevalence in children aged 6 to 59 months in DRC is heterogeneous, with the highest prevalence in Binza Ozone (31.6%), Kimbanseke (24.9%) and Mont Ngafula II (24.%) compared to Kinshasa (0.5%) and Lingwala (0.5%) (Ferrari et al., 2016). The prevalence of congenital malaria was 13.98%; 69.23% of newborns who contracted congenital malaria were from 18-34 year old mothers and 7.69% from HIV-positive mothers (Otuli Noël et al., 2020). Although malaria is often considered a paediatric disease as the majority of deaths occur among children (Deutsch-Feldman et al., 2020; WHO, 2021c), prevalence in adults in a 2020 study was very high (30.3%) ranging provincially from 6.7% to 58.3%. Several factors, such as altitude, temperature and urbanization, are the most likely causes of the high and low prevalence of malaria. Malaria was shown to be rare in the north-eastern mountainous regions of Kivu, compared to the mining districts of the south (Deutsch-Feldman et al., 2020). Malaria prevalence was found to be higher in the north and south-eastern regions of the DRC, and lower along the eastern border and throughout the Congo River basin, according to a predicted surface map by Mitchell et al. (2022). The prevalence of malaria was 7.5% higher in children living at altitudes less than 1000m than in those living at 1000m or more and 38.7% in children living in rural areas (Janko et al., 2018).

Figure 4: Estimated prevalence of *Plasmodium falciparum* (malaria causing parasite) across the DRC, 2022

Figure 5. Malaria parasite prevalence among children under 5 by province, 2017-2018

Unlike the above noted heterogeneous distribution of prevalence, there is a prominent East-West regional divide of the parasite mutations associated with specific treatment drug resistance. With

mutations associated with sulfadoxin-pyrimethamine (SP) resistance concentrated in the East of the DRC and mutations associated with chloroquine resistance found more in the West (Verity et al., 2020).

HIV: The 2013-2014 DHS data found no statistically significant difference between provinces in HIV prevalence distribution (see Figure 7) (DHS, 2014). Although there is some geographic variation in the prevalence of HIV in FSWs with an estimated 5.4% in Kinshasa, 7.4% in Lualaba, 8.2 % in Lubumbashi and 4.6% in Katanga (Kakisingi et al., 2020)

Figure 6. HIV prevalence in adults age 15-49 years by province, 2013-2014.

This figure has been remved due to copyright reasons. The full figure can be viewed at https://dhsprogram.com/publications/publication-HF55-HIV-Fact-Sheets.cfm

Source: (DHS, 2014)

TB: In the DRC, TB activities are integrated into all levels of the health system and are being implemented in 26 provinces and 519 health zones with the hopes of improving TB detection, which is a top priority in the fight to end TB. The current National Strategic Plan for TB 2021-2023, developed by the National Tuberculosis Program, directs the implementation of all TB activities (USAID, 2021a).

Rural-urban areas

Malaria: There is evidence of a rural-urban split in malaria prevalence, with higher rates of malaria detected in rural areas (Mwandagalirwa et al., 2017; Ngatu et al., 2019; Swana et al., 2018). Between rural and urban areas, the overall malaria prevalence ratio is consistently higher in rural areas (Janko et al., 2018). One study consistently found malaria prevalence to be nearly twice has high in rural (58.9%) compared to urban areas (30.6%) (Swana et al., 2018). Evidence from an on-going longitudinal data study, affirmed this finding in adolescents, with those in rural areas showing almost double the malaria prevalence compared to those in urban areas (Deutsch-Feldman et al., 2021) (see Figure 8).

Figure 7. Observed malaria prevalence by age shown by rural vs urban status

This figure has been remved due to copyright reasons. The full figure can be viewed at
https://doi.org/10.1093/infdis/jiaa650

Source: (Deutsch-Feldman et al., 2021)

Joining the DRC cross-sectional 2013-2014 DHS data with remote-sensed environmental measures and land use data for mining and logging concessions indicated that the prevalence of malaria in rural and urban areas was 36.0% and 28.5% respectively (Mitchell et al., 2022). Mining concessions were prevalent throughout the DRC, with 48% of malaria clusters (234/489) located within 15 km of one or more concessions. In this same study, the prevalence odds ratio of malaria in logging exposed rural and urban areas were 0.97% and 0.63% respectively (Mitchell et al., 2022). Evidence does not support that this increased prevalence is due to the mining or logging itself but rather to the related human migration, private and government interests and rapid expansion which have resulted in mixing of parasite populations and different approaches to malaria prevention and vector control (Mitchell et al., 2022)

HIV: While historically the highest prevalence of HIV has been seen in large urban centers, such as Kinshasa and Lubumbashi, with rurality acting as a protective factor, a spatial shift has been observed in one study between 2007 and 2013 with a noted increase in HIV prevalence in rural locations (Carrel et al., 2016). However, this shift is somewhat echoed in the two most recent DHS data sets with HIV prevalence shifting from 1.9% to 1.6% in urban settings and 0.8% to 0.9% in rural settings over the same time frame (DHS, 2008, 2014).

TB: Previous data from sub-Saharan African countries has demonstrated an increased risk of recurrent TB in rural settings (Sikalengo et al., 2018). Very limited data regarding a rural urban split specific to the DRC was available. It has however been indicated that significantly higher proportions of patients with HIV-TB co-infect are men living in urban or semi-rural health zones(Shah et al., 2021). Further, a prison setting is recognised as a high risk factor for TB. A study in the Mbuji-Mayi Central Prison with 733 inmates in 2015 reported a TB prevalence of 17.7% (Kalonji et al., 2016).

Conflict and disaster areas

The DRC is faced with conflict and disaster such as the war in north Kivu, Ebola outbreaks and COVID-19. Insecurity within north Kivu continues to directly impact the humanitarian community which hampers the vital assistance of different health programs that would have provided support to the reduction and control of malaria, HIV and TB infections, exposing more of the DRC population to infection and high morbidity and mortality.

Many children in DRC are subjected to extreme violence, increased risk of abuse, sexual violence, and frequently live in precarious conditions with limited access to basic services necessary for their survival and development (UNICEF, 2020). Sexual and gender-based violence is common, particularly in conflict-affected provinces in DRC (Lugova et al., 2020; Lussy et al., 2021). In a recent study from the HEAL Africa Hospital in the Goma area, several patients

were received between 2013 and 2017 after sexual assault (1623 female and 93 male). Male patients were more likely present for care within the recommended 72 hours after assault compared to females, as well to test and receive post exposure prophylaxis for the prevention of HIV (Lussy et al., 2021). Survivors of sexual and gender-based violence, particularly those who are HIV-positive, face high levels of stigma and shame within their families and communities, which has a negative impact on service uptake and retention for those in need of ART (The Global Fund, 2018).

Due to the on-going conflict there are 5.5 million Internally Displaced Persons (IDPs) in DRC, the majority of which live in camps (UNICEF, 2020). IDPs and refugees in conflict zones are affected by human rights barriers to HIV and TB services (The Global Fund, 2018). Disease outbreaks are common in the DRC, putting an additional strain on the country's already frail public health and social systems. Since 2018, there have been two Ebola epidemics (including the second largest global outbreak with a reported 2,287 deaths), five Ebola outbreaks and COVID-19 (CDC, 2021b; UNICEF, 2020).

3. Disease control challenges

Sectoral challenges: health systems and capacity

Due to its large population, widespread poverty, and decades of conflict, the DRC lacks a unified and functional health system (PEPFAR, 2017, 2020). A fractured and unresponsive supply chain, inadequate laboratory and sample transport systems, slow and incomplete information management systems, and a lack of institutionalized quality assurance systems were all identified as systemic weaknesses in the PEPFAR Country Operational Plan (COP) 2021 analysis, all of which pose challenges to the program's goal of epidemic control (PEPFAR, 2021). Additionally, there is some evidence of country level policies hindering treatment. In a 2017 study, only about 84% of the 455,878 PLHIV in the DRC were eligible for antiretroviral treatment (ARV) based on the country's current criteria (Kokolomami & Kayembe, 2018).

Laboratory facilities: PEPFAR and the Global Fund are responsible for their respective geographic areas. While the PEPFAR-supported zones reached HIV viral load (VL) coverage of 84% by 2020, the national VL coverage remains alarmingly low, under 20%, despite available capacity to reach 79% coverage (PEPFAR, 2021). The program will continue to provide health care workers (HCW) sensitization training to systematically request VL tests for eligible patients to address challenges related to low demand for VL testing as evidenced by the low number of specimens collected from patients eligible for a VL test. The team will focus on patient adherence and demand for VL testing from their providers by educating, empowering, and supporting them. The program will continue to advocate for PLHIV and raise VL awareness.

The program will promote family friendly approaches such as joint appointments for the entire family and combining drug pick-up and VL specimen collection to address challenges related to low VL coverage in children (under 15 years). The program will train phlebotomists to make paediatric specimen collection easier and to ensure that proper paediatric collection materials are available. Point of care VL instruments will be strategically placed targeting high volume ANC clinics to address challenges related to low coverage in pregnant and breastfeeding women (PBFW), infants, and children (PEPFAR, 2021). Emphasis will be placed on the correct filling of the viral load request form to ensure PBFW status is well captured.

Pharmacy supply chain challenges: There is an increasing body of evidence demonstrating that the ACT drugs available in the DRC do not meet quality assurance standards i.e. WHO pre-qualified, approved by European Medicine Agency or in compliance with Global Fund Quality Assurance Policy/on Global Fund list of approved products for procurement. One study found that while there was a significant decrease in the availability of non-quality assured ACT drugs in the public sector (decrease from 25.5% to 11.3% between 2013 and 2015 in Katanga), there was simultaneous significant increase in their availability in the private sector reaching almost 83% in Katanga (ACTwatch Group et al., 2017). The majority of these drugs were imported from outside of the DRC with local manufacturing only accounting for approximately a quarter of them. With the private sector responsible for a majority of the anti-malarial distribution in the DRC this is of particular concern (ACTwatch Group, 2016).

A similar study obtained samples of antimalarial medicines in Kinshasa peri-urban areas and found that 19% of the medicines where non-compliant with the manufacturer reported active ingredient levels. Additionally, of 124 brand names surveyed, 46% were unlicensed and almost 15% had expired licences; further only 1% of the pharmaceutical establishments had authorisation to practice (Landu et al., 2020). Similarly, a cross-sectional study from 2007-2018 found that only 63% of children under 5, based on direct clinical observation, were provided with appropriate antimalarial medication; further, less than 50% received a confirmatory blood test and the appropriate medication (Cohen et al., 2020).

Data on the quality of HIV and TB drugs is less readily available in the DRC, however there is some support that points towards a lack of quality control in the supply chains when drugs are procured in the private marketplace. There have been documented cases in the DRC where anti-depressants and muscle relaxers were sold under the names of the two most commonly prescribed ART drugs in pharmacies (Ahmad, 2004). A further analysis of first-line TB medicines across Africa, including the DRC, found that close to 17% of them failed basic quality testing checking active ingredient levels (Bate et al., 2013).

Quality of care/diagnosis: The number of people who are diagnosed with TB is extremely low in DRC, especially among children and PLHIV. Given that TB is the fourth leading cause of death in the DRC, especially among HIV-infected children (Mukuku et al., 2019), it is critical to conduct thorough TB screening, especially among children who are HIV-infected and PLHIV (CDC, 2021a). Moreover, despite the availability of national TB diagnostic algorithms, accurate diagnosis of patients with HIV/AIDS, TB, and TB/HIV coinfection is frequently delayed, resulting in high mortality rates (Linguissi et al., 2017). Although, the government of DRC has subsidized TB and antiretroviral treatments (ARV), the supply chain disruptions result in treatment failure and drug resistance. It is also important to note that there is no electronic monitoring database for HIV and TB (Linguissi et al., 2017).

There is evidence that the management of uncomplicated malaria in the DRC is characterised by limited adherence to treatment policy, namely inappropriate use of medication still hampers disease control; for example, unpublished data from Mesia et al. demonstrated that ACT was only used by 6% of healthcare providers three-years after implementation of it as the first-line treatment (Ntamabyaliro et al., 2018). A retrospective study of patient files from 2013 similarly found that the recommended ACT was only used in 54% of cases and just over half the patients had biological confirmation of malaria (Ntamabyaliro et al., 2018). As per the DRC National Malaria Control Program (NMCP), some factors, including the late and irregular attendance of

prenatal consultations (ANC) by pregnant women and the shortage of stock of Sulfadoxine-Pyrimethamine in healthcare settings, makes it difficult to control malaria among pregnant women in the DRC (Otuli Noël et al., 2020).

Surveillance challenges

Routine surveillance of disease prevalence, treatment, and adherence provides valuable information to health systems with regard to points of threat or inadequate performance. The DRC either does not have data available or data is not nationally representative for: 2017-2020 for retention on ART at 12 months (exception for 2017 when there was excellent performance noted), viral load testing coverage, viral load suppression, drug stock outs, and the proportion of people receiving second-line ART (WHO, 2021a).

Routine HIV program data reporting has improved significantly in recent years in PEPFAR-supported health zones, thanks to specific PEPFAR technical assistance investments, including the electronic, HIV-specific reporting system (PEPFAR, 2017). On the other hand, reporting on key indicators continues to be a major challenge across the country. Efforts to standardize, distribute, and train on new registers and data tools are ongoing, but gaps still exist. The country is also continuing to roll out District Health Information System 2 (DHIS2) as the national health management information system (HMIS), but implementation is still incomplete due to poor internet connectivity, slow deployment, and limited support at the health zone level (PEPFAR, 2017, 2021).

COVID-19: In low- and middle-income countries, including DRC, the COVID-19 pandemic have had significant negative impact on the provision of health services for major infectious diseases such as HIV/AIDS and TB and threatens to undo the Global Fund partnership's progress in the fight against HIV, TB and malaria, as well as in building resilient and sustainable health systems (Hogan et al., 2020; The Global Fund, 2021). It has prompted an upsurge of fear, stigma and virus shaming that is all too familiar to people living with HIV. The COVID-19 pandemic and the measures that were taken to contain it, have caused a sharp economic downturn, which had negative consequences on the national economies and people's livelihoods. COVID-19 appeared to have exacerbated existing health inequities, with the most vulnerable, marginalized, and stigmatized being left behind. The pandemic has brought the vulnerabilities that have long been considered as the structural drivers of HIV and TB transmission to the forefront undoing decades of progress in the fight against these diseases (Global HIV Prevention Coalition, 2020; UNICEF, 2020).

The demands on healthcare workers, as well as other containment and mitigation measures like lockdowns and physical distancing mandates, have made it extremely difficult to maintain the face-to-face health encounters that have long been the backbone of HIV prevention, testing, and treatment services, according to Global HIV Prevention Coalition (2020). The COVID-19 pandemic has also resulted in girls being at increased risk of sexual violence, pregnancy and early marriage: a trend that was widely observed in areas affected by Ebola during the 2014-2016 epidemic in West Africa. Risks are exacerbated for women and girls living in the poorest households in remote rural areas in the DRC which has resulted in increased HIV and TB mortality in women and girls (CASS, 2020).

Informational challenges

Misinformation, myths and misconceptions are challenges throughout disease management, but particularly in the case of HIV and TB. In a systematic study conducted in DRC, women, in particular, had little understanding of the mechanism by which feeding practices influenced HIV vertical transmission and 21% of participants were unaware of the availability and location of HIV testing services (Whembolua et al., 2019). A 2017 study, reveals that young women aged 15-19 years had low knowledge of HIV and TB mode of transmission, prevention and treatment which is one of the high risk groups as compared to women aged 20-24 years (Gebremedhin et al., 2017).

COVID-19: According to an American-based media development organization, the DRC is one of the Central African countries most affected by the COVID-19 pandemic (dos Santos, 2021). The DRC population heavily relies on unofficial sources of information, such as personal communication with family and friends. The scarcity of reliable, open information avenues catalyses the spread of rumours and misinformation (dos Santos, 2021). Misinformation regarding COVID-19 pandemic has significantly affected the DRC population and more specifically people living with HIV and TB. The Center for Disease Control and Prevention (CDC) identified people living with HIV as a population with a higher risk of severe physical illness from the COVID-19 disease than the general population (CDC, 2020).

Stigma: The stigma due to HIV, TB and COVID-19 still persists. Stigma is associated with the feelings of shame, guilt, and fear, and is often the result of a lack of knowledge or understanding of the disease. (The Global Fund, 2018). Stigmas built off myths and misconceptions hinder HIV and TB testing/diagnosis, ARV initiation and effective retention (Carlos et al., 2015; The Global Fund, 2021). Stigma and HIV have a cyclical relationship wherein people who experience stigma and discrimination are marginalized making them in turn more vulnerable to HIV and other diseases.

In a study conducted by CASS (2020) in DRC, staff reported observing older women criticising young women and adolescent girls for needing to use family planning and reproductive health services and for not abstaining from premarital sex. Hence, causing young women and adolescent girls to be afraid to visit health facilities to receive health care services. Members of key populations face a heavy burden of stigma and discrimination within their families and communities as a result of negative socio-cultural attitudes and beliefs about homosexuality, drug use, and sex work, affecting their motivation to use health services for fear of further negative abuse hence, making it very challenging for this group of people to receive ART as well as TB treatment exposing them to opportunistic infections and increasing mortality rate (The Global Fund, 2018).

Emerging threats to disease management

In a study conducted among households in DRC, 67.8% of households were found using insecticide-treated bed nets (ITN), while 14.0% used indoor residual spraying (IRS), 7.3% used ordinary bed nets (without insecticide treatment), 1.4% used mosquito repelling cream, and 2.2% combined ITN and IRS, whereas 7.3% of households did not employ any preventive measure (Ngatu et al., 2019).

However, there is increasing evidence of malaria vector mosquitoes exhibiting resistance to pyrethroid-based insecticides, the primary insecticides utilized in bed nets and spraying. This presents a threat to current malaria control strategies and may explain why, with relatively high bed net use, the DRC still carries a large malaria burden (*U.S. President's Malaria Initiative Democratic Republic of the Congo Malaria Operational Plan FY 2022*, 2022; Wat'senga et al., 2018). Throughout 2019, a series of entomological monitoring took place across 16 provinces in the DRC; pyrethroid resistance was widespread in the five provinces tested, with mosquitoes showing low susceptibility even at five times the diagnostic dose (*U.S. President's Malaria Initiative Democratic Republic of the Congo Malaria Operational Plan FY 2022*, 2022). Further studies have demonstrated similar results, with five of seven test sites showing resistance to permethrin and DDT in 2016 (Wat'senga et al., 2018).

Additionally, there are a series of mutations increasingly documented in the malaria parasite which are of concern to how the disease is controlled and treated moving forward. With regard to testing there has been evidence of deletion of a gene (*pfhrp2/3*) in the parasite which renders it undetectable by the RDTs leading to false negatives; investigations have reported evidence of this deletion in the DRC (Parr et al., 2017; WHO, 2021c).

Figure 8. Distribution of infection due to *pfhrp2/3* deletion parasites across the DRC.

This figure has been remved due to copyright reasons. The full figure can be viewed at .
https://doi.org/10.1093/infdis/jiw538

Source: (Parr et al., 2017)

In addition, the spread of resistance to anti-malarial drugs poses a substantial challenge for malaria control moving forward, in particular the mutations noted above which results in resistance to treatment with sulfadoxin-pyrimethamine (SP) and chloroquine (Yobi et al., 2022). It is anticipated that SP resistance will continue to spread with the ongoing use of SP, resulting in poorer outcomes for SP based prevention and treatment (Nkoli Mandoko et al., 2018; van Eijk et al., 2019). Resistance to SP is of particular concern as it threatens the usefulness for intermittent preventive treatment in pregnancy (IPTp-SP) (Kayiba et al., 2021).

Instances of suboptimal viral suppression in HIV treatment has also fostered the emergence of drug resistant HIV mutations (Rubio-Garrido et al., 2021; Villabona-Arenas et al., 2016). The global rate of drug-resistant HIV prevalence has been steadily increasing; the most recent survey findings in 10 sub-Saharan African countries found that nearly half of newly diagnosed infants carried drug-resistant HIV (WHO, 2021a). A 2011 study with adults in the DRC on ART for a median time of 25 months found almost 84% of individuals were resistant to at least one of the drugs in their ART regime (Muwonga et al., 2011). In a 2018 study of children/adolescents receiving ART in Kinshasa found 67% were carrying viruses with major drug resistant mutations to between 1-3 of the ARV families (Rubio-Garrido et al., 2021). Additionally, there is already evidence of transmitted resistance at a population level in Kinshasa (Kamangu et al., 2013).

TB control faces similar threats as malaria and HIV with regard to drug-resistance which is further compounded by the challenge in detecting drug-resistant TB strains (Kaswa et al., 2014; USAID, 2018). There is limited national level data on drug-resistant TB in the DRC, and some studies provide conflicting results. A 2016-2017 nationwide study covering 108 microscopy centres across 11 provinces found a prevalence of 7.2% resistance to any isoniazid drug among new cases and 23% among previously treated patients (Kayomo et al., 2020). Another study has found a steady increase in detection of TB drug resistance between 2013 and 2017, reaching a national prevalence of 2% for new diagnoses and 15.8% for retreatment cases (Murhula et al., 2019).

All of the above drug resistance threats tieback to surveillance and monitoring challenges. Routine resistance monitoring across HIV, TB, and malaria is vital to initiative rescue therapy or change control drugs to improve individual outcomes and prevent resistance spread in the DRC.

4. Interventions

Enabling environment

While epidemic control of HIV in Kinshasa is not as likely by 2022 as in Haut-Katanga or Lualaba, PEPFAR programmatic data indicates substantial potential for progress in identifying and linking individuals to treatment in Kinshasa and continued investment is essential. Performance data demonstrates that high yields, upwards of 25 percent, with index testing are possible and the increased use of risk assessment tools in other entry points is providing valuable testing efficiencies (FHI 360, 2020; PEPFAR, 2017). The strong upward trend in PLHIV in Kinshasa over 2020 is expected to continue well into 2021 and beyond. Along with intensified linkage and continuity of treatment strategies, streamlining investments to find more PLHIV in this high burden province will be essential for epidemic control in DRC (PEPFAR, 2020).

Cordaid collaborates with the Global Fund to run a nationwide program to combat HIV, TB, and malaria in the DRC (Cordaid, 2020). The DRC lacks a cohesive and functional health system due to its large population, widespread poverty, and decades of conflict. HIV and TB service delivery has become very challenging during the COVID-19 pandemic because of social distancing; reduced demand for services because community members are fearful of COVID-19 transmission in facilities; and reduced availability of services when providers are assisting with the pandemic response (FHI 360, 2020). PEPFAR's priority is maintaining essential HIV and TB prevention, testing, and treatment services; VL testing; and treatment of opportunistic infections to safeguard and prolong lives; and in PEPFAR-supported health zones, reporting of routine HIV program data has improved significantly in recent years, aided by specific PEPFAR investments in strategic information (SI) technical assistance, including the scale-up of the electronic, HIV-specific, patient-level reporting system (PEPFAR, 2021).

Training: The Global Fund selected DRC, with 19 other countries, for intensive support to scale up programmes to reduce barriers to HIV and TB services (The Global Fund, 2018). The DRC Country Operational Plan 2020 (COP20) included a new activity: community-led monitoring, which trains, supports, equips, and pays members of directly affected communities to monitor the quality and accessibility of HIV treatment and prevention services on a regular basis (PEPFAR, 2017, 2021).

The WHO & ENGAGE TB (2021) have been involved in the training of community mobilizers focused on community-based approaches to the management of TB and TB/HIV co-infected individuals, household contact tracing and home visits, safe sputum collection and transportation, community mobilization and awareness of TB, including action against stigma and discrimination, and advocacy targeting health-care providers and community leaders. Between January 2018 and March 2019, a study conducted in Kasaï-Central DRC showed that 2421 people with TB infection were identified, contributing approximately 88% (2421/2740) to the total TB notifications in the targeted areas in Kasaï-Central. The activities implemented at community level were shown to be particularly effective, as they more than doubled the number of people with TB diagnosed and treated (WHO & ENGAGE TB, 2021).

Universal coverage: Bed-nets is one important component of the malaria intervention program in the DRC. In 2007, the Ministry of Health launched a nationwide campaign to distribute ITNs and long-lasting insecticide nets (LLINs), while in 2008, the World Bank funded a program to distribute ITNs specifically to Kinshasa. Between 2007 and 2013, reported ITN and LLIN ownership increased from 28% to 72% and 9% to 70%, respectively, indicating the efficacy of the program (Deutsch-Feldman et al., 2020).

Integrated care

Despite recent advances in HIV and TB prevention and treatment access, many HIV-positive and TB people in the DRC lack access to the testing, care, treatment, and support they require to live long and healthy lives. The health-care system in DRC is currently unable to reach all those who require assistance (Elizabeth Glase Pediatric AIDS Foundation, 2018). The Management Science for Health (MSH) through the USAID-funded Integrated Health Project Plus (IHPplus), have increased the availability of health services via integrated community case management which have been able to improve health services in more than 31 million people, most notably in malaria, HIV/AIDS and TB (Management Sciences for Health, 2018). The Integrated HIV/AIDS Project (IHAP) in Kinshasa aims to meet UNAIDS' 95-95-95 targets by 2030 by focusing on HIV prevention, care, and treatment for priority populations such as TB and malnourished patients, adolescent girls and young women, HIV-positive children, pregnant women and their families, and men (Elizabeth Glaser Pediatric AIDS Foundation, 2022).

While distribution of bed nets is an evidence based approach to malaria control with proven effectiveness and ease of use in stable contexts and although nation wide ownership of at least one ITN increased from 9% to 70% from 2007 to 2013-2014 in the DRC there are still additional challenges in the unstable regions of the DRC which require an approach with more focus on the integration of malaria and HIV services into other care, such as antenatal care (ANC) (Karemere et al., 2021; Lengeler, 2004). One study in Kinshasa noted that distribution of bed nets during ANC visits contributed to averting over 500 low-birth weight babies and 400 infant deaths (Becker-Dreps et al., 2009). There is evidence from a trial in an IDP camp in Eastern DRC that integrating bed net distribution into ANC visits works to target the under five child population and resulted in higher retention of bed nets (rather than selling on) and higher utilisation when compared to bed-net only distribution efforts (Brooks et al., 2017). Women with access to ANC were also more likely to receive the recommended course of preventative SP malaria treatment; access to which is linked to higher birthweights and less placental malaria (Apanga et al., 2022).

Surveillance

Malaria prevention and control are still top priorities for the US in terms of national security and foreign aid. Malaria reduction allows governments, civil society, faith-based organizations, and the private sector in USAID partner countries to unlock economic growth and realize greater human potential, paving the way for self-sufficiency and productive partnerships with the US. The USAID collaborates closely with DRC governments to improve their ability to prevent and treat the malaria disease both in children under five years and the general population (USAID, 2021c).

An invaluable aspect of malaria control is real-time surveillance of cases including entomological surveillance to adjust control strategies of this. A recent example of the benefit this approach can be seen in Lualaba Province. Tenke Fungurume Mining made a commitment to work with local health authorities in Lualaba Province to reduce malaria morbidity and mortality. They implemented a malaria and vector control programme (MVCP) based on highly-organised and trained staff providing routine IRS of community homes, distribution of long-lasting insecticide treated nets (LLINs), routine entomological monitoring and larval source management using environmental and larvicidal approaches (Swana et al., 2018). From 2007 to 2014 the malaria prevalence was tracked via school-based prevalence surveys every six months across 43 primary schools; six months after the start of the MVCP intervention in 2009 malaria prevalence dropped from 77% to 34% (Swana et al., 2018). Although there were times when the prevalence trended upwards again, it never climbed over 50%.

Simultaneous entomological surveillance in the above intervention, with a focus on insecticide susceptibility, showed that a rise in malaria prevalence coincided with a significant increase in pyrethroid class chemical resistance. Switching vector control to the carbamate class formulation during the next round of IRS resulted in malaria prevalence dropping again (Swana et al., 2018). The above intervention is a prime example of the importance of real-time entomological monitoring and the role it plays in disease control.

The Global Fund committed to addressing human rights and gender in the context of the national HIV response in a stronger and more explicit manner in DRC, which included more specific strategies for improving the legal and socio-cultural context for HIV-related interventions for vulnerable populations (The Global Fund, 2018). Despite the fact that significant progress has been made in increasing the number of PLHIV on ART across PEPFAR-supported provinces, and statistical saturation has been achieved in a number of individual health zones in Haut-Katanga, programmatic data showing consistently high HIV testing yields suggest that true saturation has not been achieved in these areas (PEPFAR, 2020).

The National Tuberculosis Program (NTP), with support from the Global Fund and Cordaid, is actively detecting and screening TB cases in both urban and rural communities in the DRC. Detecting and screening TB have also been established in prisons and other high-risk locations with the goal of finding and treating patients while leaving no one behind (Cordaid, 2019; WHO, 2018b).

Contact tracing and index case testing of HIV and TB have proven to be particularly effective in improving HIV and TB testing and prevention in affected households and in identifying people with HIV as well as TB, especially in children and people living with HIV (WHO, 2019b; WHO & ENGAGE TB, 2021). This approach has shown to be very successful in identifying partners and contacts with HIV and TB who are undiagnosed. For instance, in 2018, 99 contacts from 143

index clients were tested for HIV and 47 (48%) were diagnosed HIV-positive (WHO, 2019a). PEPFAR also enforce index testing services of biological children under the age of 19 years born from HIV-positive mothers by carefully reviewing family trees to identify all missing children who may be exposed to HIV-infection. Additionally, health staff and lay workers will be scheduled in each high-volume facility to ensure that HIV positive women's family trees are complete. They will devise a plan and adequately document index testing for all eligible children in collaboration with the HIV-positive woman (PEPFAR, 2020).

However, in provinces like Lomami, detection rates are still low. Epidemiological data from the Lomami province revealed a notification rate of only 86 per 100,000 people, resulting in TB detection rates of 52.7% and MDR-TB detection rates of 24.4%. These low figures were expected to result in a 53.6% shortfall against USAID's Integrated Health Program's targets (IHP) (USAID, 2021b). To combat this, USAID concentrated its efforts in the Lomami province's Wikong health zone which had only a 23% detection rate due to a lack of public awareness of services, difficulties identifying the virus under microscopes in laboratories, and failure to follow National Tuberculosis Control Program (NTCP) directives on diagnosing and treating TB (USAID, 2021b). A USAID-funded TB mini-campaign was organized in Lomami province in February 2020 to increase case detection. It was found that this intervention was effective in improving TB detection rates, with the detection rate increasing from 23% to 62% in Lomami.

Key populations: The Global Fund's current activities in 2018 included conducting qualitative assessments of HIV-related stigma and discrimination among key populations, as well as among adolescents and young people; convening community dialogues with key populations and local authorities as part of the implementation of Global Fund and PEPFAR-supported interventions, in order to introduce programs and gain the support of key local authorities, including the police; and conducting public campaigns (The Global Fund, 2018).

Education and communication

Education and communication programmes are an effective way of creating awareness and improving health protective and care seeking behaviours. The education and communication programmes include teaching in a classroom, social medial, including WhatsApp, radio and television, and advertisements such as posters and fliers. Effective communication in communities should involve community mobilizers that have direct personal contact with people living in a community, as this helps to sensitize the population while passing out accurate information regarding the disease under investigation (WHO & ENGAGE TB, 2021). A study conducted by Walker et al. (2019) showed that when developing and implementing HIV education and testing programs, cultural and religious considerations should be considered as well as gender roles in the implementation of effective community trust-building and HIV education programs.

In one study, two semi-rural towns in the DRC were engaged in 1) a community participation WASH action programme aimed at elimination of mosquito breeding sites and an anti-malaria education campaign or 2) just the anti-malaria education campaign. This trial resulted in a significant reduction in the prevalence of positive RDTs for malaria in the WASH intervention site with no changes at sites which only received educational information on malaria prevention (Ngatu et al., 2021). Improved communication and increased counselling from peers via a Mentor

Mother programme was also able to significantly increase the retention of HIV positive women attending ANC services and initiating ART (Gill et al., 2018).

The WHO and ENGAGE TB project aimed at integrating TB screening into community-based HIV activities has also proven to be effective due in part to its ability to tackle misinformation. False beliefs about TB, such as the alleged link between TB and witchcraft, were replaced with accurate TB information, allowing people infected with or affected by TB to improve their health-care-seeking behaviour; particularly with regard to increased identification of TB (WHO & ENGAGE TB, 2021).

Conclusion

Factors operating at different levels affect the effective management of Malaria, HIV/AIDs and TB in the DRC. The table below summarizes these factors using the WHO health system building blocks: (i) service delivery, (ii) health workforce, (iii) health information systems, (iv) access to essential medicines, (v) financing, and (vi) leadership/governance.

Challenges in the management of Malaria, HIV/AIDS and TB

WHO six health system building blocks	Malaria	HIV/AIDS	TB
Service delivery	USAID's health program aims at providing primary health care services, strengthen the DRC's fragile health system and promote the health of vulnerable groups such as women, girls, new-borns, and children under 5 years while reducing the prevalence of diseases such as malaria, TB, and HIV/AIDS (USAID, 2022). However, this program is focus in 7 provinces out of the 26 provinces, implying a lot of work still need to be done	"The observatory" is a community-based services launched in 2013, which aimed to look at quality services to HIV/AIDS monitoring and control. Although this program has been effective in 3 provinces in DRC, there are still 23 more provinces in DRC that the program needs to be implemented (UNAIDS, 2021c; USAID, 2022)	"The observatory" is a community-based services launched in 2013, which aimed to look at quality services to HIV/AIDS monitoring and control. Although this program has been effective in three provinces in DRC, there are still 23 more provinces in DRC that the program needs to be implemented (UNAIDS, 2021c; USAID, 2022).

	for full coverage (USAID, 2022).		
Health workforce	Although data quality assurance practices have improved in DRC, resources to implement them remain limited, and follow-ups remain a constant challenge due to limited personnel (USAID & MEASURE Evaluation, 2019).	ICAP has partner with the MOH to increase access to comprehensive, quality HIV prevention, care, and treatment services in health zones and facilities throughout Kinshasa and Haut-Katanga provinces. However, the program focus in 2 provinces out of 26 provinces (ICAP, 2022).	The health workforce requires the simultaneous involvement of several ministries and departments (health, higher education, public service, budget, finance, and decentralization) which is a challenge in itself in DRC.
Health information system	Despite the fact that the district health information system 2 (DHIS 2) has significantly advanced across the DRC's health system, access is still not nationwide. In facilities that have access to DHIS 2, a lack of consistent electricity or Internet connectivity is a barrier to accurate and complete data reporting (USAID & MEASURE Evaluation, 2019).	Despite the fact that the district health information system 2 (DHIS 2) has significantly advanced across the DRC's health system, access is still not nationwide. In facilities that have access to DHIS 2, a lack of consistent electricity or Internet connectivity is a barrier to accurate and complete data reporting (USAID & MEASURE Evaluation, 2019).	Despite the fact that the district health information system 2 (DHIS 2) has significantly advanced across the DRC's health system, access is still not nationwide. In facilities that have access to DHIS 2, a lack of consistent electricity or Internet connectivity is a barrier to accurate and complete data reporting (USAID & MEASURE Evaluation, 2019).
Access to essential medicines	Access to essential medicines is improved at all levels of the health system and the USAID's health program also	The challenge is to control the distribution of free antiretroviral medicines, since the distribution of some	The frequent stockouts at health centers and shortage of reagents

	strengthens national health commodity supply chain systems (USAID, 2022). Unfortunately, remote areas such as the east where conflict is still ongoing is a challenge in implementing this program.	partners' free medicines may result in the same product expiring on regional distribution center shelves.	and drugs hampered HIV testing and the diagnosis of TB/HIV co-infections (WHO & ENGAGE TB, 2021) The long distance between communities and health facilities remain a major challenge for the people involved in the WHO & ENGAGE TB (2021) intervention.
Financing	The health program of the USAID in the DRC advocates for increased government funding for health, as well as leveraging funds from other donors and developing innovative financing models to improve service delivery and utilization (USAID, 2022).	Most financial partners in DRC desire a certain performance level from the national system before funding the supply of medicines and at the same time the national system cannot improve its performance if it does not have access to these funds (McWilliams, 2020).	The health financing reform remains fragile as most financial partners in DRC desire a certain performance level from the national system before funding the supply of medicines and at the same time the national system cannot improve its performance if it does not have access to these funds (McWilliams, 2020).
Leadership/governance	The USAID support the Ministry of Health (MOH) reforms to streamline and decentralize the	The provision of technical and financial assistance for the development, implementation,	Communities are trained by the USAID's health program to identify and solve health-

| | monitoring and evaluations of annual operational plans at the provincial and local levels was implemented by the USAID health program (USAID, 2022). | related challenges using locally available resources (USAID, 2022). |
| public sector (USAID, 2022). | | |

5. References

ACTwatch Group. (2016). DRC Outlet Survey Results 2015. ACTwatch Research Brief. http://www.actwatch.info/sites/default/files/content/publications/attachments/DRC_OS%20 2015_Brief.pdf

ACTwatch Group, Newton, P. N., Hanson, K., & Goodman, C. (2-017). Do anti-malarials in Africa meet quality standards? The market penetration of non quality-assured artemisinin combination therapy in eight African countries. Malaria Journal, 16(1), 204. https://doi.org/10.1186/s12936-017-1818-8

Ahmad, K. (2004). Antidepressants are sold as antiretrovirals in DR Congo. Lancet, 363(9410), 713. https://doi.org/10.1016/S0140-6736(04)15670-5

Apanga, P. A., Kumbeni, M. T., & Chanase, M. A. W. (2022). The Association Between Early Antenatal Care and Intermittent Preventive Treatment of Malaria in Pregnancy in Sub-Saharan Africa: Effect Modification by Planned Pregnancy Status. Annals of Global Health, 88(1), 1–12. https://doi.org/10.5334/aogh.3550

Baduru, J., Ketha, J., Nzanzu, A., Maliro, J., Mukokole, J., Sikakulya, F., Kalima, N., Maliro, J., Mukokole, J., & Sikakulya, F. (2018). Epidemiology of Tuberculosis and HIV Co-Infection in Butembo, Democratic Republic of the Congo. Journal of Advances in Medicine and Medical Research, 27(5), 1–6. https://doi.org/10.9734/JAMMR/2018/41560

Bate, R., Jensen, P., Hess, K., Mooney, L., & Milligan, J. (2013). Substandard and falsified anti-tuberculosis drugs: A preliminary field analysis. International Journal of Tuberculosis and Lung Disease, 17(3), 308–311. https://doi.org/10.5588/IJTLD.12.0355

Becker-Dreps, S. I., Biddle, A. K., Pettifor, A., Musuamba, G., Imbie, D. N., Meshnick, S., & Behets, F. (2009). Cost-effectiveness of adding bed net distribution for malaria prevention to antenatal services in Kinshasa, Democratic Republic of the Congo. American Journal of Tropical Medicine and Hygiene, 81(3), 496–502. https://doi.org/10.4269/ajtmh.2009.81.496

Brooks, H. M., Paul, M. K. J., Claude, K. M., Mocanu, V., Hawkes, M. T., Jean Paul, M. K., Claude, K. M., Mocanu, V., & Hawkes, M. T. (2017). Use and disuse of malaria bed nets in an internally displaced persons camp in the Democratic Republic of the Congo: A mixed-methods study. PLOS ONE, 12(9), e0185290. https://doi.org/10.1371/journal.pone.0185290

Carlos, S., Ángel Martínez-González, M., Burgueño, E., Burgo, C. L. Del, Ruíz-Canela, M., Ndarabu, A., Tshilolo, L., Tshiswaka, P., Labarga, P., & De Irala, J. (2015). Misconceptions about HIV infection in Kinshasa (Democratic Republic of Congo): A case-control study on

knowledge, attitudes and practices. Sexually Transmitted Infections, 91(5), 334–337. https://doi.org/10.1136/sextrans-2014-051734

Carrel, M., Janko, M., Mwandagalirwa, M. K., Morgan, C., Fwamba, F., Muwonga, J., Tshefu, A. K., Meshnick, S., & Emch, M. (2016). Changing spatial patterns and increasing rurality of HIV prevalence in the Democratic Republic of the Congo between 2007 and 2013. Health and Place, 39, 79–85. https://doi.org/10.1016/j.healthplace.2016.02.009

Carrel, M., Kim, S., Mwandagalirwa, M. K., Mvuama, N., Bala, J. A., Nkalani, M., Kihuma, G., Atibu, J., Diallo, A. O., Goel, V., Thwai, K. L., Juliano, J. J., Emch, M., Tshefu, A., & Parr, J. B. (2021). Individual, household and neighborhood risk factors for malaria in the Democratic Republic of the Congo support new approaches to programmatic intervention. Health & Place, 70(May), 102581. https://doi.org/10.1016/j.healthplace.2021.102581

CASS. (2020). The impacts of the COVID-19 outbreak response on women and girls in the Democratic Republic of the Congo.pdf. Cellule d'Analyse en Sciences Sociales. https://www.unicef.org/drcongo/en/reports/impacts-COVID19-response-women-girls-DRC

CDC. (2020). What to Know About HIV and COVID-19. https://www.cdc.gov/coronavirus/2019-ncov/specific-groups/hiv.html

CDC. (2021a). Country Profile: Democratic Republic of the Congo. https://www.cdc.gov/globalhivtb/where-we-work/drc/drc.html

CDC. (2021b). History of Ebola Virus (EVD) Outbreaks. https://www.cdc.gov/vhf/ebola/history/chronology.html#:~:text=On November 18%2C 2020%2C the,announced the outbreak was over.&text=The DRC government declared its,Kivu provinces%2C and in Uganda.

Cohen, J. L., Leslie, H. H., Saran, I., & Fink, G. (2020). Quality of clinical management of children diagnosed with malaria: A cross-sectional assessment in 9 sub-Saharan African countries between 2007–2018. PLOS Medicine, 17(9), e1003254. https://doi.org/10.1371/journal.pmed.1003254

Cordaid. (2019). Global Goal to End Tuberculosis Needs More Support and Funding. https://www.cordaid.org/en/news/global-goal-end-tuberculosis-needs-more-support/

Cordaid. (2020). Fighting HIV and TB in the Democratic Republic of Congo. https://www.cordaid.org/en/fighting-hiv-tb-in-drc/

Deutsch-Feldman, M., Brazeau, N. F., Parr, J. B., Thwai, K. L., Muwonga, J., Kashamuka, M., Tshefu Kitoto, A., Aydemir, O., Bailey, J. A., Edwards, J. K., Verity, R., Emch, M., Gower, E. W., Juliano, J. J., & Meshnick, S. R. (2020). Spatial and epidemiological drivers of Plasmodium falciparum malaria among adults in the Democratic Republic of the Congo. BMJ Global Health, 5(6), e002316. https://doi.org/10.1136/bmjgh-2020-002316

Deutsch-Feldman, M., Parr, J. B., Keeler, C., Brazeau, N. F., Goel, V., Emch, M., Edwards, J. K., Kashamuka, M., Tshefu, A. K., & Meshnick, S. R. (2021). The Burden of Malaria in the Democratic Republic of the Congo. The Journal of Infectious Diseases, 223(11), 1948–1952. https://doi.org/10.1093/infdis/jiaa650

DHS. (2008). Congo Democratic Republic DHS, 2007 - HIV Fact Sheet. https://dhsprogram.com/publications/publication-hf25-hiv-fact-sheets.cfm?csSearch=444507_1

DHS. (2014). Prévalence du VIH en République Démocratique du Congo : résultats de l'EDS-RDC II 2013-2014. https://dhsprogram.com/publications/publication-HF55-HIV-Fact-Sheets.cfm

Dolan, C. B., BenYishay, A., Grépin, K. A., Tanner, J. C., Kimmel, A. D., Wheeler, D. C., & McCord, G. C. (2019). The impact of an insecticide treated bednet campaign on all-cause child mortality: A geospatial impact evaluation from the Democratic Republic of Congo. PLOS ONE, 14(2), e0212890. https://doi.org/10.1371/journal.pone.0212890

dos Santos, F. O. (2021). Myths and Misconceptions on Covid-19: "Congo Check" and "Talato" Verification Experiences. Frontiers in Communication, 6, 1–21. https://doi.org/10.3389/fcomm.2021.627214

Elizabeth Glase Pediatric AIDS Foundation. (2018). The Democratic Republic of Congo Program (Issue September 2018). https://pedaids.org/wp-content/uploads/2018/01/2021-DRC.pdf

Elizabeth Glaser Pediatric AIDS Foundation. (2022). Integrated HIV/AIDS project - Kinshasa. https://www.pedaids.org/project/integrated-hivaids-project-kinshasa-ihap-kinshasa/

Emina, J. B. O. O., Doctor, H. V., & Yé, Y. (2021). Profiling malaria infection among under-five children in the Democratic Republic of Congo. PLOS ONE, 16(5), e0250550. https://doi.org/10.1371/journal.pone.0250550

Falzon, D., Mirzayev, F., Wares, F., Baena, G., Zignol, M., Linh, N., Weyer, K., Jaramillo, E., Floyd, K., & Raviglione, M. (2015). Multidrug-resistant tuberculosis around the world: what progress has been made? Eur Respir J, 45, 150–160. https://doi.org/10.1183/09031936.00101814

Ferrari, G., Ntuku, H. M., Schmidlin, S., Diboulo, E., Tshefu, A. K., & Lengeler, C. (2016). A malaria risk map of Kinshasa, Democratic Republic of Congo. Malaria Journal, 15(1), 27. https://doi.org/10.1186/s12936-015-1074-8

FHI 360. (2020). Mitigating the Impact of COVID-19 on HIV Programs: Practical Considerations for Community Based Providers. https://www.fhi360.org/sites/default/files/media/documents/epic-kp-strategic-considerations-covid-19.pdf

Gill, M. M., Ditekemena, J., Loando, A., Mbonze, N., Bakualufu, J., Machekano, R., Nyombe, C., Temmerman, M., & Fwamba, F. (2018). Addressing Early Retention in Antenatal Care Among HIV-Positive Women Through a Simple Intervention in Kinshasa, DRC: The Elombe "Champion" Standard Operating Procedure. AIDS and Behavior, 22(3), 860–866. https://doi.org/10.1007/s10461-017-1770-1

Global HIV Prevention Coalition. (2020). Preventing HIV infections at the time of a new pandemic. https://www.unaids.org/en/resources/documents/2021/20210701_HIVPrevention_new_pandemic

Hamers, R. L., Rinke de Wit, T. F., & Holmes, C. B. (2018). HIV drug resistance in low-income and middle-income countries. The Lancet. HIV, 5(10), e588–e596. https://doi.org/10.1016/S2352-3018(18)30173-5

Hogan, A. B., Jewell, B. L., Sherrard-Smith, E., Vesga, J. F., Watson, O. J., Whittaker, C., Hamlet, A., Smith, J. A., Winskill, P., Verity, R., Baguelin, M., Lees, J. A., Whittles, L. K., Ainslie, K. E. C., Bhatt, S., Boonyasiri, A., Brazeau, N. F., Cattarino, L., Cooper, L. V, … Hallett, T. B. (2020). Potential impact of the COVID-19 pandemic on HIV, tuberculosis, and

malaria in low-income and middle-income countries: a modelling study. The Lancet Global Health, 8(9), e1132–e1141. https://doi.org/10.1016/S2214-109X(20)30288-6

ICAP. (2022). Democratic Republic of the Congo - ICAP Global Health. https://icap.columbia.edu/where-we-work/democratic-republic-of-the-congo/

Jacques, M., Mahamane Salissou, M., Kaswiyi, L., Guan, F., & Lei, J. (2020). Co-infection of malaria and HIV infection in severely undernourished children in the Democratic Republic of the Congo: a cross-sectional study. Parasitology, 147(2), 248–253. https://doi.org/10.1017/S0031182019001513

Janko, M. M., Irish, S. R., Reich, B. J., Peterson, M., Doctor, S. M., Mwandagalirwa, M. K., Likwela, J. L., Tshefu, A. K., Meshnick, S. R., & Emch, M. E. (2018). The links between agriculture, Anopheles mosquitoes, and malaria risk in children younger than 5 years in the Democratic Republic of the Congo: a population-based, cross-sectional, spatial study. The Lancet Planetary Health, 2(2), e74–e82. https://doi.org/10.1016/S2542-5196(18)30009-3

JICA. (2017). Country Gender Profile: Democratic Republic of the Congo: Final Report. https://www.jica.go.jp/english/our_work/thematic_issues/gender/background/c8h0vm0000a njqj6-att/drc_2017.pdf

Kakisingi, C., Muteba, M., Mukuku, O., Kyabu, V., Ngwej, K., Kajimb, P., Manika, M., Situakibanza, H., Mwamba, C., & Ngwej, D. (2020). Prevalence and characteristics of HIV infection among female sex workers in Lubumbashi, Democratic Republic of Congo. Pan African Medical Journal, 36. https://doi.org/10.11604/pamj.2020.36.280.21378

Kalonji, G. M. P., Connick, G. De, Ngongo, L. O., Nsaka, D. K., Kabengele, T., Kandolo, F., Ilunga-Ilunga, F., Adelin, A., & Giet, D. (2016). Prevalence of tuberculosis and associated risk factors in the central prison of Mbuji-Mayi, DEmocratic republic of Congo. Tropical Medicine and Health, 44(1), 1–6. https://doi.org/10.1186/s41182-016-0030-9

Kamangu, E. N., Chatte, A., Susin, F., Boreux, R., & Kalala, R. L. (2013). Genetic Diversity and Antiretroviral Drug Resistance among Drug-Naïve HIV Type 1 Infected Patients attending Clinics in Kinshasa, Democratic Republic of Congo. https://doi.org/10.16966/2380

Karemere, J., Nana, I. G., Andrada, A., Kakesa, O., Mukomena Sompwe, E., Likwela Losimba, J., Emina, J., Sadou, A., Humes, M., & Yé, Y. (2021). Associating the scale-up of insecticide-treated nets and use with the decline in all-cause child mortality in the Democratic Republic of Congo from 2005 to 2014. Malaria Journal, 20(1), 241. https://doi.org/10.1186/s12936-021-03771-6

Kaswa, M. K., Bisuta, S., Kabuya, G., Lunguya, O., & Ndongosieme, A. (2014). Multi Drug Resistant Tuberculosis in Mosango, a Rural Area in the Democratic Republic of Congo. PLoS ONE, 9(4), 94618. https://doi.org/10.1371/journal.pone.0094618

Kayiba, N. K., Yobi, D. M., Tchakounang, V. R. K., Mvumbi, D. M., Kabututu, P. Z., Devleesschauwer, B., Mukomena, E. S., DeMol, P., Hayette, M.-P. P., Mvumbi, G. L., Rosas-Aguirre, A., Lusamba, P. D., & Speybroeck, N. (2021). Evaluation of the usefulness of intermittent preventive treatment of malaria in pregnancy with sulfadoxine-pyrimethamine in a context with increased resistance of Plasmodium falciparum in Kingasani Hospital, Kinshasa in the Democratic Republic of Congo. Infection, Genetics and Evolution, 94(December 2020), 105009. https://doi.org/10.1016/j.meegid.2021.105009

Kayomo, M. K., Mbula, V. N., Aloni, M., André, E., Rigouts, L., Boutachkourt, F., De Jong, B. C., Nkiere, N. M., & Dean, A. S. (2020). Targeted next-generation sequencing of sputum for

diagnosis of drug-resistant tB: results of a national survey in Democratic Republic of the congo. Scientific Reports, 10. https://doi.org/10.1038/s41598-020-67479-4

Kokolomami, J. H. T., & Kayembe, P. K. (2018). HIV / AIDS Epidemic in the Democratic Republic of the Congo: Current Level of Key Indicators and Projection by 2030. Central African Journal of Public Health, 4(3), 86. https://doi.org/10.11648/j.cajph.20180403.16

Landu, D. J. M., Frédérich, M., Kuwekita, J. M., Nswe, C. B. P., Mbinze, J. K., Liégeois, S., Tshilombo, N. K., Minga, M. K., Hamuli, P. C., Hubert, P., & Djang'Eing'A, R. M. (2020). Quality of antimalarials in Kinshasa peri-urban areas with regard to local pharmaceutical legislation and regulation. International Health, 12(4), 253–263. https://doi.org/10.1093/INTHEALTH/IHZ070

Lechthaler, F., Matthys, B., Lechthaler-Felber, G., Likwela, J. L., Mavoko, H. M., Rika, J. M., Mutombo, M. M., Ruckstuhl, L., Barczyk, J., Shargie, E., Prytherch, H., & Lengeler, C. (2019). Trends in reported malaria cases and the effects of malaria control in the Democratic Republic of the Congo. PLOS ONE, 14(7), e0219853. https://doi.org/10.1371/journal.pone.0219853

Lengeler, C. (2004). Insecticide-treated bed nets and curtains for preventing malaria. Cochrane Database of Systematic Reviews, 2. https://doi.org/10.1002/14651858.CD000363.pub2

Linguissi, L. S. G., Gwom, L. C., Nkenfou, C. N., Bates, M., Petersen, E., Zumla, A., & Ntoumi, F. (2017). Health systems in the Republic of Congo: challenges and opportunities for implementing tuberculosis and HIV collaborative service, research, and training activities. Internatinal Journal of Infectious Diseases, 56. https://reader.elsevier.com/reader/sd/pii/S1201971216311961?token=A47244334823EF6071F269376D71DDC777CFE2378E19DE3C6C633C0A445D7013E1A763CC29A110B6CB96F5CAB9585EC3&originRegion=eu-west-1&originCreation=20220308114422

Loukia, A., Joseph, S. D., Zacharie, K., Gertrude, L., Kapay, K., & Patrick, K. K. (2016). Trends in Tuberculosis Epidemiology among Children in the Democratic Republic of Congo. Journal of Tuberculosis Research, 04(04), 235–248. https://doi.org/10.4236/JTR.2016.44026

Lugova, H., Samad, N., & Haque, M. (2020). Sexual and gender-based violence among refugees and internally displaced persons in the democratic republic of the congo: Post-conflict scenario. Risk Management and Healthcare Policy, 13, 2937–2948. https://doi.org/10.2147/RMHP.S283698

Lussy, J. P., Dube, A., Lusi, J. K. M., Kikoli, A. M., Mukekulu, E. K., & Bartels, S. A. (2021). Trends in sexual violence patterns and case management: a sex disaggregated analysis in Goma, Democratic Republic of Congo. Conflict and Health, 15(1), 1–9. https://doi.org/10.1186/s13031-021-00398-x

Ma, C., Claude, K. M., Kibendelwa, Z. T., Brooks, H., Zheng, X., & Hawkes, M. (2017). Is maternal education a social vaccine for childhood malaria infection? A cross-sectional study from war-torn Democratic Republic of Congo. Pathogens and Global Health, 111(2), 98–106. https://doi.org/10.1080/20477724.2017.1288971

Mahittikorn, A., Kotepui, K. U., De Jesus Milanez, G., Masangkay, F. R., & Kotepui, M. (2021). A meta-analysis on the prevalence and characteristics of severe malaria in patients with Plasmodium spp. and HIV co-infection. Scientific Reports, 11(1), 16655. https://doi.org/10.1038/s41598-021-95591-6

Management Sciences for Health. (2018). Empowerment Builds Capacity for Stronger, Healthier Communities: Final Report of the Integrated Health Project Plus. https://www.msh.org/sites/default/files/ihpplus_eop_finalreport.pdf

McWilliams, S. (2020). Healthcare in the Democratic Republic of the Congo - The Borgen Project. https://borgenproject.org/democratic-republic-healthcare/

Mitchell, C. L., Janko, M. M., Mwandagalirwa, M. K., Tshefu, A. K., Edwards, J. K., Pence, B. W., Juliano, J. J., & Emch, M. (2022). Impact of extractive industries on malaria prevalence in the Democratic Republic of the Congo: a population-based cross-sectional study. Scientific Reports, 12(1), 1737. https://doi.org/10.1038/s41598-022-05777-9

Mukuku, O., Mutombo, A. M., Kakisingi, C. N., Musung, J. M., Wembonyama, S. O., & Luboya, O. N. (2019). Tuberculosis and HIV co-infection in Congolese children: risk factors of death. The Pan African Medical Journal, 33, 326. https://doi.org/10.11604/pamj.2019.33.326.18911

Murhula, I. K., Mawete, F., Ofali, L., Kaswa, M., Bompeka, F. L., Ntumba, J. M. K., & Munogolo, Z. K. (2019). Low Detection Rate of Multidrug-Resistant and Rifampicin-Resistant Tuberculosis in the Democratic Republic of Congo: Trend Analysis 2013-2017. Journal of Tuberculosis Research, 07(04), 212–219. https://doi.org/10.4236/jtr.2019.74020

Muwonga, J., Edidi, S., Butel, C., Vidal, N., Monleau, M., Okenge, A., Mandjo, J. L., Mukumbi, H., Muyembe, J. J., Mbayo, F., Nzongola, D. K., Delaporte, E., Boillot, F., & Peeters, M. (2011). Resistance to antiretroviral drugs in treated and drug-naive patients in the democratic Republic of Congo. Journal of Acquired Immune Deficiency Syndromes, 57(SUPPL. 1), 27–33. https://doi.org/10.1097/QAI.0b013e31821f596c

Mwandagalirwa, M. K., Levitz, L., Thwai, K. L., Parr, J. B., Goel, V., Janko, M., Tshefu, A., Emch, M., Meshnick, S. R., & Carrel, M. (2017). Individual and household characteristics of persons with Plasmodium falciparum malaria in sites with varying endemicities in Kinshasa Province, Democratic Republic of the Congo. Malaria Journal, 16(1), 456. https://doi.org/10.1186/s12936-017-2110-7

Ngatu, N. R., Kanbara, S., Renzaho, A., Wumba, R., Mbelambela, E. P., Muchanga, S. M. J. J., Muzembo, B. A., Leon-Kabamba, N., Nattadech, C., Suzuki, T., Oscar-Luboya, N., Wada, K., Ikeda, M., Nojima, S., Sugishita, T., & Ikeda, S. (2019). Environmental and sociodemographic factors associated with household malaria burden in the Congo. Malaria Journal, 18(1), 53. https://doi.org/10.1186/s12936-019-2679-0

Ngatu, N. R., Muzembo, B. A., Choomplang, N., Kanbara, S., Wumba, R., Ikeda, M., Mbelambela, E. P., Muchanga, S. M.-J. J., Suzuki, T., Wada, K., Al Mahfuz, H., Sugishita, T., Miyazaki, H., Ikeda, S., & Hirao, T. (2021). Malaria rapid diagnostic test (HRP2/pLDH) positivity, incidence, care accessibility and impact of community WASH Action programme in DR Congo: mixed method study involving 625 households. Malaria Journal, 20(1), 117. https://doi.org/10.1186/s12936-021-03647-9

Nkoli Mandoko, P., Rouvier, F., Matendo Kakina, L., Moke Mbongi, D., Latour, C., Losimba Likwela, J., Ngoyi Mumba, D., Bi Shamamba, S. K., Tamfum Muyembe, J.-J., Muepu Tshilolo, L., Parzy, D., Sinou, V., Mandoko, P. N., Rouvier, F., Kakina, L. M., Mbongi, D. M., Latour, C., Likwela, J. L., Mumba, D. N., … Sinou, V. (2018). Prevalence of Plasmodium falciparum parasites resistant to sulfadoxine/pyrimethamine in the Democratic Republic of the Congo: emergence of highly resistant pfdhfr/pfdhps alleles. Journal of Antimicrobial Chemotherapy, 73(10), 2704–2715. https://doi.org/10.1093/jac/dky258

Ntamabyaliro, N. Y., Burri, C., Nzolo, D. B., Engo, A. B., Lula, Y. N., Mampunza, S. M., Nsibu, C. N., Mesia, G. K., Kayembe, J.-M. N. M. N. M. N., Likwela, J. L., Kintaudi, L. M., & Tona, G. L. (2018). Drug use in the management of uncomplicated malaria in public health facilities in the Democratic Republic of the Congo. Malaria Journal, 17(1), 189. https://doi.org/10.1186/s12936-018-2332-3

Otuli Noël, L., Nguma Jean-Didier, B., Alongo Mike-Antoine, M., Bosunga Gedeon, K., Mukonkole Jean-Paulin, M., Likwela Joris, L., & Okenge Jean-Pascal, M. (2020). Prevalence of Congenital Malaria in Kisangani, A Stable Malaria Transmission Area in Democratic Republic of the Congo. Infectious Diseases in Obstetrics and Gynecology, 2020, 1–7. https://doi.org/10.1155/2020/2176140

Parr, J. B., Verity, R., Doctor, S. M., Janko, M., Carey-Ewend, K., Turman, B. J., Keeler, C., Slater, H. C., Whitesell, A. N., Mwandagalirwa, K., Ghani, A. C., Likwela, J. L., Tshefu, A. K., Emch, M., Juliano, J. J., & Meshnick, S. R. (2017). Pfhrp2 -Deleted Plasmodium falciparum Parasites in the Democratic Republic of the Congo: A National Cross-sectional Survey. Journal of Infectious Diseases, 216(1), 36–44. https://doi.org/10.1093/infdis/jiw538

PEPFAR. (2017). Democratic Republic of the Congo Country Operational Plan (COP) 2017 Strategic Direction Summary. https://copsdata.amfar.org/COPS/2017/Democratic%20Republic%20of%20the%20Congo.pdf

PEPFAR. (2020). Democratic Republic of the Congo: Country Operational Plan, (COP) 2020, Strategic Direction Summary. https://www.state.gov/wp-content/uploads/2020/07/COP-2020-DRC-SDS-FINAL.pdf

PEPFAR. (2021). Democratic Republic of the Congo Country Operational Plan (COP) 2021 Strategic Direction Summary. https://www.state.gov/wp-content/uploads/2021/09/DRC_SDS_Final-Public_Aug-11-2021.pdf

PMI. (2020). U.S. President's Malaria Initiative Democratic Republic of the Congo Malaria Operational Plan FFY 2020. http://files/287/fy-2020-democratic-republic-of-the-congo-malaria-operational-plan.pdf

Pour, M., James, L., Singh, K., Mampunza, S., Baer, F., Scott, J., Berg, M. G., Rodgers, M. A., Cloherty, G. A., Hackett Jr, J., & McArthur, C. P. (2020). Increased HIV in Greater Kinshasa Urban Health Zones: Democratic Republic of Congo (2017–2018). AIDS Research and Therapy, 17(1), 67. https://doi.org/10.1186/s12981-020-00322-y

Programme National de Lutte contre le paludisme. (2017). Rapport annuel des activités de Lutte contre le paludisme.

Programme National Multisectoriel de Lutte contre le Sida (PNMLS). (2017). Plan national stratégique de la reposte au VIH/SIDA 2018-2021 (PSN 2018- 2021). https://pnmls.cd/plan-strategique-national-de-la-riposte-au-vih-sida-2018-2021/

Rubio-Garrido, M., Id, G. R., Ndarabu, A., Rodriguez-Galet, A., Valadé S-Alcaraz, A., Barquín, D., Carlos, S., & Frica Holguín, A. ´. (2021). High drug resistance levels could compromise the control of HIV infection in paediatric and adolescent population in Kinshasa, the Democratic Republic of Congo. https://doi.org/10.1371/journal.pone.0248835

Shah, G. H., Ewetola, R., Etheredge, G., Maluantesa, L., Waterfield, K., Engetele, E., & Kilundu, A. (2021). Risk factors for tb/hiv coinfection and consequences for patient outcomes: Evidence from 241 clinics in the Democratic republic of Congo. International Journal of Environmental Research and Public Health, 18(10). https://doi.org/10.3390/ijerph18105165

Sikalengo, G., Hella, J., Mhimbira, F., Rutaihwa, L. K., Bani, F., Ndege, R., Sasamalo, M., Kamwela, L., Said, K., Mhalu, G., Mlacha, Y., Hatz, C., Knopp, S., Gagneux, S., Reither, K., Utzinger, J., Tanner, M., Letang, E., Weisser, M., & Fenner, L. (2018). Distinct clinical characteristics and helminth co-infections in adult tuberculosis patients from urban compared to rural Tanzania. Infectious Diseases of Poverty, 7(1), 1–12. https://doi.org/10.1186/S40249-018-0404-9/TABLES/4

Swana, E. K., Yav, T. I., Ngwej, L. M., Mupemba, B. N., Suprianto, Mukeng, C. K., Hattingh, I., Luboya, O. N., Kakoma, J.-B. B. S., & Bangs, M. J. (2018). School-based malaria prevalence: informative systematic surveillance measure to assess epidemiological impact of malaria control interventions in the Democratic Republic of the Congo. Malaria Journal, 17(1), 141. https://doi.org/10.1186/s12936-018-2297-2

The Global Fund. (2018). Scaling up Programs to Reduce Human Rights- Related Barriers to HIV and TB Services. https://www.theglobalfund.org/media/9782/crg_humanrightsbaselineassessmentdemocrati crepublicofcongo_report_en.pdf

The Global Fund. (2021). The impact of COVID-19 on HIV, TB and malaria services and systems for health: a snapshot from 502 health facilities'. The Global Fund to Fight AIDS, Malaria and Tuberculosis. https://www.theglobalfund.org/en/updates/other-updates/2021-04-13-the-impact-of-covid-19-on-hiv-tb-and-malaria-services-and-systems-for-health/

Tworek, J. (2018). Democratic Republic of the Congo: HIV/AIDS. 3. https://doi.org/10.1163/9789004430013_026

U.S. President's Malaria Initiative Democratic Republic of the Congo Malaria Operational Plan FY 2022. (2022). www.pmi.gov

UNAIDS. (2020). Country factsheets: Democratic Republic of the Congo 2020. UNAIDS. https://www.unaids.org/en/regionscountries/countries/democraticrepublicofthecongo

UNAIDS. (2021a). Analytic barometer on the HIV and AIDS response in the Democratic Republic of the Congo — Progress towards the 95-95-95 targets. https://www.unaids.org/sites/default/files/2021_RDC_barometre_en.pdf

UNAIDS. (2021b). Global AIDS Update 2021 - Confronting Inequalities: Lessons for pandemic response from 40 years of AIDS. https://www.unaids.org/en/resources/documents/2021/2021-global-aids-update

UNAIDS. (2021c). Monitoring HIV/TB services in the Democratic Republic of the Congo | UNAIDS. https://www.unaids.org/en/resources/presscentre/featurestories/2021/march/20210316_hiv-tb-services-democratic-republic-congo

UNICEF. (2018). MICS - Palu: The Democractic Republic of the Congo. https://www.unicef.org/drcongo/en/reports/mics-palu-2018

UNICEF. (2020). Democratic Republic of the Congo: Humanitaria Situation Report No.07. https://doi.org/10.1163/9789004430013_026

USAID. (2018). USAID/Democratic Republic of Congo Monitoring, Evaluation, and Coordination Contract Assessment of USAID/DRC Tuberculosis Portfolio. http://pdf.usaid.gov/pdf_docs/PA00WJ2Q.pdf

USAID. (2021a). Democratic Republic of Congo Tuberculosos Roadmap Overview, Fiscal Year 2021. https://www.usaid.gov/global-health/health-areas/tuberculosis/resources/news-and-updates/global-accelerator-end-tb/tb-roadmaps/drc

USAID. (2021b). Health Zone Improves TB Detection Rate in the Democratic Republic of the Congo. https://www.usaid.gov/global-health/health-areas/tuberculosis/resources/news-and-updates/global-accelerator-end-tb/stories/tb-detection-congo

USAID. (2021c). Malaria. https://www.usaid.gov/global-health/health-areas/malaria

USAID. (2022). Global Health: Democratic Republic of the Congo . https://www.usaid.gov/democratic-republic-congo/global-health

USAID, & MEASURE Evaluation. (2019). Lessons in Health Information System Strengthening: What Worked in the Democratic Republic of the Congo — MEASURE Evaluation. https://measureevaluation.org/resources/publications/wp-19-229.html

van Eijk, A. M., Larsen, D. A., Kayentao, K., Koshy, G., Slaughter, D. E. C. C., Roper, C., Okell, L. C., Desai, M., Gutman, J., Khairallah, C., Rogerson, S. J., Hopkins Sibley, C., Meshnick, S. R., Taylor, S. M., & ter Kuile, F. O. (2019). Effect of Plasmodium falciparum sulfadoxine-pyrimethamine resistance on the effectiveness of intermittent preventive therapy for malaria in pregnancy in Africa: a systematic review and meta-analysis. The Lancet Infectious Diseases, 19(5), 546–556. https://doi.org/10.1016/S1473-3099(18)30732-1

Verity, R., Aydemir, O., Brazeau, N. F., Watson, O. J., Hathaway, N. J., Mwandagalirwa, M. K., Marsh, P. W., Thwai, K., Fulton, T., Denton, M., Morgan, A. P., Parr, J. B., Tumwebaze, P. K., Conrad, M., Rosenthal, P. J., Ishengoma, D. S., Ngondi, J., Gutman, J., Mulenga, M., … Juliano, J. J. (2020). The impact of antimalarial resistance on the genetic structure of Plasmodium falciparum in the DRC. Nature Communications, 11(1), 2107. https://doi.org/10.1038/s41467-020-15779-8

Villabona-Arenas, C. J., Vidal, N., Guichet, E., Serrano, L., Delaporte, E., Gascuel, O., & Peeters, M. (2016). In-depth analysis of HIV-1 drug resistance mutations in HIV-infected individuals failing first-line regimens in West and Central Africa. Aids, 30(17), 2577–2589. https://doi.org/10.1097/QAD.0000000000001233

Wa Ilunga, E. N., Muya, R. K., Kaponda, A. A., Kaput, C. M. A., Kalonji, S. M., Chiribagula, V. B., Nshikala, B. N., N'sasi, A. N., & Simbi, J.-B. L. (2018). Prévalence de la co-infection VIH-tuberculose et impact du VIH sur les tuberculeux dans la zone de santé de Lubumbashi de 2014 à 2015. Revue de Pneumologie Clinique, 74(1), 9–15. https://doi.org/10.1016/j.pneumo.2017.12.002

Wat'senga, F., Manzambi, E. Z., Lunkula, A., Mulumbu, R., Mampangulu, T., Lobo, N., Hendershot, A., Fornadel, C., Jacob, D., Niang, M., Ntoya, F., Muyembe, T., Likwela, J., Irish, S. R., Oxborough, R. M., Wat'Senga, F., Manzambi, E. Z., Lunkula, A., Mulumbu, R., … Oxborough, R. M. (2018). Nationwide insecticide resistance status and biting behaviour of malaria vector species in the Democratic Republic of Congo. Malaria Journal, 17(1), 129. https://doi.org/10.1186/s12936-018-2285-6

Whembolua, G.-L. S., Muvuka, B., Tshiswaka, D. I., & Conserve, D. F. (2019). Socio-Structural Factors Influencing the Prevention of Mother-to-Child Transmission of HIV in the Democratic Republic of the Congo: A Systematic Review. Maternal and Child Health Journal, 23(7), 880–889. https://doi.org/10.1007/s10995-018-2688-6

WHO. (n.d.). Antimicrobial Resistance. https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance

WHO. (2018a). Malaria control campaign launched in Democratic Republic of the Congo to save lives and aid Ebola Response. https://www.afro.who.int/news/malaria-control-campaign-launched-democratic-republic-congo-save-lives-and-aid-ebola-response

WHO. (2018b). Global Tuberculosis Report 2018. World Health Organization. https://www.who.int/tb/publications/global_report/gtbr2018_main_text_28Feb2019.pdf

WHO. (2020). World Malaria Report 2020. World Health Organization. https://www.who.int/publications-detail-redirect/9789240015791

WHO. (2021a). HIV drug resistance report 2021. https://www.who.int/publications-detail-redirect/9789240038608

WHO. (2021b). Global Tuberculosis Report 2021. World Health Organization. https://apps.who.int/iris/handle/10665/352200

WHO. (2021c). World Malaria Report 2021. World Health Organization. https://apps.who.int/iris/handle/10665/350147

WHO, & ENGAGE TB. (2021). Democratic Republic of the Congo - Integrating tuberculosis screening into community-based HIV activities. https://www.who.int/publications/m/item/democratic-republic-of-the-congo-integrating-tuberculosis-screening-into-community-based-hiv-activities

Yobi, D. M., Kayiba, N. K., Mvumbi, D. M., Boreux, R., Kabututu, P. Z., Akilimali, P. Z., Situakibanza, H. N. T. T., De Mol, P., Speybroeck, N., Mvumbi, G. L., & Hayette, M.-P. P. (2022). Biennial surveillance of Plasmodium falciparum anti-malarial drug resistance markers in Democratic Republic of Congo, 2017 and 2019. BMC Infectious Diseases, 22(1), 145. https://doi.org/10.1186/s12879-022-07112-z

Suggested citation

About this report

This report is based on nine days of desk-based research. The K4D research helpdesk provides rapid syntheses of a selection of recent relevant literature and international expert thinking in response to specific questions relating to international development. For any enquiries, contact helpdesk@k4d.info.

K4D services are provided by a consortium of leading organisations working in international development, led by the Institute of Development Studies (IDS), with the Education Development Trust, Itad, University of Leeds Nuffield Centre for International Health and Development, Liverpool School of Tropical Medicine (LSTM), University of Birmingham International Development Department (IDD) and the University of Manchester Humanitarian and Conflict Response Institute (HCRI).